6th *International Conference on*

"Agricultural Innovations for Sustainable Development Goals with Special Focus on Natural Farming"

(AISDGONF-2023)

BOOK OF ABSTRACT

September 30
to
October 02
2023

CROP AND WEED SCIENCE SOCIETY
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Organized by

Crop and Weed Science Society (CWSS)

at Farmer's Academy & Convention Centre (FACC), BCKV
Kalyani, Nadia, West Bengal, India

6th CWSS

International Conference

ON

Agricultural Innovations for Sustainable Development Goals with Special Focus on Natural Farming (AISDGONF-2023)

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6th CWSS
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Agricultural Innovations for Sustainable Development Goals with Special Focus on Natural Farming
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An estimated 9.8 billion populations by 2050 will require food, fuel, fibre, flowers, livestock, fish and dairy products, production of which must be ensured. Additionally, the climatic risks and weather unpredictability are being intensified, making the situation more troublesome for the crop production. The biosphere is becoming fragile due to the ethical and sustainability trade-offs present in today's livelihood options in agriculture and related businesses. Therefore, there is a need for increasing production, lowering costs, and ensuring better use of energy and natural resources, besides achieving Sustainable Development Goals (SDGs) and augmenting farm income.

Natural Farming (NF) is a chemical-free agroecology based diversified farming system which integrates crops, trees and livestock with functional biodiversity. NF in recent years is being aimed at promoting traditional indigenous practices which reduces externally purchased inputs. Farmers across the globe are already practicing the regenerative agriculture in the form of either organic farming or natural farming. NF, being a cost-effective and ecologically compatible alternative, would be a catalyst in achieving the SDGs. The NF would ensure food security and zero hunger through better yield, diversity in cropping and access to nutritional sources and income-generating crops throughout the year.

The water-conservation and ecological preservation aspects of NF contribute to the availability and sustainable management of water and reduction of CO2 emissions in various stages of agriculture. NF would ensure good health in the community through prevention of land degradation, reduction of ocean acidification and marine pollution from land-based activities. Although innovations are in the works and industry is working to increase profits through agriculture and related activities, research still holds potential, and farmers are unable to adopt an entrepreneurial mindset due to their current level of expertise.

Agriculture no longer enjoys the same level of credit it once did, and this is due to industry enjoying less convergence with the present farm produce. This is due to countries signing global reforms and poorer nations experiencing subsidy withdrawals. Increasing employment opportunities and opening up the market are additional ways to find credit solutions. The main problem is attitude and enterprise composition, which can only be solved by enhancing farmers' ability in order to create a more sustainable, lucrative agricultural product basket that will

be appealing to the market. In the new era of skillfulness, there is a need for more collaboration among industry, the government and educational institutions. The academic community has a new responsibility to support this scenario by recognizing prospective advances in various arenas pertaining to agriculture from their research repositories that will make the entire process easier.

In this back drop, the **Crop & Weed Science Society** is going to host the **International Conference on "Agricultural Innovations for Sustainable Development Goals with Special Focus on Natural Farming"** (**AISDGONF-2023**) in the following thematic areas in order to fulfill the responsibility and provide an appropriate response to the future.

Major Thematic Areas:

A. Technology outreach and agri-trade for convergence of farm with institute, industries and policy makers

B. Frontier areas in crop production and natural resource management with special reference to Natural Farming

C. Horticulture as a growth engine in achieving sustainable developmental goals

D. Advances in crop improvement, biotechnological approaches and biotic & abiotic stress management

E. Role of farm mechanization, IT, bioinformatics, postharvest technology, big data management in agriculture, livestock farming, fisheries, sericulture, apiculture etc.

Date:	**Prof. R. K. Ghosh**	**Prof. A. K. Basu**	**Dr. Kusal Roy**
30.09.2023	**President**	**Secretary**	**Convenor**
	Organizing Committee, AISDGONF-23	**Organizing Committee, AISDGONF-23**	**Technical Committee, AISDGONF-23**

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Theme-B: Frontier areas in crop production and natural resource management with special reference to Natural Farming

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THEME - A

Technology outreach and agri-trade for convergence of farm with institute, industries and policy makers

AISDGONF/ABS/TA/1

Understanding farmers' perception about covid-19 pandemic in relation to social and livelihood perspective: A study in Jhargram district of West Bengal

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Novel Corona virus, named by World health Organization (WHO) as Corona Virus Disease-19 (COVID-19), is most known name to all over the world for its devastating effect. Agriculture is one of the sectors most affected by the pandemic. There is a need to understand location-specific farmers' perception and adaptation strategies during post covid period. With an objective to know the extent of farmers' perception about the COVID-19 pandemic and their adaptation strategies, a study has been carried out in the Karatshole village of Jhargram district of West Bengal. A set of questions were prepared and responses were collected from them. Farmers' perception about the effect of COVID-19 in their daily life and livelihood activities are medium to high score range. Daily works were hampered, job scope was limited and many more difficulties were identified. There is positive & significant correlation of educational level, mass media exposure, communication with different departments, movement, and health awareness with farmers' perception about the COVID-19. Most of the respondents follow more or less adaptation strategies like use of digital media in different mode, shifting of livelihood, development of local value chain etc. Respondents stopped all social movements and the recreation. The result showed that farmers' perceived prevalence of corona virus and its pandemic effect by the facts like livelihood problems, restricted movements etc. It is necessary to assist them by allowing critical agricultural activities, filling in gaps in agricultural supply chains and ensuring farmer's ease for the smooth functioning of the backbone of our economy.

AISDGONF/ABS/TA/2

Increase in farmers' income through FPO-led marketing of maize in Davanagere District of Karnataka

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The study was undertaken to assess the impact of FPO-led maize marketing on Farmers' income. Primary data was collected from two taluks in Davanagere district of Karnataka. Cost of cultivation, net income, B:C ratio and market efficiency was calculated and compared among different channels. The shift in area and production of maize from northern traditional maize-growing states to southern states was found over the last three decades in both share and growth rate. West Bengal, Tamil Nadu and Maharashtra showed considerable growth rates in the area, production, and productivity. In Karnataka Hassan, Shivamogga are coming into the limelight with a considerable growth rate in the last two decades. The growth rate in exports of maize from 2001-2020 was found to be 8.1 per cent in quantity and 27.7 per cent in export value. In the last decade, export showed a negative trend. Corn starch has the maximum share in maize grain export. The

price of maize in major maize-growing states showed increasing trends. Telangana and Chhattisgarh have shown considerable growth rates with stable prices comparatively. Regression adjustment model was used to compare effect of FPO-led marketing with traditional market channels. Among three channels, Channel III (FPO-led marketing) showed B:C ratio of 2.17and market efficiency of 1.7. Farmers' following channel III received 6307 ₹/ha more net income than other channels. Binary logit regression model revealed inverse relationship between distance of FPO and farmers undertaking FPO-led marketing.

AISDGONF/ABS/TA/3

Determinants of agricultural credit access by kharif rice growers in Dakshin Dinajpur district, West Bengal- An empirical analysis

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Access to agricultural credit plays a vital role for growth and development of agricultural sector in India, hence financing agriculture is an important issue in rural development. Adequate access to credit has the potential to impact technology adoption, by improving agricultural productivity and sustainable agricultural intensification. Agriculture in West Bengal is the primary source of livelihood for majority of the population of the state living in villages with above 90 per cent as small and marginal farmers. There is no further scope of horizontal expansion of area under rice cultivation in the state. The only way to sustain production to meet the demand of increasing population of the state is either to increase the productivity or increasing area under hybrid rice cultivation. Agricultural credit acts as catalyst in production. The increasing flow of agricultural credit results in improving productivity. Various socio-economic factors played significant role in accessing agricultural credit from various sources (formal and informal sector). To meet the objective, primary data using pre tested structured schedule through personal interview were collected from 200 respondents through multistage random sampling technique. A binary logistic regression model was used to analyze the influence of smallholder farmer's socio-economic characteristics in accessing credit. Age of the respondent, size of landholdings, institutional membership, credit awareness and prevailing interest rates are the determining factors for accessing the farm credit among rice farmers in the district. The study recommends the interventions in enhancing credit awareness and reduction in interest rates.

AISDGONF/ABS/TA/7

Income of agricultural households in Coochbehar district of West Bengal in India

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A study was conducted in Cooch Behar district of West Bengal. Primary data were collected from 50 sample farmers which were selected by simple random sampling without replacement from 348 agricultural households of Cooch Behar-II block of the district. Crop wise net return was estimated

from gross return and Cost C. Tabular method of analysis was extensively used in this study. A multiple regression analysis with explanatory variables was also attempted in this study. Household income was considered dependent variable in the analysis. The results indicated a positive relationship between average size of earners and average size of family. Household income was found to come from different sources, e.g. crop production, livestock enterprises, non-farm occupations and investments. In crop production the highest net return per hectare was accrued from banana. The other non- food grain crops generating net returns per hectare in descending order were garlic, ridge gourd, bitter gourd, water melon, wax gourd, cucumber, potato, radish, pointed gourd, chilli, beat and jute. Among the food grain crops the highest net return was accrued from lentil. Among fruit crops banana yielded the highest net return. Average income per household from crop production was found to increase across the larger size classes of farms. Household income earned from dairy was found to decline across larger size classes. As a whole, income earned from this source accounted for 24.25 per cent of the total household income. Percentage contribution of income earned from poultry farming and goat rearing were observed to be low. Income earned from crop production was found to influence the distribution of farm income among the households in different size classes. As a whole farm income generated 87.86 per cent income of the total household income. Non- farm income accounted for 12.14 per cent of the household income with wide differences among the size classes. Similarly wide disparities in average income per earner and per capita income were observed in different size classes. Among the factors taken for multiple regression analysis the size of agricultural holding, cropped area under vegetables and non- farm income were found to significantly influence the level of household income.

AISDGONF /ABS/TA/45

A study on the behaviour of prices and market arrivals of onion in West Bengal

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Price fluctuation of agricultural commodities is a common phenomenon due to their seasonal nature of production. So, there is a need to have a proper understanding of the inter-relationship between market arrivals and prices of farm products for formulating a sound agricultural price policy for price stabilization. The present study has been designed to examine the seasonal price movement in relation to market arrivals of onion in some selected markets of the state of West Bengal. The data on market arrivals and price of onion across the districts pertaining to the period of 2014-15 to 2019-20 (a period of 60 months) forms the basis of the present study. Relevant secondary data are collected from Agmark website (https://agmarknet.gov.in/) published by Govt. of India. ARIMA, SARIMA and GARCH have been employed to know the volatility status of the prices and arrivals of onion. For price, SARIMA (0,1,1) (1,0,0) $_{[12]}$ follows only for Bishnupur market and ARIMA (1,1,0) follows for other markets. ARIMA (0,1,1)-GARCH (1,2): GARCH effect has been noticed only for the arrivals of Siliguri market. Seasonality indices are higher (greater than 100 percent) generally on the harvesting or post harvesting season (December to April) in case of arrival for all five markets. The highest intra-year price fluctuation is found in Diamond Harbor sector followed by Chakdah market. The pattern of ASPV (average seasonal price variation) across the markets is similar to that of intra-year price rise with the difference in their magnitude. But for onion coefficient of variation of prices shows different movement i.e.,

Chakdah scores highest CV value and Bishnupur shows the lowest. Current price of onion is positively related with the market arrivals in all the five markets whereas one year lagged price is negatively correlated with markets arrivals in all five markets.

AISDGONF/ABS/TA/80

Role of Tribal Sub Plan (TSP) for improvement of livelihood of tribal people

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India is a country of different castes, creeds and religions, out of which tribal communities also found large in number. A tribe is a social group usually with a definite area, dialect, cultural homogeneity and unifying social organization. Most of them residing in rural areas, where there is a very limited resource for development.Tribals are also socio-economically backward as compared to general population.So the central govt. of India implemented Tribal Sub Plan(TSP, 1974-1975)forthe development of the tribal population.TSP has following objectives to bridge the gap between Schedule Tribe (ST) population and others by ensuring- i) human resource development; ii) enhancing quality of life; iii) sustainable reduction in poverty and unemployment and iv) protection against exploitation and oppression. There are several types of inputs which are given to the tribal beneficiaries as a part of TSP such as- animals like- pigs, duck, goats etc. and their fodders; fish seeds, lime and fertilizers, fish feed etc; seedlings of vegetables, flowering plants and fruit trees, and various inputs and equipment for farming etc. A case study was conducted to know the role of TSP in improving socio-economic condition of tribal people. The findings of the study revealed that TSP has helped in improving socio-economic condition of tribal people.

AISDGONF/ABS/TA/112

Reform in agri-market in the context of APMC, national agriculture market (e-NAM) and MSP in India: a general perspective

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Problems like low price realization, high cost of marketing and sizeable post-harvest losses necessitate the regulation of Indian agricultural markets in the post-independence period. The major focus was given towards the augmenting production and settlement of remunerative prices in a fair transparent manner. Number of reform attempts was taken in different years among which the constitution of Agriculture Produce Marketing Committee Act of 2003, NITI Aayog Taskforce, 2016, Doubling Farmers Income Committee Report, Model Agricultural Produce Marketing (Regulation Act), 2017, National Agriculture Market (e-NAM) Launched Model Contract Farming Act, 2018, Model Contract Farming Act, 2018 etc. were some of the important issues. The present study analyses the implication of APMC Act, Status of National Agriculture Market model and the status of Minimum Support Prices over the Agricultural commodities with the help of secondary data from different sources and the cross tabulation method for the analysis of the data. There are about 2332principal regulated markets based on geography (the APMCs) and 4298 sub-market

yards regulated by the respective APMCs in India (2019). Currently 1260 mandies are registered on e- NAM. There were considerable increase in MSP in 2022-23 over 2021-23 for the crop like soybean (8.9 per cent), hybrid paddy (8.5 per cent), jowar (8.4 per cent) etc. The Indian farmers can be supported by the strong MSP-backed price-safety net for the incorporation of liberal agri-marketing systems.

AISDGONF/ABS/TA/138

Medicinal plants in India: scope and importance

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Growth of the herbal-based healthcare and wellness sector across the world, including India, is putting a high demand on the medicinal plant resources, both wild collected and cultivated. Medicinal plants which are a source of potential drugs and therapeutic properties, from the base for manufacture of drugs of Indian System of Medicine, i.e., Ayurveda (86%), Unani (5.7%), Siddha (4.2%) and Homeopathic (3.5%). The growing demand of herbal material has given rise to concerns about the sustainability of herbal raw drug supplies, especially those obtained from species that are already facing threat to their very existence. India is a rich repository of traditional medicinal plants and holds second position in export demand of medicinal plants was estimated about 134500 MT with export value of Rs. 3211 crores during fiscal year 2014-15 (National Medicinal Plant Board, New Delhi). The basic step to address these concerns is to know about the diversity of medicinal plant in commercial demand and estimate annual requirements of each of these entities so that appropriate resource management strategies could be put in practice. In India, there is 44% of medicinal plants present and 1178 species having commercial demand. There are about 8610 manufacturing units that are licensed to prepare herbal medicines under different streams of Indian Systems of Medicine. The National AYUSH Mission gives 30% subsidy to 55 medicinal plants, 50% subsidy to 27 medicinal plants, and 70% subsidy to 13 medicinal plants. The % share of contribution of medicinal products to GDP is 1.02 in 2015-16.

AISDGONF/ABS/TA/145

Understanding consumer preference for fresh potatoes by analysing different levels of attributes

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Market-led approach considered consumers as the most important stakeholders in the value chain. Therefore, an in depth understanding of consumer preferences is precursor for the development of agro-food industries across the globe. In India, potato is a primary vegetable in terms of domestic consumption and production. This study analyses consumer preference pattern for fresh potatoes in West Bengal by using conjoint analysis. Price, texture and size- three attributes were selected for the study. Three levels of price, i.e. above Rs 20, Rs 10-20 and below Rs 10; two levels of texture i.e. sandy and gummy and three levels of size i.e. large, medium and small were selected based on pretesting. Data is collected from randomly selected hundred consumers in Tarakeswar municipality. Respondents were asked to rate 18 cards according to their preference. Rating scale

is fixed at 1 to 18 [where 1= Best/most preferable combination; 18= Worst/least preferable combination]. Findings after calculating utility of different levels showed that sandy texture was preferred by the consumer over gummy texture. Medium size of potato was preferred by the respondents followed by large and small size respectively. Below Rs.10' was the most preferred level of price attribute followed by 'Rs.10-Rs20' and 'Above Rs.20'. After calculating relative importance of attribute, it was found that texture was more important to buyers followed by price and size respectively. This study provides feedback to the production sector who must consider the preference pattern of their downstream buyers to increase their profits.

AISDGONF/ABS/TA/162

Socio-economic impact of Covid-19 on total calorie intake in Kalimpong district of West Bengal, India

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The socio-economic disruption caused by Corona virus (SARS-CoV-2) and its mitigation responses are impacting lives and livelihoods at an unprecedented scale. Existing nutrition challenges have been amplified by pandemic-related economic and food system crises, disproportionately affecting the most vulnerable. The present study has been carried out to investigate the impact of COVID-19 on the calorie intake among the population of Kalimpong District of West Bengal, India. In case of sampling design, Multi-stage sampling technique has been followed. As Travel and Tourism sector has been severely affected due to pandemic related restrictions, Hilly region as well as Kalimpong district has been selected purposively among the six agro-climatic zones of West Bengal. Overall a fifty sample households were selected by following the Snowball sampling technique and then interviewed face to face (survey method) with a well-structured and in-depth research questionnaire. Bisaliah method of decomposition has been used in SAS software (9.3 versions). The results depict that as compare to post-covid situation, the actual calorie intake has been found to be 11.37% higher under pre-covid situation while the estimated change is 8.50%. Covid has demolished the economic and social life to an extent of 25.09% while still its ill effect could not able to hamper the entire mass as there is still a 33.59% betterment of life. Expense due to Flour (23.92%) followed by expense due to milk (14.59%), expense due to rice (8.61%), expense due to kerosene (1.98%), expense due to pulses (1.38%) and lastly ceremonial expense (1%) have contributed positive significant impact on total calorie intake as well as overall nutritional security of the sample population, while expense due to edible oil (-9.27%) followed by expense due to fish (-3.01%), expense due to clothes (-2.82%), expense due to fruits (-1.29%) and expense due to sugar (-1.21%) have shown negative impact on total calorie intake as well.

AISDGONF/ABS/TA/169

Consumers' preferences towards buying fresh vegetables in different seasons in selected areas of West Bengal

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This study assesses consumer preferences during vegetable sales, considering the socio-demographic variables of individuals together with their choice of point of purchase in different season. A choice experiment was conducted in two different areas in West Bengal in 2021-2022. Both rural and urban areas were considered in the study as the consumer differ in many ways in terms of purchasing. SahidMatangini block from Purba Medinipur district was selected as rural area and Maheshtala municipality of Kolkata was selected as urban. 100 respondents from each area were interviewed at different Vegetable purchase points (mass retail chains and open-air markets) using a proper interview schedule. Each group of individuals is described on the basis of sociodemographic variables and by the declared vegetable point of purchase. This research demonstrates the factors that influence consumer preference and behaviour, in addition to affecting which point of purchase the consumer prefers in each season of vegetables. And also this study measures how the consumer of rural and urban area can be described in terms of their preferences towards buying seasonal fresh vegetables.

AISDGONF/ABS/TA/188

A review on homa farming: A vedic influence on contemporary Agriculture

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Homa farming is a Vedic discipline which indicates the method of annihilating harmful conditions of environmental elements and refines the atmosphere by action of flame, outfitted with copper pyramid. The Agnihotra flame is essential to Homa farming. It links the control of energy from space to the existence of life things on this planet. It is practiced when all hope is gone and has proved to be beneficial in increasing crop yield, decontaminating soil and water and reducing microbial pathogenicity. Homa farming is comprehensive method of healing of agriculture and can be used in conjunction with any good organic farming system as it is extremely inexpensive and can be performed by anybody but requires discipline and consistency. Nowadays this knowledge is being revived by many scientists to give individuals the guidance about how to address polluted conditions of planet.

AISDGONF/ABS/TA/212

Sustainable empowerment of rural women through capacity building in post-harvest management: A case study from West Bengal

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Women's empowerment has emerged as an important concern for the sustainable development of the globe. India, as a developing country, recognized gender inequality as one of the most significant barriers to achieving sustainable development. Moreover, women's empowerment has been identified as a key predictor of the long-term prosperity and well-being of women. The present study is conducted in the purposively selected Manbazar-I and Manbazar- II blocks of Purulia district of West Bengal to identify the empowerment status of women in terms of income, decision-making ability, as well as risk-taking ability. A score of 120 women who are actively associated with 12 self-help groups (SHG) are selected based on simple random sampling for the study during the year 2020- 22. The selection criteria of the members of SHG is purposively fixed to a minimum of 5 years of experience before the study and more than 50 per cent income generated through the preparation of products based on post-harvest technology. The data are collected using a structured interview schedule from the respondents and analyzed using relevant statistical tools. The study reveals that the number of training received plays a crucial role in the capacity building of the members along with the age of the SHG, time spent in SHG activity, and amount of credit received also significantly contributed in income generation as it directly proportional to the credit accessibility of SHG. The study further suggests the involvement of micro-level institutions which can help in improving credit and market facilities for sustainable development.

AISDGONF/ABS/TA/221

Vertical price transmission and volatility of tea market in India

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Tea is the most popular beverage not only in India but across the globe. Tea growers, auctioneers, wholesalers, processors and retailers are the major players of domestic tea industry. Tea production in India can be broadly categorized in two heads namely, North zone and South zone. The study was structured to identify the price leaders of Indian tea market. Price data of three different market levels of tea viz. auction, wholesale and retail were collected and analysed separately. The cointegration results suggested presence of vertical cointegration among the different market prices on both tea growing zones of India. In South zone market, both wholesale and retail price turned out as definite market leaders whereas, in North zone markets, no definite price leader(s) can be identified to lead the price transmission mechanism. Alongside price transmission, price volatility was also studied, where auction price was found to be more volatile for both the tea growing zones. Result of the auction market showed more isolated behaviour for

both tea growing zones especially South zone markets. This implied any new market or price information gets restricted to retail and wholesale markets and doesn't transmit to the auction market. Thus, vertical cointegration mechanism as a statistical tool not only finds the cointegrated markets, in return also helps in identifying the isolated market price which require proper intervention for smooth market functioning.

AISDGONF/ABS/TA/227

Impact assessment through climate resilience site-specific technological interventions on yield and economics of finger millet in Bargarh district: moving towards nutri-cereals

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Most of the Millets are native to India and popularly known as Nutri- cereals. Finger millet, (*Eleusine coracana* L.) is also known as Ragi in India. In Bargarh district of Odisha it was observed that there is large scope and opportunity for fingermillet cultivation due to rainfed condition. It's the high time to integrate novel technologies to fingermillet crop production to make it more productive and resilient. In fingermillet, three experiments have been demonstrated by Krishi Vigyan Kendra, Bargarh during 2018-19 to 2021-22. Conservation technology like demonstration of tractor drawn seed cum fertiliser drill for sowing of finger millet has been conducted during 2018-19 and the result indicated that minimum time of operation (2.5hr/ha), cost of operation (Rs. 1500/ha) and maximum B:C ratio (1:1.5) compare to farmers practices. To disseminate HYV of fingermillet "Arjun", FLD programme was conducted during 2019-20 to 2021-22 and recorded maximum tillers/plant (7.1), fingers/plant (6.8), and maximum yield (12.6q/ha). Assessment of Power Pulse Thresher in fingermillet was undertaken during 2020-21 and 2021-22 and the result showed higher field capacity (50kg/hr) and B:C ratio (1:1.6) compare to manual threshing. In different FLD programme, economic analysis was done on the basis on cost of cultivation (Rs/ha), net income (Rs/ha) and B: C ratio. Impact analysis were recorded on the basis of impact on (yield, adoption & horizontal spread), technology gap, extension gap and technology index. As most of our farmers are marginal, adoption of climate resilience techniques in nutri-cereals are prime solution to deep rooted nutritional insecurity.

AISDGONF/ABS/TA/236

Tobacco marketing: SWOT analysis in Etah district of western Uttar Pradesh

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The study has been conducted in order to access the marketing of tobacco in Etah district of Uttar Pradesh, India. Purposive cum multistage random sampling technique was used to select district, blocks, villages and respondents. Primary data were collected from 100 farmers from four villages of two blocks through personal interview method with the help of pre-structured schedule for the year 2021-2022. The two type of marketing channel identified in the study area were channel-I: producer- wholesaler- processor and channel-II: processor- village trader- wholesaler- processor. Total disposal of tobacco was 88.14 quintals out of which disposal of tobacco by Channel-I and Channel-II, came to 52.77, 35.37 quintals, respectively. The highest net price (Rs.5610.26), marketing efficiency (9.30%) and producer's share in customer rupee (90.29) were found maximum in channel I as compared to second channel. Further in SWOT analysis stable strengths, weakness opportunities and threats were estimated and ranked according to C.V. (coefficient of variation). Tobacco growers faced different types of marketing constraints which were ranked through Garrett technique.

AISDGONF/ABS/TA/244

Determinants of adoption behaviour of improved jute production practices in Murshidabad district of West Bengal

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A study was carried out in Murshidabad district of West Bengal state to assess the sustainability of the improved technologies towards improving yield and quality of jute fibre. The state and district was selected purposively. Two blocks were chosen randomly from the district, and total of four villages, two from each block was selected randomly. Total 120 respondents were picked through the computer-based research randomizer technique. Improved jute production practice (IJPP) index was developed with six improved practice indicators of jute cultivation. Data were collected by direct observation, personal interview and focus group discussion method with the help of structured interview schedule. Statistical analyses were performed by mean, frequency, percentage, standard deviation, standard error, linear regression, etc. The results revealed that the respondent farmers had a low adoption level in overall IJPP index (IJPP index value= 0.223; value can range from 0 to 1). A colour-coded stratified radar chart had been developed. In the study area, the overall extents of IJPP index vis-à-vis 6 indicators were found to be: seed and sowing (64%), nutrient management (25.83%), weeding (25.83%), fibre extraction and retting (7.0%), insect-pest

and disease management (6.25%) and cropping system (0.83%). Therefore, it can be deduced that the index value for almost all the indicators in the study area were very low except the seed and sowing indicator. The study area requires significant development in almost every segment. The regression analysis showed that the IJPP index value could be increased with the improvement in education, risk orientation, innovation propensity and frequency of contact cosmopolite channels of the respondents in the study area.

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Effectiveness of cash transfers in benefitting the small and marginal farmers by providing income support: A special reference to PM-KISAN scheme

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Among all societal ills that exist in the world, poverty is the most pervasive. Most low- and middle-income countries depend on agriculture as their primary source of income, making them subject to a variety of risks that make it difficult for them to continue their livelihood over the long term. With risks including crop failure, natural disasters, disease, accidents, and job loss, poor and near-poor households in low- and middle-income countries find it challenging, if not impossible, to raise and maintain their standard of living over time. Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) is a central sector scheme run by the Ministry of Agriculture and Farmer's Welfare (MoAFW) where all farmer households receive a direct annual cash transfer of Rs 6,000, divided into three equal instalments of Rs 2000 each. An ex post facto research design was used in the study. The present paper presents data gathered in a the Indo-gangetic belts of Uttar Pradesh and Bihar. The 120 respondents, 60 each from two states comprising four districts i.e. Bahraich, Bulandshahr, Bhojpur and Muzaffarpur were selected using stratified disproportionate simple random sampling of small and marginal farmers for the study. The majority of respondents in Uttar Pradesh, or 63.33 percent, felt that the PM-KISAN scheme was only moderately effective in addressing their needs, while 21.67 percent of respondents believed it to be highly effective. In the instance of Bihar, almost 50% of respondents, or half, thought that the PM-KISAN programme was medium successful in terms of the benefits they received to meet their needs, while 25% of respondents thought that the plan is highly effective. Additionally, 30 officials from various departments were interviewed via SWOT analysis combined with Analytical Hierarchical Process (AHP) revealed that the major strength was Amount is transferred directly to linked bank accounts without third party and major weakness was Faulty details in Aadhaar card or Land record or Bank account no. bars from receiving benefit respectively.

AISDGONF/ABS/TA/287

Growth and instability analysis of major crops in West Bengal region of India

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The present study aims to evaluate the growth and variability in agricultural production in West Bengal by analysing the trends in area, production, and productivity of key crops between 2000-01 and 2017-18. The crops examined include rice, wheat, maize, pulses, jute, rapeseed and mustard, oilseeds, vegetables, and fruits. Compound annual growth rate analysis and adjusted instability index have been utilized to determine the growth rate and instability associated with the rate of increase in area, production, and productivity. Additionally, the decomposition analysis has been applied to determine the contribution of area and yield to the enhancement of production. Results indicate a 0.75% rate of rise in food grains production and 1.93% increase in total cereals output. Jute has seen a growth of 0.51%, while oilseeds and potato have seen growth of 3.65% and 4.21%, respectively. The instability related to production is highest in the case of potato. The decomposition of output growth highlights that yield and area effects are the main sources of output rise in *aus, aman*, and *boro* rice and that total rice output growth is dependent on both yield and area effects. The output growth of wheat and total cereals is mainly influenced by area, while total food grains are influenced by the interaction effect. Yield in conjunction with area has contributed the most to the output growth of oilseeds, jute, and potato.

AISDGONF/ABS/TA/289

Increasing livelihood status of small farmers in West Bengal

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Indian Population is estimated to be 1.39 billion by 2025. Thus, India needs productivity increase as cultivated land area is decreasing and changing from LEIA to HEIA. It increases decline in soil health, loss of productivity, soil infertility, reduced agro-diversity, pesticide and environment pollution and emerging pest-resistance along with poor livelihood status of farmers causing increasing of suicide case. Therefore, we need a modified natural ecosystem, a networked web of chemical, biological, mechanical and technological environments (LEISA). Survey was conducted at Birbhum during last three years taking 400 sample small farmers (100 in each district) to understand their real problem and suggested solution. Knowledge of modern agriculture (farm mechanization, organic/natural farming, integrated farming (rice cum fish culture), diversification of agriculture (sericulture, bee-keeping, livestock, poultry farming) & availability of resources), post-harvest facilities and marketing were the major problems. For major resources like seeds of new varieties like black rice or guava, new cost saving instruments like power weeder, power sprayer, planter and harvester, environment safe organic nutrients and pesticides, water saving drip irrigation etc. all were lacking as a result they had to depend on local dealers. Poor post-harvest resources like cold storage, food processing unit, rice or oil mill, marketing facility etc. were unable to make more profit. Farmers livelihood status will increase in a sustainable manner provided policy makers will give emphasis on modern agriculture, rural development, availability of resources in addition to improvement of marketing and post harvesting processing units are the best solution. Young generation who are now leaving agriculture will again back in this sector and help for pollution free low external input sustainable agriculture.

AISDGONF/ABS/TA/290

Regenerating ideas towards attaining ecological resilience at farmers' field: A journey through undulations

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Depletion and extortion through wrong agriculture has damaged and disrupted the music of natural and traditional farming. These are being reflected when data reveal that 67.8 per cent of our agricultural land is suffering from poor organic carbon level less than 3 percent; the loss of top soil per ha per year has been to the tune of 10-15 tones. While, the most reliable actor in ecological restoration is farmer, the present case study unravels the innovation and socialization of mulching towards augmenting the principles of Conservation Agriculture with an isochronous scaling up of income and livelihood. The plastic mulching has been executed in crops like tomato, broccoli and capsicum by the farmers of Falakata block of Alipurduar Districts. After some initial jerks of apparent failure, they came up with renewed vigor and zest in a response to persuasive extension. The continuum of adoption-discontinuance-reinvention has been delved with empicism and theorization. The study would pave the pathway for technology socialization dynamics and can well be applied to accentuate moral and technical spirit in diffusion of ecological farming through Farmers Producers Organisation (FPO), albeit income and livelihood can well be secured to usher sustainability across the terrains of economic and social topography.

AISDGONF/ABS/TA/291

To ascertain the farmers and traders willingness to participate in e-NAM: Binary logistic regression analysis

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National Agriculture Market (e-NAM) is an electronic trading portal that networks the existing APMC markets to create a unified national market for agricultural commodities. The main aim of the study to determine the willingness of participates in e-NAM trading by farmers and traders in Sultanpur district of Uttar Pradesh. To know the willingness Binary Logit regression model was used in which the explanatory variables of farmers were social category, age of the respondent, education, produce sold to arhatiya or village traders and distance from mandi. On other hand independent variables of Traders were social category, age of the traders, education level of traders, lending money to farmer, number of functions involved by traders in mandi and Business profits.

AISDGONF/ABS/TA/343

A discussion on the present status of krishak bazaars in Cooch Behar district of West Bengal, India

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Marketing infrastructure acts as a facilitator for carrying out various economic operations, which is essential for the accomplishment of marketing tasks, the growth of the market, and the transmission of suitable price signals, all of which ultimately result in increased marketing effectiveness. The present study is completely based on primary data, for which Multi-stage sampling technique has been followed to select the sample units (Krishak bazaars and traders). The District of Cooch Behar which falls under the Terai zone of North Bengal, has been selected purposively as all the marketing activities have been functioning under only one Regulated Market Committee i.e. "The Cooch Behar Zilla Regulated Market Committee (C.Z.R.M.C)". A total of 8 Krishak bazaars are situated in the 8 blocks of Cooch Behar District, which are- Sitalkuchi Krishak bazaar, Haldibari Krishak Bazaar, Dinhata-I Krishak Bazaar, Mathabhanga-I Krishak bazaar, Tufanganj-I Krishak Bazaar, Mekhliganj Krishak bazaar, Mathabhanga-II Krishak Bazaar and Setai Krishak Bazaar. The present study is an attempt to study and evaluate the present status of Krishak Bazaars in the District of Cooch Behar as well as to identify the gap of infrastructural facility (constrains) with respect to the need of the stake-holders present in Krishak Bazaar. Principal Component Analysis (PCA), which entails factor extraction, rotation, and interpretation, has been used in factor analysis to discover the significant constraints. Variables with factor loadings were taken into account while interpreting the factors. Depending on the high factor loading, the constraints are ordered accordingly.

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Extension approach for revival of Darjeeling mandarin cultivation

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Darjeeling mandarin or orange is the principal fruit crop of Darjeeling and Sikkim Himalaya and considered as the major cash crop of the region. But the cultivation of Darjeeling mandarin is declining at an alarming rate and posing a serious threat to the livelihood of mandarin growers. It is estimated that more than 50% of the total area under mandarin cultivation has already been converted to vegetables cultivation, spices (large cardamom), tourism and other crops in different areas of hills. Many biotic and abiotic stresses were hold responsible for this decline in Darjeeling mandarin cultivation. Many initiative were taken by government and private players but with minimum success at ground level. Hence, an innovative extension approach namely "Darjeeling Mandarin Plant Health Clinic" was conceptualized and established at Mungpoo and Sittong of Darjeeling district, West Bengal in 2020. Under this approach, 2 innovative young farmers from the villages were selected and trained on pest and disease identification of mandarin and their management, production of healthy planting grafted and budded planting materials and their maintenance so that they can act as para-extension agent and further disseminate the knowledge

among the fellow farmers. The trained para-extension agents of plant health clinic provided diagnostic and advisory services at the village level in local dialect (Nepali) based on plant sample. In advance cases, the sample were sent to IARI laboratory for pest and disease identification. The plant health clinic acted as hub of different regular extension events and services like Field visit programme, Farmer field school, Farmers' day, Demonstration, stakeholder meet etc. One healthy nursery was also established to ensure the supply of disease free grafted, budded and nucellar planting materials of Darjeeling mandarin from Plant Health Clinic. A survey was conducted in 2022 with a sample of 300 farmers in the project villages to assess its effectiveness. The study found that maximum satisfaction was received on communication quality of plan heal clinic with a means score of 3.96 followed by location of plant health clinic (3.52), timeliness of advisory and input service (3.25), technical quality (3.23), applicability of advice (3.21), organization leadership and management body (3.10), regularity and reliability (3.08), accessibility to inputs (2.98), response to specific demand (2.88), saleability or outreach (2.81) and equipment or materials provided from health clinic (2.53). Total 10000 grafted planting materials were distributed through health clinic and farmers are producing this planting materials at large scale for revival of Darjeeling mandarin cultivation in neighboring villages. So far, 30 acres area was revived with healthy grafted planting materials under this approach. The study proved that community based focused extension approach like "Darjeeling Mandarin Health Clinic" in convergence with other government and private bodies can restore the old glory of Darjeeling Mandarin cultivation in the Himalayan belt of West Bengal.

AISDGONF/ABS/TA/504

Factors influencing future training needs of the pineapple growers in Darjeeling district of West Bengal, India

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The present study was conducted in Phansidewa Block of Darjeeling District of West Bengal state with 200 randomly selected respondents to find out the factors influencing future training need of the pineapple growers. The correlation analysis shows that socio-economic factors like age, family type, cultivation experience and technological gap were negatively and significantly associated with the training need of the farmers whereas education and farm size were having significantly positive association. The socio-psychological factors like risk orientation, production orientation, market orientation, innovation proneness, attitude of the farmer and social participation were having positive and significant association, whereas, the extension communication factors i.e mass media exposure, utilization of personal localite and cosmopolite sources of information and extension participation were having positive and significant association with the future training needs of the pineapple growers. The regression analysis shows that education, farm size, technological gap, market orientation, innovation proneness, personal localite and personal cosmopolite sources of information are having high degree of companionship to characterize the training needs. The path analysis depicts that education had been found exerting maximum direct effect and technological gap is the most potent and found exerting maximum indirect effect on the training need of the farmers. So, the study shows training needs of the farmers are highly influenced by socio-economic, socio-psychological and extension-communication factors and these need to be kept in mind while formulating training strategy for the farmers engaged in pineapple cultivation in future.

AISDGONF/ABS/TA/505

Harvesting sustainability: Empowering small farmers through pond-based integrated farming system

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The integration of diverse agricultural activities, including animal husbandry, fishery, crop cultivation, plantation crops, and organic farming, offers a promising avenue for transforming rural livelihoods by boosting productivity, income potential, nutritional security, and employment opportunities. This research endeavor encompassed a comprehensive investigation conducted across a landscape of 104 farmers' ponds, spanning a total area of 18.24 hectares, with an average pond size of 0.175 hectares per farmer. The study, executed between 2021 and 2023, aimed to provide an in-depth assessment of the implications of adopting integrated pond-based farming systems on multifaceted dimensions of rural households' well-being. The research framework embraced three pivotal components, namely fish cultivation, poultry/duckery enterprises, and meticulously planned vegetable production, intertwined with the cultivation of plantation crops and adoption of organic farming practices. The primary goal was to unravel the potential synergies among these components and their cumulative impact on production, income generation, and employment within the rural fabric of the Gangasagar Block of the Sundarbans region. The empirical results illuminated a distinct shift in outcomes when transitioning from traditional to integrated pond management. Notably, the three key enterprises—poultry/duckery, fishery, and year-round vegetable cultivation—demonstrated substantial improvements under the integrated approach. Particularly noteworthy was the twofold increase in average fish production achieved through integrated pond management, as opposed to conventional practices. From an economic perspective, the integrated model yielded a commendable gross annual return of INR 1.2 lakhs, all while upholding the nutritional requisites of marginal farming households. This economic achievement, however, was not the sole triumph of the integrated approach. The engagement of family labor throughout the year within the pond-based integrated production system emerged as a potent force behind heightened productivity. This engagement not only amplified production but also played a pivotal role in generating supplementary employment avenues to bolster household incomes. In summation, this study underscores the profound potential of an integrated pond-based management system, encompassing poultry, fish, and vegetable cultivation, as a transformative strategy capable of nurturing sustainable production, augmenting income streams, and fostering employment opportunities among resource-constrained rural households. The findings herein shed light on the pathway towards rural prosperity through holistic and harmonized agricultural practices.

AISDGONF/ABS/TA/506

Decision ecology in agricultural technology transfer: The case of system of rice intensification (SRI) at Bankura, West Bengal

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The technological gap in agriculture is responsible for inefficient technology transfer. The causes of failures for technology transfer are investigated after the training is completed. However, there is a lack of follow-up in this process. In the present study, we aimed to develop multi stakeholder mental models through Fuzzy Cognitive Mapping (FCM) and study the structure of cognitive maps representing the pathway of extension intervention. Finally, we aimed to anticipate the performance of system elements under different hypothetical scenarios as suggested by the stakeholders. Tatkanali village of Junbedia gram panchayat in Bankura II block of Bankura district was selected purposively as study locale. After identifying key informant, other respondents were identified using snowball sampling. Individual and direct interviews were conducted. Data analysis was done using 'Mental Modeler'. The results show that the stakeholders shared a substantial number of systems elements for SRI technology. Our findings show that informed interventions in these complex systems are achievable when we use stakeholders' diverse cognitive structures and predict system outcomes based on their inputs.

AISDGONF/ABS/TA/507

An interpretation on technology uncertainty in agriculture of West Bengal

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Uncertainty is an indispensable characteristic of any system where most contradictory factors are unpredictable or unfathomable. The higher is the complexity, the lesser would be the resilience. The agricultural production system, as it is managed in Indian condition, is the most vulnerable to a plethora of uncertainties. Indian agriculture has been exposed to weather and resource uncertainties, service and market volatility, poor access to technology, and a fragile input delivery mechanism. The study has been conducted in the Nadia district of West Bengal to examine and depict the possible issues and reasons for technology uncertainty as well as its sustainable policy options. A total of 100 respondents from 3 villages, mostly small and marginal farmers, have been selected for the study. The villages were selected through simple random sampling method. The transforming farmers, having quicker change in cropping system and surviving amidst the brunt of uncertainties, have been chosen by following snowball non- random sampling. It has examined the technology uncertainty as predicted characters against a score of 23 exogenous variables. The most significant contributors to perceived uncertainty have been cost of cultivation(x_{15}), irrigated land (x_{11}), cost of smart phone (x_6), land holding(x_9), and crop diversity index (x_{13}). The empirical study further focused on the direction of influence of the variable by applying Path analysis. The variable on farm (x_{16}) income has exerted both the highest direct and indirect effect on technology uncertainty by involving as many as 13 other exogeneous variables. So, these variable merits significant strategic importance.

AISDGONF/ABS/TA/508

Drudgery reduction of farm women through gender-sensitive farm mechanization

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The present study is conducted on the perceived drudgery of women agricultural labourer and the major factor behind it. Kadampur village under the Santipur block of Nadia district of West Bengal is purposively selected for the research. Among the total 511 female population of Kadampur village, 227 are engaged in agricultural activities and are selected as samples for the study by the method of total enumeration during the year 2021- 22. The study reveals that the majority of female agricultural labourers spent 10-12 hours per day in various kinds of drudgeries agricultural and household activities and get only a few hours of rest which is not enough for a healthy life. According to their perception of the agricultural activities performed by them paddy transplanting, ridge and furrow making, fertilizer and plant protection chemical spraying, grain harvesting, and threshing are comparatively difficult to perform because a majority of the female agricultural labourers have not proper information about improved agricultural tools and technologies and still, they follow traditional methods to perform their activities. The study also exposes that the drudgery perception of the women labourer is significantly and positively correlated to their age, health issues, and the extent of agricultural activities performed by them and it is significantly and negatively correlated with their annual income. The study suggests that the development of gender-sensitive tools and technologies and their proper use is crucial to reduce the workload of women agricultural labourer and their social upliftment.

AISDGONF/ABS/TA/509

Estimation of socio-ecological compliances and conflicts: yield, income and livelihood in selected farm enterprises with reference to West Bengal

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The sociology of agriculture has now built up a strong affinity with ecology of agriculture; and in between there have been income, productivity and livelihood for innumerable of farmers with marginal land and brittle income. It is nearly difficult to drive the apparently rivalry issues of income, ecology, productivity and livelihood to form an organic orchestration of what we call sustainable agriculture. Here, 105 respondents were identified from five villages viz. Chakbirohi, Kantabelia, Ghoragacha, Mitrapur, Kastodanga, from Haringhata block of Nadia district in West Bengal by following both random and non-random sampling method as per convenience and wherein applicable. Their responses were collected using pre-tested interview schedule. A set of standard variables (dependent) have been demonstrated with the help of a set of 22 exogenous variables, the following variables have been found to exert prevalent impact on the criterion variables and merit to be included while falling micro-level policy for a resilient agricultural and

social development. The dominant factors as extracted based on factor leading and Eigen values have got also extreme artistic importance. The ANN has gone further in packing the marker variables and can be applied in similar research locale across the terrains of resorts, livelihood and ecology.

AISDGONF/ABS/TA/510

Economic importance of agro-tourism for sustainable livelihood and tourism development in hilly areas of West Bengal

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The present article brings into light of economic benefits of agro-tourism and its potential contributions to the farmers, farm females, local community, homestay owners, agriculturists and tourism sector, etc. in the hilly areas of West Bengal. Agro-tourism is a nature based economic activity that involves social, economic, and environmental issues as well as giving locals a means of subsistence. It is simultaneously expected to maintain ecological aspects in a sustainable manner. The tourism industry offers exceptional natural experiences to visitors from across the world and also contributes to country's GDP (at178 billion U.S. dollars in the year 2021). Agro-tourism has grown quickly over the past few decades in the Himalayan tract of West Bengal as a result of increasing interest of tourists in learning about rural life and the need of farmers to supplement their income through diverse economic activities. The hilly areas of West Bengal (mainly Kalimpong) have the highest number of registered home stays. A survey was conducted among 90 agro-business owners from three districts namely Kalimpong, Darjeeling and Jalpaiguri district using proportionate random sampling method to find out the socio-economic variables effecting agro-tourism business, financial viability of the enterprise and to identify the constrains faced by the entrepreneurs during agro tourism business. Agro tourism is ascertained to be an effective mode of promoting the local products, bringing cultural transformation between urban and rural people, creating added value through direct marketing, boosting rural economies as a result of employment generation, women participation and empowerment, encouraging organic farming and supporting farmer's organization and promoting nature conservation and sustainable development. Recently, though, it seems that tourism in the hills is at capacity, putting undue strain on local and natural resources as a result of overpopulation and resource exploitation. However, due to the rapid onset of the global pandemic, this industry unexpectedly faces a great challenge impact of which has been observed in terms of downfall of income of local community. However, it is a source of income, and its economic potential cannot be discounted. Therefore, the article focuses on generation of information for the scopes and challenges of agro- tourism in the areas under study. Hence, there is a need to recognize the current status of agro-tourism, accept and gain knowledge and to explore preferable and advanced agro-tourism opportunities.

AISDGONF/ABS/TA/511

Diffusion of NRRI varieties in eastern and north-eastern parts of India: A micro-level assessment

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The ICAR-National Rice Research Institute (NRRI), Cuttack has a glorious history of developing improved rice varieties for different ecologies of the country. In the present study, we made a structured effort to estimate the diffusion of NRRI varieties in several Eastern and Northeastern states. Among the three popular ways of estimating varietal diffusion - 1. breeder seed indents, 2. total sale of certified seeds, and 3. sample survey, the present study resorted to the extraction and analysis of household survey-based primary cross-sectional data recorded in the NEMA surveys during 2017-21. The analysis has been restricted to six randomly selected Eastern and Northeastern states, namely, Assam, Bihar, Chhattisgarh, Jharkhand, Odisha, and Tripura with a total sample size of 1464 rice farmers (n=1464). The results of the study revealed that 28.42% of the sampled farmers adopted at least one NRRI variety. The share of NRRI varieties is the highest in of Odisha (65.97%). The average acreage of NRRI varieties in the adopter farmers' fields was the highest in the state of Jharkhand (3.15 acres). Pooja was found to be the most popular variety, adopted by 12.16% of the farmers in the sample. Pooja had the highest share in varietal replacement (36.25%). The farmers' field level yield was the highest for Gayatri (56.19 q/ha.). Given the higher extent of diffusion of the comparatively older varieties, and the meagre extent of adoption of the newly released varieties, we conclude that farmers' perspectives need to be understood well in the process of variety development for faster diffusion.

AISDGONF/ABS/TA/512

Promoting the subsistence of farmers in Chotanagpur plateau, Jharkhand

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Agriculture and allied activities play a key role in the economy of Jharkhand. A large part of the population in Jharkhand lives in villages and depends on agricultural activities for their food and nutrition security, employment, and income. This important sector of Jharkhand has many issues like supply of proper good quality seed, high dependency on monsoon as irrigation facility is still developing, low productivity and poor marketing facility etc. A project report was conducted by Birsa Agricultural University, Kanke, Ranchi to find out the socio-economic status of farmers, farming techniques and measures for increasing livelihood of farmers. The survey was conducted at Satbarwa and Daltonganj Sadar of Jharkhand to find out the major agricultural problems. Which revealed that maximum people belonged from tribal group which consisted of ST (39%), SC (30%), OBC (27%), General (4%) and mostly women dominated (about 60%), they are in favour of low external input agriculture (LEIA). Their livelihood sources are mainly vegetable cultivation, animal husbandry and collection of non- timber forest products. They are also habituated of natural farming and SI (System intensification) for cultivation of Rice (SRI), Wheat (SWI) and Pulses (SPI). But the major problems are marketing & transport for which most of the farmers are forced to sell their produce at low cost and therefore unable to get more profit from their quality products.

To improve their way of living rural development with marketing facilities adding integrated farming (agriculture and other allied sectors) would be a great approach. Encouraging farmers to produce organic fertilizers and pesticides like vermicompost, matka khad, beejamrit, neemastra etc. which would be a useful option. Moreover, through training making them aware of the use of different resistance varieties, advance agricultural techniques like precision farming along with the organic inputs and also encourage and promote some youngers in startup business etc. which would be effective in their promotion of livelihood by increasing profit and also attracted young generations on modern environment safe agriculture.

THEME - B

Frontier areas in crop production and natural resource management with special reference to Natural Farming

Plenary Lecture **AISDGONF/ABS/TB/503**

Sustainable Rice Production for Improving Food and Nutrition Security, Environmental Sustainability, and Smallholders' Income

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Currently >700 million people suffer from hunger, and almost the same number of people still live in extreme poverty worldwide on <USD 2.15 day^{-1}. Majority of them are in sub-Saharan Africa and South Asia. Additionally, worldwide, 149.2 million children under 5 years of age are stunted, 45.4 million are wasted, and 38.9 million are overweight. Among adults, about 2.2 billion people (>40% of all men and women) are now overweight with 772 million are obese; 571 million girls and women are affected by anemia; and 539 million suffer from diabetes. These data suggest that progress to tackle malnutrition and poverty is slow, and we are not on track towards achieving the targets of Sustainable Development Goals (SDGs) # 1 (end poverty) and 2 (zero hunger). To reduce all forms of hunger, malnutrition, and poverty requires promoting sustainable agricultural practices including supporting smallholder farmers to ensure access to technologies and markets. Furthermore, climate change is increasing the vulnerability of crop production to weather extremes, which in turn affects the food and income security of smallholders, especially in the global south. Rice is a staple cereal for over half of the world's population. It is cultivated on approximately 160 million hectares of land, which accounts for 8% of world cropland. About 25% of the world's farmers are involved in rice cultivation. Rice production consumes 15% of the world's fertilizer and 35% of the world's total irrigation water. Around 400 million rural poor individuals are engaged in rice cultivation, who make up 40% of the world's poor population. Additionally, rice is valued at >200 billion USD, representing 13% of the world's crop value. Moreover, rice contributes to 10% of global methane emissions, and about 20% of total methane emissions from agriculture. Being predominantly a monsoon-season crop, rice is also more vulnerable to climatic extremes such as flood, drought, and/or salinity. Considering these statistics, if we aim to make a significant contribution to food and nutritional security, environmental sustainability, climate change mitigation and adaptation, and poverty reduction for millions of poor families, rice will continue to become an important target crop. Sustainable rice cultivation practices coupled with climate resilient, and nutrient dense rice varieties, can help achieve food and nutritional security, mitigate the impact of climate change, improve environmental sustainability and livelihoods of rice farmers, and thereby contribute to the SDGs # 1, 2, and 13. This presentation will focus on emerging topics, with examples: (1) climate-resilient rice varieties that are adapted to climate change and hence increase rice yields, (2) healthier and more nutritious rice varieties, either alone or in combination with agronomic fortification, to address malnutrition, and (3) innovative crop and resource management practices that improve yield, profitability, resource use efficiencies, and adaptation and mitigation to climate change. Additionally, this paper will highlight the power of big data and advanced analytical methods such as machine learning (ML), artificial intelligence (AI), and the Internet of Things (IoT) in rice production to empower sustainability transitions. By adopting these innovative and sustainable practices, rice farmers can contribute to a more resilient and sustainable agricultural system, ensuring food security and nutrition for present and future generations.

Lead Lecture **AISDGONF/ABS/TB/491**

Evaluation of non-chemical approaches of weed management in brinjal (*Solanum melongena*) under organic farming

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A field experiment was conducted during *kharif*, 2022-23 at Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu to study the effect of non-chemical approaches on weed management on weed flora and productivity of brinjal grown under organic farming. Nine treatments were evaluated in the experiment and replicated thrice under randomized block design. The treatments were biodegradable polythene mulch, weed mulch @ 5 t/ha, multi-varietal techniques, stale seed bed technique by using weeders, intercrop green leaf vegetable *fb* HW at 40 DAT, live mulch of sunhemp *fb* mulching of sun hemp at 40 DAT, crop residue mulch @ 5 t/ha, mechanical weeding and unweeded control. Grasses and broad-leaved weeds more the predominant weed category in all the treatments on 20 & 40 DAT. Among the broad-leaved weeds, *Digeria arvensis, Trianthema portulacastrum* were predominant and *Dactyloctenium aegyptium, Cynodon dactylon* were dominant species observed in grasses group. Based on experimental results, higher weed control efficiency of 63.4% was recorded with treatment of application of weed mulch @ 5 t/ha and it was followed by biodegradable polythene mulch of 61.9% at 20 DAT. At 40 DAT also the similar trend was observed. Higher brinjal yield of 35.5 tons/ha was recorded with application of weed mulch @ 5 t/ha followed by treatment of biodegradable polythene mulch (32.9 tons/ha). The lowest yield was recorded with unweeded check. Application of weed mulch @ 5 t/ha recorded higher benefit cost ratio of 4.94.

Lead Lecture **AISDGONF/ABS/TB/516**

Tapping the potentials of weed-competitive rice cultivars under direct-seeded conditions

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Weeds are one of the major impediments to achieve full genetic potentials of rice cultivars under direct-seeded conditions. Weed competition in direct-seeded rice (DSR) may cause yield reduction up to 70-90%, and even lead to complete crop failure. IRRI has been working in collaboration with different partners and stakeholders under the DSR Consortium to identify high-yielding, weed-competitive, and DSR-suitable cultivars, and design their best bet agronomy across different regions in India. Recent studies under wet-DSR systems at Rice Research Station, Chinsurah, West Bengal reveal 28-49 and 17-62% higher yields with the hybrids over the inbreds under weed-free and partially weedy conditions during *kharif* and *boro* season, respectively. Short- to medium-duration rice cultivars perform better than those of long-duration under direct sowing, while hybrids are more weed-competitive and highly productive than inbreds. Crop-weed competition

can further be influenced by adjusting/optimizing seed rate, seeding depth and crop geometry, which help crop plants to better compete with weeds. Crop competitiveness is increased under narrow row spacing through faster canopy cover, better light interception, higher leaf area index, and less light penetration for developing weeds. Precise agronomic manipulations in seeding parameters and planting patterns not only supplement to weed suppression, but also reduce the need for herbicide usage and address the environmental trade-offs. Rice morphological characteristics including root traits for enhanced nutrient uptake are associated with weed competitiveness. Hence, rice cultivars suitable for direct seeding should have the right combination of traits, depending on growing conditions, cropping seasons, and crop establishment methods. Potential cultivars along with appropriate interventions can ensure a sound crop and weed management with higher yields under direct-seeded conditions.

Lead Lecture **AISDGONF/ABS/TB/541**

A land use system for natural resource management in Nagaland through traditional knowledge

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Nagaland is a hilly state with mountainous terrain richly endowed with natural resources with 70% of its population engaged and dependent on agriculture, Due to its topography, *Jhum*/Shifting cultivation is popular in the state where mixed cropping pattern is practiced incorporating various kinds of crops which are organic in nature. The larger area under WTRC/TRC falls in the foothills of the state.Due to increasing urbanization and shift from rural to urban, the agricultural productivity in the state is yet to achieve remarkable growth. Natural resources based sustainable agriculture is decreasing due to decline in ecosystem and man-made activities. Therefore, to sustain the way of farming which has been natural and organic by default, there have been many technological interventions or innovations to increase the efficiency for improvement in productivity so that Nagaland achieves food security the natural way. The topography of the state mostly restricts the cultivation of crops to Shifting cultivation in a large scale. The traditional way of slashing and burning the forest and leaving it fallow has been in many cases improved by introduction of Alder based farming system. The farmers incorporate this natural nitrogen fixing plant to regenerate faster allowing the *jhum* cycle to be managed at a minimum of four years with two cropping fallows. With beginning of civilization, there has always been close association with nature and the slopes of hills has been the field for the farming system. Another innovation for natural farming in Nagaland with respect to land use system is the *Zabo* Farming system where the farming community emphasizes on rain water harvest and use for the entire cropping period.The idea of *Zabo* farming originated as there is always scarcity of water even if enough rainfall is received, due to surface run off. The main aim is to save run off water during monsoon peak period and to reduce the rate of soil erosion which takes away fertile soil from the slopes. The paper aims to review the innovations adopted under *Zabo* Farming in the hills of Nagaland for Natural Resource Management.

Lead Lecture **AISDGONF/ABS/TB/545**

Bringing seed inoculations to smallholder farms for improved crop performance, nutritional security, and agricultural sustainability

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Sustainably increasing agricultural productivity warrants a combined tactic. One of the essential elements for amplified production and productivity is for farmers to have access to good seed of adapted varieties. Under marginal and fragile agroecologies and rainfed conditions, and where most smallholder farmers use less or disproportionate external inputs, yield stability rather than higher yields is often more imperative. Despite its importance, seed alone cannot solve the problem. The use of improved seed must be complimented by good agricultural practices adapted to the local farming systems (e.g. priming interventions with bio primer, integrated soil fertility, biotic and abiotic stress management and market connections). Seed inoculation is a fairly simple procedure which involves covering the seed surface with a bio primer prior to planting. Therefore, comprehension regarding the seed inoculations in restoring soil health, improving plant nutrition, and maintaining crop/seed quality has a major role in achieving the UN-Sustainable Development Goals such as no poverty, zero hunger, good health and well-being, etc.

AISDGONF/ABS/TB/515

Significance of living mulch for sustainable crop production- a review

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Living mulch is a cover crop that is seeded beneath or in between two other crops in agriculture. Its goalis to perform the duties of mulch, including weed control and soil temperature control. It's goal is to perform the roles of mulch, such as managing soil temperature and controlling weeds. Legumes can be used as living mulch to reduce the need for fertilizer in addition to fixing nitrogen. Therefore, an attempt has been made to review work done by many workers on a related problem in order to gain a deeper understanding the significance of living mulch and its management for sustainable crop production. The main benefits of cover crops in agro-ecosystems include i) Control of soil erosion: ii) Improved soil structure and water holding capacity iii) Improves soil physical properties Iv) Increase the amount of organic matter in the soil v) Weed Control vi) Fix atmospheric nitrogen by legume cover crops: vii) Living mulches can prevent water run- off.

Management of Living Mulch: The fundamental problem with living mulches is that they often suppress the main crops. This section objective is to describe management techniques that may boost the probability of beneficial results in living mulch systems. Even though there aren't many generalizations that can be made about all living mulch systems, the aim to spot any new patterns in the management literature and bring attention to any remaining knowledge gaps. Some of the management tactics are highlighted as hereunder i)*Type of Living Mulch,* ii) *Interference Period* iii) *Planting Pattern and Density,* iv) *Irrigation and Nutrient Inputs and* v) *Mechanical Control*:

Green Manure Crops as Living Mulch: Legumes constitute the majority of the cover crops used for green manure. While they are growing, the crops both cover and preserve the soil as well as add minerals to increase fertility. Per hectare of land, cover crops can add more than 30 tonnes of

organic matter and 200 kilogrammes of nitrogen each year. Legumes that are intercropped with cereal based cropping systemare: Rice - soybeans, pigeon peas, and mung beans; Wheat - lathyrus, lentils, and chickpeas and Maize - pea, sunnhemp, and cowpea. *Sesbania rostrata* is a legume that is used most importantly as a green manure and as cover crop either as pre-rice or as an inter- or mixed crop with rice. long with rice, it is sown at a rate of 25 kg per hectare. *Sesbania* is smothered with 2,4-D ester at a rate of 0.50 kg per hectareafter 25 to 30 days of growth, or when it is roughly 30 to 40 cm tall. Without having any negative effects on rice yield, this co-culture method can cut the weed population in half.

Future Scope of Living Mulch: Research on living mulches for more than 50 years has shown that cultural, mechanical, and chemical management techniques can boost the yields of major crops and support services like weed control. To create system-specific recommendations, additional study isrequired because best management practises vary between living mulch systems. The identification of low-input chemical control techniques, the improvement of alternatives for organic systems, the improvement of the list of efficient living mulch species, and the adoption of a more comprehensive strategy for managing living mulch are all general research topics.

Invited Oral **AISDGONF/ABS/TB/549**

Conservation agriculture for bringing sustainability in intensive agricultural systems

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Despite the country has achieved self-sufficiency in foodgrain production, still the production remains cereal centric and resource-intensive. The country still has growing concerns in various aspects of agriculture like the increasing problems of land degradation, water scarcity, increasing climate vulnerability, rapid urbanization leading to limited scope for area expansion under agriculture; the greatest challenge is to make the agricultural systems sustainable and climate resilient for achieving sustainable development goals for the nation. Conservation agriculture (CA) is perceived as a system which could meet the ever-increasing food demand worldwide with sustainable intensification of crops balancing various resources. CA is a farming system approach which is designed to hasten sustainability of the agricultural systems through its three basic principles: minimum disturbances of soil, leaving and managing crop residues, and crop diversification through temporal or spatial means. The CASI (Conservation Agriculture for Sustainable Intensification) technology has been tried to reach our farming community since 2012 in this region. Attempts have been made in the form of participatory trials, refinement of technologies, farmers' field days, exposure visits, capacity building sessions, and so on. Conservation agriculture-based sustainable intensification crop management practices improve crop productivity and profitability while reducing energy, water and labour requirements, and greenhouse gas emissions. The CIMMYT-led project 'Sustainable and Resilient Farming System Intensification' (SRFSI) is instrumental in bringing CASI technologies and the introduction of CASI practices within villages and districts of this region provides opportunities for farming households to sustainably diversify and/or intensify their crop production while facilitating micro-entrepreneurship and employment opportunities within rural communities. Multi-criteria assessments of conventional tillage (CT) (rice) followed by conventional tillage (Maize; Wheat;

Lentil) and CASI technology, i.e., unpuddled transplanted rice followed by zero tillage (ZT) (maize;wheat;lentil) showed the clear patterns on the positive impacts of the CASI over CT. CASI technology on average reduced irrigation water, energy, labour, and production costs by significant extent, while it increased system productivity, net returns, and net energy production. CASI also reduced the CO_2 equivalent emissions in rice-maize, rice-wheat and rice-lentil systems and thus showed potential to mitigate the potential impact of climate change. After seeding through zero tillage, most of the crops face major challenges from weeds. By selecting suitable pre and post emergence herbicides, the CA-based new agronomic management practices are advocating to overcome these challenges. Use of Nutrient Expert in CA system is showing its potentiality in optimum use of fertilizers with greater fertilizer use efficiency. However, proper integration of institutional-technological-policy related issues is the need of the hour to make it a sustained viable option. Building partnership amongst farmers, scientists, extension agents, policy makers, private players is very important for ultimate adoption of CA technologies.

AISDGONF /ABS/TB/4

Effect of seaweed extract based growth promoter on crop productivity and soil health

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The successful implementation of regenerative farming depends largely on finding alternative and effective natural nutrient sources. Seaweed extracts are emerging as an effective option which reportedly boosts farm productivity without any negative consequences to the environment. The Indian Farmers Fertilizer Cooperative Ltd. has recently developed a fortified granule and a liquid product '*Sagarika'* from extracts of red and brown marine algae. A field experiment was conducted at the research farm of ICAR-Indian Agricultural Research Institute, New Delhi to evaluate the performance of soil and foliar application of *Sagarika* in a maize-wheat-mungbean system. Ten treatment combinations were applied comprising of 3 levels of soil applications of Sagarika granules [S(G)] (@ 5, 10 and 20 kg $acre^{-1}$), 3 levels of foliar application of Sagarika liquid [S(F)] (@ 2.5, 5 and 7.5 ml L^{-1}), and 2 levels of NPK fertilizer applications (@ 100% and 75% of recommended doses). Results indicated that granular and foliar application of *Sagarika* along with NPK significantly enhanced the available soil nutrient, soil microbial activity, crop productivity and crop nutrient uptake, as compared with NPK. Highest grain yield of maize and wheat was observed with NPK+ $S(F)_5$ and NPK + $S(G)_{20}$, respectively. The treatment 75% NPK + $S(G)_{10}$ + $S(F)_{2.5}$ produced maize and wheat yield similar ($P<0.05$) to recommended NPK dose, and registered similar values of soil physico-chemical and biological properties, indicating the possibility of reduction in NPK fertilizer dose with conjoint use of these products.

AISDGONF /ABS/TB/5

Comparative on farm study of weed flora variation and yield of potato crop at Hooghly and Bankura district of West Bengal

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The global population is expected to reach 9.8 billion and food demand is projected around 14.89 mt in 2050. Weeds are the major biotic constraints to agriculture production besides adversely affecting agrobiodiversity, environment and human health. Globally weed causes 34 % losses followed by insects 18% and pathogens 16%. Cultivating in 23 States the important cash crop Potato in West Bengal is producing around 11 mt (23% of India) cultivated in 0.46 m ha. Weed causes around 12-40% potato yield losses in different districts of West Bengal and as it is a tuber crop PE management of weeds is more scientific (Ghosh et al., 2017). For recording observations on the composition of weed flora, 5 Sites were selected in each of two districts Hooghly and Bankura. 10 fields in each site were selected randomly. Weeds associated with the crop potato were noted from three spots (1 m^2 area) of each field. Ecological analysis of weed flora was done by traditional quantitative method based on relative frequency (RF), relative density and relative dominance and importance value index (IVI). The tuber yield of potato was also recorded in all 50 farmers fields each of Hooghly and Bankura District. *Echinochloa colona, Cyperus rotundus* and *Chenopodium album* were the dominant weed flora in most of the observed potato fields. Farmers were used toxic chemical herbicides (Metribuzin / Pendimethalin / Paraquat dichloride /Diuron etc.) as PE / POE and earthing up as weed control measure which will in turn causing environment pollution, affect human health and decrease in soil health in long run. The yield (30 t/ha) was also below the expectation. Considering biosafety, reducing seed bank before planting of potato followed by botanical herbicide as PE and subsequently earthing up at 30 DAP may be the best solution of increasing potato yield by minimizing the losses due to weeds in long run. To increase the livelihood status of farmers it is urgently needed to reform the potato marketing system, increasing cold storage facilities and small-scale industries at rural areas.

ISDGONF /ABS/TB/6

Augmenting effect of biofertilizer on French bean (*Phaseolus vulgaris* L.*)* production under different nutrient regime

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A field study was carried at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal to find out the augmenting effect of biofertilizers along with inorganic nutrients on French bean production, during the rabi season of 2020-21. The experiment was laid out in RBD with ten treatments like- 100% RDF (T1), 25% RDF + PSB @2.5 Kg/ha (T2), 25% RDF + *Rhizobium* @10 g/Kg seeds (T3), 25% RDF + PSB @2.5 Kg/ha + *Rhizobium* @10 g/Kg seeds (T4), 50% RDF + PSB @2.5 Kg/ha (T5), 50% RDF + *Rhizobium* @10 g/Kg seeds (T6), 50% RDF + PSB @2.5 Kg/ha + *Rhizobium* @10 g/Kg seeds (T7), 75% RDF +

PSB @2.5 Kg/ha (T8), 75% RDF + *Rhizobium* @10 g/Kg seeds (T9), 75% RDF + PSB @2.5 Kg/ha + *Rhizobium* @10 g/Kg seeds (T10).The treatment T_{10} recorded significantly maximum values for plant height (37.44 cm), number of primary (4.20) and secondary branches plant^{-1} (6.54),number of leaves plant^{-1} (48.46) & LAI (2.15) and minimum days to 50% flowering (54.89) as well as minimum days to first harvest (62.54) , number of pods per plant (8.03), number of seeds per pod (6.67), length of pod (15.44 cm), weight of 100 seed (32.28 g) and total yield (12.51 t/ha). The treatment T_{10} also recorded maximum percentage of crude protein (3.19) and minimum percentage of crude fibre (0.66). The treatment T_{10} showed highest benefit: cost ratio (2.58)over rest of the treatments. So it may be concluded that application of PSB @2.5 Kg/ha + *Rhizobium* @10 g/Kg seeds in combination with 75% RDF was found economically more viable and sustainable than rest of the treatments.

AISDGONF /ABS/TB/8

Novel synthesis of ZnO and TiO_2 Nanoparticles using *Ipomoea carnea* leaf extract and its effect on black carrot (*Daucus carota* L.) production

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Nano fertilizers (NFs) are now becoming an important tool for plant nutrient management having capabilities to improve soil fertility, crop productivity and quality of agricultural products. Since, they are needed in very small amount, thus, reduces cost of crop production. Among different essential or beneficial plant nutrients, Zn and Ti are important micro nutrients having number of beneficial effect on crop growth, yield, quality and post harvest life. Present experiment was carried out to prepare ZnO and TiO_2 nanoparticles (NPs) through green technology by using aqueous extract of *Ipomoea carnea* (morning glory) leaves. In order to investigate size, morphology, composition, and stability of selected NPs, the detailed characterization was carried out using UV-visible spectroscopy, FTIR, HRTEM, EDX, BET, X-ray diffraction, XPS and particle size distribution studies. Subsequently, the effect of foliar spray of ZnO and TiO_2 NPs was evaluated in respect of vegetative growth, yield and quality of black carrot (*Daucus carota* L.) cv. Pusa Asita. There were 8 treatments viz. Control (no fertilizer), recommended dose of fertilizer (RDF), TiO_2 (5, 10 and 15 ppm), ZnO (50, 75 and 100 ppm)] with 3 replications following Randomized Block Design having 24 plots (1 m x 1 m). The observations were taken for vegetative growth, edible root yield and root quality parameters. Although, the growth, yield and quality parameters were found superior under conventional system of recommended dose of fertilizers (RDF) of NPK, however, TiO_2 NPs also showed very promising result close to RDF as compared to ZnO NPs. Among them, 5 ppm TiO_2 foliar application was found to be the best for vegetative growth, root yield and quality of black carrot. It was also found that higher concentration of TiO_2 and ZnO NPs had adverse effect on the plant performance.

AISDGONF /ABS/TB/19

Variation in rice yield due to application of FYM in different blocks of district Bankura

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Paddy production in India is 127.93 mt, 11.49 mt more than mean of last 5 years (Second Advance Estimate 2021-22 - Production of Major Crops Ministry of Agriculture & Farmers Welfare India –16th February, 2022). West Bengal produced 16.6 mt of rice and the total production of kharif rice in Bankura district was 68762 t (Bureau of Applied Economics and Statistics Department of Statistics and Programme Implementation Government of West Bengal 2016). Organic manuring of rice is important in tropical acid lateritic soils which are low in organic matter and available plant nutrients because of high temperatures, rainfall and intense microbial activity. The variation in rice production in different blocks of district Bankura was recorded along with the relation between productivity and FYM content. An extensive survey was carried out in 4 different blocks (Onda, Raipur, Gangajalghati, and Chatna) of Bankura district for finding out the ways of increasing Rice production using natural farming. The rice cv. BB11 showed higher coverage and along with the production, the average use of FYM in different blocks was also recorded. The soil nutrient status was also tested. The average paddy productivity of Onda, Raipur, Gangajalghati and Chatna blocks were 5.6, 5.2, 4.5 and 4.1 t/ha and the FYM was applied @ 4.9, 4.4, 3.0 and 2.6 t/ha, respectively proving that continuous use of FYM helps in increasing rice productivity. It can be concluded that avoiding inorganic fertilizers application of nutrients through homemade FYM like natural resources not only can build up the soil productivity which in turn can increase the paddy yield in a sustainable manner but also helps farmers to get more income by selling the better-quality rice in higher price. The farmers livelihood status will be increased more if the marketing facility and processing units (farmers will also get rice bran oil) are available in local areas. The authors are thankfully acknowledged Mr. N. Nandi, Visva Bharati University for helping in soil physio-chemical properties and Administrators of Midnapore City College for giving the scope of Survey work.

AISDGONF /ABS/TB/22

Assessing the impact of integrated nutrient management practices on growth and yield performance of direct seeded rice in dystrudepts of Nagaland

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Since Indian agriculture continues to be a gamble in monsoon, DSR can prove to be a promising method technically and economically, which is an achievable alternative to transplanted rice. On the other hand, soil has become dilapidated of late due to ill-agricultural practices. Therefore, it is in dire need for restoration of soil fertility and productivity which can be done through integrated nutrient management. The investigation was conducted to assess the impact of integrated nutrient management on growth and yield performance of direct seeded rice in dyrtrudepts of Nagaland at the experimental farm of School of Agricultural Sciences and Rural Development, Medziphema Campus, Nagaland University during *kharif* season of 2019 and 2020. Randomized Block Design with three replications and twelve treatments was applied for the trial. The treatments details are: T_1: Control, T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 ha^{-1} + 30 kg K_2O ha^{-1}), T_3: 100% RDF +PSB, T_4: 100% RDF + 2 t FYM ha^{-1}, T_5: 100% RDF + 2 t FYM ha^{-1} + PSB, T_6: 75% RDF + PSB, T_7:

75% RDF + 2 t FYM ha^{-1}, T_8: 75 % RDF + 2 t FYM ha^{-1} + PSB, T_9: 50% RDF + PSB, T_{10}: 50% RDF + 2 t FYM ha^{-1}, T_{11}: 50% RDF + 2 t FYM ha^{-1} + PSB, T_{12}: 109 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 46 kg K_2O ha^{-1} (SSNM). Result revealed that application of 100% RDF + 2 t FYM ha^{-1} + PSB (T_5) significantly increased the growth and yield of direct seeded rice which was at par with T_4 (100% RDF + 2 t FYM ha^{-1}) in both the years of cultivation. Therefore integrated use of nutrients enhanced the growth characters and maintained sustain yield of direct seeded rice at less production cost.

AISDGONF /ABS/TB/23

Evaluating the effect of nano-urea and herbicide mixtures on weeds along with growth and yield of wheat

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As India is going to overtake China in terms of population by the end of this year towards becoming world's most populated country, the demand of wheat is also increasing simultaneously along with increasing population. To maintain the supply along with increasing demand, effective management of production constraints related to wheat cultivation is important. Out of various production constraints, weed interference and poor nitrogen use efficiency are very crucial, reducing the yield along with, increasing cost of cultivation and polluting the environment directly or indirectly. Nano-urea with its higher use efficiency and herbicide mixtures with its ability to manage weeds as well as associated resistance problem, can be two important options in this regard. Considering this, an one season experiment was undertaken at Indian Agricultural Research Institute, New Delhi in winter (rabi) season of 2021-2022 to investigate the effect of nano-urea and herbicide mixtures on weeds along with growth and yield of wheat (var. HD 2967). The experiment was conducted in split-plot design with three replication of four main plot treatments viz. N_1 = control (no nitrogen), N_2 = RDN (120 kg N/ha), N_3 = 50% RDN + two spray of nano-urea (40 & 60 DAS) and N_4 = 75% RDN + one spray of nano-urea (60 DAS) and four sub plot treatments viz. W_1 = sulfosulfuron 75% + metsulfuron methyl 5% WG (ready mix) @ 40 g/ ha (product basis) at 30 DAS; W_2 = tank mix of clodinafop propargyl @ 60 g a.i./ha + Carfentrazone-ethyl @ 20 g a.i./ha at 30 DAS; W_3 = weed free check and W_4 = un-weeded check. The result of the experiment showed that weed density and dry biomass was significantly lower with 100% RDN over other main plot treatments and among sub plot treatments, tank mix of clodinafop-propargyl + carfentrazone-ethyl performed better compared to ready mix of sulfosulfuron + metsulfuron-methyl at 40 DAS, 80 DAS and at harvest. Weed index was also considerably lower in 100% RDN (9.16%) over other main plot treatments and in case of subplot, it was lower in tank mixed clodinafop-propargyl + carfentrazone-ethyl (7.83%) compared to ready mix of sulfosulfuron + metsulfuron-methyl (11.79%).Various growth parameters like plant height, leaf area index, dry matter accumulation, number of tillers/m^2 at 40,80 DAS and at harvest were also significantly higher in 100% RDN main plot treatment than nano-urea based treatments and in case of subplot, although these parameters were highest in weed free check, tank mixed application of clodinafop-propargyl + carfentrazone-ethyl was superior in terms of these parameters than ready mix of sulfosulfuron + metsulfuron-methyl .Grain yield also highest in 100% RDN (5.21 t/ha) which is around 40 and 18 % higher over 50% RDN +2 spray of nano urea treatment (3.7 t/ha) and 75% RDN + one spray of nano urea treatment (4.4 t/ha), respectively. And in case of sub plot, it

was 4% higher with clodinafop propargyl + carfentrazone ethyl (4.33 t/ha) than sulfosulfuron + metsulfuron methyl (4.15 t/ha) combination. Significant interaction effect was observed in grain yield, indicating 100% RDN along with clodinafop propargyl + carfentrazone ethyl combination might be a good option for managing weeds as well as maintaining productivity of wheat.

AISDGONF /ABS/TB/26

Response of groundnut varieties to phosphorus management and its residual effect on succeeding baby corn

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Phosphorus gets fixed in the soil and become unavailable to crop. Therefore it is very important for particular soil for particular crop like groundnut. Baby corn can be successfully followed after groundnut. The experimental was conducted at RRS, BCKV, Jhargram in split plot design to find out the effect of phosphorus management on growth and yield of groundnut varieties and its residual effect on succeeding Baby corn. Treatments were- main plot treatments (variety- TAG 24, TG 51, TG 37A)) and six subplot treatments (phosphorus dose-P_1- Pure Control of P with full dose NK,P_2-100% RDF,P_3 -75% RDP + full dose NK + PSB @ 25 g/ kg of seed,P_4- 75% RDP+ full dose NK + FYM @ 2 t/ha,P_5-75% RDP + full dose NK + PSB @ 25 g/ kg of seed + FYM @ 2 t /ha,P_6 -100% RDF + PSB @ 25 g/ kg of seed + FYM @ 2 t /ha . Highest pod yield (200.7 kg/ha), shelling % (67.35%), haulm yield (2876.22 kg/ha), oil % (49.97%), no. of kernels /plant (2.1) & 100 kernel weight (40.55g) were obtained with groundnut variety TG 51. Whereas phosphorus dose P_6 provided highest value for the above characters. Interaction effect was significant for pod yield, shelling%, 100 kernel weights. The residual effect on succeeding baby corn was highest for variety TAG 24 and treatment P_6 applied to previous groundnut crop. So groundnut variety TG 51 can be successfully grown with application of Phosphorus @ 60 kg/ha along with P.S.B @ 25 g per kg of seed & F.Y.M @ 2 ton /ha followed by succeeding baby corn crop.

AISDGONF /ABS/TB/31

The effect of stubble burning and residue management practices on soil properties under the rice-wheat cropping system

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Crop residue burning is carried out with regard to the timely preparation of the land for the sowing of wheat after the harvesting of paddy, thereby making it an inevitable menace. The present study was conducted at the Regional Research Station (OAZ) of UBKV during the *rabi* season (2021-22). The detrimental effects of this practice were demonstrated following the objectives of quantifying the effect of short-term burning and evaluating the impact of residue management and tillage practices on some soil properties in a rice-wheat cropping system. The experiment was laid out in Randomized Block Design (RBD) comprising eight treatment combinations. The

comparison has been done based on the percentage change among the treatments between the 0-15th day of burning and the 15th day of burning up until harvest, considering the 0-10 cm depth of the wheat crop. During the 0-15 day time period, T_3 (Conventional tillage + Residue burned) treatment exhibited a negative percentage change in soil organic carbon. During the subsequent 15th day to harvest time period, T_4 (Zero tillage + Residue - Standing residues) treatment demonstrated a noticeable positive percentage change in organic carbon and microbial biomass carbon. The T_1 (Conventional tillage without residue - Farmers' practise) treatment experienced negative percentage changes in microbial biomass carbon (-48 %), available nitrogen (-13 %) and acid phosphatase activity (-4 %). This short-term trial has revealed by far that zero tillage with standing residues (T_4) reflects positive changes in some soil properties in contrast to the farmers' practise and residue burning.

AISDGONF /ABS/TB/33

Effect of nano nitrogen in conjunction with urea on yield attributes and yield of rice

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A field experiment was conducted during *kharif* season of 2022 at District Seed Farm (AB-Block) of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal to evaluate efficacy of nano-urea based nutrient management in rice in new alluvial zone of West Bengal. The experiment was laid down in Randomized Block Design with three replications and twelve nutrient management practices. The experimental results showed that the yield attributes like number of effective tillers per meter square, number of filled grain per panicle, 1000 seed weight were highest in treatment T_6 (75% recommended dose of nitrogen (3 split) + two nano urea spray at 25-30 and 40-45 days after transplanting) which was followed by treatment T_{10} (2/3rdrecommended dose of nitrogen+ one nano urea spray at 25-30 days after transplanting). Lowest number of effective tillars per meter square, number of filled grain per panicle, 1000 seed weight were recorded in control plot (T_1) where only phosphorus and potassium were applied. Maximum grain yield (3.06 t ha^{-1}) and harvest index (34.63%) was recorded in treatment T_6 followed by treatment $T_{10.}$ Minimum grain yield (1.68 t ha^{-1}) and harvest index (25.60%) were recorded in treatment T_1 (control). From the above results, it can be concluded that application of 75% recommended dose of nitrogen (3 split) + two nano urea spray at 25-30 and 40-45 days after transplantingconsidered as an effective nutrient management for obtaining higher yield attributes and yield of kharif rice.

AISDGONF/ABS/TB/39

Effect of minimum tillage on growth and productivity of potato (*Solanum tuberosum* L.) in rice-potato production system

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In minimum tillage, soil disturbance is kept to minimum level. It is a tool for conservation agriculture with several advantages. A Field experiment was carried out during rabi seasons of 2020-21 and 2021-22 in at C-unit research farm of Bidhan Chandra Krishi Viswavidyalaya, to determine the effect of minimum tillage on growth and productivity of potato in rice-potato system. The experiment was laid out in a randomized block design with three replications having seven treatments viz. T_1- Farmer's practice, T_2 - Flat planting of seed tubers after FYM & fertilizer application+ covering with paddy straw mulch, T_3- Regional AICRP/ ICAR-CPRI recommendations, T_4- Flat-bed planting: Direct planting of potato by opening slit and covering it with soil and no mulching or earthing, T_5- Flat-bed planting & mulching by opening slit + mulching by chopped straw and no earthing, T_6 -Flat-bed planting & ridging: Direct planting of potato by opening slit and covering it with soil, earthing after 20-25 days by tilling soil between rows and no mulching, T_7 - Flat-bed planting, ridging & mulching. The results of the experiment revealed that the treatments significantly affected the plant height, no. of leaves/plant, grade wise tuber yield and total tuber yield of potato. The highest total tuber yield (31.19 t/ha) was recorded under T_3 which was found statistically at par with T_1 (28.04 t/ha). Among the minimum tillage practices T_2 i.e. Flat planting of seed tubers without slit opening after FYM & fertilizer application+ covering with paddy straw mulch recorded the highest total tuber yield (26.08 t/ha) which was found statistically at par with T_7. The treatment T_2 also recorded significantly higher periodic soil moisture content just before irrigation, highest soil organic carbon content at 0-15 cm soil depth and reduced soil bulk density at post harvest soil and recorded highest net return.

AISDGONF /ABS/TB/43

Weed management with new generation herbicides in *rabi* maize

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A field experiment was conducted during *rabi* season of 2019-2020 at District Seed Farm (AB-Block) of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal to evaluate best weed management practices of maize in new alluvial zone of West Bengal. The experiment was laid down in Randomized Block Design with three replications and nine weed management practices. Results indicated that the lowest grassy, sedges and broadleaves weed density and dry weight of weeds were observed in weed free plot (T_2) but among the herbicide treated plots, pre-emergence application of Atrazine 750 g/ha followed by Topramezone 25.2 g/ha at 25 DAS (T_4) was recorded lower weed density and weed dry weight which was statistically at par with the treatment T_8 (Topramezone 25.2 g/ha + Atrazine 750 g/ha at 15 DAS). The weed control efficiency (46.65%)

was the highest in weed free treatment (T_2) which was followed by treatment T_4 followed by T_8. Lowest weed index (8.10) was reported in treatment T_4 followed by T_8. The highest net return was recorded in weed free plots (T_2) which was statistically at par with treatments T_4 and T_8. The highest benefit cost ratio was recorded in T_4 plots which were statistically at par with T_8 treatment. From the experimental results, it can be concluded that herbicides Atrazine 750 g/ha as pre-emergence followed by Topramezone 25.2 g/ha at 25 DAS and Topramezone 25.2 g/ha + Atrazine 750 g/ha at 15 days after sowing were found to be most effective weed control measures in maize with higher benefit cost ratio during *rabi* season under new alluvial zone of West Bengal.

AISDGONF /ABS/TB/54

Impacts of inorganic fertilizer, organic manure, and biofertilizer application on soil aggregate stability and aggregate-associated organic carbon under rice-mustard-sesame cropping system in Inceptisols, Gayeshpur, West Bengal

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Long-term fertilization impact soil fertility and its sustainability. Inorganic fertilizers, organic manure, and biofertilizers have an effect on soil aggregate stability and its carbon content due to long-term use. Keeping the above facts, we planned to understand the long-term impacts of inorganic fertilizers, organic manure, and biofertilizer application under a rice-mustard-sesame cropping system in Inceptisols, Gayeshpur on aggregate stability and aggregate associated carbon. For this soil samples were collected from two soil depths (0-15 cm and 15-30 cm) with treatments detail: control, recommended inorganic fertilizer (NPK), NPK with biofertilizers (*Azospirillum* and *Phosphobacteria*), and biofertilizers (*Azospirillum* and *Phosphobacteria*) with farmyard manure (FYM). Results reveal that the structural indices were higher in the soil receiving organic amendments than in the soil receiving inorganic fertilizer alone. The lowest and highest aggregate stability was in the recommended inorganic fertilizer and biofertilizers (*Azospirillum*and *Phosphobacteria*) with farmyard manure (FYM) in both surface and subsurface layers. Aggregate-associated carbon was highest in the treatment applied with biofertilizers (*Azospirillum* and *Phosphobacteria*). Correlation studies showed that there was a positive relationship between water-stable macroaggregate with soil organic carbon content. Therefore, we can conclude that cultivation without organic amendments and biofertilizers results in more macroaggregates (malignant to soil tilth) that could be checked by the application of organic amendments such as FYM and biofertilizers such as *Azospirillum* and *Phosphobacteria*, which increased the proportion of water-stable macro aggregates by consolidating micro aggregates into macroaggregates. Thus, we should suggest the conjoint application of biofertilizer and FYM in agricultural soils

AISDGONF/ABS/TB/71

Growth and yield of hybrid mustard (*Brassica juncea*.) as influenced by foliar nutrition in Gangetic plains of West Bengal

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A field experiment was conducted to study the effect of foliar nutrition on hybrid mustard var. Kesari-5111 during rabi seasons of 2018-19 and 2019-20 at Instructional Farm, BCKV, Jaguli, Nadia (West Bengal).The experiment was laid out in randomized complete block design (RCBD) with three replications comprising of nine foliar nutrition treatments viz. T1- No foliar spray (Control-1);T2- Water spray (Control-2); T3- Urea (46%N) at 2% (20 g litre^{-1} of water); T4-DAP (NPK- 18:46:0) at 2% (20 g litre^{-1} of water); T5- Water soluable sulphur at 0.5% (5 g litre^{-1} of water); T6-NPK (grade 19 : 19 :19) at1% (10 g litre^{-1} of water) ;T7- Zinc (in form of $ZnSO_4$) at 0.2% (2 g litre^{-1} of water); T8- Boron (in form of Borax) at 0.1% (1 g litre^{-1} of water); T9- Salicylic acid 100 ppm. Results revealed that mustard plot fertilized with recommended dose of chemical fertilizer (RDF) along with the foliar application of di-ammonium phosphate (DAP) at 2% recorded the highest plant height, leaf area index, dry matter accumulation and number of siliqua plant^{-1}, number of seeds siliqua^{-1}. Different foliar nutrition significantly improved the seed yield of hybrid mustard by 15.8 to 81.3% over control plot. The maximum seed yield of hybrid mustard was recorded as1971 kg ha^{-1} with DAP @ 2% followed by sulphur @ 0.5% obtaining seed yield of 1867 kg ha^{-1}. Among the foliar spray treatments, highest oil content (39.9%) was recorded with sulphur at 0.5% followed by Boron (Borax) at 0.1%, recording 38.7% oil content. The bacterial population were improved at ($ZnSO_4.7H_2O$) at 2g litre^{-1}of water and for fungi and actinomycetes population significantly greater value was obtained with foliar application of DAP @ 2% (20 g litre^{-1}) at flowering stage and harvest respectively.Based on the experimental results,it may be recommended that an integration of recommended dose of chemical fertilizer (RDF) along with either foliar application of DAP at 2% or Urea at 2% or Sulphur at 0.5% enhanced the growth and yield of hybrid mustard as well as improved the soil nutrient status in Gangetic alluvial soil of West Bengal.

AISDGONF/ABS/TB/72

Effect of post-emergence chemical weed control measure in direct seeded rice (*Oryza sativa* L.*)* in New Alluvial Zone of West Bengal

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Direct seeded rice seems to be a viable option under erratic rainfall and water scarcity. Despite of several advantages in DSR, weeds are the major biological constraint. In view of that a field experiment **"**Effect of post-emergence chemical weed control measure in direct seeded rice (*Oryza sativa L.)* in New Alluvial Zone of West Bengal **",** was conducted at Central Research Farm, Gayeshpur, B.C.K.V., Nadia, West Bengal during two consecutive *kharif* season of 2020 and 2021with 9 treatments viz. T_1-Imazethapyr 10% SL @ 1000 ml/ha at 15 DAS, T_2Imazethapyr 10%

SL @ 1250 ml/ha at 15 DAS ,T_3- Imazethapyr 10% SL @ 2000 ml/ha at 15 DAS, T_4- Imazethapyr 10% SL @ 750 fb 750 ml/ha at 15 DAS and 30 DAS, T_5- Imazethapyr 10% SL @ 1000 fb 1000 ml/ha at 15 DAS and 30 DAS, T_6- Imazethapyr 10% SL @ 1250 fb 1250 ml/ha at 15 DAS and 30 DAS, and T_7- Imazethapyr 10% SL @ 2000 fb 2000 ml/ha at 15 DAS and 30 DAS, T_8- weed free check (2 times hand weeding @ 20 DAS and 40 DAS) and T_9- un treatment control (weedy check) were laid out in RBDwith three replications. The herbicide tolerant high yielding rice variety Sava 134with row spacing of 20 cm apart was used.Among the herbicidal treatments, T_7recorded lowest weed density, weed dry matter production and comparatively higher weed control efficiency than other treatments which is at par with T_8. T_7treatment also registered the highest grain and straw yield (4.13 t ha^{-1}/4.22 t ha^{-1} and 4.30 t ha^{-1}/4.37 t ha^{-1}respectively) closely followed by T_6. Economic analysis depicted the maximum net return and BCR obtained from T_6 which is statistically at par with T_7 due to low cost of cultivation. It is concluded that tedious, time consuming and costly hand-weeding can be profitably replaced by the application of Imazethapyr 10% SL @ 2000 fb 2000 ml /ha, which have satisfactory performance in remunerative weed control in DSR with better grain yields.

AISDGONF/ABS/TB/78

Fish cum sericulture: A system for approaching towards natural farming

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Fish farming can be integrated with sericulture which is a highly balanced system that benefits both ecology and economy while producing minimum waste and zero pollution to environment. This system includes 3 units: mulberry tree cultivation, silkworm rearing and fish farming. Mulberry tree cultivation secures the dyke foundation and produces mulberry leaves for silkworm rearing. The excess leave wastes are processed as ingredients of farm animal fodder. Then silkworm cocoons are processed into silk products. Silkworm pupae and faeces are collected and used as fish feed. Silkworm wastes contain higher nutritive contents than any kind of livestock or poultry manures (organic material 87%; N 2.2–3.5%; P_2O_5 2.0–2.5%) and serve as both fertilizers and feeds. Pupae, which are by-products of silk extraction of cocoons act as good feedstuff for fish. The waste water from cocoons processing factory contains large amount of protein which enriches aquatic environment especially for detritivores. After decomposing organic waste in water, inorganic elements mixed into pond sludge are restored to the mulberry dyke, providing nutrition and energy for the growth of the trees. Economic analysis of a model in China shows that 875 kg/mu mulberry leaves can yield 45 kg cocoons and36 kg pupae along with 1800kg silkworm waste. The feed conversion ratio of pupae to fish is 2:1 in this system. Fish production in this integrated system is 75 kg per cycle. Fish farmer can earn additional 25-35% profit from this system. Thus, Fish-cum sericulture has immense potential for rationalizing natural resources.

AISDGONF/ABS/TB/85

Growth, yield and quality of medicinal plant *chia* (*Salvia hispanica*) as influenced by planting method and density

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The field experiment was conducted during two consecutive *rabi* seasons of 2019-20 and 2020-21 at Central Research Farm, Gayeshpur, Nadia under Bidhan Chandra Krishi Viswavidyalaya, West Bengal with an aim to evaluate the effect of sowing density and planting methods on growth, yield and seed quality of chia during *rabi* season under sub-tropical condition. Treatments were distributed in split-plot design, with two methods of establishment (M_1, direct sowing and M_2, Transplanting) in main plot and four planting densities (S_1, 60 cm × 50 cm = 33,333 plants/ha; S_2, 50 cm × 50 cm = 40,000 plants/ha; S_3, 50 cm × 25cm= 80,000 plants/ha; S_4, 50 cm × 20 cm = 1,00,000 plants/ha) in the sub-plots. Thus, the experiment consisted of 8 treatment combinations and was replicated thrice. Crop under direct sowing with closer spacing (50cm × 20 cm) had the highest number of primary branches/plant (15.7), length of primary branches (38.4cm) and length of main inflorescence (25.9cm), thereby reflecting superiority of this treatment combination over others. The same treatment combination produced significantly the highest grain yield (671.7 kg/ha), stem yield (1109.4 kg/ha), husk yield (375.2 kg/ha) and harvest index (31.2). The greatest economic response in terms of Gross Return (228.4×10^3Rs./ha), Net Return (166.3×10^3Rs./ha) and Benefit-Cost Ratio (3.67) was recorded in crop under the same treatment combination. Thus, it can be inferred that direct sowing of seeds at a density of 1,00,000 plants/ha (spacing 50cm × 20 cm) can be recommended as a best crop management practice for sustainable and profitable chia production in *rabi* season of West Bengal.

AISDGONF/ABS/TB/91

Conservation agriculture and biofertilizer application impact soil microbial diversity and enzyme activities under *Terai* agroecological zone of West Bengal

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This study informs the effect of long-term conservation tillage, residue retention, and biofertilizer application on the variation of microbial diversity and enzyme activities in the *Terai* Agroecological zone located in Coochbehar, eastern India. Tillage (zero-tillage and conventional), residue, and biofertilizer management were imposed on a sixteen-year continuous rotation of rice and wheat crops. After sixteen years, there were significant effects on rhizosphere microbial

activity and enzyme activities. The retention of crop residues and biofertilizer application compared to residue removal and without biofertilizer application significantly improved all measures of chemical and biological soil quality. The values of AWCD (average well color development) derived from Biolog®eco-plates, which asses the metabolic utilization of organic compounds, were higher in zero-tillage treatments than in conventional tillage treatments. Crop residue retention increased AWCD value, and the difference increased with an increasing incubation period. Our study also clearly reveals that the retention of crop residues and biofertilizer application significantly enhanced microbial indices and enzyme activities, compared to conventional tillage, and therefore contribute to sustainable cultivation in acid alluvial soil. Overall, we conclude that conservation agriculture and biofertilizer application impact soil microbial diversity and enzyme activities under the *Terai* Agroecological zone of West Bengal.

AISDGONF/ABS/TB/94

Response of hybrid mustard to different row spacing and fertilizer levels in New Alluvial Zone of West Bengal

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Mustard is an important rabi oilseed crop grown in India. It occupies 53% of total area under oilseed crop. Fertilizer application and row spacing are some factors which has significant effect on growth and yield of mustard. To access the effect of different spacing and fertilizer level, two year field experiment was conducted at district seed farm of Bidhan Chandra Krishi Viswavidyalay, West Bengal. The experiment was laid out in Split Plot Design (SPD) with four replications and the variety taken was "Kesari Gold". In this study, 2 row spacings (S_1:30×10 cm; S_2:45×10 cm) are taken as main plot treatment and 3 fertilizer levels (F_1: NPK@80-50-50 kg ha^{-1}; F_2: NPK@100-60-60 kg ha^{-1}; F_3: NPK@120-70-70 kg ha^{-1})under sub-plot treatment. Among different row spacings, highest plant height (158.4 cm), yield attributing characters like number of branches per plant (5.5), number of siliqua per plant (269) , number of seeds per siliqua (13.1) and oil content (36.6 %) were obtained at wider row spacing (S_2). Although highest seed yield (1917 kg ha^{-1}) and harvest index (32.3 %) were observed at closer spacing (S_1) due to higher plant population. In case of different fertilizer level highest seed yield (1978 kg ha^{-1}) along with plant height (162.3 cm), LAI (3.14) and dry matter accumulation (552 g m^{-2}/plant) were reported from highest fertilizer doses (F_3). But the economic analysis values conclude that S_1F_2 treatment was the highly economized with B: C ratio 2.1, hence recommended for adoption for sustainable yield of hybrid mustard.

AISDGONF/ABS/TB/95

Biofertilizers as a sustainable tool for improving soil fertility

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Producing enough food on a sustainable basis for a population that is growing swiftly is one of the biggest challenges in agriculture under the changing climatic conditions. A crucial tactic for guaranteeing food and nutritional security is improving soil productivity through nutrient management as a key strategy ensuring food and nutritional security. An adequate supply of nutrient determines crop growth and productivity. At present, crop nutrient requirement is mainly supplied through chemical fertilizers. However, perpetual and excessive use of chemical fertilizers to supplement the nutrient requirements of crops witnessed the severe deterioration of the soil's physical, chemical and biological properties. Besides, it also triggered several environmental issues endangering agricultural sustainability. To combat this, it is urgently necessary to investigate the untapped potential of organic food sources as an alternative to chemical fertilizers. Among various organic sources, bio-fertilizers are widely gaining popularity due to their recognized role in improving nutrient use efficiency, reclamation of degraded soil, nitrogen fixation, etc. Microbial bio-fertilizers, when employed for nutrient management, were reported to enhance the rate of mineralization thus improving soil fertility and e biochemical properties of soil. Therefore, it is identified as an ecologically safer and economically viable option that addresses the global demand for green technology in crop production. This study mainly focused on exploring the potential role of bio-fertilizers in ameliorating soil fertility and ensuring agricultural sustainability.

AISDGONF/ABS/TB/102

Studies on productivity, nutrient uptake and economics of *rabi* transplanted paddy as influenced by Fytovita (bio-stimulants)

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Bio-stimulant is a mixture of micro and macro nutrients, amino acids, carbohydrates, plant growth regulators and other plant growth elicitors which is gaining popularity in modern crop production. Keeping this in mind, a field experiment regarding Fytovita (Bio-stimulants) on *rabi* transplanted paddy were studied during 2021-22 in Lower Gangetic Plains of West Bengal. Experiment was formulated following RBD comprising 5 treatments and 4 replications with different doses of Fytovita as foliar spray along with RDF. Fytovita at 2.5 L/ha recorded promising results in yield and yield attributes such as productive tillers per m^2, panicle length, filled grain per panicle, test weight, grain (4.69 t/ha) and straw yield in paddy which is statistically higher than other doses and standard Biostimulant treatment. No phytoxic symptoms was observed in transplanted paddy plants in all doses of the Fytovita. Besides treatment comprising Fytovita at 2.5 L/ha showed significant nutrient uptake status compared to other treatments along with highest B:C ratio i.e.,

1.94. From this study it can be concluded that Fytovita @ 2.5 L/ha can be recommended for promising performance in crop growth, yield attributes and yield of paddy, nutrient uptake and B:C ratio.

AISDGONF/ABS/TB/103

Fertilizer prescription equation based on IPNS-target yield model for garden pea (*Pisum sativum*)

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The present investigation has been contemplated with Garden pea to elucidate the relationship between soil test values and crop response to added fertilizers, to formulate fertilizer prescriptions under IPNS by targeted yield model. The test crop (garden pea) experiment was conducted on alluvial soil (Typic Haplustepts) of West Bengal in a pre-established fertility gradient field during Rabi of 2021-22 at Central Research Farm (Gayeshpur), Bidhan Chandra Krishi Viswavidyalaya under AICRP on STCR. Four levels of each of N (0, 10, 20 and 30 kg ha^{-1}), P_2O_5 (0, 30, 40 and 50 kg ha^{-1}) and K_2O (0,10,20 and 30 kg ha^{-1}) and three levels of FYM were randomized in three pre-established fertility gradients, each comprising 21 plots. Basic parameters of target yield equation were calculated by analysing the soil and plant samples. The nutrient requirement (NR) of Garden pea for nitrogen, phosphorus and potassium were 0.28, 0.07 and 0.19 kg for the production of one quintal yields of Garden pea. The percent contribution from soil (C_s), fertilizer (C_f) and FYM (C_{FYM}) were calculated as 3.28, 48.16 and 1.10 for N, 7.52, 13.38 and 0.28 for P_2O_5 and 3.92, 36.13 and 1.24 for K_2O, respectively. Ready-reckoner developed from soil test based fertilizer adjustment equations showed that FYM application at 5 t ha^{-1} along with NPK fertilizer resulted net saving of 2.84, 2.37 and 2.46 kg ha^{-1} of N, P and K respectively, and simultaneously nutrients values are 2.86, 2.37 and 2.45 kg ha^{-1} respectively. This fertilizer prescription equation should be validated by conducting test verification trials.

AISDGONF/ABS/TB/108

Studies on carrier and liquid based bio-fertilizer on performance of lentil (*Lens esculenta*) in alluvial soil of West Bengal

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An essential crop in a sustainable agricultural system with high nutritional value is lentil (*Lens esculenta*). At the field level, liquid biofertilizer formulations are proven to produce superior results. A field experiment was carried out in the gangetic alluvial soil zone, in order to research the performance of the lentil variety WBL 77 (Moitree) at a farmer's field in Krishnaganj block, Nadia, West Bengal in the *rabi* season of 2020–21. Ten treatments were reproduced three times in the experiment, which was done using a randomised block design. Rhizobium and phosphorus solubilizing biofertilizers were utilised in liquid and carrier-based formulations. According to the findings, varied mixes of biofertilizer and inorganic fertilisers had a good impact on the growth and yield indices for lentil. In terms of growth, nodulation, and yield qualities, the recommended dose of fertilisers (RDF) with liquid-based rhizobium and PSB was determined to be superior.

However, was statistically at par with treatment RDF + Carrier based Rhizobium & PSB. Plots with 75% RDF + liquid or carrier based biofertilizers were found to be at par with treatments with RDF plus any one biofertilizer. We may conclude from the study that liquid biofertilizer formulations can improve lentil growth, nodulation, and yield.

AISDGONF/ABS/TB/109

Effect of residue management on yield, yield attributes, soil environment and weed flora in rice-mustard cropping system in Lower Gangetic Plain of West Bengal

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Rice-based cropping systems in IGP are being mechanized to reduce the COC.As a result surplus residue was burned that causes environmental hazards, deteriorate soil health which has a direct impact on succeeding crops. A field experiment was conducted during *rabi* season 2020-22 at Teaching Farm, College of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Burdwan following split-split-plot design with 3 replications, comprising 2 main plot treatments E_1: Traditional sowing and E_2: Mustard transplanting and 4 sub-plot treatments Pr_0: Traditional paddy + No residue, Pr_1: Mechanized paddy +Residue Burning, Pr_2: Mechanized paddy + In-situ residue incorporation, Pr_3: Mechanized paddy + In-situ compost by Waste Decomposer and 3 sub-subplot treatments W_1: Farmer Practice, W_2: Pendimethalin 30EC@1kg a.i. ha^{-1} + HW, W_3: Aqueous extract of *Tectona grandis*, *Calotropis procera* and *Parthenium hysterophorus* (10%v/v) @ 100ml L^{-1} +HW to study the effect of yield, yield attributes of mustard and to find out the changes in soil properties and weed flora. Mustard transplanting coupled with treatments Pr_3 showed highest yield attributes and yield of Mustard followed by Pr_2. A superior soil physical condition and normal NPK ratio was found in the treatment Pr_3. Weed flora identified in the field are *Grangea maderaspatana*, *Polygonum plebeium*, *Chenopodium album*, *Cyperus rotundus*, *Digitaria sanguinalis*. Among the weed management treatments W_2 showed better result over the farmers practices.Mustard transplanting integrated with treatments Pr_3 (Mechanized paddy + In-situ compost by Waste Decomposer) and Pendimethalin 30EC@1kg a.i. ha^{-1} + HW should promising result to be recommended.

AISDGONF/ABS/TB/110

Isolation and characterization of plant growth promoting bacteria from *Vigna radiata* rhizosphere and geyser soil for studying their effect on overall growth of rice plants

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A plant growing under field conditions is not an individual, it is a complex. The microbes of phyto-microbiome are associated with every plant tissue. Plants regulate the composition and activity of their associated bacterial community very carefully. These bacteria provide a wide range of services to the plants in return the plant provides them with reduced carbon and other metabolites. These bacteria which plays an important role in plant growth are called plant growth promoting bacteria. Here two strains of plant growth promoting bacteria which are capable of phosphate solubilising were isolated from Geyser soil as well as from the rhizosphere soil of *Vigna radiata* and given the names GB and PSB, respectively. Their Phosphate solubilising ability was determined based on their ability to form a clear or halo zone on Pikovskaya's agar medium.16S rRNA of the isolated strains were amplified using different universal primers 341F, 518R, 8F and 1492R. With the sequencing results Nucleotide BLAST was performed. GB and PSB showed maximum sequence similarity with *Pseudomonas aeruginosa* and *Bacillus circulans*, respectively. Morphological and other characterizations like antimicrobial activity were performed on the isolated strains. The strains were grown under various stress conditions to check their tolerance. Then the isolated pure strains are inoculated on the rice plants to study their plant growth promoting ability.

AISDGONF/ABS/TB/111

Studies of foliar nutrients on yield attributes and yield of *boro* rice *(Oryza sativa)*

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An experiment was conducted to study the effect of different foliar nutrients spray on the growth and yield of *boro* rice variety "Satabdi (CR 146-7027-224)" at the Agricultural Experimental Farm, University of Calcutta, Baruipur, Kolkata during the consecutive *boro* season of 2021 and 2022. The eight foliar nutrient treatments were: water spray, potassium chloride (KCl) @ 7.5 g lt^{-1}, sodium chloride (NaCl) @ 7.5 g lt^{-1}, potassium dihydrogen phosphate (KH_2PO_4) @ 7.5 g lt^{-1}, sodium dihydrogen phosphate ($NaHPO_4$) @ 7.5 g lt^{-1}, potassium nitrate (KNO_3) @ 7.5 g lt^{-1}, potassoim sulphate (K_2SO_4) @ 7.5 g lt^{-1}, NPK 10:26:26 @ 7.5 g lt^{-1} and NPK 19:19:19 @ 7.5 g lt^{-1}. These treatments were assigned in a randomized block design with three replications. Foliar nutrient treatments were applied twice at panicle initiation stage and grain development stage along with 100% recommended dose of fertilizer (RDF) and other recommended package of practices. From the salient features of the findings it was found that supplementary foliar application of NPK 10:26:26 at 7.5 g lt^{-1} (T_8) and NPK 19:19:19 at 7.5 g lt^{-1} (T_9) were superior over rest of the treatments in no of panicle per m^2, grain filling percentage, 1000 grain weight,

grain yield. There were no significant differences observed in panicle length among the treatments. Whereas the production economics were concerned the higher benefit: cost ratio (BCR) (1.66) was recorded with foliar spray of NPK 10:26:26 at 7.5 g lt^{-1} (T_8) which was at par with NPK 19:19:19 at 7.5 g lt^{-1} (T_9). Only these two treatments were found cost effective compared to control plot (1.57) BCR. From experimental studies it can be concluded that NPK 10:26:26 at 7.5 g lt^{-1} (T_8) or NPK 19:19:19 at 7.5 g lt^{-1} (T_9) supplementary foliar nutrients spray with recommended dose of fertilizer during panicle initiation and grain filling stages were capable of producing higher grain yield of *boro* rice. These treatments were also economically profitable.

AISDGONF/ABS/TB/113

Growth, yield and water use efficiency of grass pea (*Lathyrus sativus* L.) as influenced by phosphorus, micronutrients and organics in New Alluvial Zone of West Bengal

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A field experiment was carried out to examine the crop performance and water use efficiency of grass pea (*Lathyrus sativus* L.) as influenced by phosphorus, micronutrients and organics in New Alluvial soil during *rabi* season of 2020-21 at the Teaching Farm, Bidhan Chandra Krishi Viswavidyalaya, Mondouri, Nadia, West Bengal. The experiment on lathyrus was done by using 10 different nutrient management techniques with three replications in randomized block design. According to the experiment's findings, the lathyrus plot that received the recommended dose of fertilizer (N, P_2O_5 and K_2O at 20, 40 and 20 kg ha^{-1} respectively) and treated with foliar application of Borax @ 0.5% had the highest plant height, number of branches $plant^{-1}$, dry matter accumulation, number of pods per plant, pod length, number of seeds per pod and seed index. The plot treated with RDF + Borax @ 0.5% yielded the maximum amounts of seed (1450 kg ha^{-1}) and stover (2513 kg ha^{-1}) and recorded highest WUE (10.00 kg ha^{-1} mm^{-1}). In terms of quality parameter, the plot fertilized with RDF and ammonium molybdate @ 0.1% had the greatest seed protein content (31.18%). From the experiment it can be inferred that applying RDF and borax together at a rate of 0.5% to grass peas is one of the best options for increasing both the quality and quantity of the crop's output for cultivation in West Bengal's New Alluvial Zone.

AISDGONF/ABS/TB/116

Effect of different planting geometry for crop-weed interventions in chickpea under New Alluvial zone of West Bengal

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A field experiment was conducted during *rabi* season of 2020-2021 at District Seed Farm (AB Block), Bidhan Chandra Krishi Viswavidyalaya to study the consequences of varied planting geometry on yield and crop-weed interventions of Chickpea (*Cicer areitinum* L.) under new alluvial zone of West Bengal. The treatment consisted with three inter row spacing (30 cm, 40 cm and 50 cm) combined with five intra- row spacing (10 cm, 20 cm, 30 cm, 40 cm and 50 cm). The experiment was laid out in Randomized Block Design in twelve treatments of three replications. Wider spacing of 50 cm inter- row and 50 cm intra- row showed significantly highest number of primary branches per plant (5.47 nos.), secondary branches per plant (14.83 nos.), number of pods plant^{-1} (91.98 nos.), number of seeds pod^{-1} (1.33 nos.) and seed weight (15.37 gm). Significantly the highest seed yield (1500.70 kg ha^{-1}) was obtained with 30 cm inter- and 10 cm intra- row spacing where the lowest (709.65 kg ha^{-1}) seed yield was found in 50 cm inter- and 50 cm intra-row spacing. Following the same result treatment combination with 30 cm inter- and 10 cm intra-row spacing had significantly highest weed control efficiency (63.63%) over others. Highest benefit-cost ratio (2.45) was achieved from the treatment with 30 cm inter- and 10 cm intra-row spacing. Thus, 30 cm inter- and 10 cm intra- row spacing can be recommended for chickpea production over consecutive wider spacing.

AISDGONF/ABS/TB/118

Impact of late sowing on nodulation, crop growth rate and seed yield of lentil

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Lentil (*Lens culinaris* Medik.) is an important *rabi* season crop, that has long been prized for its significant ability to fix atmospheric nitrogen. It has been found that in India, the majority of lentil sowings are delayed due to delayed harvest of the preceding crop, which is most often long duration rice. As a result, the crop growth gets impeded in number of ways. To understand the variation in growth and yield between normally sown (15 Nov) and late sown (30 Nov), this experiment was conducted in two subsequent rabi seasons (November-March) at the District Seed Farm of BCKV, Kalyani during 2019-2020 and 2020-2021. The late-sown lentil had a greater nodule count at pod initiation (60 DAS) while, the normally-sown lentil had a higher nodule count in the early maturity stage (90 DAS). When comparing the crop growth rate (CGR) of lentils planted on 15th November and 30th November, we found that early seeded lentils recorded higher CGR during both the vegetative phase (30-60 DAS) and the reproductive phase (60-90 DAS). In case of seed yield, the result of the experiment showed that the seed yield from lentils planted on the 15th of November (2340 kg.ha^{-1}) was substantially higher than that of the crop planted on the

30th of November (1630 kg.ha^{-1}). The experimental findings revealed the impact of late sowing of lentils on it's different growth indices and seed yield. Hence, farmers of new alluvial zone of West Bengal are suggested to complete the sowing of lentil within first fortnight of November for ensuring a better crop yield.

AISDGONF/ABS/TB/119

Performance of ricebean [*Vigna umbellata* (Thunb) Ohwi and Ohashi] as influenced by biochar and pig manure amendments under fine typic Kanhapludalf soil

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Rice bean also known as red bean, oriental bean and climbing mountain bean is one of the important pulse crops in Northeast India. This crop has immense potential due to its high nutritional quality, high grain yield and multipurpose usage as food, fodder, cover crop and green manure. Biochar is the carbon-rich product produced by thermal decomposition under limited supply of oxygen called pyrolysis. Incorporation of biochar can enhance soil fertility while improving crop productivity. Pig manure being most abundant in the Northeastern region is a great way of recycling plant nutrient. The current research aimed to study the influence of biochar and pig manure on the performance of rice bean. A field experiment was conducted during *Kharif* season of 2019-2020 and 2020-2021. The experiment was laid out in randomized block design with 11 treatments and 3 replications. Growth and yield parameters were recorded and plant samples were analyzed for nutrient contents and their uptake. Physico-chemical and biological properties of post-harvest soil were determined. The data were analyzed and computed statistically to compare the treatment effect. The growth and yield attributes influenced markedly with combined application of biochar, fertilizer and pig manure. These result may attribute to the improvement of soil properties, in addition enhanced microbial community following the application of treatment @ RDF + 2.0 t ha^{-1} pig manure + 5.0 t ha^{-1} wood biochar in acidic soil. Combined application of treatment also improved the nutrient status of the post-harvest soil. Application of RDF + 2.0 t ha^{-1} pig manure + 5.0 t ha^{-1} wood biochar gave the best result over the other treatment to sustain the productivity and maintenance of acid soil in north-eastern region.

AISDGONF/ABS/TB/128

Response of soybean varieties to integrated nutrient management in Lower *Gangetic* Plains of West Bengal

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Field experiment was carried out during *kharif* 2019 and 2020 under sub-humid climate at Instructional Farm of BCKV, Jaguli, Nadia to study the effect of integrated nutrient management on yield, quality, nutrient uptake and production economics of soybean varieties in a factorial RBD having three soybean varieties [V_1-PS 1225, V_2-YEZIN 15 and V_3-PS 24] as factor A and five nutrient treatments [N_1-100% RDF (N:P_2O_5:K_2O @ 20:60:40 kg/ha), N_2-75% RDF+3 t/ha FYM,

N_3-75% RDF+1.5 t/ha vermicompost, N_4-75% RDF+3 t/ha FYM+25 kg/ha $ZnSO_4$ and N_5-75% RDF+1.5 t/ha vermicompost+25 kg/ha $ZnSO_4$] as factor B with three replications. The experimental soil was sandy loam (*entisol*) with neutral pH, low available N and Zn, high P_2O_5, and medium organic C and K_2O. Pooled results revealed that among the varieties, PS 24 excelled other two varieties in terms of yields, nutrients uptake and economics. Further, N_5 nutrient treatment was found superior than others. Similarly, the interaction effects of V_3N_5 exhibited highest seed yield (2601 kg/ha), stover yield, (5241 kg/ha), protein content (41.42%), uptake of nutrients (186.93 kg N, 21.90 kg P_2O_5, 130.24 K_2O and 216.84 g Zn/ha), gross return (Rs. 75,448/ha), net return (Rs. 42,994/ha) and benefit-cost ratio (2.32) than other combinations. However, maximum seed oil content (21.18%) was obtained with V_2N_1. Therefore, the variety PS 24 along with application of 75% RDF plus 1.5 t/ha vermicompost and 25 kg/ha $ZnSO_4$ can be recommended for *kharif* soybean in lower Gangetic plains of West Bengal.

AISDGONF/ABS/TB/131

Effect of different methods of crop establishment and nutrient management practices of Indian mustard cv. Kesari Gold in lateritic soil of West Bengal

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A field trial was conducted during *rabi* season of 2019-2020 to study "Effect of different crop establishment methods and nutrient management practices of Indian Mustard (*Brassica juncea* L.) Palli Siksha Bhavana, Visva-Bharati, Sriniketan, Birbhum. The treatment comprised of three methods of crop establishment (transplantation, broadcasting and line sowing) as main plot and four nutrient managements such as 60:30:30 (NM_1); 70:35:35 (NM_2); 80:40:40 (NM_3) and 90:45:45 (NM_4) of N:P_2O_5:K_2O kg ha^{-1}respectively as sub plot and replicated thrice in split plot design. The outcomes indicated that transplanting method with the nutrient management NM_4(90:45:45 of N:P_2O_5:K_2O kg ha^{-1}) was significantly superior in terms of growth attributes, yield parameters, productivity (2320 kg ha^{-1})and profitability as compared to the other sowing and nutrient management practices. Transplanting method of sowing showed optimistic and favorable consequences on enhancing growth parameters, yield attributes and productivity [seed yield (1586 kg ha^{-1}) and stover yield]. Transplanting reported maximum gross return, net return and benefit-cost ratio of mustard. The nutrient management also expressed optimistic and favorable consequences on enhancing almost all growth and yield parameters of mustard under this research. The fertilizer dose, NM_4 i.e. 90:45:45 (N:P_2O_5:K_2O kg ha^{-1}) expressed a meaningful impact on increasing almost all the growth and yield parameters, and seed yield (1883kg ha^{-1})of mustard and ascertained maximum profitability.

AISDGONF/ABS/TB/133

Effect of different organic sources of nitrogen on dual purpose ricebean (*Vigna umbellata* (Thunb.) Ohwi and Ohashi)

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Legume fodders plays a crucial role in crop production, nutritional security of livestock apart from enhancing soil health. Among several fodder legumes one of the potential legume is Ricebean. Legumes fix atmospheric nitrogen but timely and adequate nitrogen requirement as a booster dose in the initial stages plays a key role. Now a days, soil degradation and so different organic sources of nitrogen plays crucial factor in ricebean production. Different organic nitrogen management practices are T1 : 100% RDN through inorganic fertilizers, T2 : 100% RDN through FYM, T3 : 75% RDN through FYM+25% RDN through vermicompost, T4 : 75% N through FYM+25% RDN through Bio-compost, T5 : 50% RDN through FYM+50% RDN through vermicompost, T6 : 50% RDN through FYM+50% RDN through Bio-compost, T7 : 75% RDN through FYM, T8 : 50% RDN through FYM+25% RDN through Vermicompost+25% RDN through Poultry manure, applied on Bidhan ricebean 2 variety laid in Randomised block design at Central research farm, Gayeshpur, B.C.K.V. Growth and yield parameters were significantly influenced by different organic nitrogen sources. Green forage yield, stover yield and seed yield were significantly highest with application of 50% RDN through FYM+50% RDN through vermicompost. Hence, integrated use of organic sources of nitrogen will greatly influence the growth of dual purpose ricebean. Further research can be extended in this field by use of other organic manures like poultry manure, sewage extracts etc. Keeping more focus on soil health, microbial status, enzymatic activity etc. in underutilized legumes fodders like ricebean.

AISDGONF/ABS/TB/136

Long term conservation agricultural practices on aggregate stability and AM fungi dominance in an inceptisol

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The potential of conservation tillage to store soil organic carbon is considerably increased and high biodiversity ecosystems absorb or store more carbon than low or decreased richness ecosystems. Based on combined behaviour of carbon pools (physically, chemically, biochemically protected and non-protected pools), soil organic carbon stabilization as a factor of carbon input levels. Since SOC is strongly related with the biogeochemical cycles of most major nutrients and provides energy as substrates for microbial activities and it was employed as a critical indicator to evaluate variance in soil quality. The novelty of the study was determining the impact of conservation agriculture practices on various labile and stabilized pools of carbon and their relationship with biochemical stability through arbuscular mycorrhizal fungi (AMF). Keeping in view above points, a work entitled "Long term conservation agricultural practices on aggregate stability and AM fungi dominance in an inceptisol" has been done. When compared to treatments using conventional agriculture, the CA-based treatments significantly increased soil aggregation.

The result of mean weight diameter (MWD) showed that the CA (ZT-2 and ZT-1) practices had a greater impact on the MWD than the CT practices. Regardless of tillage, the weed control techniques WC, WFC, PRE+HW, and PRE+POST had a substantial impact on the fraction of macroaggregates. The release of polysaccharides and organic acids during the decomposition of crop wastes may be the cause. Arbuscular mycorrhizal fungi release this glycoprotein glomalin. When compared to only zero tillage and conventional plots, the concentration of glomalin proteins in the current study was highest in the plots containing ZT with brown manuring. It also decreased with depth across all treatments. Tillage methods and weeds significantly affected the population of AMF spores in soil at surface depth. The highest level of spore counts in soil was found in zero tillage with brown manuring treatment as compared to conventional one. The richness of spores recorded from each of the AMF species was attributed to soil organic carbon and the population of AMF spores was highly correlated with the soil organic carbon.

AISDGONF/ABS/TB/137

Effect of sowing time, tillage and variety management on growth, yield parameters, nitrogen uptake and economics of lentil after *kharif* rice in New Alluvial Zone of West Bengal

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[*Based on a part of the Ph. D. (Ag.) Thesis work of the 1st author]

A field experiment was carried out during the consecutive two *rabi* seasons of 2018-19 and 2019-20 at District Seed Farm, B.C.K.V., Kalyani, West Bengal to ascertain the impact of sowing timing, tillage operation, and variety on the growth, nodulation, yield characteristics, nitrogen uptake and economics in lentil. The investigation was laid in a split-split plot design with 3 replications comprising two different sowing condition (S_1: early sowing after harvesting of short duration *kharif* rice, S_2: delayed sowing after harvesting of long duration *kharif* rice) in main plots, three different tillage operations (T_1: Relay cropping, T_2: Zero tillage, T_3: Conventional tillage) in sub plots and two different varieties (V_1: short duration: L4717, V_2: long duration: Moitri) in sub-sub plots. Pooled data showed that early November sown crop in combination with zero tillage and short duration variety after harvesting of short duration rice resulted significantly higher values regarding growth attributes (plant height, dry matter accumulation, LAI) at observed stages, nodulation, yield attributes and yield (seed yield- 1362 kg ha^{-1}, stover yield- 2657 kg ha^{-1}) of as compared to late November sown crop combined with other tillage operations taken with long duration variety after harvesting of long duration rice. Total N uptake by lentil grain and stover also followed the similar trend to the growth and yield attributes of lentil. Maximum gross return (Rs. 82660 and 93237) net return (Rs. 51220 and 59257) and B:C ratio (2.63 and 2.74) under treatment combination early sowing + zero tillage + short duration variety in the experiment with near minimum cost of cultivation for both years was also calculated for lentil cultivation. Based on the results obtained in the present study, the combination of early sowing + zero tillage + L4717

variety after harvesting of short duration *kharif* rice may be recommended for the farmers regarding lentil cultivation in this zone.

AISDGONF/ABS/TB/140

Growth, yield and uptake of heavy metals in *kharif* rice under integrated use of municipal solid bio-waste compost and chemical fertilizer in New Alluvial Zone of West Bengal

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Municipal solid waste (MSW) disposal is currently a major global concern. Since the organic fraction represents a large portion of the generated waste, mainly from domestic wastes, this biodegradable portion could be recycled as compost and used as a potential source of plant nutrients instead of being lost through improper disposal/treatment. A series of field experiments of potato-okra-rice cropping system were conducted for two consecutive years during *rabi*, *pre-kharif* and *kharif* seasons of 2017-18 and 2018-19, respectively at Regional Research Sub-Station (RRSS), Chakdaha, Nadia under Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal with two types of composts i.e., municipal solid bio-waste compost (MSBWC) and commercial compost (CC) which were integrated with 50% and 100% RDF level of chemical fertilizer and biodegradable mulch sheet. All the growth attributes (Plant height, number of tillers per m^2, LAI and dry matter accumulation) recorded highest with the application of 100% RDF+ SSMSBWC @ 3.75 t ha^{-1} + biodegradable mulch (T_7)during all the observation i.e., 30, 60 and 90 DAT. Compared to control treatment (T_1), 43.27% more dry matter accumulation was recorded in case of MSBWC. Among yield attributes, number of panicle m^{-2}, grain and straw yield were recorded highest under T_7 treatment whereas, panicle length and test weight observed highest in 100% RDF + CC @ 3.75 t ha^{-1} + biodegradable mulch (T_6) treated plot. Heavy metals like Cd, Pb and Ni concentration in the component crops were lower in the organically amended soil. This may be due to organic carbon in the form of humus soil decreased the bioavailability of Cd and Pb by complexation, adsorption and precipitation. The efficient use of MSBWC with chemical fertilizers and biodegradable mulch not only increase the growth and yield attributes of high yielding varieties of *kharif* rice but it is also so much vulnerable for our environment in the context of MSW management.

AISDGONF/ABS/TB/152

Assessment of heavy metal contamination in leafy vegetables grown on sewage irrigated soils in Kolkata

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Vegetable crops are extensively grown around the landfilling site of Dhapa, Kolkata as well as on the banks of sewage canals. A substantial quantity of heavy metal (HM) contamination in agricultural soil as well as in cultivated crops was caused by the long-term usage of sewage water as irrigation and of compost made of dumping waste, containing a significant amount of HMs viz. Cd, Cr, Ni, Pb, and Cu. In order to determine the health risks associated with consuming HM-contaminated vegetables in sewage irrigated peri-urban areas of Kolkata, a thorough survey has been conducted during pre-monsoon season of 2021-22. Soil and leafy vegetable samples were collected from a different locations using GPS. Following sample digestion with a di-acid mixture, the sample extracts were analyzed for HMs using Atomic Absorption Spectrophotometer. Translocation factor (TF), daily intake of metal (DIM) were evaluated based on HM content in soil and plant samples on dry wt. basis. The relative abundance of HMs in leafy vegetables was found to be in the order of Cu>Ni>Pb>Cr>Cd, whereas the highest TF was calculated for Ni followed by Cd indicating their bioavailability and easy of translocation to leafy vegetables. The order of DIM through consumption of leafy vegetables was found to be in the same order as their relative abundance. Despite highest accumulation of Cu, Cr was found to be showing maximum health risk. Being hyper accumulators of HM, spinach, and amaranthus showed maximum health risk among the leafy vegetables.

AISDGONF/ABS/TB/155

Study on evaluation of various principles of drip irrigation for banana cultivation in New Alluvial Zone of West Bengal

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Irrigation is the backbone of modern-day agriculture. It is important to search and adopt suitable irrigation practices which could considerably reduce the irrigation water requirement by optimizing the need and the availability of water. Banana is one of the most important leading fruit crops in India as well as West Bengal. But banana is a long duration crop and requires large amount of water for its entire plantation period. Therefore, application of irrigation water through drip system could be used as an effective and water saving alternative to conventional application of irrigation water for this crop. The present study was aimed to find a suitable irrigation practice which could considerably reduce the irrigation water requirement for banana plantation. In this experiment, 4 irrigation treatments namely, conventional method, moisture deficit method, proposed modified method and IW/CPE = 0.8 were practiced with 3replications for each treatment. In T_1 treatment, irrigation interval was fixed at 2 days in summer and 5 days in winter.

In T_2 treatment, irrigation was applied through drip method at fixed soil moisture deficit (at 0.4 bars in summer & 3.5 bars in winter). In T_3 treatment, irrigation water requirement was determined following modified Shawrzman and Zur (1985) and required amount of water was applied at fixed interval (2 days in summer and 5 days in winter) through drip irrigation. T_4 treatment was the control drip treatment. The results of the study revealed that the minimum irrigation water requirement was in T_3 treatment (662.40 mm) while the maximum was observed in T_1 treatment i.e., (1138.94 mm) (pooled values for both the year).The saving of water was 41.67%(plant crop) and 42.02% (ratoon crop), respectively in T_3 treatment as compared to T_1 treatment. This observation evaluated that T_3 treatment held high amount of moisture in the root-zone for longer period in spite of its lower water requirement. Overall, the study resulted in identifying the modified proposed method of drip irrigation (T_3 treatment) as the most efficient principle method among the four treatments practiced in this study. Therefore, efforts must be taken to popularize this practice among the farmers in field level for sustainable and efficient utilization of available freshwater.

AISDGONF/ABS/TB/158

Effect of precision nutrient management on growth and yield of hybrid maize

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Due to heavy nutrient requirement by maize crop, over and under nutrient fertilization results in lesser yield than the genetic yield potential, leads to finally deterioration of soil health. To address this complex problem of nutrient mining and deterioration of soil health, Precision Nutrient Management is one of the ways of increasing the crops productivity and sustains the soil health. In order to evaluate the effects of Precision Nutrient Management on growth and yield of Hybrid Maize, a field experiment was conducted during *Rabi* season of 2021-22 at District Seed Farm, AB Block, B.C.K.V., Kalyani, Nadia, West Bengal in a Split-plot design with 3 replications comprising two hybrids in Main plot viz. H_1: DMRH-1301 & H_2: P3355 and 4 nutrient management practices in sub plot viz. N_1: 100% RDF, N_2: SSNM, N_3: Green Seeker & N_4: Farmers' practice. Among the growth parameters, highest plant height (cm) during tasselling (157.16 cm) and harvesting stage (296.58 cm) and highest leaf area indexat harvest (4.1) were recorded from the treatment H_2N_3 followed by H_2N_2 and lowest value were obtained from H_1N_4. The maximum grain (9.92 t ha^{-1}) and stover yield (11.85 t ha^{-1}) were obtained also from H_2N_3 plot followed by H_2N_2 and lowest yield from H_1N_4 plot. Based on the above results, it could be concluded that green seeker based nutrient management with the hybrid P3355 is most effective crop management technique for getting higher yield and return of *rabi* maize in new alluvial zone of West Bengal.

AISDGONF/ABS/TB/163

Effect of NPK fertilizers and foliar spray of zinc sulphate and borax on growth, productivity and economics of fodder oats in red and lateritic soil of West Bengal

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A field experiment was conducted during *rabi* seasons of 2020-21 and 2021-22 at Agricultural Farm, Institute of Agriculture (Palli Siksha Bhavana),Visva Bharati, Sriniketan, Birbhum, West Bengal to study the effect of NPK fertilizers and foliar spray of zinc sulphate and borax on growth, yield attributes, fodder yield and economics of oats cultivation in red and lateritic soil of West Bengal. The experiment was laid out in factorial randomized block design with sixteen treatment combinations having four levels of NPK fertilizers and four levels of foliar spray where each treatment was replicated thrice. Experimental findings pooled over two years revealed that application of NPK fertilizers @ 100:50:50 registered significantly higher respect to growth attributes, green fodder yield (36.46 t/ha), dry fodder yield (9.18t/ha) than the use of NPK fertilizers @ 80:40:40 and 60:30:30 kg/ha. Combined foliar application of $ZnSO_4$ and borax was significantly higher than sole application of borax and zinc sulphate with respect to growth attributes, green fodder yield (28.54 t/ha) and dry fodder yield (6.37 t/ha) of oats. Treatment with 100:50:50 kg/ha of NPK fertilizers exhibited significantly higher gross return (Rs. 54685/ha), net return (₹25681/ha) and return per rupee invested (₹1.89) and combined foliar spray of ZnSO4 and borax exhibited significantly higher gross return (₹42812 /ha), net return (Rs. 15517/ha) and return per rupee invested (1.54) over other treatments. Thus, NPK fertilizers @ 100:50:50 kg/ha and combined foliar application of $ZnSO_4$ and borax appeared to be promising for obtaining higher fodder yield and profitability from oats.

AISDGONF/ABS/TB/164

Response of mustard (*Brassica juncea* L.) cultivars to date of transplanting in lateritic soil of West Bengal

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A field experiment was conducted during *Rabi* season of 2020-2021 at Agricultural Farm of Palli Siksha Bhavana, Visva-Bharati, West Bengal, to study the response of mustard (*Brassica juncea* L.) cultivars to date of transplanting in lateritic soil of West Bengal". The field experiment design was in factorial RBD with 3 replications and two factors- Factor A (3 mustard cultivars-NRCHB 101, Kesari Gold and Kesari 5111) and Factor B(4 transplanting dates - 3rd, 14th, 25th November and 6th December). The results showed that cultivar Kesari Gold recorded maximum plant height, leaf area plant^{-1}, dry matter accumulation and CGR over other cultivars. Kesari Gold recorded higher number of branches plant^{-1}, siliquae plant^{-1}, seeds siliqua^{-1} and highest seed yield (1107 kg ha^{-1}) and stover yield (2154 kg ha^{-1}) in comparison to NRCHB 101 and Kesari 5111.The different

date of transplanting also showed positive and favourable influence on improving almost all growth and yield parameters of mustard. Transplanting on 3rd November recorded significantly maximum plant height, dry matter accumulation, leaf area plant^{-1}, CGR, yield attributes such as number of branches plant^{-1}, siliquae plant^{-1}, seeds siliqua^{-1} and test weight. Highest seed yield (1361 kg ha^{-1}), stover yield (2718 kg ha^{-1}) was recorded by mustard transplanted on 3rd November. As interaction effect between cultivar and date of transplanting Kesari Gold cultivar transplanted on 3rd November recorded highest growth and yield parameters and also yield (seed yield-1751 kg ha^{-1}, stover yield-3201 kg ha^{-1}) over the other cultivars along with other date of transplanting.

AISDGONF/ABS/TB/170

Assessment of resistance and resilience of β-glucosidase activity under conservation agriculture based rice-wheat cropping system in Indo-Gangetic plain

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Alteration in land and water regimes brought on by temperature and precipitation changes as a result of climate change will have an impact on crop productivity. Concerned about possible long-term climatic change implications on agriculture, soil samples were collected from 0-15cm depth from a 11 years old long-term conservation agriculture based rice-wheat-mung bean cropping system, conducted at the Research Farm of the Division of Agronomy, ICAR-IARI, New Delhi. β-glucosidase activity following heat stress of 48°C for 24 hours and 3 days of air drying were examined in the soil samples on day 1, 15, 30 and 45 days after stress. The activity of β-glucosidase in the soil samples varied from 20.2 µg PNP g^{-1} h^{-1}to 49.6 µg PNP g^{-1} h^{-1}which was obtained in fully conventional plot and triple zero tillage with triple residue retention treatment, respectively. Fully conventional treatment had 59% less β-glucosidase activity than zero tilled treatment. β-glucosidase activity was significantly reduced by heat and moisture stress. The triple zero tillage with triple residue retention treatment demonstrated the highest resilience and resistance to heat and moisture stress among all the zero tilled treatments. The recovery rate of enzyme activity ranged from 69% to 85% at 45 days after stress. The effect of zero tillage and long-term residue incorporation significantly affected the stability of β-glucosidase activity. Triple zero tillage with triple residue retention may be recommended to farmers in the Indo-Gangetic plain under a conservation agriculture-based rice-wheat system.

AISDGONF/ABS/TB/174

Performance of sesamum (*Sesamum indicum* L.) grown with production components constraints in New Alluvial Zone of West Bengal

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The experiment was conducted during summer season of 2020 and 2021 at Jaguli Instructional Farm, Jaguli under Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. The soil of the experimental field was sandy loam in texture with organic carbon content was 0.59 % and available N, P_2O_5 and K_2O contents were 188.4, 24.9 and 159.8 kg ha^{-1} respectively. Each and every production component positively impacted crop growth; however, the most sensitive factor was fertilizer, which was followed by irrigation and weeding. Plant protection factors had little to no impact on crop growth. The application of fertilizer was strongly correlated with increased growth and yield attributes, hence of the four components, the fertilizer component had the greatest influence on yield attributes. Among the four components the most crucial component was fertilizer component followed by weeding, irrigation and plant protection which were associated with seed yield. The seed yield was reduced by 25.6% when the fertilizer component was skipped, followed by weeding by 23.9%, irrigation by 14.3%, and plant protection by 3.7%.The yield reduction was more profoundly noticed when two components were skipped off and it was found comparatively more when fertilizer component was skipped off with weeding (T7) it was 31.1% and with irrigation (T6) it was 30.7%.The highest BCR was found under the treatment T11 [FP-(Weeding +PP)] and lowest was recorded with the treatment T2 (FP-Fertilizer). Therefore, the fertilizer component of sesame was a more crucial resource component that could not be compromised in order to increase profit.

AISDGONF/ABS/TB/178

A review on zero budget natural farming: a path towards sustainable agriculture

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Agriculture is an important sector in India. It is indispensable for the sustenance and growth of the Indian economy. Most of the farmers heavily depend on inorganic external chemical inputs such as fertilizers and pesticides that contaminate ground water and other water-dependent ecosystems, reduce soil fertility over time. A continuous use of pesticides and chemicals is a serious problem for the health of farmers across India. Sixty percent of the Indian population will experience severe food deficiencies by 2050. Increased food production is urgently needed, but the high cost of production, fluctuating prices in the market are driving farmers into debt. Witnessing the harmful effects of chemical farming, newly introduced agriculture technique among farmers is zero budget natural farming (ZBNF), also known as zero budget spiritual farming (ZBSF). ZBNF is the best solution to reduce the input cost of farmers. The word zero budget means “no credit” and natural

farming means "growing of crops without chemicals". Japanese agriculturist, M Fukuoka 1st developed natural farming in the world and the same trend was made in India by Mr. Subhash Palekar. Zero budget farming promises to drastically cut production costs. Zero budget farmers use mulching, soil protection techniques, natural pesticides and fertilizers. The principal methods of zero budget natural farming has basically four pillars *jivamrita*, *bijamrita*, *acchadana* (mulching) and *whapasa*. These four concepts help better soil health, increased microbial population and enhanced crop yield. This paper deals to find opportunities and actions to increase the demand of natural farming over chemical based conventional farming system.

AISDGONF/ABS/TB/180

System of mustard intensification – A review on a revolutionary way to boost the production of mustard in India

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The system of mustard intensification is a very new initiative for enhancement ofrapeseed-mustard production over the conventional method of sowing. Though the optimum time of sowing of the oilseed *Brassica* is the first fortnight of October to first week of November but sowing of these crops get delayed to the end of November to the first week of December owing to the delayed harvest of *kharif* rice or post monsoon rains especially in eastern India due to which productivity of rapeseed-mustard declines. Besides in order to accommodate multiple cropping systems on scarcely available land, transplanting of seedlings rather than direct seeding of rapeseed-mustard could be practiced.To overcome the problem of late sowing a new method of intensification is being developed known as System of Mustard Intensification (SMI). This method is ensuring high return, with a lower seed rate. In this method, seedlings are raised in a different nursery bed or trays or polythene bags or micro pots and later transplanted (20-25 DAS) in main field after the harvest of *kharif* paddy to successfully overcome the problems of late transplantation. Transplanting the seedlings of rapeseed-mustard could offer such an option to boost the seedling growth and yield, which is already being practiced and demonstrated by many agriculturists in some irrigated rapeseed-mustard growing regions in the country like Umaria and Sehore districts of Madhya Pradesh, some parts of north Bengal. A system of mustard intensification depends on low density of crop and seeks to utilize the full potentiality of each plant, rather than on communities of plants as done with high-density planting. Under SMI, crop geometry is 60cm x 30cm and seedlings about 20 days old are transplanted. System of Mustard Intensification (SMI) will be very helpful among the resource-poor farmers to use less water and seeds and yet achieve significantly higher yields.

AISDGONF/ABS/TB/187

A review on carbon sequestration: a long-term approach to pollution reduction, improved air quality, and decreased health hazards

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The burning of fossil fuels and changes in land use have increased atmospheric CO2 concentration by 31% since 1750, which calls for the development of methods for reducing the hazard posed by the ensuing global warming. Global carbon (C) emissions since the industrial revolution are estimated to be 270±30 Pg (Pg = petagram = 10^{15} g = 1 billion tonne) due to the burning of fossil fuels and 136±55 Pg due to land use change and soil cultivation. Deforestation, biomass burning, converting natural ecosystems to agricultural ones, draining wetlands, and soil cultivation are just a few of the emissions brought on by changing how land is used. The International Panel on Climate Change identified three key possibilities for the agricultural sector to reduce atmospheric CO2 concentrations: (1) reducing emissions connected to agriculture, (2) creating and enhancing soil carbon sinks, and (3) producing biofuels to replace fossil fuels. In current scenario the requirement to lower greenhouse gas concentrations in the atmosphere, options for sustainable sequestration of C in the soil through customised management of land resources are examined. Such initiatives will also support the reversal of land degradation processes, enhancing food security and productivity for those living in the affected regions.

AISDGONF/ABS/TB/190

An assessment on potassium pool by quantity- intensity parameters of some rice growing soils of India

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Potassium exchange equilibrium parameters were outcome from quantity-intensity isotherms, viz potential buffering capacity (PBC^K), labile K (K_L), specific K (K_o) , specific K sites (K_x) equilibrium activity ratio (AR^K) , non-specific K (K_s) and free energy of K replenishment (-ΔG). The potassium (K) supplying capacity of three rice growing soils of India was investigated by employing the quantity –intensity approach. Non-specific K values changes among three different soils may be attributed to the changes in clay mineralogy and organic matter content. The values of AR^K at equilibrium ranges of three different soils Bhanderdihi, Mohanpur and Moukhali are 0.034, 0.0051, 0.0050 $(mol\ L^{-1})^{0.5}$. The decreasing trends of AR^K values suggested that bulk of K was preferentially held at edge position of the clay crystals. PBC^K of three native soils Mohanpur, Moukhali and Banderdihi are 109.1, 116.7 and 111.2 $Cmol_c kg^{-1}$ $(mol\ L^{-1})^{0.5}$. The variation among these soils associated to the changes in soil- clay mineralogy. These values indicate all three soils possess good supply of K besides its higher potential to replenish K concentration in soil solution. Potassium potential of the soils expressed as free energy change ranged from -8.26 to -13.35 KJ mol^{-1}. With increasing or decreasing PBC^K value free energy change increases or decreases. The changes of Q/I parameters is associated with the contents of clay, organic matter and clay

mineralogy of the soil. High exchangeable cation in soil matrix and higher cation exchange capacity (CEC) favours labile K, specific K and specific K sites. Equilibrium activity ratio of potassium increases with decreasing free energy change as well as increasing CEC and exchangeable cations.

AISDGONF/ABS/TB/199

Studying the radiation interception pattern of green gram of Lower Gangetic Plains of West Bengal and delineating future yield based on RUE

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Capturing of photosynthetically active radiation (PAR) and its conversion directly regulate crop yield and biomass production. A field experiment based on studying radiation interception pattern of green gram was carried out during 2017 and 2018. Three commonly grown varieties of green gram (*viz.Samrat, PM*05 and *Meha)* were selected. The behaviour of PAR components throughout the growth phases were observed for individual varieties. A Radiation Use Efficiency (RUE) based equation irrespective of varieties was also generated to assess the future yield of green gram. *PM*05 with the highest radiation use efficiency (1.786 g MJ^{-1}) produced 3 to 4% higher pod and 4 to 15% more biomass than *Samrat* and *Meha*. The results revealed that enhanced thermal condition would trigger the crop maturity by 9 to 15 days in future. Subsequent reduction in green gram biomass and yield would be 7.60-11.70%10.19-14.17% respectively on an average during 2040 to 2090. Both the present study and the other supporting literatures indicate that future yield prediction under projected climate based on "radiation to biomass" conversion efficiency can be used successfully as a method to evaluate climate change impact in agriculture.

AISDGONF/ABS/TB/207

A review on biological control for pest management under natural farming on special emphasis on sustainable development goals (SDGS)

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The possible advantages of using a biological control agent are to accomplish the Sustainable Development Goals (SDGs) of the United Nations. Economic, social, and environmental are the major components of sustainability. Nowadays, a wide range of agro-ecological activities are expanding in response to worries about food safety and the environment. The advancement of sustainable farming practices demonstrates how it supports the majority of the SDGs in a number of different ways. But, uncontrolled use of agricultural chemicals, particularly insecticides and pesticides, leads to hazardous residues in food, soil, air, and water and prompted the development of pest resistance. Additionally, the compound also have an impact on soil enzymes, which are important for soil catalysis. Therefore, in order to support the soil's micro and macro fauna and make the soil alive, we need organic farming systems that replenish rather than deplete the soil's organic matter. This makes the system more sustainable. Therefore, increasing food production in

a safe and sustainable manner is necessary to ensure global food security for increasing population. Sustainable agricultural techniques are made it possible by the employment of predators and parasitoids. The biological control "systems approach" against insecticide-resistant pests, that includes reducing the use of pesticides, is a key element of integrated pest management. In this review we have discussed about the importance of non-chemical pest management for sustainable agriculture.

AISDGONF/ABS/TB/208

System of mustard intensification through micropot technique in alluvial soil of West Bengal

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A field experiment was conducted during *rabi* season of 2021-22 in factorial randomized block design (FRBD) at the farmer's field at Thakurnagar (22°55'12" N latitude and 88°45'00" E longitude and 6.5 m altitude), North 24 Parganas to assess the performance of three mustard varieties (Bond, Keshari Gold and Shivani) grown in three different planting geometry (50 cm × 50cm, 60cm × 45cm and 60cm × 60cm) through micropot cultivation technology. Results revealed that maximum plant height (153.01 cm) and number primary branches (18.67) were recorded by hybrid mustard variety Keshari gold. Significantly highest plant height (141.21 cm) and number of primary branches (17.22) were obtained at planting geometry 60cm x 60 cm. Whereas in yield attributing characters Keshari gold also recorded significantly highest number of siliquae plant (1596.89), 1000 seeds weight (4.11 g) and seed yield (888.67 kg ha^{-1}). Among the different planting geometry the mustard crop transplanted at 50cm x 50 cm recorded the highest (1513.67) number of siliquae per plant and seed yield (900.11 kg ha^{-1}). The results clearly had shown that Keshari gold variety was superior among the rest of the varieties (Bond and Shivani) and 50cm x 50cm spacing was optimum for mustard intensification for higher yield as the other two larger spacing (60cm x 45 cm and 60cm x 60cm) gave excessive vegetative growth and that lowers the yield potential. Keshari gold variety spaced at 50 cm x 50 cm distance exhibited highest benefit cost ratio (1.47) also.

AISDGONF/ABS/TB/210

Climate-smart agriculture through precision nutrient management

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One of the essential elements of precision agriculture is precision nutrient management, which controls all the critical challenges of increasing productivity, sustainability, profitability, and turbulence caused by climate change. The goal of enhancing food grain production has been achieved with suggestions for nutrient management based on soil tests, but the efficiency of nutrient usage has remained the same. The focus of research has correctly switched to feeding the crops rather than the soil. In the present studies, more emphasis is being placed on balancing nutrient supply with plant requirements. Plant growth at any given time combines the influence of nutrient delivery from all sources, making it a more reliable indicator of its availability and a more

effective method of assessing plant nutrient demand from plants. The process of applying nitrogen to crops depending on seasonal demand has been made easier because of the availability of rapid and non-destructive tools (such as optical sensors, chlorophyll metres, and leaf colour charts) to assess the spectral features of leaves. As farmers are forced to pay the full price for nitrogen fertilisers, affordable and helpful tools like leaf colour charts are gaining popularity and will soon become prestigious equipment for every farm. In developed countries, research and application of precision management of nutrients other than nitrogen are steadily expanding. Still, developing countries need to strengthen the field for establishing recommendations for precision nutrient management based on the nutrient management models.

AISDGONF/ABS/TB/214

Crop growth and yield of rice as influenced by Integrated Nutrient Management in the Lower *Gangetic* Plains

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The field experiment was undertaken to study the "Crop Growth and Yield of Rice as Influenced by Integrated Nutrient Management in the Lower Gangetic Plains" at Jaguli Instructional Farm, Jaguli of Bidhan Chandra Krishi Viswavidyalaya during the kharif season of 2019. The experiment was laid out with eight different nutrient management practices i.e. T1 - Control (No fertilizer),T2 - NPK @ 80:40:40 kg ha^{-1} (RDF), T3 - NPK @ 80:40:40 kg ha^{-1} + Leaf manure (Subabool) 2.5 t ha^{-1} ,T4 - NPK @ 80:40:40 kg ha^{-1}+ vermicompost 2 t ha^{-1} , T5 - NPK @ 80:40:40 kg ha^{-1}+ FYM 5 t ha^{-1} ,T6 - NPK @ 80:40:40 kg ha^{-1}+ $ZnSO_4$ @ 25 kg ha^{-1} ,T7 - NPK @ 125% OF RDF ,T8 - 125% NPK (RDF) + FYM 5 t ha^{-1} + vermicompost 2 t ha^{-1} following the randomized block design with 3- replications. The result of the experiment revealed that rice plot fertilized with the combination of 125% NPK (80:40:40 kg ha^{-1}) + FYM 5 t ha^{-1} + vermicompost 2.0 t ha^{-1} recorded the highest grain yield (5.25 t ha^{-1}). The grain yield was supported by the yield components like the number of effective tillers, filled grain $panicle^{-1}$, panicle weight, and test weight. In case of nutrient uptake by the crop, the treatment of a higher dose of 125% NPK + FYM 5 t ha^{-1} + vermicompost 2.0 t ha^{-1} recorded maximum uptake of N, P, and K. Post-harvest soil analysis revealed that the fertilizer dose125% NPK (RDF) + FYM 5 t ha^{-1} + vermicompost 2 t ha^{-1}treatment had the maximum available N, P, and K in the soil. Transplanted rice during Kharif season cultivated with fertilizer dose of NPK @ 80.40:40 kg ha^{-1} + Zn @ 25 kg ha^{-1} gave the highest value of B: C ratio (2.39) followed by the dose of 80:40:40 kg ha^{-1} + FYM @5 t ha^{-1} . Cultivation of rice with 125% NPK + FYM 5 t ha^{-1} + vermicompost 2.0 t ha^{-1} gave the lowest value of B:C ratio (1.61).Based on the experimental results, it may be suggested that a combination of125% NPK of RDF + FYM 5 t ha^{-1} + vermicompost 2.0 t ha^{-1}enhanced the growth and yield of rice as well as improved the soil nutrient status in Lower Gangetic alluvial soil of West Bengal.

AISDGONF/ABS/TB/215

Establishment of phosphorus threshold for soils of West Bengal

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There is no doubt about the essentiality of phosphorus in plant nutrition and the need of phosphatic fertilizer in food production to meet the demand of ever-increasing world population. But, over use of phosphatic fertilizer would build up phosphorus level in surface waters resulting environmental pollution. The present investigation was carried out with the surface soils from five agro-climatic zones of West Bengal viz. terai, old alluvial, new alluvial, saline, and red and lateritic soil to find out their P threshold values and to establish a comprehensive model to determine the threshold value from soil parameters. The equilibrium P concentration and quantities of P adsorbed by the soils increased as the level of added P in the solution increased, but the proportion of added P sorbed followed a reverse trend in all the soils. P adsorption maxima for old and new alluvial soil, saline soil, red and laterite soil, and terai soil were found to be 1039.7 mg kg^{-1}, 1379.7 mg kg^{-1}, 428.1 mg kg^{-1}, 476.9 mg kg^{-1} and 771.6 mg kg^{-1}, respectively. The amount of P extracted by the Bray-1 method was always more than that of the Mehlich-1, regardless of soil at any level of Pmax saturation. The change point value at which there was a sharp rise in water soluble P with the addition of P, was established using segmental linear regression. The change point values measured with Bray-1 and Mehlich-1 were 62 mg kg^{-1} and 31 mg kg^{-1}, respectively for the Terai soils. While, those were 48 mg kg^{-1} and 21 mg kg^{-1} for old alluvial soils, 59 mg kg^{-1} and 23 mg kg^{-1} for red and laterite soil, 54 mg kg^{-1} and 22 mg kg^{-1} for the saline soils and 42 mg kg^{-1} and 21 mg kg^{-1} for new alluvial soil, respectively with Bray-1 and Mehlich-1 extractant. For safety reasons, it is recommended that the application of phosphate fertilizers or waste disposal should not be allowed beyond 75% of the change-point value to avoid the risk of being the soil as source of P pollution to surface waters. A detailed model on the P-threshold value for the soils of West Bengal was created using Bray-1 and Mehlich-1 extracted P as a dependent variable and soil properties were included competitively as independent variables. When organic carbon, iron, and silt contents of soils were included in the model as independent variables 94.6% variability in P-threshold value assessed by Bray-1 method could be explained. On other hand, when organic carbon, iron, cation exchange capacity and sand contents of soils were included in the model 93.9% variability in P-threshold value could be explained measured by Mehlich-1 method. Although, both soil test methods were found to be equally effective to determine P-threshold value for the soils of West Bengal, Bray-1 was superior to Mehlich-1 in explaining its variability with inclusion of minimum number of soil properties in the model.

AISDGONF/ABS/TB/216

Effect of integrated nutrient management on growth, yield and yield attributes of rice (*Oryza sativa* L.) in *Gangetic* Alluvial Zone in West Bengal

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A field experiment was conducted at the Agricultural Experimental Farm, Baruipur of Institute of Agricultural Science, University of Calcutta, during summer (Boro) season at 2018 and 2019 to evaluate the effect of different proportions of recommended chemical nutrients and different sources of organic manures and biofertilizer. Among the integrated nutrient treatments application of 75 % recommended dose of NPK along with 2.5 tones farm yard manure (FYM) and 10 kg PSB recorded higher growth attributes, yield attributes, grain yield (5.56 t/ha), straw yield (6.90 t/ha), net monetary returns (Rs 50461.3 ha) and benefit : cost ratio (1.93).

AISDGONF/ABS/TB/217

Influence of vermicompost, farmyard manure and chemical nutrients on chickpea (*Cicer arietinum* L.) yield and photosynthetic pigments

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Balanced nutrition is essential for obtaining high pulse yield. The aim of study was to find out proper nutrient management in chickpea with different sources of nutrients and photosynthetic pigments activity. A field experiment was conducted during *rabi* season of 2020-21 and 2021-22 at the AB- Block Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani. The treatments included nine nutrient management practices viz. T_1= Control (No NPK), T_2= RDF (20:40:20 NPK), T_3= RDF (20:40:20 NPK)+ Foliar spray of NPK-10:26:26 twice, T_4 = FYM @ 2.5 t/ha, T_5= FYM @ 5 t/ha,T_6= vermicompost @ 1.0 t/ha, T_7 = vermicompost @ 2.0 t/ha, T_8= FYM @ 2.5 t/ha + vermicompost @ 1.0 t/ha andT_9= FYM @ 5 t/ha + vermicompost @ 2.0 t/ha. The plant height, dry matter accumulation and number of pod per plant and photosynthetic pigments were significantly higher in FYM @ 5 t/ha + vermicompost @ 2.0 t/ha treatment. Among the treatments maximum significant yield (1550 kg/ha) was recorded in treatment $T_9$and followed by treatment T_3 (1520 kg/ha) and lowest yield (750 kg/ha) was recorded in control plot. Significant, maximum chlorophyll content was existed in T_8 treatment *fb* T_3 treatment and total chlorophyll content in leaves of chickpea were varies between 0.42 to 1.05 mg/m.

AISDGONF/ABS/TB/219

Evaluation of seed priming techniques for enhancing seed quality in sesame (*Sesamum indicum* L.)

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Sesame is known as "Queen of oil seeds" because seeds have high quality poly unsaturated stable fatty acids (PUFA). Any achievement in the crop improvement can be propagated and established in the field only through seeds. The seed priming technique with organic agents (plant and animal products) has been used for invigorating the performance of seed in many crops. With this background, the present investigation was carried out in the Seed Technology Research Laboratory of Department of Plant breeding and Genetics, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal during 2019 to know the influence of seed priming on seed quality characters of seasame (*Sesamum indicum L.*) *cv.* TMV 3. The experiment was laid out in a completely randomized design with three replications. The treatments comprised of six seed priming agents *viz*., T_1- 1% coconut water, T_2 - 1% cow urine, T_3- 3% moringa leaf extract, T_4 - 3% panchakavya, T_5- 3% arappu butter milk solution and T_6 - water and T_7 - control (untreated seeds). Among the treatments, priming of seeds with 1% coconut water registered significantly superior seed quality parameters *viz*., germination percentage (92.3%), speed of germination (31.16), seedling root length (10.47 cm), seedling shoot length (6.93 cm), seedling dry weight (0.025 g 10 seedlings^{-1}), seedling vigour index length (1450.99) and seedling vigour index mass (2.10). From the present study, it is concluded that coconut water (1%) was the superior priming agent for sesame seed quality enhancement which is cost effective, non-toxic and eco-friendly sources.

AISDGONF/ABS/TB/222

The disparity in soil organic carbon under short-term conservation agriculture in a clayey soil

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The surface (0-20 cm) soil samples were collected from plots of short-term (three years) conservation agricultural (CA) practices with rice-based cropping systems [rice-mustard-black gram (RMuB), rice wheat-green gram (RWG), and rice-lentil-fallow (RLF)] in a very fine textured soil (silt + clay-90%) of lower Indo Gangetic Plain (IGP) of West Bengal. The objective of this study was to evaluate the disparity in soil organic carbon (SOC) concentrations using different fertilizer doses, crop residues, tillage and cropping systems. Significant variation in SOC was found between 0-10 and 10-20 cm depths. The adoption of zero tillage (ZT) and reduced tillage (RT) practices increased 30.9 % and 27.9 %, 12.3 % and 15.5 % of the total SOC concentration in the 0-10 and 10-20 cm depths as compared to the conventional tillage (CT). The effect of residue or fertilizer did not affect SOC concentration, even tillage-residue interaction showed no disparity in the short-term experiments. Among the rice-based cropping system, Rice-Wheat-Green gram

showed the highest change in SOC. Minimal soil disturbance, residue addition, and inclusion of legumes or crop diversification after three years of zero tillage and reduced tillage systems improved soil organic C and thus established the role of CA in maintaining better soil aggregation in the lower Indo-Gangetic Plain.

AISDGONF/ABS/TB/224

Influence of mulching levels under varied irrigation regimes on growth, yield attributes and yield of baby corn (*Zea mays*) in lower *Gangetic* plane of West Bengal

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A field investigation was carried out at the Central Research Farm of BCKV, Gayeshpur during *pre-kharif* seasons of 2017and 2018 to study the effect of irrigation and mulch on growth, yield attributes and yield of baby corn. The experiment was designed in split-plot with three irrigation regimes in main plot like IW/CPE 1.0 (I_1), 0.80 (I_2) , 0.60 (I_3) and four mulches in sub-plot like no mulch (M_0), polythene mulch (30 µ) (M_1), paddy straw mulch @ 5t/ha (M_2) and jute mulch @ 500 gsm (M_3) replicated thrice. Irrigation regimes showed positive and favourable influence on growth, yield attributes and yield of baby corn. Pooled data of both years depicted that, the maximum increase in growth attributes like plant height (186.46 cm), leaf area index (4.46), dry matter accumulation (1654.67 g/m^2) along with yield attributes like cob length without husk(7.01 cm), cob girth without husk (7.44mm) and maximum dehusked cob and green fodder yield (1618 kg/ha and 33.13 t/ha, respectively) was obtained from the crop receiving irrigation at I_1 (IW/CPE 1.0).The lowest values of all the growth, yield attributes and yields (dehusked cob and green fodder) of the crop were recorded in I_3 (IW/CPE 0.6) irrigation regime. The mulch levels showed significant impact on increasing the growth, yield attributes and yield of baby corn. The maximum increase in the growth attributes i.e. plant height (198.00 cm), leaf area index (5.18), dry matter accumulation (1819.29 g/m^2) yield attributes like cob length without husk (8.01 cm), cob girth without husk (8.15 mm) and maximum dehusked cob and green fodder yield (1557 kg/ha and 37.20 t/ha respectively) were obtained from M_1 (polythene mulch) treatment as evident from the pooled data of both the years of experimentation. Lowest values of all the growth, yield attributes and yield (cob and fodder) were observed in M_0 (no mulch) treatment. As far as the interaction effects are concerned, application of I_1M_1 treatment (Irrigation at IW/CPE 1.0 with polythene mulch application) recorded maximum dehusked cob yield and green fodder yield (2019 kg/ha and 38.88 t/ha, respectively). So, from the experimental results, it may be recommended that irrigation scheduling at IW/CPE 1.0 along with use of polythene mulch (30 µ thickness) can be advocated to the farmers for enhancing the productivity and profitability of baby corn in lower *Gangetic* plains of West Bengal

AISDGONF/ABS/TB/225

Effect of foliar spray of sodium selenate on growth and nodulation of lentil cultivars under different irrigation levels

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The field experiment was conducted at the Regional Research Sub-Station (New Alluvial Zone) of Bidhan Chandra Krishi Viswavidyalaya (BCKV), Chakdaha, Nadia, West Bengal during Pre-Kharif 2020-21. The experiment was laid down in a split-split plot design with three replication, the main plot factor consisted of three irrigation levels (no irrigation (I_1), irrigation at 50 DAS (I_2) and irrigation at 25 and 50 DAS (I_3)) and sub-plot factor consisting five lentil varieties (Moitree (V_1), IPL 220 (V_2), L 4717 (V_3), Pusa Vaibhav (V_4) and BM 8 (V_5)) and the sub-sub-plot factor comprising four levels of foliar application (control (S_1), foliar spray of sodium selenate (Na_2SeO_4) at the rate of 10 g ha^{-1} at 35 DAS (S_2), at 60 DAS (S_3) and at 35 + 60 DAS (S_4)). Significantly different plant heights and nodules number $plant^{-1}$ and nodules dry weight $plant^{-1}$ were recorded within irrigation levels and varieties. The triple interaction effect of irrigation levels, varieties, and foliar spray of sodium selenate was significant for the plant height and it was non-significant for the nodulation of lentils. The combination of $I_3V_1S_4$ recorded the highest plant height (54.2 cm) at 90 DAS and nodule number $plant^{-1}$ (31.3) at 60 DAS.

AISDGONF/ABS/TB/226

Effects of nano zinc on growth and yield attributes of lentil (*Lens culinaris* Medik.)

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Though lentil is one the important pulse crop in India, stagnation in yield is now a major concern. One of the reasons for yield stagnation may be the low nutrient use deficiency, which in turn is due to micronutrient deficiency, particularly Zinc deficiency in Indian soil. Use of Zn as nano particle and foliar spray could be a great option for correcting Zn deficiency. Nano particle due to their small particle provide better surface contact, penetration and availability of nutrients. A field experiment was carried out during rabi season of 2019-20 and 2020-21 on sandy loam alluvial soil (Inceptisol) with medium fertility and neutral pH at the Instructional Farm, BCKV, West Bengal to find out the effect of nano zinc on growth and yield of lentil, to evaluate how nano zinc particles, used as source of micronutrient, influenced on growth and yield attributes of lentil. Seven treatments such as T_1-100% RDF (20:40:20 kg/ha N, P_2O_5 and K_2O) (control), T_2-$ZnSO_4$ @25 kg/ha soil application as basal, T_3-$ZnSO_4$ @ 0.5% foliar spray at 45DAS, T_4- Nano Zn @ 20 ppm foliar spray at 45DAS, T_5- Nano Zn @ 20 ppm foliar spray at 30 and 50 DAS,T_6- ZnO @ 20 kg/ha soil application as basal and T_7- ZnO @ 0.2% foliar spray at 45DASreplicated thrice in RBD. The standard package of practices was followed in lentil. The results revealed that foliar spray of nano Zn fertilizer @20 ppm, at 30 and 50DAS (Treatment 5) resulted highest plant height (52.03 cm), LAI (3.48) and dry matter accumulation (447.78 gm/m^2), number of nodules per plant (28.79), dry weight of nodules (12.83 mg). Treatment 4 significantly recorded highest number of pods per

plant(125.99).Again 1000 seed weight (21.25 gm) grain yield(1312.16 kg/ha), stover yield (3260.39 kg/ha) were found maximum in Treatment 5. This treatment has a positive influence on crop growth and yield attributes also. Foliar spray of zinc sulphate and zinc oxide also showed a positive effect over soil applied Zn fertilizer. Considering the above findings, it can be concluded that foliar spray of nano Zn @20 ppm at 30 and 50 DAS has a positive effect on growth and yield of lentil.

AISDGONF/ABS/TB/229

Enhance beneficial microbial population in soils of baby corn through nutrient practices in the New Alluvial Zone of West Bengal

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Baby corn (*Zea mays* L.) supplies the profitable nutrients that are needed in most people's diets. Two-year field experiment was conducted during the *rabi* season of 2018 and 2019 at the Experimental Farm of Calcutta University located at Baruipur, West Bengal after the harvest of Kharif rice to study the influence of integrated nutrient management in baby corn (*Zea mays* L.) on soil microbial population in lower Gangetic alluvial land. The experimental plot was laid out in Randomized Block Design replicated thrice having eight integrated nutrient management treatments in soil pH of 6.2 and the land was medium low land with clay loam texture. The soil micro-flora is a stimulant for creating earth as inhabit, across microbe that reason several procedures admire change as concerns nutrients and decay of wastes is occupied. Their activities are determined by management practices. Microbial populations were determined in this study, and results showed that baby corn recorded a greater number of microfloral populations at 20 DAA and after harvest viz., fungi, total bacteria, and actinomycetes under the treatment application of 75% NPK with 2.5 t vermicompos t/ha along with seaweed 2.5 litre/ha whereas low microbial count was recorded in the control plot. Evaluation of production technology particularly appropriate nutrient management strategy for baby corn is necessary for realizing higher yield and economic returns as well as soil health aspects.

AISDGONF/ABS/TB/230

Morpho-molecular characterizations of rhizobacteria collected from lentil rhizosphere

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Plant growth promoting rhizobacteria (PGPR) are also known to colonize in the soil rhizosphere and prevent the development of other soil borne pathogens residing in the root surface. These microorganisms play a vital role in growth and development of the plant and also enhance the soil fertility by enriching the soil with different beneficial nutrients. This study was aimed at isolation of different rhizobacteria and their molecular characterization in search of efficient bacterial strains with multiple growth regulating activities. A total 36 bacteria were isolated from lentil root nodule

as well as soil from different lentil growing fields with a view to screen/evaluate their plant growth promoting potential. Morphological characterization of isolated rhizobacterial candidates were done by observing the colonies on YEMA and nutrient agar media. Determination of CFU, Congo red test and gram staining tests were done to further screen them according to their morphology. All the isolates were then undergone molecular phylogenetic analysis using the partial sequences of the 16S rDNA. Based upon the Gram staining test, all the isolates were negative in gram reaction except 6 *Bacilllus* isolates, PSB2 and AB3. Results of BLASTn from 16S rDNA gene sequences showed that these isolates are genetically diverse. A total of 15 isolates of *Rhizobium,* 6 isolates of *Bacillus,* 3 isolates of *Pseudomonas*, 2 isolates of Phosphate Solubilizing Bacteria,4 isolates of actinomycetes were identified by molecular sequencing of their 16s rDNA region and comparing them with the other isolates enlisted in the database of NCBI for the similarity percentage, query coverage. The purpose of the present study was to select native rhizosphere bacteria from the lentil nodule and soil of Lentil field and to evaluate their plant growth promoting potential as an alternative of chemical fertilizer for sustainable, environment friendly agriculture and assessment of their phylogenetic characterization.

AISDGONF/ABS/TB/233

Phosphorus management in crops in relation to rhizosphere pH and yield

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Enormous P has been applied to the World's soil yet we know little about its effect on crop performance. Excessive amount of phosphorus in soil is reported to cause toxicity to plants. High phosphorus modifies soil pH. It changes the soil rhizosphere pH at a higher level which might not be desired considering the yield. This necessitates the appropriate combination of phosphorus level and management of soil pH. In the present study an attempt has been made to determine the role of soil pH on the rhizosphere pH and P-levels on nutrients uptake and yield of sesame (*Sesamum indicum*), Rice (*Oryza sativa*) and green gram (*Vigna radiata*). Surface soil sample 0-20cm was collected from Regional Research Station, B.C.K.V., Jhargram. The collected soil was modified to obtain five different pHs ranging from 3.7 to 7.1. The crops were grown in the modified soils with 10 levels of phosphorus for about 21 days. Roots, with mono layer soil adhered, were collected to measure the rhizosphere pH. Uptake of P and Fe, Cu, Mn, Zn were measured. The findings revealed that plants have differing ability to modify the rhizosphere pH that favours nutrient uptake. At low pH, P application increased the rhizosphere pH and in neutral to alkaline soil it decreased it. P application increased the P uptake progressively while the dry matter yield of crops decreased after a certain level. Uptake of P was in general high in soil pH range 5.5 to 6.5. When, desorption of P from soil was lowest. Uptake of Zn, Cu, and Fe in crops gradually decreased with increasing pH and levels of P. High level of P lowered the Mn uptake in crops and a pH range of 5.5 to 6.5 may be considered suitable. Only sesame behaved differently in these traits. The present study suggests giving priority to the rhizosphere pH and fertilizer P – an important resource for management.

AISDGONF/ABS/TB/235

Performance of isolated salinity tolerant rhizobium (*Rhizobium mesoamericanum*) for productivity enhancement of groundnut (*Arachis hypogaea* L.) in Coastal Saline Zone of West Bengal

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Experiment was undertaken during 2016-2017 with a view to isolate salinity tolerant rhizobacteria from coastal saline zone of West Bengal through a series of *in-vitro* and *in-vivo* experiments, following the standard procedures. For final validation of the results, a field experiment was conducted at Farmer's field of Charbidya village under Basanti block of South 24-Parganas.The isolated efficient strain of *Rhizobium mesoamericanum* (Accession number: MT007262) which had the tolerance level up to 6% w/v of salt concentration, was inoculated in groundnut to judge the efficacy under different inorganic fertilizer levels in the field of saline soils during summer season of 2018 and 2019. The experiment was laid out in randomized block design with seven treatments *viz*. T_1: Control; T_2: *Rhizobium* (Rh); T_3: 100% of RDF; T_4: 75% of RDF; T_5: 50% RDN + 100% of P_2O_5 and K_2O + Rh; T_6: 75% RDN + 100% of P_2O_5 and K_2O + Rh; T_7:100% of RDF + Rh and were replicated thrice. *Rhizobium* with inorganic fertilizers increased the yield over application of inorganic fertilizers only. This efficient *Rhizobium* was functional in saline soil and increased average pod yield to a tune of 3-4% when it was supplemented with 100% of RDF and percent of yield enhancement was more a tune of 11-12% when supplemented with 75% of RDN+ 100% of P_2O_5& K_2O. Application of biofertilizer, containing efficient strain of salinity tolerant *Rhizobium* would be one possible option to mitigate salinity stress for proliferation of groundnut cultivation under saline soil.

AISDGONF/ABS/TB/239

Carbon mineralization pattern in field soils under two different crop seasons in a rice-wheat rotation as influenced by long-term tillage, residue and bio-fertilizer practices

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The dynamics of C mineralization is of strong interest for the prognosis of the soil's ability to supply the potentially mineralizable organic carbon and its soil balance. In this study, it is aimed to find out the carbon mineralization pattern along with kinetics parameters in field soils after the harvest of rice and wheat crop grown in a crop rotation as influenced by cultivation practice in the *terai* agro-ecological situation of West Bengal, eastern India. The first order exponential model $C_m=C_0*(1-e^{-kt})$ is appeared as the best-fit model because it produced lower MSE and higher R^2 value. Long-term effect of conventional tillage, with residue and biofertilizer application resulted into in higher potential mineralizable carbon and cumulative carbon mineralized than Zero tillage, without application of residue and biofertilizer. Carbon mineralization rate constant (k) varied

between 0.063 – 0.089 & 0.042- 0.127 in post-rice soils and 0.025- 0.050 and 0.019- 0.107 in post-wheat in 0-10 cm and 10-20 cm respectively. The carbon mineralization pattern was curvilinear (increased exponentially) in all the treatments at both soil depths. Lower values of Cumulative CO_2 emission in 10-20 cm soil layer was due to less labile Carbon and microbial activity. The post wheat soils, which have a higher metabolic quotient, should be supplied with an adequate amount of carbon source to maintain microbial carbon demand than in rice soils. In this context, it is evidenced that the no-tillage practice with residue retention and biofertilizer application showed microbiologically sound sustainable environment than in the conventional tillage practice.

AISDGONF/ABS/TB/243

Effect of poultry manure, vermicompost and biofertilizer on fennel (*Foeniculum vulgare* Mill.) in the New Alluvial Zone of West Bengal

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Fennel (*Foeniculum vulgare* Mill.) is an important *rabi* season spice crop belongs to Apiaceae family. It is mainly grown in India and different parts of the world for its aromatic seeds used as spice, flavoring in food and perfumery industries. A field experiment was investigated to study the effect of different organic manures (poultry manures and vermicompost) including or excluding biofertilizer on the performance of fennel, during the years 2020-21 and 2021-2022 at HRS, Mondouri of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India under new alluvial zone. The experimental site is having sandy clay loam soil, good water holding capacity, well drained, moderate soil fertility status with Soil pH 6.7. The experiment was laid out in *RBD* with 16 treatments and 3 replications. The treatments were consisting of absolute control, 3 levels of poultry manures, vermicompost and recommended dose of fertilizer with and without biofertilizer. Fennel seeds were sown @ 10 kg ha^{-1} after treating seeds with *Trichoderma* sp. @ 10 g kg^{-1} during second week of November by maintaining row to row spacing of 45 cm. Irrigation and intercultural operations were done as per crop requirement. The observations data of growth, yield and its quality parameters were recorded periodically and at the time of final harvest. Soil and plant samples were also collected at the time of final harvest and analyzed for available nutrients in soil and nutrient content in plant samples. The association of biofertilizers with all sources of nutrients proved beneficial and resulted in higher growth and yield. Application of recommended doses of fertilizer with seed inoculation by biofertilizer proved to be superior for realizing highest net return and benefit: cost ratio in fennel.

AISDGONF/ABS/TB/247

Effect of water-soluble fertilizers on growth and yield of summer groundnut (*Arachis hypogaea* L.)

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The field experiment was conducted during the summer season of 2020 and 2021 at Jaguli Instructional Farm, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. The experiment was laid out in a split-plot design with three replications, in the main plot; F0= control; F1=100% of RDN & K; F2=75% of RDN & K and F3=50% of RDN & K and subplot; T1=Starter dose of water-soluble fertilizer @ 2% of N & K with the ratio of 10:20 + micronutrient mixture of Fe, B, Zn, and Mo, applied at 30 DAE; T2=Booster dose of water-soluble fertilizer @2 % of N&K with the ratio of 5:40 + micronutrient mixture of Fe, B, Zn, and Mo applied at 45 and 60 DAE and T3=Starter dose + Booster dose. Higher groundnut pod yield was obtained with basal application of 100% RDF but the crop was also equally responsive to 75% RDF. Water soluble fertilizer applied at the latter part of the growth period (Booster dose of N: K at 5:40 at 45 and 60 DAE @ 2%) was comparatively more conducive to the early stage (Starter dose of N:K at 10:20 at 30 DAE @ 2%) to increase pod and oil yield. Maximum profit was found 100% of RDF + foliar application of booster doses of water-soluble N& K fertilizer. Supplementation of water-soluble fertilizer + micronutrient mixture inorganic fertilizer as basal increased the groundnut pod yield but water-soluble fertilizer along with or without mixture of micronutrients was not substitute for 260any quantity of inorganic fertilizer.

AISDGONF/ABS/TB/249

Effect of herbicide and straw mulch application on weed management in green gram [*Vigna radiata* (L.) Wilczek]

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An experiment was conducted with short duration and synchronized green gram variety "*Samrat*" during pre-*kharif* season of the year 2022 at Agricultural Experimental Farm, Baruipur, to study the most effective and economic methods of weed control in green gram. The treatments were: T_1: Pendimethalin 30 EC at 0.75 kg a.i. ha^{-1} as PE (pre emergence) at 3 DAS (days after sowing), T_2: Quizalofop ethyl 5 EC at 0.05 kg a.i. ha^{-1} as PoE (post emergence) at 15 DAS, T_3: Pendimethalin 30 EC at 0.75 kg a.i. ha^{-1} as PE at 3 DAS *fb* (followed by) Quizalofop ethyl 5 EC at 0.05 kg a.i. ha^{-1} as PoE at 15 DAS, T_4: Pendimethalin 30 EC at 0.75 kg a.i ha^{-1} as PE at 3 DAS *fb* One HW (hand weeding) at 15 DAS, T_5: Paddy straw mulch 5 tonne ha^{-1}, T_6: Two HW at 15 and 30 DAS and T_7: Control (Weedy plot).The experiment was laid out in randomized block design (RBD) with 3 replications. The crop was raised with recommended dose of fertilizer application and water management. Observations were recorded on weed flora, weed density, weed biomass, crop growth, root nodulation, yield attributes and seed yield. From the salient features of the experiment

it was observed that at harvest stage the maximum weed control efficiency (60.53%) was recorded at T_6 (Two hand weeding at 15 DAS and 30 DAS). The next superior treatment was T_4 (Pendimethalin *fb* HW) which was followed by T_3 (Pendimethalin *fb* Quizalofop ethyl), T_5 (paddy mulch), T_2 (Quizalofop ethyl) and T_1 (Pendimethalin).Highest (1287.30 kg ha^{-1}) seed yield was recorded at T_6 (Two HW at 15 & 30 DAS) which was at par with T_4 (Pendimethalin *fb* HW) and T_3 (Pendimethalin *fb* Quizalofop ethyl). In cost benefit ratio (BCR) the highest (3.74) BCR was obtained from treatment Pendimethalin *fb* Quizalofop ethyl (T_3) then Pendimethalin *fb*HW (T_4) (3.50). Whereas weed free plot i.e. two hand weeding (T_6) gave 3.10 BCR. Though the two hand weeding treatment (T_6) gave highest yield but the high labour cost reduced the BCR.

AISDGONF/ABS/TB/260

Studies on nutrient management in finger millet (*Eleusine coracana* L.) through organic sources

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Field experiment was carried out during *kharif* 2019 at Agronomic Main Research Station, OUAT, Bhubaneswar in a moist hot climate having loamy sand soil to study the effect of nutrient management in finger millet through organic sources in a randomized block design replicated thrice with ten treatments *viz.* T_1-8 t/ha FYM, T_2-4 t/ha FYM, T_3-T_2+125 l/ha biodecomposer (1kg of jaggery and half packet of waste decomposer was mixed with 100l of water and was kept for 25 days before applying in the field), T_4-T_2+15 kg/ha seaweed extract, T_5-T_2+15kg/ha wildark with seaweed extract, T_6-T_3+15 kg/ha seaweed extract, T_7-T_3+15 kg/ha wildark with seaweed extract, T_8-T_6 + 4 kg/ha Growth G (Humus derivatives-30%, Sea weed extract-30%, Protein hydrolysates-25%, Micronutrient-5%, Organic acid-5%, Plant metabolites-5%), T_9-T_7+4 kg/ha Growth G and T_{10}-control. The study revealed that application of FYM 8t/ha(T_1) produced highest yield attributes like number of ear heads $hill^{-1}$(5.2), fingers $earhead^{-1}$ (6.4), spikelets $finger^{-1}$ (68.3), grains $spikelet^{-1}$ (5.7)and test weight(3.36g), and grain yield (2821 kg/ha)of finger millet. Under this treatment (T_1), the nutrients removed by the crop was maximum (61.1 kg N, 13.9 kg $P_2O_5$and 63.6 kg K_2O/ha), however, also improved the residual soil available N and $P_2O_5$by 21.9 and 4.7 kg/ha respectively over the initial level. The higher net return (Rs.36, 309/ha) and BCR (1.80) was recorded under T_1. However this treatment was statistically at par with $T_9$with respect to grain yield, nutrients uptake, residual soil fertility and economics. Therefore, the study concluded that application of 8t/ha FYM can be recommended for higher productivity and profitability of finger millet.

AISDGONF/ABS/TB/262

Innovative mycoherbicides application against alien invasive weeds parthenium, lantana and water hyacinth: Commercialization perspectives

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Weeds cause serious ecological problems and are capable of altering the process of ecosystem, displacing the native flora and fauna. Invasive weeds pose a serious threat to the biodiversity of natural ecosystems and a significant constraint to agricultural production worldwide. Due to the recent trends in environmental awareness concerning the side effects of herbicides, public pressure is mounting to force industry to develop safer, more environmentally friendly approaches for controlling weeds. Weed pathogens are also able to produce a wide array of toxins, bioactive metabolites with different biological activities, chemical structures, mechanism of action, and specificity with respect to plants, environmental impact and stability. Fungus or their metabolites-based pesticides, referred to as mycoherbicide, for the management of weeds offer such an approach. The use of mycoherbicide has proven to be a potentially efficacious, cost-effective, and safe option for the management of weeds. The advancement of formulation techniques is of paramount importance to the continued development of mycoherbicides. It is also essential to continue intensive screening programs for the selection of fungal pathogens, especially hemibiotrophs, if mycoherbicides are to become a viable component of integrated weed management in the future. We have made significant progress in the development and application of isolated & patented fungal pathogens for some invasive weeds of India. This paper will discuss the progress on those mycoherbicide for the management of invasive weeds *viz*., parthenium, lantana and water hyacinth.

AISDGONF/ABS/TB/265

Evaluating the efficiency of calcium and potassium-thiosulphate on yield and economics of *rabi* maize

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Maize (*Zea mays* L.) is one of the most prominent, multipurpose monocotyledonous C_4 plant with greater adaptability to a wide range of soil and climatic conditions. It is the third largest essential crop after rice and wheat in terms of areas and production in India. Fertilizer plays an important role in increasing maize productivity, accounting for 40-45 percent of the total. To evaluate the influence of different level of calcium and potassium thiosulphate on maize at Crop Research Centre, RPCAU, Pusa, Bihar, the variety Dekalb 9081 was selected. An experiment was laid out in Randomized Block Design with four replications and twelve treatments using different levels of calcium and potassium thiosulphate @ 0, 15, 30 & 60 L ha^{-1}. The experimental results indicated that the treatment having 150:75:38 N-P_2O_5-K_2O kg/ha + 30 L Ca TS/ha + 30 L KTS/ha- drip produced significantly high weight of grains cob^{-1} (121.6 g), 100-grain weight (32 g), weight of stones cob^{-1} (21.3 g), maximum grain yield (9063.0 kg ha^{-1}), stone yield (1591.7 kg ha^{-1}) and stover yield (7951.3 kg ha^{-1}). Economic analysis showed that the treatment comprising 150:75:38 N-P_2O_5- K_2O kg/ha + 30 L CaTS/ha + 30 L KTS /ha- drip exhibited maximum gross return, net return and B:C ratio of Rs.184163 ha^{-1}, Rs. 124905 ha^{-1} and 2.11, respectively.

AISDGONF/ABS/TB/269

Weed management in wet direct seeded rice

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Direct seeded rice has received much attention because of its low- input demand. An experimental was conducted at BAU, Ranchi, Jharkhand during Kharif 2018 on clay loam soil with low organic carbon (3.6 g/kg), having pH 5.7, available nitrogen (190.76 kg/ha), phosphorus (31.33 kg/ha) and potassium (182.27 kg/ha). The experiment was laid out in split plot design with three replications, comprised of 4 weed management practices i.e., weed free up to 15 days, weed free up to 30 days, weed free up to 45 days and weedy check in main plot and 5 rice cultivars i.e., DRR Dhan 44, DRR Dhan 45, DRR Dhan 46, RP Bio 226 and Swarna Shreya in sub plot. The crop was sown on 17 July 2018 with 60 kg seed/ha and fertilizer N:P:K 80:40:20 kg/ha. Weed free up to 45 days was found most effective in reducing weed density and weed dry weight as it recorded 86.44 and 80.58 % lower than weedy check resulting maximum weed control efficiency (80.53%) at maturity, thus recorded higher crop dry weight (141.32%), grains/panicle (55.98%), grain yield (154.46%) and harvest index (9.47%) as compare to weedy check, consequently recorded maximum net return (₹ 61746/ha) and B: C ratio (1.63) and 18.55 and 18.12 % higher net return and B:C ratio compared to normal practice (weed free upto 30 days). Rice cultivar DRR Dhan 46 recorded 42.53% higher crop dry weight, 25.96% higher grains/panicle, 43.40% more grain yield and 3.36% higher harvest index as compare to cultivar Swarna Shreya.

AISDGONF/ABS/TB/270

Effect of foliar zinc application on different growth, yield and biochemical parameters of lentil under New Alluvial Zone of West Bengal

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[*Based on a part of Ph. D. (Ag.) Thesis of the 1st author]

This study aimed to investigate the impact of different level of Zinc (Zn) fertilizations on different growth and yield parameters and on seed zinc, leaf zinc, and non-leaf shoot zinc and root zinc concentrations of five different promising lentil varieties under new alluvial zone of West Bengal. The two-year field experiments with lentil were carried out during the consecutive two *rabi* seasons of 2017-18 and 2018-19 at District Seed Farm, B.C.K.V., Kalyani, West Bengal. The investigation was laid in factorial Randomized Block Design with 3 replications comprising three different zinc treatment condition (T_1: Control/ 0 ppm zinc application, T_2: 10 ppm foliar zinc application at 30 and 60 days after sowing, T_3: 20 ppm foliar zinc application at 30 and 60 days after sowing) in five Lentil varieties namely Maitree, Subrata, Ranjan, Bari Masoor 8 and Precoz. Zinc fertilization has positive impacts on seed, leaf, non-leaf shoot and root zinc content on all the lentil varieties. But Bari Masoor 8 showed highest amount of seed, leaf, non-leaf shoot zinc content in comparison with other varieties. Zinc application led to improve different growth and yield parameters in all the lentil varieties and 20 ppm zinc application shown highest impact

among the treatments. Maitree and BM 8 had a better response than other cultivars comparatively against zinc application in respect of different growth and yield attributes. Maitree secured highest yield among the varieties but Bari Masoor 8 performed well as an accumulator lentil variety which can be suggested for the biofortification of zinc in lentil.

AISDGONF/ABS/TB/271

Response of black gram (*Vigna mungo* L.) to soil and foliar application of molybdenum in acidic sandy loam soil of Jalpaiguri, West Bengal, India

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More than 55% soils of West Bengal are acidic in nature, with predominance of Fe and Al and deficiency of Mo, which affects the yield of black gram. With this background, a pot culture study was conducted on black gram (variety PU-31) to assess the impact of soil and foliar application of Mo by considering eight treatments including four soil application doses i.e., 0 (S_1), 250 (S_2), 500 (S_3), 750 (S_4) gm Mo per hectare and two foliar spray-doses *i.e.*, 0.1% Mo (A_1), 0.2% Mo (A_2) on light textured sandy loam soil of Jalpaiguri, which was deficient in organic matter, Mo and available primary macronutrients content but dominated by micronutrients like Fe, Mn, Cu, Zn. Morphological parameters like effective nodulation efficiency, seed yield, biochemical parameters like nitrate reductase activity, crude protein content and relationship of Mo with key soil nutrients were subsequently determined. According to the results, combination of foliar spray and soil application up to S_2A_2 treatment, boosted growth and yield attributing characters of black gram, after which most of the attributes decreased. Seed yield varied from 527 kg.ha^{-1} to 583 kg.ha^{-1} and S_2A_2 treatment recorded highest significant seed yield (583 kg.ha^{-1}). Nitrate reductase activity showed a similar trend but chlorophyll content rose with higher Mo dosages. Uptake of Mo significantly increased with increase in Mo application rate and highest uptake was observed in S_4A_2 treatment, whereas the S_2A_2 treatment showed the highest uptake of the key nutrients like N, P, and K. Mo showed a synergistic effect with P uptake. Therefore, it was concluded that in poor fertile acidic soil, combination of soil and foliar spray (S_2A_2 treatment) was superior for black gram cultivation, suitable for climate of North Bengal.

AISDGONF/ABS/TB/273

Organic carbon dynamics under different land use systems of Assam

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Soil and climate have long-term effects on soil organic carbon, while land use has a strong and direct impact on the balance between storages and losses of organic carbon from soils. Therefore, the present research was conducted to assess the impact of different land uses on SOC stock, organic carbon fraction, carbon cycling enzymes and aggregate stability. The trend of total organic carbon stock up to 45 cm as affected by different land use systems are Forest system > Sugarcane ≃ Inorganic tea ≃ Organic tea > Rice-fallow system. Soil labile carbon percent in different land use system followed the order Forest > Organic tea > Rice-fallow > Sugarcane > Inorganic tea system. In case of recalcitrance carbon pool (%), the sugarcane land use system recorded highest in lower depth of soil which varied from 34 (0- 15 cm) to 67% (30-45 cm). Mean weight diameter was significantly lower in rice-fallow system as compared to other land use systems. Forest and organic land use system recorded more dehydrogenase and β-glucosidase activity. In soil layers with lower depth, organic and sugarcane land use systems had higher phenol oxidase activity than other systems. Regardless of depth, glomalin concentration was found to be considerably higher in organic and forest land use systems. This study also advised that upper Brahmaputra valley of Assam region have very good carbon accumulation potential in different land use systems, if it is managed in best possible way.

AISDGONF/ABS/TB/276

Effect of tillage and rice straw retention along with fertilizer dose on *rabi* maize in New Alluvial Zone of West Bengal

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A field experiment on response of maize (*Zea mays*) as influenced by tillage and rice straw retention along with fertilizer dose was studied during *rabi*, 2019-20 at Balindi Research Farm of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal. The experiment was laid out in a split-plot design comprising 3 tillage practices (*viz*. T_1: Conventional tillage, T_2: Zero tillage and T_3: Reduced tillage) in main plots and 5 combinations of rice straw retention with fertilizer doses (*viz*. N_1: 0% rice straw retentions + 100% recommended fertilizer dose-RDF; N_2: 100% rice straw retentions + 50% RDF; N_3: 100% rice straw retentions + 75% RDF; N_4: 50% rice straw retentions + 100% RDF and N_5: 50% rice straw retentions + 75% RDF) in sub-plots. Experimental results revealed that, growth attributes *viz*, plant height, leaf area index and dry matter accumulation at 90 DAS were significantly higher under zero tillage practice along with higher crop growth rate during 60-90 DAS over reduced and conventional tillage practices. Treatment receiving N_4: 50% rice straw retentions + 100% RDF performed better compared to other sub-plot treatments. Maize grown under Zero tillage along with 50% rice straw retentions + 100% RDF (T_2N_4) yielded higher (10.1 t ha^{-1}) being at per with T_3N_3 (10.05 t ha^{-1}). Having lower cost of cultivation with higher grain yield, maize grown under zero tillage condition resulted significantly higher net return of Rs.

136531/- and BC ratio (3.01). Among subplot treatments, N_3: 100% rice straw retentions + 75% RDF proved to be economically beneficial having higher net return (Rs. 140501/-) and BC ratio (3.07). Zero tillage and 50% rice straw retention along with 100% RDF can be recommended for higher yield of maize and monetary return.

AISDGONF/ABS/TB/281

Water management opportunities including micro-irrigation and water harvesting in agriculture

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Efficacy in water saving, fairness in water sharing and regulated delivery are essential for the sustainable use of accessible water resources. For realizing these goals Micro-irrigation and rain water harvesting are appropriate. The agriculture sector is the largest consumer of water, having compelling and probable interests which double the farmer's income along with agricultural sustainability and environmental quality. Micro-irrigation helps to increase the yield, reduce water, fertilizer, labour requirements and rainwater expands the soil water storage capacity. Also the application of GIS is constantly being applied, including surface hydro-logic, water supply, groundwater, sewer system modelling. Localized water supplies can move directly through the root zone by reducing water loss through conveyance, runoff, deep percolation and evaporation, also helps in use of saline water without causing salinity or osmotic stress to plants. Rainwater problems can be solved by dual water systems. The major techniques in rainwater harvesting are surface runoff harvesting and groundwater recharge. Groundwater recharge practiced in in Rural areas are Gully plug, Recharge shaft, Contour bund, Gabian structure, Percolation tanks, also pug well recharge and others. In urban areas, like recharge pit, tube wells, recharge trench. Rainwater management is used to mitigate extreme rainfall events without enlarging the existing sewer system. Drip irrigation is the most effective practice to increase water use efficiency, maintaining the optimum soil moisture conditions for overall productivity and profitability. Supplemental irrigation aids in giving ecological and economic development also benefits by overcoming the obstacles of drought and soil erosion.

AISDGONF/ABS/TB/292

Studies the effect of irrigation and nanofertilizers on antioxidants, soil enzymes, yield and water use efficiency of potato (*Solanum tuberosum* L.)

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Field experiment was delineated during *rabi* seasons of 2019-20 and 2020-21 at Instructional Farm, BCKV in split plot design with three irrigation schedules (I_1:15, I_2:30 and I_3:45 mm CPE) in main plot and five nutrient management [N_1:100% RDF (200:150:150 kg ha^{-1} of N: P_2O_5: K_2O), N_2:75% RDF+ nano-fertilizers (N, P, K at 80:40:40 ppm), N_3:100% RDF+ Nano-Zn (10 ppm), N_4:75% RDF+ nano-fertilizers (N, P, K and Zn at 80:40:40:10 ppm) and N_5:Nano-fertilizers (N, P, K at 80:40:40 ppm)] in subplot to find out the effect of irrigation and nano-fertilizers on antioxidants, soil enzymes, yield and water use efficiency of potato (variety *Kufri Himalini*).

Nano-fertilizers were foliar sprayed at 25 and 50 DAP. Results revealed that Stress-degree days (32 and 44 days with 1.76 and 3.91 values respectively) and antioxidants (Super oxide dismutase and Proline) were highest in irrigation at 45 mm CPE. Interaction showed that I_1N_3 exhibited highest tuber yield (23.04 t ha^{-1}) and consumptive use (235.06 and 198.68 mm respectively), however, consumptive use efficiency maximum in I_3N_4 (14.93 and 14.40 kg m^{-3}) and lowest yield (6.21 t ha^{-1}) recorded in I_3N_5. Studies also indicated that N_5 treatment alone was not sufficient to meet the crop nutrient demand for higher yield, and the soil enzymes and antioxidant activities were not markedly influenced by nano-fertilizers. In terms of tuber yield, irrigation at 15 mm CPE along 100% RDF with foliar applied Nano-Zn @ 10 ppm at 25 and 50 DAP can be recommended for New Alluvial zone of West Bengal.

AISDGONF/ABS/TB/293

Prevalence of major plant-parasitic nematodes infesting vegetable crops related to certain abiotic factors

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Investigations were carried out to know the diversity of plant parasitic nematodes associated with vegetable crops in Jorhat district of Assam and to study the community structure of various plant parasitic nematodes around the rhizosphere of vegetable crops. A total of one hundred and forty six soil as well as root samples were collected from thirty-nine different vegetable crops from five administrative block of Jorhat district. Survey of plant parasitic nematodes revealed that eight species of plant parasitic nematodes belonging to eight genera were associated with the vegetable crops of Jorhat district. The species of plant parasitic nematodes recorded were viz., *Meloidogyne incognita*, *Helicotylenchus dihystera*, *Rotylenchulus reniformis*, *Macroposthonia onostris*, *Hoplolaimus indicus*, *Scutellonema brachyurus*, *Tylenchorhynchus annulatus* and *Xiphinema radicicola*. Assessment of plant parasitic nematodes around the rhizosphere of vegetable crops in Jorhat district revealed that bean ranked first in infestation (infested by 7 out of 8 plant-parasitic nematodes) followed by tomato, pea and cowpea in second place (infested by 6 out of 8 plant-parasitic nematodes) and brinjal, potato, squash, carrot and beetroot hold the third position (infested by 5 out of 8 plant-parasitic nematodes). Out of thirty-nine economically important crops vegetable crops, only nine major vegetable crops suffer infestation from more than fifty percent of total number of plant-parasitic nematodes found. Soil temperature, soil moisture content percent and rainfall were found to be closely related to the nematode population fluctuations. The increase in temperature and soil moisture content percent was associated with the increase in nematode population within the range of favourable condition which is in between 15.5°C - 28.0°C (ideally around 25°C); with a soil moisture level of 15.0 – 22.0 percent and monthly rainfall of 0.6 – 302.2 mm.

AISDGONF/ABS/TB/294

Effect of maize crop residue management practices and fertilizer levels on physico-chemical properties, post-harvest soil fertility and rhizosphere biota of direct seeded rice in rice-maize sequence

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A field experiment was conducted during *kharif* seasons of 2020 and 2021 on a sandy clay loam soils of Agricultural College farm, Bapatla to study the effect of maize crop residue management practices and fertilizer levels on physico-chemical properties, post-harvest soil fertility and rhizosphere biota of direct seeded rice in rice-maize sequence. The experiment was laid out in split-plot design with four maize residue management techniques (M_1: Exportation of maize stover, M_2: *In-situ* burning of maize stover (farmers practice), M_3: Mulching of maize stover with rotary mulcher and M_4: Incorporation of maize stover with rotovator) as main plot treatments and three fertility levels (100% RDF, 75% RDF and 50% RDF) as sub plot treatments. The results showed that mean values for organic carbon, available nitrogen, phosphorus, potassium, bacterial, fungi and actinomycetes population were significantly higher with incorporation of maize stover with rotovator. Mean values for fertility levels revealed that highest available nitrogen, phosphorus, potassium were recorded with application of 100% RDF (S_1). However, pH, E.C and bulk density of the soil after harvest of rice did not show any significant difference during both the years of study.

AISDGONF/ABS/TB/295

Variation of photosynthetically active radiation use efficiency of *kharif* rice influenced by different conservation agriculture practices

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Conservation agriculture (CA) is a practice which was evolved to maintain sustainability of agriculture around the globe. CA now covers about 8% of the world's arable lands. It is necessary to conduct more research on this aspect, to create awareness among farmers and to promote large-scale adoption. With the objective to evaluate the impact of conservation tillage on Photosynthetically Active Radiation (PAR) interception and its utilization efficiency (PARUE), an experiment was conducted on wet-season rice or *kharif* rice (Cultivar: IET 22066, Ajit) under rice-maize-cowpea cropping system at Balindi Research Complex, Bidhan Chandra Krishi Viswavidyalaya (Lat.: 22° 96' Long.: 88° 53'), during the *Kharif* season of 2019. Rice was grown under three different tillage systems, viz., conventional tillage (CT), zero tillage (ZT) and reduced tillage (RT) with recommended dose of fertilizer (RDF). Observations on biometeorological parameters, like leaf area index (LAI), biomass, grain and straw yield and Photosynthetically

Active Radiation (PAR) components were recorded at regular (7 days) intervals. The results indicated that higher LAI in RT treatment absorbed more PAR and produced more biomass and grain yield than others. Among the different tillage treatments, highest PARUE was obtained in case of RT followed by CT. The lowest PARUE was recorded with ZT, which also had the lowest grain and biomass yield. Hence, rice may be grown with the recommended dose of fertilizer (N:P:K @ 80:40:40 kg/ha) under reduced tillage to obtain higher grain yield, radiation interception and PARUE in the new alluvial zone of West Bengal.

AISDGONF/ABS/TB/296

Crop growth and yield of zero tilled mustard as influenced by integrated nutrient management under rice mustard sequence

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A field experiment was conducted on crop growth and yield of zero tilled mustard under rice mustard sequence at Instructional Farm (ICAR), Jaguli, Nadia under Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, India during the rabi season (2019-2020) in alluvial soil on hybrid mustard Keshari 5111. The field experiment was conducted in Randomised Block Design with three replications and eight treatments T_1- FYM + N; T_2-FYM + Straw mulch + N; T_3- Suphala @ 150 kg/ha; T_4-Suphala + N; T_5- Suphala + N + K_2O; T_6- Suphala + N + $ZnSO_4$; T_7- Suphala + N + B; T_8- Suphala + Straw mulch + N to evaluate the performance of hybrid mustard. The result of experiment revealed that the maximum seed yield of hybrid mustard Keshari 5111(858 kg/ha) was recorded with application of Suphala + N @ 30 kg/ha at 30 DAS+ B @ 0.25% and least yield (367 kg/ha) at FYM + N @ 30 kg/ha at 30 DAS. The maximum oil percentage of 43.5% was noted with the application of Suphala + N @ 30 kg/ha at 30 DAS. The ETa loss was found highest (129.3 mm) with Suphala @ 150 kg/ha and the maximum water use efficiency (12.35 kg/ha-mm) was achieved with Suphala + N @ 30 kg/ha at 30 DAS+B @ 0.25%. Considering the results of the experiment, it may be concluded that hybrid mustard may be grown at zero tillage with the application of Suphala + N @ 30 kg/ha + B @ 0.25% in new alluvial soils of West Bengal.

AISDGONF/ABS/TB/297

Improving profitability of farmers through integrated farming system in Jharkhand

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The agriculture Sector has faced multiple problems related with crop production, profit food and nutrition security, environmental externalities and the overall system stability and sustainability by high external input agriculture (HEIA) from low external input agriculture (LEIA). These problems are also caused by inappropriate technologies, gender relations, and an open market regime. The declining availability of agricultural land per capita forces most farmers to work on small fragments of land for cultivation. All these are very serious and dangerous matters to the agro-ecological systems, especially the complex, diverse and risk-prone ones. So, these areas' small and marginal farmers tested new land use systems to improve their farming systems using

low external input sustainable agriculture (LEISA). These techniques of integrated farming systems improved the livelihood status of farmers by reducing problems like crop production, profit, food, nutrient and environment security. About 80% people of the rural population in Jharkhand are involved in agriculture. It is their source of employment and primary income. The economy of agriculture of this state is characterized by dependence on nature, small and marginal holdings, low productivity, inadequate irrigation. A survey was conducted in Mardanpur village of Chatra District in Jharkhand where a farmer modified his 5-acre farm to an integrated farming system (IFS) model. His farm consisted of field crops in 2 acres, vegetables in 1 acre, fruit plants in half acre combined with dairy, poultry, piggery in 0.25 acres each and fish farming in 0.75 acres. In most areas he was used natural farming concept, avoiding the HEI (high external inputs). The farmer received technical support from Krishi Vikas Kendra (KVK) of Chatra District of Jharkhand. Adopting the new model, the farmer received more than 80% profit. His annual income has increased 69% as compared to his previous income from the same farm. His income increased due to reduced external inputs like the chemical fertilizers & pesticides, feed for animal husbandry etc. In conclusion, natural IFS can lead to increased profitability for farmers by increasing the efficiency of resource use, increasing the resilience of farming systems, improving marketing opportunities, and improving environmental sustainability. This approach to farming can help farmers to navigate the challenges of the modern agricultural landscape and to achieve long-term success. This model is having gradual adoption (presently 46%) by other farmers of this region.

AISDGONF/ABS/TB/298

Nutrient content and uptake of rice at different growth stages by different tillage and nutrient sources

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The experimental field was laid out in a strip-plot design with tillage practices in horizontal strips and nutrient management in vertical strips and replicated three times for rice crop during *kharif* seasons 2019-20 and 2020-21 and the treatments were randomized as per procedure given by Cochran and Cox (1952). Four different tillage practices *viz,* Dry seeding on puddled soil (T_1), Reduced tillage (T_2), Minimum tillage (T_3) and Conventional tillage (T_4) were taken as horizontal strip treatments and five nutrient sources treatments to rice *viz.,*100% STBN through fertilizer (N_1), 75% STBN through fertilizer + 25% N through FYM (N_2), 50% STBN through fertilizer + 50% N through FYM (N_3), 75% STBN through fertilizer + 25% N through cured poultry manure (N_4) and 50% STBN through fertilizer + 50% N through cured poultry manure (N_5) as vertical strips at the Agricultural College Farm, Bapatla, ANGRAU, Lam, Guntur, Andhra Pradesh, India during *kharif* and *rabi* seasons of 2019-20 and 2020-21. The results revealed that during all the growth stages the total nutrients content and uptake (N, P and K) in conventional tillage practice was significantly higher than other Dry seeding on puddled soil, Reduced tillage and Minimum tillage during the both the years of experimentation. Among the different nutrient sources and their combinations, the highest total content and uptake (N, P and K) by crop during all the growth stages was recorded under 50% STBN through fertilizer + 50% N through cured poultry manure than other treatments.

AISDGONF/ABS/TB/300

Appraising the impacts of physical priming on morpho-physiological and yielding traits of wheat (*Triticum aestivum* L.)

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Seed priming with low doses of physical agents would potentially stimulate growth and crop yield, and as such physical priming techniques are now gaining lots of interest among the agricultural researchers or scientists. The present experiment was carried out to investigate the potentiality of various physical priming techniques towards influencing morpho-physiological parameters as well as to improve yield of wheat under *Terai* zone of West Bengal. Seeds were pre-treated with five different physical agents at different doses or exposure durations, and the field performances of wheat crop grown from these physical primed seeds were evaluated. The results revealed some interesting effects that all the physical agents would either had beneficial or adverse impacts on seed germination, crop growth and yield of wheat depending upon doses or duration of exposures. Remarkably, maximum crop growth rate was found particularly at lower doses of gamma radiation (150 Gy) and magnetic field (800 G for 1 hour) exposure. Magneto-priming @ 800G for 2hours and 1450G for 1 hour had recorded the maximum grain yield. Highest harvest index was recorded in ultrasonication for 30 minutes among the all non-ionizing agents. Higher values of harvest index were recorded when seeds were pre-exposed with X-ray irradiation @ 50mA/45KV and Gamma radiation @ 150 Gy among the ionizing agents. The instant results indicated that impacts of pre-sowing exposure of seeds with the physical agents on seed germination, crop growth and yield of wheat would vary depending upon the type of agent, strength and duration of exposures.

AISDGONF/ABS/TB/301

Maize based intercropping system under deficit irrigation management for higher crop and water productivity

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A field experiment was conducted at CR Farm, RRS, BCKV, Gayeshpur, Nadia during two consecutive *rabi* season of 2020-21 and 2021-22 with 3 level of irrigations (ET_0 at 1, 0.8 and 0.6) as main plot and 5 level of cropping system [C_1- sole maize, C_2- sole groundnut, C_3- sole chickpea, C_4- maize and groundnut (1:1) (M+GN), C_5- maize and chickpea (1:1) (M+CP)] as sub plot under split plot design which were replicated thrice. The result of pooled data revealed that all the growth and yield attributes of maize and intercrops like chickpea and groundnut recorded higher in optimal irrigation scheduling at ET_0: 1.0. Maize grain yield was significantly higher in ET_0: 1.0 (5538 kg ha^{-1}) which was 10.7 and 18.4% higher than ET_0: 0.8 and ET_0: 0.6 respectively. Similarly under optimal moisture condition different intercrops, like groundnut recorded 14.6 - 21.4% more yield and chickpea obtained 15.7 - 20.5% higher yield than deficit irrigation management. Water use efficiency was 44.1 and 32.3% higher in M+GN based intercropping coupled with irrigation

scheduling at ET_0: 1.0 compared to sole maize or sole groundnut cultivation under same irrigation regime, respectively. The maize equivalent yield of M+GN intercropping system (7161 kg ha^{-1}) was 42% higher than sole maize cultivation. In terms of economic M+GN recorded higher BCR (2.94) followed by M+CP intercropping (2.92) when irrigated at ET_0: 1.0. Intercropping of M+GN or M+CP also produced higher results in terms of crop and water productivity and economic returns than their sole crop cultivation when irrigated at ET_0: 0.8 also. So, from the experiment it can be concluded that intercropping of Maize + Groundnut cultivation with irrigation application at ET_0: 1.0 can be recommended for this location.

AISDGONF/ABS/TB/302

An economic assessment of conservation agriculture in West Bengal

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A study was mainly focused on the importance of promoting conservation agriculture (CA) in Nadia district of West Bengal. To judge the highest economic return under various cropping systems, an on-station experimental trial was performed at Balindi Farm, BCKV in 2019-20 and 2020-21 sessions in order to evaluate the production, yield, and economic profitability of seven cropping systems and data were analysed on system rice equivalent yield (kg/ha), system gross return (Rs./ha), system net return (Rs./ha) and system return-cost ratio for two years over three tillage operations and five doses of fertilizer treatments. Randomized Complete Block Design (RCBD) with Split-split plot technique was performed over three replicated data set where year and cropping system were treated as main effects, Tillage as sub effect and Treatments as sub-sub effect. The result depicts that the second year of trial has achieved better system rice equivalent yield and economic return as well over previous year. Among seven cropping systems, *Kharif* rice-potato-pumpkin has achieved the highest economic return pooled over years but differs individually as *Kharif* rice-maize-cowpea exhibits better economic return on first year. Among the three tillage operations, conventional tillage has given highest economic return in both the years. In case of various treatments, 0% Residue + 100% RDF has achieved the highest economic return pooled over years but differs individually as 50% Residue + 100% RDF exhibits better economic return on first year. Pooled analysis over the years exhibits better economic return in *Kharif* rice-maize-cowpea in conventional tillage with 100% Residue + 50% RDF which differs in the second year, resulting higher economic return in *Kharif* rice-potato-pumpkin cropping system in conventional tillage with 50% Residue + 75% RDF.

AISDGONF/ABS/TE/317

Assessment of agricultural drought in red laterite zone of West Bengal using Palmer Drought Severity Index (PDSI)

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With an objective to characterize drought conditions in the Red Laterite Zone of West Bengal, an investigation was undertaken to compute the frequency of different categories of agricultural drought and their temporal dynamics for the period 1951-2020, Palmer Drought Severity Index (PDSI), one of the most popular agricultural drought index, were employed. For this calculation daily gridded rainfall (0.25° X 0.25°), maximum temperature and minimum temperature (1° X 1°) data were collected from IMD and subsequently processed for different temporal period. And information on AHC (mm/mm depth; Grid based) was obtained from Harmonized World Soil Database developed by FAO. An investigation over the entire study location showed that there is a prolonged drought period in Bankura, Birbhum and Purulia combining MLD/MOD/SD/ED from 1960-1969 and 2006-2011. On the other hand Paschim Medinipur showed comparatively shorter and moderate drought period from September 1960 to October 1966. Among the districts Birbhum (5.2%), Purulia (4.39%), Bankura (10.69%) recorded maximum frequency for extreme, severe and moderate drought respectively while among the months May (2.85%) January (3.56%) and November (12.12%) recorded maximum frequency for extreme, severe and moderate drought respectively. Temporal trend of monthly PDSI values mainly during kharif season showed an increasing trend of drought intensity for all the districts up to 1960s after that there is an decreasing trend of drought intensity up to 1990s and there after again an increasing trend.

AISDGONF/ABS/TB/345

Productivity and economics of rice under different weed management practices

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A field investigation was conducted at AICRP on Weed management farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* season 2020. The experiment was laid out in split plot design with three replications. There were twenty treatment combinations having four different fertigation levels and five weed management practices. The main plot treatments comprised of different levels of fertilizer whereas, sub plot treatments comprised of five weed management practices *viz.,* Pendimethalin @ 1 kg a.i. per ha PE *fb.* Bispyribac sodium @ 0.025 kg a.i. per ha at 25 DAS; Pretilachlor + Pyrazosulfuron Ethyl @ 0.615 kg a.i. per ha PE *fb* Bispyribac sodium @ 0.025 kg a.i. per ha at 25 DAS; Pretilachlor @ 0.75 kg a.i. per ha PE *fb.* Bispyribac sodium @ 0.025 kg a.i. per ha at 25 DAS; farmer practices – 2 HW at 15-20 days interval after sowing *fb.* 2 hoeing and weedy check. Among the various weed management practices, farmers' practice (2 HW at 15-20 days interval after sowing *fb.* 2 hoeing) recorded significantly good result regarding major parameters whereas, in herbicidal treatments, directed spray of Pretilachlor +

Pyrazosulfuron Ethyl @ 0.615 kg a.i. per ha PE *fb.* Bispyribac sodium @ 0.025 kg a.i. per ha at 25 DAS resulted in maximum rice grain yield (5231 kg/ha). The herbicidal application of Pretilachlor + Pyrazosulfuron Ethyl @ 0.615 kg a.i. per ha PE *fb.* Bispyribac sodium @ 0.025 kg a.i. per ha at 25 DAS registered maximum GMR (₹ 128755 per ha), NMR (₹ 81412 per ha) and B:C ratio (2.72) among all herbicidal treatments, indicating the feasibility of using herbicides for effective weed management in rice.

AISDGONF/ABS/TB/346

Response of Indian mustard (*Brassica juncea*) to sole and combined foliar application of zinc and boron

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An experiment was conducted at the Central Research Farm of Bidhan Chandra Krishi Vishwavidyalaya located at Gayeshpur, Nadia (WB) during *rabi* season of 2020-21 to evaluate the role of foliar application of Zn and B on growth, yield and quality of mustard. The experiment was laid out in Randomized Block Design with three replications. Treatments were: T_1 - control, T_2 -0.1% Zn-EDTA at 30 DAS, T_3 - 0.2% Solubor at 30 DAS, T_4 - 0.1% Zn-EDTA+ 0.2% Solubor at 30 DAS, T_5 - 0.1% Zn-EDTA at 30 and 50 DAS, T_6 - 0.2% Solubor at 30 and 50 DAS and T_7 - 0.1% Zn-EDTA+ 0.2% Solubor at 30 and 50 DAS. Results revealed that mustard plot fertilized with 0.1% Zn-EDTA + 0.2% Solubor at 30 and 50 DAS recorded the highest plant height, dry matter accumulation, number of siliqua/plant and number of seeds/siliqua. The highest seed yield of 1864 kg/ha was recorded in T_7. This was followed by T_4, which produced a seed yield of 1726 kg/ha.

AISDGONF/ABS/TB/347

Effect of iron slime waste on availability of secondary nutrients in relation to yield of *kharif* onion in lateritic soil

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Iron ore-based steel-making, generates huge amounts of by-products viz., slag, sludge, dusts, scales and fines. Considering the potentiality of iron slime waste (ISW), its alternate use as input in agriculture was explored in a field experiment conducted in a Lateritic soil at College of Agriculture, Extended Campus of B.C.K.V, Chhatna, Bankura, West Bengal during *kharif* 2021. Ten different levels of ISW (0, 100, 200, 300, 400, 500, 600, 700, 800 kg ha^{-1}) integrated with 10 t ha^{-1} FYM and recommended dose of fertilizer (RDF) were tested for growing *kharif* onion (cv. Agrifound Dark Red). Soil samples collected after harvest of onion were analysed for soil properties viz., pH, EC, organic carbon, available secondary nutrient (Ca, Mg, S); nutrient content in onion bulb and haulms and onion bulb yield. Appraisal of results indicated positive effect of application of ISW stabilizing soil pH towards neutrality, effectuating increase in soil organic carbon content, available Ca, Mg and S content compared to their initial values and values under control treatment; bringing about significant increase in total Ca, Mg and S content of onion bulb

and haulms; and bulb yield of *kharif* onion compared to control treatment. Compared to the values under control treatment, application of ISW, in general, effectuated significant increase, while the highest increase in these parameters was observed under 800 kg ISW ha^{-1}. The possibility of harnessing a wasted opportunity in agricultural production using a huge amount of iron slime, hitherto considered a waste has been indicated by the results recorded here.

ASDGONF/ABS/TB/348

Effect of zinc application on growth, tuber biofortification and productivity of potato (*Solanum tuberosum* L.) in inceptisols

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Keeping in mind the importance of Zinc application for potato cultivation in Zn deficient soil a field experiment was conducted during *Rabi* season of 2021-22 at C-Unit Research Farm (Kalyani) of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. The total number of treatments was 7 which were replicated thrice in randomized complete block design. The treatments details were – T_1: RDF of NPK (200:150:150 kg N: P_2O_5: K_2O/ha), T_2: T_1 + Soil application of Zinc @ 2.5 kg/ha at the time of planting, T_3: T_1 + Soil application of Zinc @ 5 kg/ha at the time of planting, T_4: T_1 + Foliar application of Zinc sulphate @ 2 g/liter at 25 days after planting., T_5: T_1 + Foliar application of Zinc sulphate @ 2 g/liter at 25 and 50 days after planting, T_6: T2 + Foliar application of Zinc sulphate @ 2 g/liter at 25 days after planting, T_7: T2 + Foliar application of Zinc sulphate @ 2 g/liter at 25 and 50 days after planting. Growth parameters like plant height (at 60 DAP), leaf area index (at 50, 65 and 80 DAP), dry matter accumulation (at 50, 65 and 80 DAP) and tuber bulking rate (at 50-65 and 65-80 DAP) were maximum in T_7. Highest total tuber yield (31.45 t/ha), Nutrient (N, P, K and Zn) uptake from soil, Zn content in tubers (24.53 mg/kg) and B:C ratio (2.10) were also recorded in T_7. T_7 recorded 22.27% higher yield than T_1 and T_5 recorded 20.33% higher yield than T_1. N, P, K and Zn uptake was higher in T_7 than T_1 by 24.26%, 24.64%, 28.63% and 72.95% respectively. The highest Zn content in tuber was obtained in T_7. Zn content in tuber was increased by 84.43% for T_7 and 78.13% for T_5 as compared to T_1. So, it can be concluded from the experiment that recommended dose of NPK (200:150:150 kg N: P_2O_5: K_2O/ha) with soil application of Zinc @ 2.5 kg/ha at the time of planting and two foliar application of Zinc sulphate @ 2 g/liter at 25 and 50 days after planting is the most profitable treatment for potato cultivation.

AISDGONF/ABS/TB/349

Performance of lathyrus (*Lathyrus sativus* L.) varieties under various sowing conditions in *Vindhya* alluvial soil of West Bengal

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The common practice of sowing of lathyrus is broadcasting, which causes non-uniform plant population, poor growth and low yield but line sowing and dibbling can be good alternative options under no-tilled condition. Keeping in view a field experiment was conducted in a split-plot design with 3 replications comprising 3 establishment methods (Broadcasting, Line sowing and Dibbling) in main-plots, 3 varieties (Nirmal, Prateek and Ratan) in sub-plots at Teaching Farm, College of Agriculture, B.C.K.V., Bardhaman, West Bengal during *rabi* season of 2020-2021. Broadcast-sown lathyrus crop recorded maximum plant population (30.2 m^{-2}) due to higher seed rate (80 kg ha^{-1}), but it required less time to maturity (111.7 days) and less growing degree days (1623^0C) for entire life cycle compared to line sowing and dibbling method. Ratan recorded highest aerial dry matter (94.5 g m^{-2}) at 80 DAS and CGR (1.74 $gm^{-2}day^{-1}$) at 60-80 DAS, but Nirmal produced tallest plants (110.9 cm) and maximum branches $plant^{-1}$ (8.5) at harvest. With regard to number of pods $plant^{-1}$, three varieties of lathyrus could be arranged as: Ratan (59.4) >Nirmal (56.0) >Prateek (48.8). Lathyrus raised in line-sown plots yielded highest (1757.4 kg ha^{-1}), which was 6.7 and 27.3% greater over dibbling and broadcasting methods. Among three varieties, Ratan produced highest grain yield (1672.2 kg ha^{-1}) mainly due to greater number of pods $plant^{-1}$ compared to Prateek (1605.3 kg ha^{-1}) and Nirmal (1506.8 kg ha^{-1}). Above all, Ratan could be adopted under line-sown condition in vindhya alluvial soil of West Bengal during *rabi* season for greater yield (1901 kg ha^{-1}) and profitable cultivation (Rs. 43,701 ha^{-1}).

AISDGONF/ABS/TB/350

Amelioration of neurotoxin (N-Oxalyl -L-α, β-Diamino Propionic Acid) content through agronomic biofortification of Zn and Fe in grass pea (*Lathyrus sativus* L.)

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Neurotoxin (N-Oxalyl -L-α, β-Diamino Propionic Acid) is present in different parts of the grass pea plant. In this study, the agronomic biofortification of Zn and Fe in grass pea varieties and its effect on growth, yield and total β – ODAP accumulation pattern were evaluated. A field experiment was conducted at the AB block Farm (District Seed Farm), Bidhan Chandra Krishi Viswavidyalaya, Kalyani during 2019-20 and 2020-21. The experiment was laid out in a split-plot design with three replications. Two grass pea varieties i.e. Ratan and Bidhan Khesary-1 in the main plot and six nutrients applications comprising control, 0.5% Zn, 0.1% Fe, 0.5% Zn + 0.1% Fe, seed treatment with 2 g Zn kg^{-1} seeds and soil application of $ZnSO_4$ were assigned in the subplot. The results found that a maximum number of pods per plant and yield was recorded in

Bidhan Khesari-1 with the recommended dose of fertilizers with foliar spray of both 0.5% Zn + 0.1% Fe; twice at pre-flowering & flowering stage treatment. Significantly, the lowest neurotoxin value was noticed in Bidhan khesari-1 with the combined application of foliar nutrients. Combine application of Zn and Fe consistently reduced β - ODAP compare with the control and the reduction was 10-40% of the original value without Zn. Significant differences in total ODAP content (%) were observed in two varieties and foliar nutrient treatments.

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Impact of seed priming with ultra violet radiation on growth and yield of Chak-hao rice cultivars

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Innovation of eco-friendly technologies are always essential to enhance plant growth and improve yield in a sustainable manner. Seed priming methods such as conventional and physical priming are well known pre-sowing techniques that are considered to be effective in improving the growth and yield of a crop. In view of this, a field experiment was carried out to study the impact of seed priming with ultra violet radiation on growth and yield of Chak-hao rice cultivars. The experiment was laid out in Factorial Randomized block design having three replication and three Chak-hao rice cultivars namely Black (*Amubi*), Red (*Angangbi*) and White (*Angoubi*) were used, and the seeds were initially treated with UV-C (8.32 KJ/m^2) radiation for 3 hours. Then seeds were soaked in water at 28±2 ^{0}C for 2 days and the emerged seedlings were again treated with UV-C (8.32 KJ/m^2) for different durations i.e. 30 mins (T_3), 45 mins (T_4) and 60 mins (T_5), seeds without any UV-C treatment (T_1) and only seed treatment for three hours (T_2) were taken as control. The observations on parameters such as plant height, no. of tiller/m^2, dry matter accumulation, chlorophyll content and CGR for field data, and yield or yield attributing traits were recorded following the standard protocols. Interestingly, the plant height was found to reduce under UV-treatment as compared to control. The results showed that all three rice cultivars recorded maximum yield when the seedlings were pre-treated with UV-C for 60 mins including initial exposure of dry seeds to UV-C for 3 hours.

AISDGONF/ABS/TB/352

Root characterization of rice genotypes in drought prone rainfed environment

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Drought stress and nutrient limitations are the major constraints affecting rainfed rice. Therefore, efficient root systems could be assumed essential for high water and nutrient use efficiency as well as stress tolerance of rice in drought prone rainfed environments. The experiment was conducted at farmer's field in a drought-prone rainfed environment of the high *Barind* tract, Bangladesh during successive two wet seasons to test genotypic variation and to evaluate rice genotypes tolerant to drought stress based on root characteristics and yield performance. Thirty rice genotypes including

four check varieties were evaluated, using a randomized complete block design with 3 replications. Uniform management practices were followed for all genotypes in both experimental seasons. Root length, root dry weight, root length density, root shoot ratio and root dry weight efficiency index varied significantly among the genotypes in both seasons. Root length of 6 genotypes had more than 100 cm, 10 had above 80 cm, and the rest had root lengths below 80 cm under drought stress. Accordingly, the six genotypes with high root length (IR74371-70-1-1, IR83377-B-B-93-3, IRRI123, NERICA-4, IR 83381-B-B-6-1 and IR 83383-B-B-129-4) had also higher root biomass (> 3.3 g $hill^{-1}$ or (0.0375 m^2). Across the genotypes, most of the root biomass (61.1%) was in the 0-10 cm soil layer and decreased rapidly below (27.1% in the 10-20 cm layer, 8.8% in the 20-30 cm layer, and 3.0% in the 30-40 cm layer). Root length density ranged from 0.020 to 0.040 across the genotypes and experimental years. The root-shoot ratio significantly diverged among the genotypes and ranged from 0.076 to 0.173. The genotypes showed significant variation in the root dry weight efficiency index (RDWEI) and could be classified into three groups. The best six genotypes obtained RDWEI values >1.50 and classified as drought tolerant, the next ten genotypes including local check Guti Swarna had RDWEI values between 0.75 and 1.50 and classified as moderately drought tolerant, and the remaining fourteen genotypes, including Binadhan-7 and BRRI dhan49, had RDWEI values <0.75 and classified as drought susceptible. RDWEI values of the genotypes were not related to their growth duration. The genotypes with higher RDWEI values generally produced higher yield in the drought-prone lowland environment, with the exception for NERICA-4 which is an upland variety. Consequently, we could confirm a relation between rice root characteristics and the performance in a typical rainfed lowland system. Then, the genotypic variation in our germplasm selection indicated considerable scope for improvement of rainfed lowland rice varieties.

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Evaluation of black gram genotypes under late *kharif* situation in red and laterite zone of West Bengal

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Paddy is only cultivated in the medium and low land areas in Purulia district, but a vast amount of uplands, named '*Tanr*' in local language, which covers 10% of the total cultivable area of the district, remains vacant in *kharif* season. So, short duration pulse like black gram, having less water requirement, can be a good choice for these fallow uplands during rainy season. Keeping this in view, an experiment was conducted at Regional Research Sub Station, Bidhan Chandra Krishi Viswavidyalaya, Raghunathpur, Purulia, West Bengal, India to evaluate the performance of 17 black gram genotypes under late *kharif* situation of 2021 in Red and Laterite Zone of West Bengal. Among 17 black gram genotypes, number of days to maturity varied between 79.00 days (V_{13}: KU 16-80) and 87.33 days (V_6: KU 15-98). KU 17-63, PU 10 and KU 16-77 produced a greater number of pods $plant^{-1}$ and also had much higher test weight (> 50g) due to larger seed size and thus gave higher seed yield (578, 575 and 544 kg ha^{-1}). KU 15-07 (V_5) recorded the highest protein content (22.74%), while the seeds of KU 16-80 (V_{13}) had lowest protein content (16.70%). Thus, three genotypes namely KU 17-63, PU 10 and KU 16-77 performed better and can be identified as potential *kharif* black gram genotypes in Red and Laterite Zone of West Bengal, India.

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Effect of zinc and iron nutrition on growth, productivity and quality of field pea

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Micronutrient enrichment of pulses with Fe and Zn through agronomic interventions is a feasible strategy to alleviate micronutrient malnutrition across the country. Field pea is a potential target for agronomic fortification as it is an integral component of Indian vegetarian diet because of its rich protein content. Hence, a field experiment was conducted at A-B Block Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani during *rabi* season 2021-2022 to evaluate the impact of zinc and iron application on productivity and nutrient content of field pea. The treatments comprised of 11 Zn and Fe nutrition protocols viz. T_1: control; T_2: 0.5% $ZnSO_4$ spray at pre-flowering and pod initiation; T_3: 0.5% $FeSO_4$ spray at pre-flowering and pod initiation; T_4: T_2+T_3; T_5: seed priming with 0.05% $ZnSO_4$; T_6: seed priming with 0.05% $FeSO_4$; T_7: soil application of $ZnSO_4$ @20 $kgha^{-1}$; T_8: T_7 + T_6; T_9: T_7 + T_3; T_{10}: T_5 + T_3; T_{11}: T_6 + T_2 in a randomized complete block design replicated thrice. Results revealed that T_4 recorded the highest seed yield with 25% yield increment over control. Zinc and iron content increased with T_4 by 59.61% and 64.72% respectively over control. Maximum zinc and iron uptake in field pea seeds was also observed in T_4 Hence, combined application of 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ spray at pre-flowering and pod initiation stage is an effective agronomic fortification strategy to improve yield as well as Zn and Fe content in field pea to possibly amend the widespread Zn and Fe deficiencies in our regular Indian diet.

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Influence of different levels of boron and sulphur on growth, yield and oil content of niger (*Guizotia abyssinica* L.)

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Niger is a minor oilseed crop that is grown predominantly under rainfed conditions. Sulphur and boron both are essential nutrients for oilseeds production. Sulphur is actively involved in the nutrition of oilseeds, oil and protein synthesis. Among the micronutrients, boron plays an important role in pollination and fertilization of oilseeds. In order to evaluate the influence of different levels of boron and sulphur on growth, yield and oil content of niger (*Guizotia abyssinica* L.), a field experiment was conducted during *Rabi* season of 2021-22 in the Instructional Farm of BCKV, Jaguli, Nadia (WB) with four different levels of sulphur and three different levels of boron in 12 treatment combinations (T_1 : control, T_2 : 0.2% Solubor at branching stage, T_3 : 0.2% Solubor at branching and flowering stage, T_4 : 20 kg S ha^{-1}, T_5 : 20 kg S ha^{-1}+ 0.2% Solubor at branching stage, T_6 : 20 kg S ha^{-1}+ 0.2% Solubor at branching and flowering stage, T_7 : 30 kg S ha^{-1}, T_8 : 30 kg S ha^{-1}+ 0.2% Solubor at branching stage, T_9 : 30 kg S ha^{-1}+ 0.2% Solubor at

branching and flowering stage , T_{10} : 40 kg S ha^{-1}, T_{11} : 40 kg S ha^{-1}+ 0.2% Solubor at branching stage, T_{12} : 40 kg S ha^{-1}+ 0.2% Solubor at branching and flowering stage, $N_{20}P_{40}K_{30}$ kg ha^{-1} was applied in all the treatments). Each treatment was replicated thrice in RBD. Basal application of 40 kg S ha^{-1} along with 0.2% Solubor once at branching and another at flowering stage exhibited excellent performance in terms of all the growth parameters, yield parameters [seed yield (815 kg ha^{-1})] and quality parameters [oil content (35.20%) and protein content (23.01%)] of niger along with maximum B:C ratio (1.93). The application of sulphur in soil alone and in combination with foliar application of boron (single and double) might have increased the growth, yield and oil content of niger.

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Weed management in dry direct seeded kharif rice in new alluvial soils of West Bengal

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A field experiment was conducted during the *kharif* season 2022 at Agricultural Experimental Farm, University of Calcutta, Baruipur with the main emphasis to study the different treatments of weed management on the yield and find out the most effective weed management for dry direct seeded rice variety "Puspa (IET 17509)". The experiment was laid out in a randomized block design with nine treatments replicated thrice. The treatments were T_1: Pendimethalin 30 EC at 1kg a.i. ha^{-1} at 3 DAS; T_2: Pretilachlor 30.7 EC at 0.5kg a.i. ha^{-1} at 3 DAS; T_3: Oxidiargyl 80 WP at 0.08kg a.i. ha^{-1} at 3 DAS; T_4: Pyrazosulfuron ethyl 10 WP at 0.025 kg a.i. ha^{-1} at 3 DAS; T_5: Bispyribac sodium 10 SC at 0.025 kg a.i. ha^{-1} at 20 DAS; T_6: Triafamone 20 % + Ethoxysulfuron 10 % WG at 0.150 kg a.i. ha^{-1} at 20 DAS; T_7: Pretilachlor 30.7 EC at 0.5kg a.i. ha^{-1} at 3 DAS + Bispyribac sodium 10 SC at 0.025 kg a.i. ha^{-1} at 20 DAS; T_8: Hand weeding at 20 + 40 DAS and T_9: Unweeded control. Results revealed that among all the treatments, significantly lower weed population (56 per m^2) and highest weed control efficiency (71.23%) at 90 DAS were recorded in the two round of hand weeding plot (20 and 40 DAS) (T_8). Highest plant height (106.33 cm), no of tiller per m^2 (322.33), panicle length (23.09 cm) and grain yield (4.13 t ha^{-1}) were found in the treatment two round of hand weeding plot (20 and 40 DAS) (T_8) which was at par with Pretilachlor 30.7 EC at 0.5kg a.i. ha^{-1} at 3 DAS + Bispyribac sodium 10 SC at 0.025 kg a.i. ha^{-1} at 20 DAS (T_7) and Triafamone 20 % + Ethoxysulfuron 10 % WG at 0.150 kg a.i. ha^{-1} at 20 DAS (T_6).

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Superfood cultivation: A lucrative enterprise for farmers

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The global trend of consuming "superfoods" has included Indians as well. People are turning to old treasures such as amla (Indian gooseberry), pumpkin seeds and berries etc., which are high in antioxidants, vitamins, and minerals. Moringa, jamun (Indian blackberry), amla, ashwagandha (winter cherry), buckwheat, flax seeds, forest honey, and millets like ragi are just a few of the superfoods that India has contributed to the global market.Due to more consumer demand and a profit margin that is three to four times higher than that of other foods, superfoods have developed into a profitable sector. As superfoods, Indian millets are also being recognized on a globally. Millets include high amounts of dietary fiber and vitamins in addition to being rich source of minerals like calcium, iron, zinc, phosphorus, magnesium and potassium. Because of changes in consumption behaviour and substitution by wheat and rice, millet production in India has decreased over time. India's farmers can come back to millets. Through exports, these superfoods can ensure farmers a higher profit. Similarly, another local superfood moringa has become well-known for being high in calcium and is in high demand all over the world. Sambar, a popular South Indian dish, is made from Moringa. It is now a part of Indian drinks. The Indian superfood market is still underrated, but it will grow rapidly as people become more conscious of the benefits of eating nutritious foods and adopt new vegetarian and vegan lifestyles. Superfoods can help Indian farmers turn their agriculture into a lucrative enterprise because they typically require less investment, less water, and can tolerate extreme weather conditions.

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Factor affecting chemical pesticides use pattern and identification of buying behaviour of vegetable growers in Nadia district of West Bengal

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Plant protection is an exercise basically followed in any crop for control of insect-pests, diseases, weeds etc. to avoid economic losses. Farmers who are cultivating vegetables, they are using maximum numbers and amount of pesticides compared to cereal crops per unit area. For proper application of pesticides –there are specific recommendations. Due to lack of awareness of farmers regarding those recommendations, they are using pesticides deviating its proper processes and considerations. As a result, they are facing health related problems. Hence, to know the pesticides use patterns of the vegetable growers were the outmost important as well as the factor influencing pesticides use patterns of vegetable growers. Pesticides buying behaviour of vegetable growers was the precursor of pesticides use pattern. Keeping all these in view the present study was

designed with objectives - To identify the factors affecting pesticides use pattern and pesticides buying behaviour of vegetable growers. The present study was conducted in Nadia district of West Bengal. Nadia district was purposively selected for the study and Chakdah community development block of kalyani sub division was randomly selected for the study. Rautari gram panchayat was selected randomly from all the gram panchayats of Chakdah community development block. Three villages namely Teghara, Ruppur and Rameswarpur was selected purposively as the villages were in close proximity. Complete enumeration of the farmers in the villages was attended. Farmers who were available up to three times were included in the sample. In this way 73 brinjal growers from Teghara, 62 pointed gourd growers from Ruppur and 69 cauliflower growers from Rameswarpur were selected for the study who grow crops in parcels of plots under bigger common field. The main significant factors of pesticides consumption or use pattern were –(a) land holding, (b) time of cultivation, (c) economic motivation (d) risk orientation (e) profit risk avoidance and (f) knowledge about pesticides. Vegetable growers major ingredients of buying pesticides were—(a) Brand selection (b) Shopping behaviour (c) Preference to product, dealer and company characteristics (d) Cost consciousness of market segments (e) Preference to packaging (f) Credit orientation behaviour of market segments (g) Consultancy behaviour of tmhe market segments. Therefore, the base level extension agencies should take proper measures on the basis of findings of the study to make their further extension programme more effective.

AISDGONF/ABS/TB/359

Effect of long-term fertilization on temperature sensitivity of soil nitrogen mineralization in rice-wheat system under middle *Gangetic* plain of India

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Quantitative information of nitrogen (N) mineralization of soil under different long term nutrient management strategies is an essential component for better assessment of N availability and loss from soil system. The temperature sensitivity (Q_{10}) of the soil net nitrogen mineralization (N_{min}) directly influences the feedback between soil productivity and climate warming, however information remains limited about how fertilization effects the Q_{10} and N min under long term fertility experiments (LTFEs). A laboratory incubation study was conducted at four temperature (10˚C, 20 ˚C, 30 ˚C and 40 ˚C) and two moisture regime (100% FC and 80% FC) with the surface soils (0-15cm) collected from 38 years of rice-wheat cropping system with treatments- control (Non fertilized), chemical fertilization with different grades of NPK and integrated nutrient management (INM) with farm yard manure (FYM), wheat straw (WS), green manure (GM). Study resulted, higher temperature sensitivity (Q_{10}) under control treatments, followed by INM and 100% chemical fertilization, whereas mean Q_{10} declined with increase in moisture content. Furthermore activation energy (Ea) was negatively correlated with substrate quality index, which supports application carbon quality temperature (CQT) hypothesis in N mineralization. This study demonstrated that, long term application of FYM or organic source with chemical fertilization potentially reduces temperature sensitivity of N_{min} to increasing temperature, which certainly prevent N loss and increase the yield potential under global warming scenarios.

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Weed management practices for enhanced productivity of green gram [*Vigno sinensis* (L.)] in western Rajasthan

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A weed management research trial was conducted at Instructional Farm, College of Agriculture, Sumerpur (Agriculture University Jodhpur-Rajasthan) for efficient management of weeds in greengram on sandy loam soils of Western Rajasthan from Kharif 2020 and Kharif 2021. The experiment comprised of ten treatments with four replications in randomized block design (RBD) using cultivar GM 4. The greengram is promising crop of western Rajasthan and cultivated on wide scale under rainfed conditions. The crop perform well on sandy loam soils of western Rajasthan where it is mostly raised as rainfed during kharif season while irrigated during spring season. The crop was sown with onset of monsoon i.e. I week of July in respective years. The application of pre-emergence and post emergence application of various herbicides were found significantly superior over weedy check. Results of experiment showed significant differences among each other in terms of weed dry matter, weed control efficiency, weed index and growth and yield attributes of crop recorded at harvest. The maximum mean seed yield (11.7 q/ha) was recorded under treatment Fomesafen11.1% +Fluazifop-p-butyl 11.1% SL @ 220 g a.i./ ha at 20 DAS and was at par with treatment Propaquizafop 2.5% + Imazethapyr 3.75% w/w @ 135g a.i./ha at 20 DAS (11.6 q/ha) and Sodium Acifluorfen 16.5% + Clodinafop Propargyl 8% EC @250g a.i./ha at 20-25 DAS (11.5 q/ha) as compared to application of Pendimethalin 30 EC@ 750 g a.i./ha as pre-emergence (11.3 q/ha) and unweeded check (6.7 q/ha). Further, the application of Fomesafen11.1% +Fluazifop-p-butyl 11.1% SL @ 220 g a.i./ ha and Propaquizafop 2.5% + Imazethapyr 3.75% w/w @ 135g a.i./ha at 20 DAS in terms of B:C ratio of 3.1 and 3.2 and also found promising to control weeds in greengram as compared to Pendimethalin 30 EC@ 750 g a.i./ha as pre-emergence. The same trend was found in weed parameters, growth and yield attributes at harvest.

AISDGONF/ABS/TB/361

Studies on dynamics of sulphur in rice soil under nutrient and water management

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A pot culture experiment was conducted at BCKV, Kalyani, Nadia, West Bengal, India to study the effect of 3 water management practices viz., (I_1) Farmer's common practice (3-5cm of standing water throughout the crop growth periods); (I_2) Irrigation at soil hair crack stage during vegetative phase + 3 cm of standing water through panicle initiation and flowering stage, and (I_3)Moist condition throughout the cropping season and 6 INM practices comprising substitution of the recommended dose of N (100 $kgha^{-1}$) by (i) N_1:0% , (ii) N_2:25%, (iii) N_3:50%, (iv) N_4:75%, (v) N_5: 100% through vermi-compost and (vi) N_6:100% N trough Urea, laid out in a Factorial CRD on

sulphur transformations, nutrient uptake and yield of rice. All the pots were treated with the RDF of P_2O_5 (50 $kgha^{-1}$) and K_2O (50 $kgha^{-1}$). Except in N_6, Neem cake @2 tha^{-1} was added to each pot. Soil samples collected from the rice rhizosphere during tillering, flowering and harvesting, were analyzed for available S content and rice grain and straw yield. Analysis of the generated data using standard statistical methods indicated significant influence of water management, INM and their interaction on the tested parameters. Appraisal of results indicated superiority of I_3 effectuating congenial soil pH, higher organic carbon and higher available S content and higher grain yield; while N_5 resulted in the highest grain and straw yield. Regression analysis revealed strong influence of soil pH; oxidisable organic carbon; available sulphur content and straw yield, predicting almost 99.8%-99.9% of the variability in rice grain yield.

AISDGONF/ABS/TB/362

Identifying suitable crop geometry and nutrient dose for rainfed groundnut in Red and Laterite Zone of West Bengal

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Field experiment was conducted during two consecutive rainy seasons of 2020 and 2021 at Regional Research Station, Bidhan Chandra Krishi Viswavidyalaya, Jhargram, West Bengal to evaluate the response of nutrients at varying crop geometries of groundnut under rainfed condition in Red and Laterite soil. The experiment comprising in a split plot design with fifteen different treatment combinations replicated thrice. The main plot comprises of three different crop geometry *viz*., G_1: 22.5cm x 10cm; G_2: 30cm x 10cm; G_3: 45cm x 10cm and subplot under five nutrient management practices *viz*., F_1: FYM @ 7.5 t ha^{-1}; F_2: 100% of RDF; F_3: 125% of RDF; F_4: 75% of RDF alongwith biofertilizers and F_5: 100% of RDF alongwith biofertilizers. Result revealed that the significantly highest pod yield was observed under closer spacing of 22.5cm x 10cm (G_1) followed by the G_2 (30cm x 10cm), whereas, the maximum pod yield was recorded under the treatment F_5 (100% RDF and biofertilizers) which was statistically similar with F_3 (125% RDF). Pod yield of groundnut influenced significantly due to the treatment interaction and highest value was observed in closer spacing of 22.5cm x 10cm with 125% of RDF (G_1F_3), which was statistically at par with the treatments G_1F_5. Economics of different treatments revealed that the utmost gross and net return was recorded under the treatment G_1F_3, but due to lesser cultivation cost the maximum B:C ratio was obtained under the treatment G_2F_5 (30cm x 10cm spacing with 100% RDF and biofertilizers) followed by G_1F_3 and G_1F_5 respectively.

AISDGONF/ABS/TB/363

Effect of biostimulant (Ratchet) on growth and yield of transplanted *kharif* rice in lower *Gangetic* plains of West Bengal

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Ratchet is a plant biostimulant which enhances the plant's nutritional capabilities and ultimately increases the crop yield. An experiment was conducted in Randomized Block Design (RBD) with four replications during *kharif* season of 2019 at Jaguli farm of B.C.K.V., Kalyani, West Bengal, India to study the effect of Ratchet on growth and yield of transplanted rice. All the Ratchet sprayed plot (either single or twice application) perform better and gave higher yield over the plot where only recommended fertilizer dose was applied. However, the application of Ratchet twice (at 35-40 and 65-70 DAT) @ 450 ml ha^{-1} (T_7) with the application of standard fertilizer dose recorded higher growth attributes *viz*. plant height at maturity (99.2 cm), tillers m^{-2} at 85 DAT (452.4) as well as yield attribute *viz*. highest number of productive tillers (212.3) and 1000 grains weight (21.7 g) over other six treatments and thus gave highest yield of 6.36 t ha^{-1}. So, Ratchet @ 450 ml ha^{-1} at 35-40 and 65-70 DAT may be applied in transplanted *kharif* rice for better growth, higher productivity.

AISDGONF/ABS/TB/364

Growth and yield of sisal (*Agave sisalana*) as affected by planting materials and fertilizer levels

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Field experiment was conducted during 2019-22 at Sisal Research Station (of ICAR-CRIJAF) at Bamra, Sambalpur Odisha to find out the effect of size of planting material (sucker) at planting and dose of fertilizers on the growth and fibre yield of Sisal (*Agave sisalana*), an important leaf fibre crop of central plateau region of India. It was noted that the mean leaf length and mean leaf breadth of sisalana sisal significantly varied with sucker size at planting and fertilizer dose. Irrespective of fertilizer dose, the longest leaf was produced by large sized sucker at planting (106.19 cm); similarly, irrespective of sucker size, the longest leaf was produced by the highest fertilizer dose (94.98 cm). Similar pattern of variation like leaf length were recorded in case of leaf breadth of sisalana sisal. The broadest leaf was produced by large sized sucker and higher fertilizer dose (9.59 cm). It was observed that the number of leaf production varied significantly due to different size of planting materials at planting and fertilizer doses in Sisalana sisal. Irrespective of nutrients levels, the maximum number of harvestable leaves was produced by the large sized sucker at planting (112.5 x 10^3/ha) which was statistically at par with the harvestable leaf produced by the medium sucker size (106.3 x 10^3/ha). Similarly, irrespective of sucker size, the maximum number of harvestable leaves was produced by the highest dose of fertilizer i.e., N, P, K @ 120, 60, 120 kg/ha (109.3 x 10^3/ha) which was closely followed by and at par with the harvestable leaf produced by medium fertilizer dose (106.1 x 10^3/ha). In the interaction effect of the size of sucker at planting and fertilizer dose, it was recorded that the maximum number of harvestable leaves

produced either by the large sized sucker x higher fertilizer dose (117.8 x 10^3/ha) or with medium sized sucker x higher fertilizer dose (111.1 x 10^3/ha). It can be concluded that fibre yield from the 1st cutting year, the large sized sucker x high fertilizer dose yielded the highest (1146.7 kg/ha) which was closely followed by and statistically at par with the fibre yield obtained with medium sucker size x high fertiliser dose (1049.1 kg/ha).

AISDGONF/ABS/TB/365

Effect of nano-dap on growth, yield and economics of rapeseed

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Nano-fertilizers have emerged as a promising alternative that ensures high crop production and soil restoration. The effect of Nano-DAP comprising of N and P nano particles was tested on growth and yield of *rabi* rapeseed in 2021 at the Instructional Farm, BCKV, West Bengal, in a randomized block design with ten treatments and three replications. Nano DAP was applied through seed treatment (5 and 10 ml/kg seed) and foliar application at @ 2, 4,6 ml/l at 30 DAS. The soil was sandy clay loam in texture with pH 6.65, organic carbon 5.8 g/kg, available N 163.2 kg, P 42.9 kg and K 104.8 kg/kg of soil. The results revealed that 25 % N & P replacement through Nano DAP seed treatment @ 5ml /kg seed at time of sowing followed by Foliar spray @ 2 ml /litre of water at 25- 30 DAS exhibited maximum plant height (95.95 cm), LAI (3.51), dry matter accumulation (188.81 g/m^2), CGR (3.17), number of siliqua/plant (60.90), no. of seeds/siliqua (17.12), seed yield (767 kg/ha) .This treatment enhanced 21.38% of seed yield over control (No Basal DAP) and also showed higher net return (Rs. 16224/ha) and benefit-cost ratio (1.54) in comparison with other treatments. The preliminary investigation shows that Nano DAP may be a potential alternative of chemical fertilizers.

AISDGONF/ABS/TB/366

Assessing soil quality indices under different land situations in Red and Lateritic Zone of West Bengal

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Assessment of soil quality of the red and lateritic zone of West Bengal was done by collecting representative soil samples from farmers' field at Bankura-I and Chhatna blocks of Bankura district. The different physical, chemical properties of surface soils were determined and Soil quality index (SQI) was calculated by principal component analysis (PCA) and multiple correlation analysis based Minimum Data Set (MDS) selection. The soils of both the Chhatna and Bankura-I blocks were moderate to slightly acidic, soil organic C content was low to medium, available N was low, available P content was medium to high and the available K was low to medium in both the blocks. The content of DTPA-extractable micronutrients viz. Zn, Cu, Fe, Mn in most of the soils were medium to high and available B was low in both the blocks. The majority of soils are sandy loam. Soil pH, OC, available N, P, K, B, clay content, Zn were screened as key indicators for assessment of soil quality under low land. Under medium land, soil pH, WHC, clay

content, available N, S and Zn were screened as key indicators, whereas, silt content, available N, S, B, Zn were screened as key indicators for assessment of soil quality under up land. The dimension less SQI varied from 3.86-5.09, 2.97-3.90 and 1.85-2.81 with the mean values of 4.46, 3.43 and 2.28 for low, medium and up land. Thus, the SQI follows the order as low land> medium land> upland.

AISDGONF/ABS/TB/367

Growth and productivity of summer urdbean as influenced by bio-nano P and K

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The global population is increasing enormously leading to a havoc demand for food. In New Alluvial zone of West Bengal, a substantial acreage of land usually remains fallow during summer months. Growing summer urdbean enriches soil health, provides food and nutritional security and increases farmers' income. Common fertilizers are one of the causes of soil and environmental pollution and loss of biodiversity. Nano-fertilizers increase nutrient use efficiency, reduce soil toxicity, amount of fertilizer requirement and finally help in achieving sustainable agriculture. To study the effect of Bio-nano P and K on growth and yield of summer urdbean, a field experiment was conducted in summer season of 2019 and 2020 at B.C.K.V. Farm (West Bengal) in sandy loam soil having the order *Inceptisol*) using variety Pant U-31 in Randomized Block Design replicated thrice. The treatments were: T_1= Control; T_2= Recommended dose of Fertilizer $N:P_2O_5:K_2O$::20:60:40 kg/ha (RDF);T_3= 50% of RDF; T_4= Spray of tap water at 25 and 50 DAS;T_5= Spray of Bio-Nano P (SP) at 25 DAS;T_6= SP at 25 and 50 DAS;T_7= Spray of Bio-Nano K (SK) at 25 DAS;T_8= SK at 25 and 50 DAS; T_9= T_3+T_5; T_{10}= T_3 +T_6; T_{11}= T_3 +T_7; T_{12}= T_3+T_8.The growth parameters like LAI and aerial dry mass per unit area were significantly higher in the treatments where the plants got Bio-nano P or K along with 50% of RDF. The maximum grain yield (1027.52 kg/ha) was obtained in T_{10} which is significantly better than T_2 (848.30 kg/ha).Thus, it may be concluded that application of Bio-nano P along with 50% of RDF had a beneficial effect to increase the growth and yield of summer urdbean crop.

AISDGONF/ABS/TB/368

Assessing the effect of irrigation and integrated nutrient management under bitter gourd production in New Alluvial Zone of West Bengal

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Natural resource management with a clear focus on environment quality enhancement leading to sustainable development and adaptation to climate change have become one of the pivotal issues to fight the instability in crop productivity and weather variations. For this, proper application of organic as well as inorganic fertilizers along with water management for better crop production lead to high income. Hence, a field experiment was conducted during the summer season of March to July 2018, at the Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal to investigate the effect of irrigation and integrated nutrient management under Bitter gourd (Var. Pusa Vishesh) production. The experiment was laid out in split plot design having three main plot treatment (I_1 – irrigation at 7 days interval, I_2 - irrigation at 10 days interval, I_3 - irrigation at 15 days interval) and four sub plot treatment (N_1 –Inorganic fertilizer (100%) (NPK: 60, 40, 40), N_2 – Inorganic fertilizer (75%) + bio-fertilizer, N_3 – Inorganic Fertilizer (50%) + Organic manure + Bio-fertilizers, N_4 – Organic manure (FYM: 15 t/ha) + Bio-fertilizer, with three replications. Results showed that the yield is increased with each treatment, attaining the highest value of 17.79 t/ha in treatment I_2N_3 which is 14.62 % more than treatment I_1N_1. The moisture use efficiency of the crop was increased significantly by 90.05% in the treatment I_2N_3 over treatment I_1N_1. Thus the treatment I_2N_3 having the integration of both inorganic and organic nutrient suppliers had been proven more beneficial than any other treatments for improving the productivity of crop and also for improving soil properties and building up soil fertility.

AISDGONF/ABS/TB/369

Mitigation of abiotic stress by millets

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The world is celebrating the “International Year of Millets” in 2023. Millets are regarded as "Miracle Grains" as they are adaptive to a range of ecological conditions and marginal lands. Large tracts of India are under rain-fed and dryland where nutritive millets are potential to bridge the projected demand gap in cereals. Millets, under era of fluctuations of precipitation and temperature outperform other grains like wheat and rice. They have high water productivity, drought and heat tolerance, nutritional value and existing food value chain will improve food security. Millets are C_4 plants with better tolerance to environmental stresses. While elevated CO_2 concentration has led to grain nutrition reduction in most staple crops, millets are tolerant and have more desirable nutritional traits for combating hidden hunger. Unlike major cereals, millets have adaptation of phenological shifts allow them to grow as ephemeral crops. Root behaviour, transpiration, stomatal conductance, photosynthesis, and metabolism make them tolerant to higher temperature. Improved morpho-physiological traits and antioxidant activities of SOD, CAT,

Peroxidase, Proline along with phenolic compounds help to combat adverse conditions. Millets, in absence of gluten, contain high amounts of proteins, fibre, niacin, thiamine, riboflavin and minerals like iron, magnesium, calcium and potassium. They help prevent cancer, cardiovascular disease, growth of tumors and lower blood pressure. Millets offer value addition and afford income generation. Millets yield low compared to major cereals and call for more research investment and promotion in the climate change era. Many national and international initiatives are on the way.

AISDGONF/ABS/TB/370

Evaluating the effect of applied sulphur on nitrogen, phosphorus and potassium uptake of rice

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Sulphur, a secondary plant nutrient, is believed to enrich the activities of mineral transport protein channels in plant body through formation of amino acids and protein. A field trial on rice (variety MTU 1153) has been conducted in Kharif season of 2022 at the research farm of College of Agriculture, BCKV, Burdwan Sadar to evaluate the effect of applied sulphur on plant nutrition. Four treatments, besides a control, consist of application of sulphur at different doses to the crop through T-90 dispersible granule and Sulphur 90% granules (Bentonite pastille) as basal application along with another treatment comprising of only top dressing through Sulphur 90% powder (Fertis). The crop has been raised with other standard management practices. After harvesting of crop, plot-wise grain yield has been recorded and the harvested grains were further processed to analyze Nitrogen (N), Phosphorus (P), Potassium (K) and Sulphur (S) uptake. Application of Sulphur increased grain yield of rice by 25 to 30% over control. Increased uptake of S in rice through its external application also possesses significant correlations with N, P and K uptake. Thus, the study confirmed that the application of S is beneficial to improve grain yield of rice by enriching N, P and K nutrition.

AISDGONF/ABS/TB/371

Evaluation of growth, yield and water use efficiency of different maize based intercropping system under various irrigation regimes

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Cropping system under various irrigation regimes had a significant role in improving crop and water productivity. There were 3 levels of irrigations *viz.* ET_0 at 1, 0.8 and 0.6 and 5 level of cropping system *viz.* sole maize, sole groundnut, sole chickpea, maize and groundnut (1:1) (M+GN), maize and chickpea (1:1) (M+CP) under split plot design which were replicated thrice. The experiment was initiated during *rabi* season of 2021-22 at CR Farm, RRS, BCKV, Gayeshpur, Nadia with an objectives to find out growth, yield and water use efficiency of various cropping system and different irrigation regime. Result of the experiment showed that under various irrigation regimes maximum growth attributes like plant height, dry matter, LAI, CGR were higher under optimum irrigation (ET_0 at 1.0) for all the component crops. In various intercropping

systems, in general, all the sole crop *i.e*., sole maize, sole groundnut or sole chickpea attained comparatively higher growth attributes when they were grown as a component crop in an intercropping system. Optimal moisture supply (ET_0 at 1.0) resulted more dry matter accumulation which was 5.43% - 11.08% in maize, 10.2 - 28.8% in ground nut and 21.9 - 56.1% in chickpea than deficit irrigation practices. Grain yield of maize was 10.7% and 26.4% higher in ET_0 at 1.0 than ET_0 at 0.8 and 0.6, respectively whereas the kernel yields of groundnut in optimal moisture regime was 14.4% -39.2% more than deficit irrigation practices and the result pf chickpea was 15.7% - 39.9% more in ET_0 at 1.0 in comparison with ET_0 at 0.8 and ET_0 at 0.6, respectively. Sole crop generally resulted in lower WUE than intercropping practices and among the sole crop, chickpea resulted lowest CWP under deficit irrigation with ET_0 at 0.6. Among the intercropping M+GN with ET_0 at 1.0 resulted maximum WUE (35.6 kg/ha-mm) followed by same intercropping system with deficit irrigation with ET_0 at 0.8 (34.6 kg/ha-mm).

AISDGONF/ABS/TB/398

Effect of different mulching and nutrient management practices on growth and yield of *rabi* maize (*Zea mays* L.)

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Maize (*Zea mays* L.) ranks 3rd among cereals in production and is consumed as a staple food in several tropical and sub-tropical countries; being a nutrient-exhaustive crop, it demands a relatively high amount of fertilizer and responds well to applied nutrients. A field experiment was conducted during winter season of 2019-20 with the objective of evaluating the effect of mulching and nutrient management practices on growth and yield of maize in Balindi Research Complex, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India on clay loam soil having slightly alkaline pH (7.2).The experiment was laid out in Randomized Block Design with nine treatment (T) combinations *i.e.* T_1-Live mulch (*Trifolium alexandrium;* @ 20 kg ha^{-1})+50% recommended dose of fertilizer (RDF) [120:60:40 kg ha^{-1} N, P_2O_5 and K_2O], T_2-Live Mulch+75% RDF, T_3-Live Mulch+100% RDF, T_4-Straw Mulch (@ 3t ha^{-1})+50% RDF, T_5-Straw Mulch+75% RDF, T_6-Straw Mulch+100% RDF, T_7-No Mulch+50% RDF, T_8-No Mulch+75% RDF and T_9-No Mulch+100 % RDF, replicated thrice. Experimental findings demonstrated that different mulching and fertilizer levels substantially impacted different growth parameters and yield. Among all the treatments T_6 exhibited the highest values of growth characters viz., plant height, Leaf Area Index (LAI), Crop Growth Rate (CGR), and Dry Matter Accumulation at different intervals. T_6 treated plots recorded higher grain yield (13.8%) and stover yield (4.2%) over conventional treatment (T_9) however, treatment T_7 recorded the lowest yield. So, the integrated application of straw mulch along with 100% RDF could be recommended for better yield and higher productivity of the nutrient-exhaustive *Rabi* maize.

AISDGONF/ABS/TB/399

Effect of different potassium levels on nutrient uptake, soil fertility status and yield of *kharif* maize (*Zea mays* L.)

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Maize (*Zea mays* L.), the 'Queen of cereal' is one of the most versatile crops with wider adaptability under varied agro-climatic conditions in diverse seasons and ecologies. A field experiment was conducted during *kharif* season of 2018 with the objective of optimization of potassium fertilization for maize at District Seed Farm of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal on sandy clay loam soil with pH 7.2. The experiment was laid out in Randomized Block Design having four replications and six treatments (T) *viz*; 0 (T_1), 30 (T_2), 60 (T_3), 90 (T_4), 120 (T_5) and 150 (T_6), kg K_2O ha^{-1} with recommended dose of nitrogen and phosphorus (120:60:: N: P_2O_5 kg ha^{-1}) applied uniformly to all plots. Application of 150 kg ha^{-1} recorded the highest nitrogen, phosphorus and potassium uptake which were statistically at par with T_5 and T_4 treatments. In case of residual soil fertility after harvest, maximum available nitrogen (213. 27 kg ha^{-1}) and phosphorus (36. 64 kg ha^{-1}) recorded in T_1 (control) treatment whereas highest available potassium recorded in T_6 (111 kg ha^{-1}) treatment. The results revealed that highest grain and stover yield were obtained from T_6 treatment but yield increased was more pronounced up to 90 kg K ha^{-1} which was 40.81 % (grain yield) and 26.92% (stover yield) higher than the yield obtained from T_1 treatment. So, it could be concluded that application of 90 kg K_2O ha^{-1} is the optimum potassium dose for obtaining higher yield and supplementing balanced nutrition in *Kharif* maize under new alluvial zone of West Bengal.

AISDGONF/ABS/TB/481

Impact of foliar nutrition on growth and productivity of relay cropped lentil *(Lens culinaris* Medikus) in the lower *Gangetic* plains of West Bengal

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The protein-rich lentil is a staple pulse in Indian diet due to its high nutritive values. However, to meet the national requirement and secure the food and nutritional demand, incorporating lentil in the rice fallows is emerging as a profitable option among the marginal farmers of the lower Gangetic plains of West Bengal. In rice fallows, rapid depletion of soil moisture after rice harvest compels the farmer to opt for relay cropping where basal application of fertilizers is often difficult due to the standing rice crop in the field. Hence, a field experiment was conducted to determine the effects of foliar spray of nitrogen, phosphorus, potassium and zinc on the growth and productivity of relay cropped lentil (var. Moitree).The results indicated that the highest plant height (49.7 cm), nodule number (35 $plant^{-1}$), dry matter (211.95 g m^{-2} at harvest), crop growth rate, pods $plant^{-1}$ (113), seed yield (1458 kg ha^{-1}), and harvest index (0.40) was obtained with foliar spraying of 0.5% NPK (19:19:19) + 0.5 % ZnSO4 at pre-flowering and pod initiation stages. No significant difference in yield and harvest index was observed between this treatment and foliar spray of 2% DAP + 0.5% ZnSO4 at the same growth stages. Moreover, the former treatment also generated

higher B:C ratio (2.81) with highest gross and net returns. Thus, timely foliar nutrition with 0.5% NPK (19:19:19) + 0.5 % ZnSO4 might be an economically viable agronomic strategy for augmenting overall growth and productivity of relay-cropped lentil.

AISDGONF/ABS/TB/482

Assessment of temporal trend of rainfall for analyzing rainfed crop potential in Alipurduar district of West Bengal

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In order to sustain the productivity of the crops and cropping system, particularly in a typical rainfed area an investigation was undertaken for 5 blocks of Alipurduar District of West Bengal district to assess the crop water availability pattern, its associated climatic risk for successful crop planning under rainfed condition. Gridded Rainfall and temperature data were obtained from the website of India Meteorological department. Weekly rainfall was analyzed to find suitable sowing time/ cropping window. Annual trend of crop water availability indicator i. e. rainfall was computed using non-parametric Mann-Kendall and Sen Slope method. Minimum expected amount of weekly rainfall at different probability levels and probabilities of consecutive dry periods using various weekly threshold limits of rainfall (20 and 50 mm) were analyzed by using weather cock software. For the purpose of estimating seasonal rainfall 10-22 SMW was considered as Pre - Kharif, 23-41 SMW as Kharif and 42-9 SMW as Rabi season. Crop water availability for a week was considered humid when rainfall(R)> Potential Evapotranspiration (PET), Moist (R between ½ PET and PET), Moderately Dry (R between ¼ PET and ½ PET) and dry (R<¼ PET). Stable rainfall of rice was analyzed for total of 13 weeks. It is observed that in every alternate year, minimum 28-30 weeks for upland crops and 24-25 weeks for transplanted rice are assured for ideal water availability under rainfed condition with little variability within the district. Climatic risk of consecutive two dry weeks has been found to be <50% during 13-42 SMW for upland crops and 15-41 SMW for Transplanted rice. Annual and seasonal rainfall showed negative trend for all the study locations but not significantly except Madarihat. Among the seasons, kharif rainfall showed significant negative trend in three out of five study locations. In case of Alipurduar block a decreasing trend is found for both humid and dry weeks. In case of stable rain fall it was found that in each station the trend is decreasing in each station for all the transplanting weeks except at 22 SMW at Kumargram.

AISDGONF/ABS/TB/483

Different irrigation methods and mulch condition in sweet corn (*Zea mays* L. var. *saccharata*) for augmenting higher water productivity

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Water is a limited natural resource and must be used efficiently for the improvement of crop and water productivity. An experiment was initiated at CR farm, Gayeshpur, BCKV, Nadia during *Rabi* 2019-20 to determine the impact of various irrigation methods and mulch condition in sweet corn to find out variation in water use and WUE of the crop. There were two factors in the experiment: three irrigations methods *viz*., furrow irrigation, alternate furrow irrigation, and flood irrigation as in main plot whereas four mulch conditions *viz.* paddy straw mulch, black polythene mulch, jute textile mulch, and soil

mulch in sub plot treatment which were laid out in a Factorial RBD design and replicated thrice. Results of the experiment depicted that all the growth parameter like plant height, dry matter accumulation, CGR, LAI except RGR were highest with furrow irrigation when coupled with black polythene mulch. Among the different irrigation methods, furrow irrigation registered 5.7% and 12.7% higher crop yield than flood and alternate furrow irrigation. There was 7.7-16.1% higher fresh cob yield was obtained due to adoption of different types of mulches than soil mulch in sweet corn cultivation. The combination of furrow irrigation and black polythene mulch resulted in the highest cob yields (173.95q ha^{-1}), biological yields (530.54 q ha^{-1}), and harvest index. Total water use was maximum in flood irrigation along with soil mulch whereas, alternate furrow irrigation with black polythene mulch registered the highest water use efficiency (8.86 kg/ha-cm). The results of the present study clearly indicate that furrow irrigation along with black polythene mulch may be the best management practices in the case of sweet corn for getting higher crop yield and water use efficiency.

AISDGONF/ABS/TB/484

Integrated nutrient management in lady's finger (*Abelmoschus esculentus* L.) under bael (*Aegle marmelos* L.) based agri-horti system

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The present investigation was conducted during spring season of 2021 at Agricultural research farm of Rajiv Gandhi South Campus under Banaras Hindu University, Uttar Pradesh with a view to study the effect of integrated nutrient management on lady's finger under bael based agri-horti system. The experiment was laid out in a Randomized Block Design with three replications. The treatments were T_1: 75% RDF; T_2: 100 % RDF; T_3: 75% RDF + 2.5 t/ha of vermicompost; T_4: 75% RDF + 2.5 t/ha of poultry manure; T_5: 75% RDF + 5 t/ha of FYM; T_6: 100% RDF + 2.5 t/ha of vermicompost; T_7: 100% RDF + 2.5 t/ha of poultry manure; T_8: 100% RDF + 5 t/ha of FYM. Growth of lady's finger was greatly influenced by integrated nutrient management practices and significantly higher dry matter production was found when 75% of RDF was integrated with either 2.5 t/ha of vermicompost or 2.5 t/ha of poultry manure or 5 t/ha of FYM. Number of fruits and fruit yield per plant was found maximum with 100% of RDF + 2.5 t/ha of vermicompost including overall fruit yield (t/ha).Integration of three organic manures *viz.* vermicompost, poultry manure and FYM both at 75% and 100% RDF was found effective over sole application of fertilizers. For obtaining a higher yield and profit by cultivating lady's finger variety PAN 2199 under bael based agri-horti system in Vindhyan region of India,100% RDF + 2.5 t/ha of vermicompost was followed.

AISDGONF/ABS/TB/485

Effect of tebuconazole on soil enzymes and microbial activity of coastal saline and new alluvial soils of West Bengal

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Modern day agriculture heavily relies on the use of pesticides for crop production. More than 1000 pesticides used around the world to ensure food is not damaged or destroyed by pests. Each pesticide has different properties and toxicological effects. The excess exposure of pesticides and their offsite mobility instead of controlling target pests are of significant environmental concern in the current decade. Soil enzyme activity as well as microbial population are good bio-indicators of soil health. The present investigation was undertaken to evaluate the effect of the widely used triazole group fungicides –'tebuconazole' on soil enzymes, namely dehydrogenase and phosphatase and the microbial activity. Soil samples from two agro-climatic zones i.e. coastal saline soil (Kakdwip, South 24 Parganas) and new alluvial soil (Mohanpur, Nadia) at 0-15 cm depth were collected. For this experiment, 200 g air dried sieved soil were taken in each plastic container of 500 ml capacity and treated with different concentrations of tebuconazole- T1: Control - no use of pesticides**,** T2: Half of the recommended dose of tebuconazole (25% W/W) @ 187.5 g a.i. ha^{-1}**,** T3: Recommended dose of tebuconazole (25% W/W) @ 375 g a.i. ha^{-1}**,** T4: Double of the recommended dose of tebuconazole (25% W/W) @ 750 g a.i. ha^{-1}. Soil incubation study was done under controlled condition and data was recorded at regular time interval. The findings revealed that tebuconazole treatment did not express any significant change of dehydrogenase activity at different concentrations in new alluvial soil but at high dose a significant decrease of the enzyme was found in coastal saline soil. The phosphatase enzyme activity was found to be increased in both the selected soil samples with tebuconazole in the treatments against control. The maximum enhancement of phosphatase activity was found in tebuconazole applied at its recommended dose on 21 days of incubation. Similar result was found in case of bacterial population in both the treated soils. At the end of the incubation period, maximum bacterial population was found in recommended does in both experimental soil. An inhibitory effect between the rate of concentration of tebuconazole and the fungal population was found both in coastal saline and new alluvial soil. Maximum reduction was found after 28 days of interval at double dose of tebuconazole in both the experimental soil. In tebuconazole treated soil highest actinomycetes growth was found on 28 days of interval at high concentration of chemicals though all the treatments exhibited the increment on actinomycetes population. Tebuconazole did not show any significant change over control on CO_2 evaluation throughout the study in both experimental soil. From the overall findings, tebuconazole may be used safely at recommended concentration but with the increase of dose may adversely affect the overall microbial and soil enzymes activity.

AISDGONF/ABS/TB/486

Response of summer green gram (*Vigna radiata* L.) varieties to different levels phosphorus and potassium fertilization under Nagaland condition

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Green gram (*Vigna radiata* L.) is the third most important pulse crop in India which is mostly grown during *kharif* and summer season. Every crop requires adequate fertilization, to achieve maximum growth and yield. This research attempts to find out the optimum doses of phosphorus and potassium for green gram under Nagaland soil condition, along with the suitable variety. The field was laid in factorial randomized block design with 12 numbers of treatments replicated thrice. The treatment had two components; one part is green gram varieties *viz.,* green gram cv. IPM02-3, cv. SGC-20 and cv. SGC-16. The other part is the combine application of P and K fertilizers at varying rates *i.e.,* 40, 50 and 60 kg ha^{-1} each of P_2O_5 and K_2O. The research was carried out during April-July 2021. A linear increase in growth attributes, yield and stover yield was observed with increasing rate of P and K fertilization. 60:60 kg ha^{-1} P_2O_5:K_2O gave the highest seed yield. This was however, statistically similar with the results obtained under 50:50 kg ha^{-1} P_2O_5:K_2O which gave 48.7% higher yield over control. Among the varieties, the performance of IPM 02-3 was superior than the other varieties in test. Green gram variety IPM 02-3 under Nagaland condition with 50 kg ha^{-1} P_2O_5:K_2O in summer season will be beneficial owing to the better adaptability of the variety.

AISDGONF/ABS/TB/487

Effect of integrated weed management on the growth and yield of Indian mustard (*Brassica juncea*)

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The field experiment was conducted during *rabi* season of 2018-19 at the experimental farm, Himgiri Zee University, Dehradun, Uttarakhand with the aim to evaluate the effect of integrated weed management on the growth and yield of Indian mustard. The experiment was conducted in Randomized block design (RBD) with 7 treatments viz. pre- emergence (PE) application of pendimethalin 750 g/ha, pendimethalin 750 g/ha (PE) followed by (*fb*) one hand weeding (HW) at 30 days after sowing (DAS), post-emergence (PoE) application of clodinafop 60 g/ha, clodinafop 60 g/ha (PoE) (*fb*) one hand weeding (HW) 60 days after sowing (DAS), hand weeding twice at 30 and 60 DAS, weed free and weedy check. All the weed control treatments significantly reduced the weed density and biomass. The result revealed that among all treatment two hand weeding at 30 and 60 DAS recorded highest weed control efficiency and minimum weed index. The integrated weed management treatment pendimethalin 750 g/ha PE *fb* one hand weeding was superior than other treatments in recording highest growth and yield attributes viz. plant height, plant population, dry matter, seed/ siliqua, siliqua/ plant, length of siliqua, seed weight, stover and biological yield. The higher economic returns in terms of Gross return, Net return and Benefit-

Cost ratio was recorded under the same integrated weed management treatment. Thus, it can be inferred that integrated weed management with pendimethalin 750 g/ha PE *fb* one hand weeding can be recommended as a suitable management practice for better growth and yield of Indian mustard.

AISDGONF/ABS/TB/488

Improving sunflower production in alluvial Soils of West Bengal as influenced by sulphur, zinc and boron application

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A field experiment was conducted at farmer's field in Panchakahania, Haringhata, West Bengal during *rabi* season of 2021-22 to assess the different growth & yield attributes and also quality of hybrid sunflower cv. Sunfarm with different doses of S, Zn and B application. The experiment was laid out in a factorial randomized block design which included factor-I (three doses of Sulphur viz. S_1= 25 kgha^{-1}, S_2= 35 kg ha^{-1} , S_3= 45 kg ha^{-1}) with factor-II (six treatments of micronutrients (Zinc and Boron) viz: M_1 = Foliar application of Zn @ 0.5% at 30 DAS, M_2 = Soil application of Zn @ 4 kg ha^{-1} as basal, M_3 = Foliar application of B @ 0.2% at 50 DAS, M_4 = Soil application of B @ 2 kg ha^{-1} as basal, M_5 = Foliar application of Zn @ 0.5% at 30 DAS and B @ 0.2% at 50 DAS, M_6 = Soil application of Zn @ 4 kg ha^{-1} and B @ 2 kg ha^{-1} as basal) and replicated thrice. The results of the study revealed that the application of 45 kg S ha^{-1} was significantly recorded maximum growth, yield attributes and produced the highest seed yield and oil content (2306 kg ha^{-1}, 38.7%); as compared to other doses of sulphur, whereas, in case of micronutrient application (Zn & B), foliar application of Zn @ 0.5% at 30 DAS and B @ 0.2% at 50 DAS resulted highest seed yield and oil content (2264 kg ha^{-1},39.3%) as compared to other micronutrient application. However, the treatment combination of S, Zn and B (S_3M_5: 45 kg S ha^{-1} along with foliar application of Zn @ 0.5% at 30 DAS and B @ 0.2% at 50 DAS) resulted highest seed yield and oil content (2520 kg ha^{-1}, 40.7%) during the experimental season.

AISDGONF/ABS/TB/489

Strategies for improving phosphorus availability in agriculture

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Phosphorus is the second most important macronutrient for plants. Most soils possess considerable amounts of phosphorus bound to soil constituents. Application of phosphorus to deficient soils is unable to sustain as it becomes fixed as insoluble complexes with metal ions. These accumulated phosphates in agricultural soils, if can be mobilized, are adequate to sustain crop yields for long. Excessive phosphorus application and subsequent run-off ends in eutrophication. Alternative cost efficient strategies for better availability of soil phosphorus are the need of the day. Worldwide demand ofphosphate fertilizer, including India, is met from high grade rock phosphate (>30% P_2O_5) whose source is extremely limited; implied imports along with sulphur for this purpose is costly. Approach to use indigenous low grade rock phosphates uses sulphur from pyrite and gypsum for

acidulation. Enrichment of rock phosphate using microflora and crop residue processes are being standardized. Better phosphorus management considers soil management, organic interventions and microorganism backed processes like phosphate solubilizing microflora, arbuscular mycorrhizal fungi which help facilitate phosphate ion uptake. Modification of soil pH to reduce fixation, conservation agriculture practices showed promise. Foraging for soil phosphorus through altered root morphology, architecture and root exudates constitute important findings. Land management like buffer strips, terrace cultivation, wetland cultivation contributes to the cause. Shortlisting more responsive crop varieties to phosphorus are important along with safer options through coated P and nano-fertilizer. Other than cost effective strategies development of P index for cultivable fields, water sheds and intensive cropping systems are important.

AISDGONF/ABS/TB/490

Land shaping for improving yield and economics of low land rice-rice system of New Alluvial Zone of West Bengal

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The lowland area of New Alluvial Zone of West Bengal is dominated by single rice or rice-rice system. Land shaping of low lying rice area through construction of alternate raised and sunken beds (RSB) improves the physical environment and creates the proper conditions for the growth of crops other than rice. A field experiment was conducted to diversify low land rice-rice cropping system with vegetables and flower through RSB during 2018-19 to 2021-22 (4 consecutive years) at research farm of B.C.K.V. Gayeshpur, Nadia, West Bengal to investigate the potentiality of different cropping systems in RSB for improving productivity and profitability. The experiment was laid out in RBD design with 4 replications comprising 6 systems. viz. raised bed (RB) with elephant foot yam - brinjal system alongwith sunken bed (SB) of *kharif* rice+fish - *boro* rice, RB with ridge gourd – potato - pumpkin alongwith SB of *kharif* rice+fish – *boro* rice, RB with okra - bottlegourd - *poi* alongwith SB of *kharif* rice+fish - *boro* rice, RB with elephant foot yam - marigold alongwith SB of *kharif* rice+fish - *boro* rice, RB with maize – brinjal - greengram alongwith SB of *kharif* rice+fish-*boro* rice, and control rice-rice. The results of experiment reveals that RB with elephant foot yam - marigold alongwith SB of *kharif* rice+fish - *boro* rice system recorded the highest rice equivalent yield (95,628 kg/ha) and RB with okra - bottlegourd - *poi* alongwith SB of *kharif* rice+fish - *boro* rice showed maximum net return (₹4,68,377/ha), whereas significantly lowest rice equivalent yield and net return was observed in rice-rice system.

AISDGONF/ABS/TB/492

Effect of natural farming components on yield, soil properties and uptake of nutrient in wheat + gram intercropping system

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The study was conducted at Holta farm, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during *rabi* 2019-20 and 2020-21 to find out the effect of different components of natural farming on yield of wheat + gram intercropping system, different soil health parameters, and uptake of nutrient by crops. The field experiment was carried out in Randomized block design with three replications and eight treatments. Results revealed that ghanjeevamrit + jeevamrit + mulching was found to produce significantly highest available nitrogen, NPK content and uptake, viable microbial count (bacterial, actinomycetes, fungi, dehydrogenase activity) and highest seed yield of wheat and gram. Treatment having ghanjeevamrit + jeevamrit recorded highest available phosphorus and potassium. Application of ghanjeevamrit + jeevamrit + mulching treatment was recorded greater influence over different soil properties followed by ghanjeevamrit + jeevamrit application and it was significantly lowest in control plot.

AISDGONF/ABS/TB/493

Effect of slag based gypsum on availability of primary nutrients in relation to growth and yield of *kharif* onion in lateritic soil

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Slag based gypsum (SBG) having calcium sulfate and considerable amounts of iron oxide and other elements, is a steel industry by-product made from -60 mesh Linz-Donawitz (LD) steel slag fines. A field experiment was conducted in a Lateritic soil at the College of Agriculture, Chhatna, Bankura, West Bengal during *kharif* 2021 to study the effect of 10 different levels of SBG (0, 100, 200, 300, 400, 500, 600, 700, 800, 900 kg ha^{-1}) integrated with 10 t ha^{-1} FYM and recommended dose of fertilizer (RDF) on availability of primary nutrients in soil and growth, yield and nutrient content of *Kharif* onion (cv. *Agrifound dark red*). Soil samples collected from the experimental plots before and after harvest were analysed to assess the changes in soil pH, Electrical Conductivity; Organic Carbon, available nitrogen, phosphorus, potassium content after harvest; primary nutrient content in haulm and bulb and bulb yield. Compared to the control plot, application of 900 kg SBG ha^{-1} effectuated 11.08%, 45.65%, 176.14%, 87.16%, 148.12%, 38.42%, 110%, 190%, 736.36%, 24%, 83.25%, 217.17%, 199% increase in soil pH, EC, OC, available N, P, K after harvest; total N, P, K in onion haulm and bulb and bulb yield, respectively. The results of this experiment pointed out that use of SBG, hitherto considered a waste material into the example of utilization of a wasted opportunity, for its ability to favorably improve different soil parameters and improving the availability of N, P and K in soil and nutrient content and bulb yield of *kharif* onion.

AISDGONF/ABS/TB/494

Sorption of fluoride in soil under different level of phosphate in some Dooars tea plantation of West Bengal and Meghalaya

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Application of phosphate fertilizer more and more, we add Fluoride, as an impurity to the soil since the later constitute an integral part of mineral of fluorapatite from fertilizer-phosphorus. Due to continuation of phosphate fertilization, buffering capacity of phosphate and sulphate ion has been decreased and stopped slow diffusion reaction that follows an initial adsorption in soil. To extend the further investigation on this phenomenon a laboratory based experiment was conducted in some soil of northern (Dooars area) tea plantation site of West Bengal and some barren land of Meghalaya to generate the information whether the long term application of phosphate, often phosphate rocks, helps accommodation of fluoride in soils. Also a comparison was made between sorption-desorption of fluoride and phosphate. There was no evidence of build-up of soluble fluoride in soil. When phosphate status of the soil was low, fluoride showed sorption-desorption hysteresis. That is the desorption curve differed from the sorption curve. When the phosphate status of the soil was higher, this was not the case. It was speculated that the fluoride ion, being smaller, might have been able to penetrate pores blocked by previous reaction with phosphate, but this did not happen probably because of increased negative charge of the surface caused by the previous application of phosphate and this appeared to be more important cause of the decreased penetration than physical blocking of pores.

AISDGONF/ABS/TB/495

Evaluation of new molecules of herbicide on weed infestation, growth and yield of *kharif* rice

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India is the second largest rice producing country of world next to china and occupy first position in area coverage. But a huge amount of yield loss which is to the extent of 15-20 % is caused by weed. Considering this fact, an experiment was conducted during *kharif* season of 2020, laid out in Randomized Block Design(RBD) with nine treatment combinations replicated thrice at Instructional farm Jaguli, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. Treatments are : T_1-UPH-814(S) 1500 ml/ha ; T_2-UPH-814 2000 ml/ha; T_3-UPH-814 2500 ml/ha; T_4-Pyrazosulfuron ethyle 10 % WP 150 g/ha; T_5-Pretilachlor 50 % EC 1500 ml/ha; T_6-Bensulfuron methyl 0.6%+ Pretilachlor 6% GR 10000 ml/ha; T_7 -Hand weeding 20 & 40 DAT; T_8- Weedy check (control plot); T_9-UPH- 814 4000 ml/ha. The result stated that, pre-emergence application of Bensulfuron methyl 0.6%+ Pretilachlor 6% GR 10000 g/ha (T_6), pre-emergence application of UPH 814 (S) 2500 g/ha (T_3) and hand weeding at 20 and 40 DAT(T_7) recorded

significantly higher grain yield (3.67, 3.65 and 3.47 t/ha respectively), straw yield, crop growth rate, weed control efficiency, benefit cost ratio. It may be concluded that based on the findings in respect of weed management, appreciable growth and grain yield, pre-emergence application of either new molecule UPH 814 (S) @2500 g/ha or Bensulfuron methyl 0.6%+ Pretilachlor 6% GR 10000 g/ha or hand weeding twice at 20 and 40 DAT may be recommended for weed control in transplanted *kharif* rice depending on timely availability of labour, chemical herbicide and capital at hand.

AISDGONF/ABS/TB/496

Effect of nutripriming of zinc and boron on growth and productivity of lentil with irrigation regimes in the lateritic belt of the of sub-humid tropical region

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Micronutrient deficiencies resulting from unbalanced use of fertilizer application and it is a major bottleneck in growth and productivity of pulse crops in the lateritic belt of the subtropical region. In the present experiment, the moisture sensitive crop lentil was taken into consideration; in the year 2014–15 and 2015-16 in lateritic belt of West Bengal. Where the main plots represented irrigation regimes: irrigation at 75% CPE (I_{75}), irrigation at 100% CPE (I_{100}) and irrigation at 125% CPE (I_{125}); while subplots represented zinc and boron micronutrient priming in a split-plot design with three replications. Plant height, leaf area index, crop growth rate, chlorophyll content, chlorophyll stability, relative leaf water content, root length, root area, root volume, root diameter, and productivity were evaluated. All growth indicators or productivity were influenced by irrigation regimes, and seed priming with zinc and boron. The overall grain yield enhancement with irrigation at 100% CPE (I_{100}) over irrigation at 75% CPE (I_{75}) and 125% CPE (I_{125}) was 16.4% and 33.1%, respectively; while it was enhanced by zinc sulphate + boric acid (P_5), zinc sulphate (P_3) boric acid (P_4) and hydro priming (P_2) over no-priming (P_1) was 44.0%, 30.5%, 27.4% and 10.0%, respectively. The results suggest that the combination of irrigation at 100% CPE (I_{100}) with Zn sulphate heptahydrate + boric acid (2 mM + 4 mM) priming (P_5) requires further studies to find climate-smart management techniques in lentil crop.

AISDGONF/ABS/TB/497

Effect of phosphorus (P) and zinc (Zn) interactions on dry matter, P and Zn concentration and uptake in green gram

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Phosphorous (P) and zinc (Zn) are the two key elements required for crops, especially pulses, in appropriate quantities. These minerals commonly interact adversely with one another in soil-plant systems. Interactions between Zn and P in soil-plant systems can impact both Zn and P bioavailability in soil as well as Zn and P accumulation within plants. A green-house experiment was set up to evaluate the effect of P (0, 25, 50, 100, 200, 400 and 600 mg kg^{-1}) and Zn (0, 5, 10, 15 and 20 mg kg^{-1}) and their interactions on dry weight, P and Zn concentrations and their uptake in green gram. Increasing the P rate to 200 mg kg^{-1} soil had a significant impact on P concentration, P and Zn intake and dry matter. Similarly, increasing Zn doses increased Zn concentrations, dry matter weight, P and Zn uptake while having no effect on P concentration. Dry matter was unresponsive to Zn treatment at low P dosages, although green gram plants produced more dry matter at high P and Zn levels than the control. While P and Zn treatments improved greengram growth, high amounts of P lowered Zn concentration dramatically. Excess P application in P and Zn-deficient soils causes P-imposed Zn deficiency in plants. We propose that a combined application of P and Zn up to a limit for maintaining an ideal P/Zn molar ratio in shoots of around 190-260 may be utilized to improve green gram dry mass, P and Zn absorption, and that if the P:Zn molar ratio in plant tissues reaches 380, Zn fertilisation would be a good technique for green gram growth.

AISDGONF/ABS/TB/498

Performance of lathyrus varieties under different establishment methods in Red and Lateriete Zone

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In red and lateriete zone of West Bengal, only *kharif* rice is grown annually due to poor irrigation facility. Lathyrus, as succeeding pulse in rice field with minimum or no-tillage may be introduced in this regions to fetch extra income to the farmer as well as improve soil health. Keeping this in view a field experiment was conducted in a split-plot design with 3 replications comprising 3 establishment methods (Broadcasting, Line sowing and Dibbling) in main-plots and 3 varieties (Nirmal, Prateek and Ratan) in sub-plots at the Regional Research Sub-Station, Bidhan Chandra Krishi Viswavidyalaya, Raghunathpur, Purulia, during *rabi* season of 2020-21. Broadcast sowing of lathyrus led to highest number of plants m-2 (34.2) at maturity stage compared to line sowing (26.8 plants m^{-2}) and dibbling (23.2 plants m^{-2}) method, but, crop sown in line (E_2) produced maximum number of pods $plant^{-1}$ (56.1). Based on seed yield, three establishment methods could be arranged as: line sowing (1400.6 kg ha^{-1}) > dibbling (1261.6 kg ha^{-1}) > broadcasting (1211.2 kg ha^{-1}). Among three varieties, Ratan had 53.9 and 83.3 kg ha^{-1} greater seed yield over Nirmal and

Prateek, respectively. The net return varied between Rs. 15,505.10 (E_1) and Rs. 21,745.70 ha^{-1} (E_2), which led to higher B : C ratio of 1.62 for line sowing crop (E_2) in Red and Laterite Zone of West Bengal. Thus, Ratan could be adopted under line-sown condition in red and laterite soil of West Bengal during *rabi* season for greater yield and profitable cultivation.

AISDGONF/ABS/TB/499

Underutilized crops of south Odisha and their domestication by the tribal communities

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South Odisha is one of the agro biodiversity hotspots which abound with a number of plant genetic resources that have contributed significantly towards enriching the biodiversity of the region. These plant genetic resources hold potential for a number of traits including drought, frost, disease and pest resistance, tolerance to salinity and alkalinity, growth in various ecological habitats, higher yield as well as nutritional and medicinal traits. A number of these plant resources have been neglected and underutilized due to the advent of many high yielding varieties. The present study is an attempt to highlight the importance of these crop species and to showcase the roles being played by the poor and marginal farmers towards conserving the gene pool of these races by way of their cultivation and domestication. Tribal communities represented by Bhumia, Paroja, Bhatra, Gondo, Gadaba, Kandha, Koya, Saora have truly served as custodians of the crops which have largely been ignored by the scientific fraternity, breeders as well as policy makers. Crop species including landraces of rice, maize, millets, wild edible tubers, leaves, fruits, flowers etc. are underutilized but are found to possess a number of nutritional and climate resilient traits. These crops have been intricately associated with the cultures, rituals and social ceremonies of the tribes. Bioprospecting the valuable germplasm resources would surely ensure food and nutritional security for the global climate change scenarios and would also contribute towards their conservation besides successful utilization of their medicinal properties.

AISDGONF/ABS/TB/500

GIS -based evaluation of soil irrigability and land capability for agriculturalsustainability affected by fly ash

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Silt is found more in the adjacent area (<4km) of coal based Kolaghat thermal power plant whereas clay is rich for the rest of study area. Water holding capacity is little bit higher (54.4%) in the site close to power plant than the remaining area (53.02%). Calcium carbonate content (1.06%), electric conductivity (0.26 dSm^{-1}) and exchangeable sodium percentage (3.98%) are also influenced by fly ash while these are 0.88%, 0.124 dSm^{-1} and 3.37% respectively for thearea (>4km) outside of impact zone. Gypsum status (1.59%) and infiltration rate (0.316 $cm.h^{-1}$) in further location (>4km) compared to the nearer area (0.4% and 0.3 $cm.h^{-1}$ respectively). Cation

exchange capacity (16.46cmol.kg^{-1}), base saturation (89.3%) are found more in the surrounding area (<4km) whereas these are 13.17 cmol.kg^{-1} and 85.23% respectively for the rest of area. Organic carbon is comparatively less (0.49%) in the plant site. The land near to thermal power plant is moderately suitable for irrigation with limitation of organic carbon (<0.75) and alkalinity (pH>7) while the drainage is the limiting factor for the remaining area. The surrounding land is capable for moderately good for cultivation with limitation of soil and climate. This evaluation precisely designed by GIS technology suggests the best alternative usesof land for environmental and agricultural sustainability as well as the improvement of socio- economic profile of the agrarian community.

AISDGONF/ABS/TB/501

Performance of straw and green mulch as the tool for weed suppression and yield maximization in jute-rice crop sequence under conservation agriculture management system

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A field experiment was carried out during *pre-kharif* & *kharif* season of 2022 to study the performance of straw and green mulch as the tool for weed suppression and yield maximization in jute-rice crop sequence under conservation agriculture management system in inceptisol at Mondouri Teaching Farm (latitude: 23.5˚ N, longitude: 89˚32' E, altitude: 9.75 MSL) of BCKV, West Bengal. The experiment was laid out in split plot design with three replications comprising of two main plot treatments *viz.* Conventional Tillage (CT) and Minimum Tillage (MT) and five sub plot treatments *viz.* T_1: 100 % RDF to all crops in sequence, T_2: 75 % RDF to all crops in sequence, T_3: T_2 + *ex-situ* application of paddy straw @ 3 t/ha to jute only, T_4: T_2 + *ex-situ* addition of plant biomass of *Sesbania spp.* @ 3 t/ha to jute only and T_5: T_2 + *ex-situ* addition of plant biomass of *Crotalaria spp.* @ 3 t/ha to jute only. Both in jute and rice, the weed related parameters like, weed population, dry weight of weeds, weed control efficiency (WCE); and yield parameters *viz*. fibre yield of jute and grain yield of rice were significantly influenced by various treatments in the experiment. Amongst different weeds, *Cynodon dactylon*, *Cyperus rotundus*, *Sporobolus diander*, *Alternanthera sessilis*, *Phyllanthus niruri* etc. were the dominant species in the field. At 15 & 30 DAE of the jute crop, the respective lowest values of total dry weight of weeds (147.04 & 175.89 g/m^2), the dry weight of grasses (31.56 & 44.2 g/m^2), sedges (24 & 25.33 g/m^2) and broadleaved species (91.48 & 103 g/m^2) were recorded in treatment T_5 under conventional tillage. The total weed population (231 number/m^2) & total dry weight (913.78 g/m^2) of weed were recorded to be the lowest in treatment T_3 under conventional tillage system and the highest one of weed control efficiency of 47.17 % was found in treatment T_3 under minimum tillage at 45 DAE of the jute crop. The maximum fiber yield (1.59 t/ha) was recorded in treatment T_3 followed by T_5 under conventional tillage. Similar trends in observation were recorded in total dry weight of weed at different growth stages, WCE as well as grain yield of rice.

AISDGONF/ABS/TB/502

Understanding the effect of different planting methods and levels of herbicide on the growth and yield of lowland rice (*Oryza sativa* L.)

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A field experiment was conducted at the Research Farm of College of Agriculture, Central Agricultural University, Imphal, Manipur during the *Kharif* season of 2017. The experiment was laid out in a factorial randomized block design comprising of three crop planting methods i.e. broadcasted DSR (M_1), drum seeded line sown direct seeded (20 × 10 cm) (M_2) and manual transplanted rice (20 × 10 cm) (M_3) and four levels of pyrazosulfuron-ethyl i.e. 0 (D_0), 15 (D_1), 25 (D_2) and 35 (D_3) g a.i. ha^{-1}. The result revealed that the maximum number of effective tillers per sq. m (336.67), number of filled grains per panicle (112.20), panicle length (24.95 cm), test weight (30.67 g) and grain yield (39.11 q/ha) was observed with PSE @ 35 g a.i. per hectare under transplanted rice (D_3M_3). The maximum plant height (113.80 cm) and straw yield (58.07 q/ha) was observed in application of PSE @ 35 g a.i. per hectare under line sown DSR (D_3M_2). The highest gross return (Rs 88584.00 /ha) was obtained in application of PSE @ 35 g a.i. per hectare under transplanted rice (D_3M_3), highest net return (Rs 45751.67 /ha) and benefit: cost ratio (1.11) was obtained in application of PSE @ 35 g a.i. per hectare under line sown DSR (D_3M_2). From the present investigation, it was observed that, application of PSE @ 35 g a.i. per hectare under line sown DSR was the most convenient treatment for optimizing the yield and monetary returns with effective weed control measures.

AISDGONF/ABS/TB/513

Tillage and crop residue on weed dynamics and productivity of rice under rice-wheat cropping system

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A field experiment was conducted during 2019-20 & 2020-21 to evaluate the effect of tillage and residue management on weed dynamics and productivity of rice under rice-wheat cropping system with four tillage systems; conventional tillage in rice and wheat, zero tillage in rice and wheat and two rotational tillage sequences that alternated between conventional tillage and zero tillage whereas four residue management practices; residue applied in both season, residue applied in *kharif* season only, residue applied in rabi season only and without residue in both season. The experiment was carried out at agronomical research farm of Birsa Agricultural University, Ranchi, Jharkhand. Results revealed that in direct seeded rice having highest grain yield (10%), straw yield (8%) and the entire yield attributes (10-15%) as well as lesser weed density and weed dry matter found under Conventional tillage during both the season of experiment but performance of zero tillage was better (3-4%) in second year as compared to all treatments. Whereas surface retention of residue @ 5 t/ha was significantly more effective in controlling different category of weeds, it decreased up to 60-75% weed population,

resulting increment in grain yield up to 19% and 23% during first and second year respectively, as compared to plot receiving no residue.

AISDGONF/ABS/TB/517

Long-term effect of organic sources of nutrients on yields and soil properties of the rice-wheat rotation

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An experiment was carried out at the ICAR–IARI, New Delhi, India, during *Rabi* 2022-23 to investigate the effect of organic manures and bio-fertilizers on wheat (var. HD 2967) productivity and profitability under long-term rice-wheat rotation. The experiment was carried out with 11 treatment combinations, and each treatment was replicated thrice. The treatment combinations were T_1 (control), T_2 (FYM at 10 t ha^{-1} applied only to wheat), T_3 (Leucaena green leaf manuring to wheat), T_4 (LGLM + *Azotobacter* to wheat), T_5 (LGLM + FYM to wheat), T_6 (LGLM + FYM + *Azotobacter* to wheat), T_7 (FYM at 10 t ha^{-1} given to both rice & wheat), T_8 (SGM to rice and LGLM to wheat), T_9 (SGM + BGA to rice and LGLM + *Azotobacter* to wheat), T_{10} (SGM + FYM to rice and LGLM + FYM to wheat), and T_{11} (SGM + FYM + BGA to rice and LGLM + FYM + *Azotobacter* to wheat). After 21 years, results revealed that GM + FYM + BF applied to both crops recorded the highest grain yield, followed by GM + FYM applied to both crops and GM + BF applied to both crops. Compared with the control, applying GM + FYM + BF to wheat and previous rice increased dry matter accumulation, effective tillers, and flag leaf length. These various sources of nutrients also rejuvenated soil health. After 21 years of experiment, the biological qualities of the soil - DHA as well as the chemical soil properties - available N, and total organic carbon were considerably enhanced by the nutrient source GM + FYM + BF applied to both the crops compared to control. Thus, it can be concluded that GM + FYM + BFs applied to rice and wheat crops is the most suitable treatment, followed by GM + BFs given to both crops for improving wheat yields, soil health and profitability.

AISDGONF/ABS/TB/518

Evaluating the effect of phosphorus management through organic and microbial sources on growth and productivity of baby corn (*Zea mays* L.)

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Maize comes in third place after wheat and rice as a food grain crop. Among different types of maize, baby corn becomes a popular vegetable in Indian market with a great demand. To produce high quality and enough quantity of baby corn, effective nutrient management strategies should be followed. Among the major nutrient phosphorus (P) is the second most important after nitrogen for proper growth and development of crops. There are some organic and microbial sources of P fertilizer which should be used in an integrated manner. In this backdrop, an experiment was undertaken at Indian Agricultural Research Institute, New Delhi in *Kharif* season of 2022-23 to investigate the effect of phosphorus management through organic and microbial sources in baby corn (var. Pusa HM 4 (Shishu)). The experiment was laid out in a randomized block design

comprising three replications with ten treatments *viz.* control (no P), phosphate solubilizing bacteria (PSB) @ 500 g ha^{-1}, AM Fungi @ 12.5 kg ha^{-1}, PSB @ 500 g ha^{-1}+AM Fungi @ 12.5 kg ha^{-1}, 27 kg P ha^{-1} through phosphate rich organic manure (PROM), 27 kg P ha^{-1} through DAP, 20 kg P ha^{-1} through PROM, 20 kg P ha^{-1} through PROM+PSB, 20 kg P ha^{-1} through PROM+AM fungi, 20 kg P ha^{-1} through PROM+PSB+AM fungi. The application of 27 kg P ha^{-1} through PROM recorded significantly higher plant growth parameters like plant height, dry matter accumulation, leaf area index at 40 DAS and 55 DAS. But the treatment 27 kg P ha^{-1} through DAP resulted better plant growth at initial stage (20 DAS). The highest baby corn yield with husk (11.80 t ha^{-1}), without husk (2.90 t ha^{-1}) and fodder yield (27.81 t ha^{-1}) was recorded under the treatment 27 kg P ha^{-1} through PROM followed by 27 kg P ha^{-1} through DAP and 20 kg P ha^{-1} through PROM+PSB+AM Fungi. Co-inoculation of PSB and AM fungi resulted higher baby corn yield compared to P control. Post harvest soil available P status was improved (16.27 kg ha^{-1}) due to application of 27 kg P ha^{-1} through PROM compared to DAP application. Better performance of PROM in baby corn growth and productivity indicate that PROM can be an effective alternative of DAP in coming future.

AISDGONF/ABS/TB/519

Performance of scented rice (cv. Kalonunia) under varied seedling age and spacing in New Alluvial Zone of West Bengal

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The common practice of rice establishment is square and rectangular planting, but 3-row planting is a newconcept for better growth, yield and crop management. Keeping in view, a field experiment was conducted in a split-plot design with 3 replications comprising 3 ages of seedlings (15 days old, 30 days old, 45 days old) in main plots and 4 row spacings (20 cm × 20 cm, 15 cm × 20 cm, 10-10-30 cm × 20 cm, 10-10- 10- 30 cm × 20 cm) in sub-plots at Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia, West Bengal during *kharif* (wet) season of 2022. The planting of 45 days old seedlings resulted in highest plant height (82.4 cm, 130.2 cm and 153.2 cm) and dry matter accumulation (158.9, 322.4 and 442.8 g m^{-2}) at 30, 60 and 90 DAT, respectively. The crop raised with 30 days old seedlings yielded highest (2.37 t ha^{-1}) mainly due to significant improvement in filled grains $panicle^{-1}$ (102.2). Kalonunia rice planted at a spacing of 10-10-30 cm × 20 cm recorded maximum grain yield (2.34 t ha^{-1}), which was 6.3%, 1.3% and 11.4% greater over 20 cm × 20 cm, 15 cm × 20 cm and 10-10- 10-30 cm × 20 cm, respectively. The lodgingsusceptibility of plant was gradually increased with increase in seedling age from 15 days (score 4.3) to 45 days (score 5.6). On the other hand, 4-row planting (10-10-10-30 cm × 20 cm) reduced the lodging susceptibility of Kalonunia rice due to intermingled rooting system followed by rectangular planting (15 cm × 20 cm). The grains obtained from the square planted plots (20 cm × 20 cm) had maximum protein content (7.46%), while those from 4-row system (10-10-10-30 cm × 20 cm) recorded highest alkali spreading value (score 4.09). Seedling age and row planting did not influence the intensity of aroma of the tested scented rice in the study. With these, it can be concluded that planting of Kalonunia rice with 30 daysold seedlings at triple-row spacing (10-10-30 cm × 20 cm) resulted in highest grain yield (2.52 t ha^{-1}) withgreater lodging susceptibility (score 5.3) and less aroma (score 1.53). But the crop raised with 30-day old seedlings at rectangular spacing (15 cm × 20 cm) produced moderate yield (2.45 t ha^{-1}) with less lodging tendency (score

4.67) and slightly better aroma (score 1.93) in New Alluvial Zone of West Bengal.

AISDGONF/ABS/TB/521

Evaluating the efficiency of the pigeonpea-wheat system across different production scenarios: natural, organic, conservation, and conventional system

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Lately, natural and organic farming have gained prominence, underscoring the need to assess their productivity potential and compare it against the existing conservation and conventional agricultural production methods. Hence, a field experiment was conducted at ICAR-Indian Agricultural Research Institute during 2022-2023 that integrated conventional, natural, organic and conservation agriculture along with different crop establishment methods such as narrow bed, broad bed and flatbed system and comparing their effects on productivity and soil health. The experiment was laid out in randomized plot design with twelve treatments and three replication. The result of this study showed that among different production system, conservation agricultural practices gave maximum productivity for both pigeon pea and wheat. The result indicated that there was ~41%, 26% and 19% yield reduction of pigeon pea in natural farming system, organic farming system and conventional system respectively compared to conservation system. However, wheat yield was ~36%, 24% and 15% lower in natural farming, organic farming and conventional farming as compared to conservation agriculture. Nevertheless, system productivity also followed the same trend that showed ~39%, 24% and 17% yield reduction compared to conservation agriculture. Harvest index for both the crop remained non-significant although conservation agriculture recorded higher value followed by organic farming treatments and natural farming treatments.

AISDGONF/ABS/TB/522

Impact of climate smart technologies on carbon and water footprint for sustainable mustard production in semiarid ecology of India

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Globally, the sustainability of agricultural production systems faces a significant risk due to decreasing water productivity, inefficient resourcde use, and increased greenhouse gas emissions. To increase water productivity and reduce GHGs emission, micro-irrigation especially deficit drip irrigation and agro forestry is a carbon efficient and sustainable option. In response, this research experiment was conducted at Indian Agricultural Research Institute, New Delhi, in *Rabi season* 2020-2021. The experiment was carried out in split plot design (SPD) with 5 main-plot treatments and three sub-plot treatments and replicated thrice. The aim of this experiment was to study and understand the effect of Agri-Horti system (AHS) and deficit irrigation scheduling (DIS) on crop growth, yield, moisture dynamics, physico-chemical properties, economics and water productivity in mustard crop. Main plot treatment consists of moringa (*Moringa oleifera* Lam.), phalsa (*Grewia asiatica* L.), karonda or Carandas plum (*Carissa carandas* L.), aonla or Indian gooseberry (*Phyllanthus emblica* L.) and guava (*Psidium guajava* L.) and subplot consist of three deficit-

irrigation scheduling level (DIS), viz. rainfed, 0.4 IW: CPE ratio (irrigation water: cumulative pan evaporation) and 0.6 IW: CPE. The greatest water footprint was observed using the drip irrigation technique at 0.6 IW: CPE, which significantly exceeded the water usage in rainfed conditions and the drip method with a ratio of 0.4 IW: CPE by about 100.1% and 15%, respectively. The water footprint, was minimized when using a moringa, which was similar to the water footprint of the phalsa-based system. The water footprint in the moringa-based AHS was notably lower (between 16.6% and 24.2% lower) compared to the water footprints of AHS systems based on karonda, aonla, and guava. The system using moringa as its base showed notably increased carbon output, surpassing those of aonla and guava-based systems by 19.7% and 24.7%, respectively.

AISDGONF/ABS/TB/524

Effect of nano-urea for enhancing the productivity of rainfed maize (*Zea mays* L.)

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Maize (*Zea mays* L.) is the world's most widely cultivated food crop providing ample food calories and protein for more than one thousand million human beings in the world. Maize being an exhaustive crop requires a large quantity of nutrients during entire growth periods. Balanced and optimum use of nitrogen, phosphorus and potassium fertilizers plays a pivotal role in increasing the yield of maize. Farmers apply a huge quantity of urea as nitrogenous fertilizer in their crops. Being highly soluble in water, a considerable amount of urea is lost to the environment by volatilization, leaching, runoff, denitrification and create pollution besides increasing cost of cultivation. Effective nitrogen management is the key to increase the nitrogen use efficiency (NUE) through minimizing losses and enhancing the yield and profit of rainfed maize. In comparison to traditional urea, foliar application of nano-urea (make: IFFCO) at critical crop growth stages of a plant successfully fulfills its nitrogen need and leads to improved crop yield and quality. As because nano-urea is a new product, there has been limited research on the rate and time of application. Keeping the above facts in view, an one season experiment entitled "Effect of nano-urea for enhancing the productivity of rainfed maize'' was undertaken at the Indian Agricultural Research Institute, Jharkhand in *Kharif* season of 2022 to investigate the effect of nano-urea on the productivity of rainfed maize (var. DHM 121). The field experiment was laid out in randomized block design in a fixed layout with 10 treatments comprising 4 rates of N (0, 50, 75, and 100% of recommended N) and 3 combinations of spray (simple water spray, nano-urea spray, and commercial urea spray) with 3 replications. The recommended dose of nitrogen is applied in split 1/3 at basal, 1/3 at 30 DAS top dressed and 1/3 at 50 DAS top dressed. The spray of nano-urea and commercial urea has coincided with top dressing *i.e*., 30 DAS and 50 DAS. The result of the experiment revealed that the highest grain yield (5.80 t/ha) was recorded with 100% RDN which was closely followed by 50% RDN + 25% RDN (30 DAS) + 1 NUS (50 DAS) (5.30 t/ha), 75% RDN + 2 NUS (30 & 50 DAS) (5.25 t/ha), 50% RDN + 25% RDN + 1 CUS (50 DAS) (5.12 t/ha) and 75% RDN + 2 CUS (5.08 t/ha). Nano-urea led N levels of 50% RDN + 25% RDN + 1 NUS and 75% RDN + 2 NUS, resulting in higher grain yield of 102.30 and 100.38% over the control where nitrogen was not applied. The same trend has also been followed for the stover and biological yield of rainfed maize. Based on one-year field experiment, it can be inferred that about 25% RDN can be saved by applying 2 nano-urea sprays at 30 and 50 DAS respectively with providing 75% RDN through commercial urea.

AISDGONF/ABS/TB/536

Enhanced corm yield, water and energy productivity in elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] through water smart practices

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Water is expected as the scarcest input in agriculture in near future and the situation may still worsen with anticipated climate change effects. Hence, development of suitable climate smart practices, especially water smart technologies for judicious management of irrigation water is the need of the hour in tropical countries. In this context, field experiments were carried out at ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala for two seasons, in *Amorphophallus paeoniifolius* (Dennst.) Nicolson, commonly known as elephant foot yam, suran or jimmikhand or ole, which is as an important tropical tuber crop in India, gaining popularity as a food security crop, and cash crop due to its production potential and preference as a starchy vegetable having high nutritive and medicinal values. Drip irrigation at 50% cumulative pan evaporation (CPE) along with six different sets of water saving techniques, i.e., plastic porous ground cover mulching, antitranspirant spray on foliage, soil application of Pusa Hydrogel, synthetic super absorbent polymer, coir pith and biomulching were tried and drip irrigation at 50% CPE, 100% CPE, and a rainfed crop without any water saving measures were kept for comparison. The leading variety of *Amorphophallus*, 'Gajendra' was used for the study. In both the years, the treatment with ground cover mulching recorded the maximum corm yield (40.1 t/ha), B:C ratio (2.94) and water productivity (3.87 kg/m^3), and reduced the irrigation water requirement by 50% and enhanced the corm yield by 32% and energy use efficiency by 30% as compared to 100% irrigation. The study suggests the possibility of reducing water requirement of *Amorphophallus* and enhancing water productivity and farmers income by adopting suitable water smart practices.

AISDGONF/ABS/TB/539

Effect drip irrigation and biofortification of nano zinc oxide on maize during summer

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Maize is one of the most important cereals crops in the world. It is not only an important source of human nutrition but also a raw material for production of wide variety of industrial goods, animal feed and as bio-fuel. Among the different constraints, moisture stress is an important factor affecting the growth of maize especially in arid and semiarid regions. Higher water productivity may be achieved by irrigation scheduling and adaptation of proper irrigation methods during summer season. Zinc deficiency in human population occurs mostly in regions where cultivated soils are low in plant available Zn and deficiency in food stuffs is well known problem. To address these problem, zinc biofortification through nano-scale fertilizer particles may offer new techniques in improving existing crop management. In this regard a field experiment was conducted at Agricultural Farm, Palli Siksha Bhavana, Visva-Bharati, West Bengal in the year

2022 to evaluate the effect of micro irrigation and comparative influences of zinc oxide nanoparticles on summer maize (*Zea mays*), var. GK 3155. Four irrigation regimes viz. DI_1: Once in 2 days, DI_2: Once in 3 days, DI_3: Once in 4 days, DI_4: Farmer Practice, as main plot treatment and five levels of Zn application viz. Zn_0: Control, Zn_1: Soil application of ZnSO4 at 20 kg/ha, Zn_2: Foliar application of ZnO NP at 40 ppm, Zn_3: Seed of coating ZnO NP at 40 ppm, Zn_4: Seed priming of ZnO NP at 40 ppm as sub plot treatments were used following the split plot design model with three replications. Drip irrigated maize crop, once in 3 days had higher values of plant height, leaf area index, and dry matter accumulation at 30 DAS followed by once in 2 days, once in 4 days and farmer practice but at 60 DAS, 90 DAS and harvest once in 2 days had higher values of plant height, dry matter accumulation and leaf area index followed by once in 3 days, once in 4 days and farmer practice. Among the Zn application levels Zn_4: Seed coating of ZnO NP at 40 ppm showed the highest plant height, leaf area index, and dry matter accumulation followed by Zn_3: Seed priming of ZnO NP at 40 ppm. Maximum yield was recorded under drip irrigation regimes of once in 2 days followed by once in 3 days, once in 4 days and farmer practice. Zn_4: Seed coating of ZnO NP at 40 ppm showed the optimum yield followed by Zn_3: Seed priming of ZnO NP at 40 ppm and Zn_0: Control treatment showed the lowest yield among the Zn application treatments. Considering the water difficulties of present day and cost of zinc oxide nano particles, drip irrigation at once in 2 days and seed coating with zinc oxide nano particles (ZnONP) could be an alternative option to realize a reasonably good yield of summer maize in future.

AISDGONF/ABS/TB/550

Dhaincha coculture and mulching effect on dry direct seeded rice under different methods of crop establishment and deficit fertilizer application

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The sustainable soil health management issue of dry direct seeded rice (DSR) can effectively be addressed by dhaincha brown manuring practice. However, dhaincha coculture with DSR can result some competition which can be overcome by staggered sowing of dhaincha. A field experiment on DSR was conducted during kharif season 2022 at Agricultural Farm, Visva-Bharati, Sriniketan, West Bengal with three methods of sowing (broadcast, line and pellet seeding) combined with no dhaincha brown manuring (DBM), with simultaneous sown DBM and with staggered (20 days after) sown DBM. 100% recommended dose of fertilizers (RDF) was applied in case of no DBM, whereas 75% RDF was applied in case of DBM treatments. Apart from the above nine treatment combinations, the last treatment (T_{10}) was consisted of surface broadcasted of rice seeds and 75% RDF with mulching of dhaincha biomass of 45 days growth to simulate the natural farming practice of Costa Rica known as 'frijol tapado'. The experiment was laid out in randomized complete block design with three replications. Both the grain and biomass yield were declined significantly in broadcast and line sowing due to simultaneous DBM coculture. However, in pellet seeding of rice, simultaneous dhaincha did not affect the grain and biomass yield. But when dhaincha seeds were sown 20 days later (staggered sowing), grain yield was at par or slightly increased over the grain yield of rice without DBM under respective methods of sowing. Therefore, 25% of RDF could be saved due to staggered sowing of dhaincha under broadcast and line sowing. Dhaincha mulching (T_{10}) showed a significantly higher value in grain yield and biomass yield, but it required growing of dhaincha separately.

AISDGONF/ABS/TB/551

Degree of phosphorus saturation for assessing environmental risk in acidic soils of West Bengal

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Phosphorus (P) movement from nonpoint soil sources to surface water bodies, resulting in environmental pollution, must be measured by an indicator. This study was conducted on West Bengal's terai and lateritic acidic soils to determine their environmental threshold degree of P saturation (DPS) values as an indicator of environmental pollution. Comparisons between DPS and soil-test P and water-soluble P indicated that DPS could be a useful environmental indicator. For terai and lateritic soils, the change point DPS was 17.8 and 19.8% with the Bray-1 extractant and 16.8 and 18.3% with the Mehlich-1 extractant. For terai and lateritic soil, the water-soluble P at the respective change points was 2.94 and 3.42 mg kg^{-1} with the Bray-1 method and 2.83 and 3.34 mg kg^{-1} with the Mehlich-1 method. The relationship between DPS_{B-1} (%) and Bray-1 P (mg kg^{-1}) revealed that agronomically optimal levels of Bray-1 P cannot be used to predict environmental risk. Therefore, it is urgent to refine the optimum agronomic P rating with Bray-1 extractant, while also focusing on environmental quality. Consequently, agronomic and environmental interpretation of soil tests for determining the threshold DPS (%) in the surface soil layers is essential for regulatory compliance and prudent management of P sources. Taking into account the change points, confidence intervals, and agronomic soil test values, we can recommend replacing Bray-1 P with three categories of DPS_{B-1}: 20%, 20-40%, and >40%, to indicate different levels of P loss from these soils.

AISDGONF/ABS/TB/552

Boron and molybdenum availability in soil under long term fertility experiments

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Boron (B) and Molybdenum (Mo) are critical elements required for plant growth and carrying out different metabolic activities in plants. Information regarding the availability of B and Mo in soil under different long term fertilization is essential for better assessment of their status for crop nutrition. Different management practices plays a great role on depth wise distribution of these element in soil. Long term fertility experiments (LTFE) provides real signature of their status in soil. For this experiment soil samples were collected from 4 different LTFE sites (Akola, Pantnagar, Udaipur, sabour) at 4 depths (0-15 cm, 15-30 cm, 30-45 cm, 45-60 cm) from different nutrient management practices. Result showed that, conjoint long term application of NPK+ Farm yard manure (FYM) maintain a higher level of available B and Mo in soil over other treatments. Incorpoation of organic matter favoured the availability of B and Mo through chelation mechanism. Availability of both these element is higher at surface and it decreases along the depth

irrespective of LTFE sites. Available status of Mo under different LTFE sites follow this order: Udaipur > Akola > Pantnagar > sabour while the availability of B did not follow any trend.

AISDGONF/ABS/TB/553

Depthwise distribution of different forms of potassium under three different rice based cropping system

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The long-term fertility experiments (LTFE) with integrated organic amendments and chemical fertilizers helps to determine the potassium (K) dynamics in soil and plant availability. With this background the present investigation was undertaken to capture the different forms of potassium *viz.* Water soluble, Exchangeable, Non-exchangeable and Total K with four treatments: T1-Control, T2- 50% RDF, T3 -100% RDF and T4-100% NP +50% K+ 7.5 ton FYM/ha under a LTFE. The experiment design was split-split plot. Results indicated that, under Rice-Mustard-Jute, Rice-Wheat-Maize and Rice-Mustard-Greengram cropping system surface soil (0-15 cm) recorded lowest soil pH *i.e.* 7.43, 7.58 and 7.54 irrespective of treatments and pH increased gradually with the depth. Soil organic carbon (SOC) in surface soil recorded highest values *i.e.* 0.90%, 0.88%and 0.83% for the above mentioned cropping system and irrespective of treatments SOC lowered down with the depth. Surface soil recorded lowest soil bulk density (BD) *i.e.* 1.33 Mg/m^3 for Rice-Mustard-Jute cropping system irrespective of treatments and gradually BD increased with the depth. Surface soil (0-15 cm) having highest value of soil available N of 102.7 kg ha^{-1} was obtained for Rice-Mustard-Jute cropping system *i.e.* irrespective of treatments and this values decreases along the depth. Similar trends of results were also found for other two cropping systems. Under Rice-Mustard-Jute cropping system the soil available P and K recorded with 29 kg P $ha^{-1}$and 162 kg K ha^{-1}which is highest irrespective of treatments for surface soil and this values decrease with the depth. Results also indicated that for different potassium fractions surface soil having highest water soluble K with values 12.8, 13.66 and 13.27 mg kg^{-1}irrespective of treatments and gradually decreased with the depth for all the three cropping systems. Similar trends of results were also found for exchangeable, non-exchangeable and total K among the three cropping systems.

THEME - C

Horticulture as a growth engine in achieving sustainable developmental goals

Lead Lecture **AISDGONF/ABS/TC/537**

Underutilized vegetable crops vis-à-vis food and nutritional security of Tripura

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Underutilized crops are lesser-known plant species in terms of research, documentation and commercial utilization, but well known to adapt to subsidiary and stress or unfavourable conditions. Its native potential and Ethno botanical data are well known to people, whereas, commercial importance and market value are unknown to the public. Underutilized vegetable crops play a significant role in the food and nutritional security of the rural and tribal populations of Tripura. Tripura is one of the richest reservoirs of genetic resources for different vegetable crops. More than 64 numbers of underutilized vegetables are regularly consumed in the state. Many of these crops are abundantly rich in micronutrients and minerals which can help in alleviating the widespread prevalence of malnutrition. *Alpina galangal* is a rich source of Mn (1438.49 ppm) and *Xanthosoma sagittifolium* is a rich source of Vit. A. Besides possessing medicinal properties, these indigenous crops are a source of desirable traits for future crop improvement. *Solanum torvum* is not infested by brinjal shoot and fruit borer and *Abelmoschus manihot* is a source of resistance to YVMV. There is also an urgent need to widen the food security basket by incorporating many minor and underutilized vegetables for both sustainable food and nutritional security. Keeping in view the nutritional and economic value, proper conservation and cultivation practices need to be developed.

Invited Oral **AISDGONF/ABS/TC/179**

Growth and yield of potato (*Solanum tuberosum* L.) as influenced by biostimulant under soilless culture system

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Soil-based agriculture is facing some major challenges with the advent of civilization all over the world, such as decrease per capita land availability. Soilless culture is becoming more relevant in the present scenario, to scope-up with these challenges. An experiment to study the growth and yield of potato (*Solanum tuberosum* L.) as influenced by biostimulant under soilless culture system, was conducted in the glasshouse of the Department of Vegetable Science, BCKV during the year 2020-21. The experiment was laid out in Completely Randomized Design with three replications. The treatments were comprising of six varieties (*viz*., Kufri Jyoti, Kufri Chandramukhi, Kufri Himalini, Kufri Gaurav, Kufri Khyati, Kufri Pokhraj) and two different biostimulant (viz: Pilatus @ 1ml/l water and Goldstar @ 2g/l water). Significant differences were found in the interaction effect of biostimulant and variety. Among the varieties, Kufri Khyati had the highest plant height (58.170 cm at 60 DAP and 61.233 cm at 90 DAP). All of these yield-related characteristics were most effective in plants treated with Pilatus biostimulant. In terms of quality parameters, variety Kufri Jyoti had the highest total soluble solids (7.115^{o}Brix). Whereas Goldstar exhibits the maximum values of total sugar (0.535%), reducing sugar (0.389%) . total

soluble solids (5.455° Brix) From this present investigation it may be recommended that the application of Pilatus is the best for growth and yield attributing characters whereas Goldstar was found effective for quality traits. Overall, the variety Kufri Khyati is best for cultivation of potato under soilless culture systems.

Invited Oral **AISDGONF/ABS/TC/278**

Potential of commercial cultivation of tropical orchids and way forward

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Indian floriculture is the fast emerging and highly competitive industry after globalization. Today, India rank second largest producer of flowers in the world, but the share in the world trade is very negligible (0.89%).Floriculture is a multifaceted enterprise characterized by growing traditional loose flowers and cut flowers under open field conditions and protected environment. The major share (>60%) of floricultural exports is from dry flower industry. Other segments like cut greens (fillers), indoor and landscaping plants, seeds and planting material, turf grass and value-added products also contribute their share in the overall growth of the sector. Production of flowers is estimated to be 2151.96 thousand tonnes of loose flowers and 828.09 thousand tonnes of cut flowers in 2020-21. India has exported 23,597 mt of floriculture products to the world mainly the USA, Netherland, Germany, UK, UAE, and Canada valued at USD 103.47 million in 2021-22. It is predicted that in the near future the Indian floriculture market will grow exponentially. Over the last half a century, importance of orchids in floriculture has been highlighted by various workers and agencies in India. Commercial potentials of orchids in India or its strength and weaknesses in orchid development and trade were discussed in different forums. Keeping the view of orchid trade different organizations of Govt. of India viz. NHB, NABAARD and APEDA have been promoting entrepreneurs to undertake lucrative business. Green house technology is the latest trend and is most desired for production with the required quality, quantity, and regularity of orchids. Green house technology is required to be modified and adopted to various agro climatic zones, depending upon the orchids. Green-house technology has to be adopted for quality, quantity and regularity of production and supply chain management in a business oriented venture. Orchid farming requires huge investment and intensive management by trained workers devoted to the profession. The success of orchid industry depends on timely action right from planting, production management, green house management, post harvest management and cool chain management. There is plenty of scope to cultivate commercially hybrids of tropical and subtropical orchids in the states of Assam, Goa, Karnataka, Kerala, Maharashtra, Tamil Nadu, Tripura, West Bengal and other north eastern states where temperature ranges from 18^0C to 30^0C and humidity ranging from 50-80% and 3000 to 6000fc light. The hybrids of Aranda, Ascocenda, Cattleyas, Dendrobium, Mokara, Oncidiums, Phalaenopsis, Paphiopedilum, Vanda etc. are dominating the floriculture market worldwide. A holistic approach is the need for sustainable development of orchid farming in India. In this direction, there is a need to create awareness amongst farmers, educated unemployed youths and women to take up orchid farming. Different Institutes, Societies and Self-Help Groups should be encouraged to take up awareness campaign. Concept of village and urban clusters involving the communities in promoting cultivation and production of the commercial orchids with a market driven approach - one for domestic market and the other for export purpose would help boost the development of a vibrant orchid industry in India. Involvement of corporate sector for the bye back policy would benefit the economy of all the stakeholders.

AISDGONF /ABS/TC/9

Off season onion production

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Research and development in off season production is important to mitigate the gap between demand and supply of onion during the critical period of price jump between November – March along with increasing farmer's profit. There are four important issues viz., (a) date of transplanting, (b) suitable variety, (c) Nursery raising and (d) raising of crop through seeds or sets along with GAP which need to be addressed for successful off season onion production. Among the various dates transplanting on mid August to September was found to be ideal for West Bengal and North Indian condition. Earlier study showed that N-53, Nasik Red, N-53, LR- 241 and Red Creole varieties performed better as off season production. However, cultivar Agrifound Dark Red, L-883 Bhima Super, Bhima Red, Bhima Raj, Bhima Dark Red, Bhima Shakti, Punjab Selection, Pusa Red, N2-4-1, Pusa Madhavi, Arka Kalyan, and Arka Lalima were found to be the best for *Kharif* and post *Kharif* production in north and central India. The raised bed (10 cm height, 3m length and 2m width) was used to prepare the nursery for off season onion to avoid water stagnation and it should be open (cover only during rainfall). However, nursery production of *kharif* onion seedlings often is affected severely by cloudy atmosphere, late rains and incidence of various pest and diseases. Therefore, at present *kharif* onion cultivation is restricted to certain area with low yield potential and poor keeping quality. Successful raising of nursery during summer season is the main problem for growing of *kharif* season crop. Seed rate and set planting time are also important factors which may influence the growth and yield of onion sets in nursery. In an experiment conducted in Lucknow, it was seen that raised bed cultivation was better when transplanting was done during July to September while, flat bed cultivation was better for April transplantation of Agrifound Dark Red onion.

AISDGONF /ABS/TC/24

Effect of organic supplements on production of onion

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Onion (*Allium cepa* L.*)* is one of the most important commercial bulbous vegetable and is mainly used as salad, cooked vegetable. In view of demand for organically grown vegetables it is pertinent to use locally available organic resources to substitute chemical fertilizers. Thus, studies on the use of different organic sources of nutrients and their combination on the growth and yield of onion are necessary. The present investigation was carried out at Horticulture Research Station, Mondouri, under Bidhan Chandra Krishi Viswavidyalaya during the *Rabi* season of 2021-2022 following RBD with three replication and eight treatments with the view to investigate the effect of different organic supplements for growth and yield of onion and also to find out the suitable organic supplements for higher growth, and yield of onion. Sukhsagar variety was used and the treatments were T1: Enrich vermicompost @ 4t/ha, T2: Enrich vermicompost @ 4.5t/ha, T3: Enrich Vermicompost @ 5t/ha + Hydrogel @ 200g, T4: Local vermicompost @ 5t/ha + Hydrogel @ 200g, T5: Karbon vermicompost @ 5t/ha, T6: Neem Cake @ 4q/ha, T7: Mustard Cake @ 6t/ha along with a treatment T8: Control (untreated). The treatment T3 (Enrich vermicompost @ 5t/ha + Hydrogel @ 200g) was recorded significantly the highest mean value for the most of the characters

of onion in terms of plant height, number of leaves per plants, equatorial diameter, polar diameter, neck thickness, average weight of bulb, total yield followed by T2 (Enrich vermicompost @ 4.5t/ha).

AISDGONF /ABS/TC/27

Studies on microbial growth pattern and quality during preparation of sauerkraut

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Cabbage variety Shaan was harvested in winter and summer months for preparation of sauerkraut in both the season separately. During fermentation bacteria colony and quality recorded at different days interval in winter and summer months. Microbial growth (submerged and surface) during fermentation was maximum on 15th day of fermentation in summer and 20th days of fermentation in winter and thereafter the growth decreased. Although in summer, the initial microbial growth rate was higher than winter, during subsequent fermentation period the decrease pattern of microbial count in both the season was more or less similar. The pH of sauerkraut decreased from 5.89 to 3.25 on 20th day and then it gradually increased to 3.76 on 75th day in winter. In summer months the pH (3.41) on 60th days. In winter months TSS increased to 8.4ºBrix on 20th day and then it gradually decreased upto 60 days and subsequently it increased to 7.8ºBrix on 75th day, similar trend was observed in summer. Acidity and lactic acid increased to 1.85% to 2.61% respectively on 20th day and then it gradually decreased on 75th day on winter. In summer acidity and lactic acid increased to 1.03 and 1.45% respectively on 20th day and then it decreased on 60th day. Ascorbic acid content increased during winter and summer months respectively on 20th day and then it declined gradually on 60th and 75th day respectively. Sensory score for colour, texture, flavour and overall acceptability was high on 20th day. Sauerkraut prepared in summer months deteriorated faster than winter and quality was poor on after 60 days of fermentation as indicated by low sensory score. Whereas sauerkraut prepared in winter months was observed to be fair with regard to colour, texture, flavour and acceptability on 75th days of fermentation.

AISDGONF /ABS/TC/35

Pollen biology and pollen-pistil interaction following pollination of tuberose cultivars

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Tuberose (*Agave amica* (Medik.) Thiede & Govaerts) is a bulbous crop commercially cultivated for cut flower, loose flower and perfume extraction. Development of improved cultivars through conventional breeding methods is limited due to incompatibility and poor seed-set. The inherent nature of incompatibility exhibited by cultivars upon pollination has not been thoroughly examined and understood. In this investigation, pollen viability and germinability of eight tuberose cultivars *viz*., Arka Shringar, Arka Prajwal, Arka Nirantara, Arka Sugandhi, IIHR-6, IIHR-12, Mexican Single and Variegated were studied. Results revealed that cultivars expressed high pollen viability

and germinability on matured bud stage and 1st day of anthesis declining in the subsequently days. Arka Nirantara showed the highest pollen viability (87.14%) whereas IIHR-6 showed maximum *invitro* pollen germination (60.07%) on 1st day of anthesis. Analysis of pollen morphology using scanning electron microscope (SEM) exhibited marked variations among cultivars. Completely shrunken or distorted pollen shape were observed in Arka Prajwal and IIHR-12, these cultivars displayed low viability and germinability. Pollen-pistil interaction following compatible and incompatible crosses was observed under fluorescence microscope revealing growth stages of pollen tubes. The sequential events from pollination to entry of pollen tubes into the ovary projected different pathways in compatible and incompatible cultivars indicative of the existence of post zygotic barrier or late acting incompatibility in the latter. These findings will provide valuable insight in understanding barriers causing incompatibility in tuberose. Further research can be emphasised on genetic constitution and development of male and female gametophyte to rationalize the pretext of incompatibility in the cultivars.

AISDGONF/ABS/TC/38

Cherry tomatoes: a high value crop for urban horticulture

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Cherry tomatoes (*Solanum lycopersicum* var. *cerasiformae*) are the first tomatoes to be domesticated and form an inherent part of diet of South and Central Americans which forms the centre of diversity of tomatoes. Being small and berry-like, these tomatoes have high aesthetic value besides being nutritionally rich. Cherry tomatoes have more organic acids, ascorbic acid, lycopene, beta-carotene, phenolic compounds, and α-tocopherol and other nutrients than regular tomatoes. For example, they have 1.7 times more ascorbic acid than regular tomatoes. The cherry tomato is a special fruit that is good for health in many ways, like making immune system stronger, slowing down ageing, lowering blood pressure and cholesterol, and preventing cancer. Cherry tomato contains the highest lipo-peroxides scavenging capacity as well as the highest ferric reducing antioxidant power. They are excellent sources of dietary carotenoids with health-promoting properties. Cherry tomatoes are gaining popularity in India also with urbanization and their demand among the urban health-conscious people and in restaurants is increasing. The cultivation of this crop in polyhouses in the peri-urban area can become a great source of income for the farmers. Research on cherry tomatoes in India has also initiated and some varieties like Pusa cherry tomato-1, Pusa Yellow Cherry-1, Swarna Ratan, Punjab Sona Cherry, Punjab red cherry, Punjab Kesari Cherry, Swarna Ratan, Pant Cherry tomato-1, BRCT-1 have been developed by different institutes for farmers of the country. Awareness needs to be created among the farmers about the economic and health benefits for its adaptation.

AISDGONF /ABS/TC/58

Marker assisted selection for orange tomato lines carrying resistance alleles for root knot and late blight diseases

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Natural mutation in the *carotene isomerase* (*CrtISO*) gene results in hyper-accumulation of prolycopene in the orange-fruited *tangerine* mutant of tomato (*Solanum lycopersicum* L.). Interestingly prolycopene has been proposed to provide more health benefit in comparison to lycopene, as its absorption in human body is supposed to be more. Naturally, developing multiple disease resistant orange tomato lines is a lucrative area of research. Here we report the molecular marker assisted identification of superior orange tomato segregants carrying natural disease resistance alleles *Mi1.2* (for root knot disease) and *Ph3* (for late blight disease) from the F_2 population of the cross combination IIHR 2614 (pink-fruited line) x TI-05 (orange-fruited line). Heterozygosity of the F_1 plants were validated using molecular markers and the seeds collected from the F_1 plants were used to raise F_2 population in plug-trays. Identification of allelic status for the *CrtISO*, *Mi1.2* and *Ph3* genes in the seedlings were done through gene-based co-dominant markers. The anther cone of the orange fruited line TI-05 exhibits a characteristic orange colour in comparison to the yellow-coloured anther cones in the pink-fruited lines. Flowers of the selected F_2 plants, carrying the *CrtISO* mutant allele and the *Mi1.2* and *Ph3* resistance alleles in homozygous condition were found to have orange-coloured anther cones, validating the results obtained through marker assisted selection. Generation advancement of these selected plants should generate nutritionally enriched orange-fruited tomato lines with resistance to root knot and late blight diseases.

AISDGONF /ABS/TC/59

Adventitious rooting from tomato cuttings: an opportunity for root trait analyses

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The conventional way of tomato (*Solanum lycopersicum* L.) cultivation is raising seed bed followed by transplanting of the seedlings. However, under extreme cold condition, seed germination might be problematic, which becomes anobstacle in off-season cultivation of the crop.On the other hand, in protected cultivation, pruning of secondary branches is a routine practice and yields a huge amount of trimmed secondary branches. This natural resource is often under-utilized. Here we report the evaluation of different conditions through which adventitious roots can be generated in the tomato cuttings. We used the cuttings from un-transplanted seedlings of an F_2 population and studied their rooting ability in 5 different rooting media [i.e. simple water, water with 0.05 % (w/v) fungicide, coco-peat, coco-peat with rooting hormone and sand] and 2

different conditions(i.e., either open or covered within zip-lock bags).In all the cases, covering the cuttings in zip-lock bags performed poor, whereas best rooting was observed in simple water, even only after 10 days. Coco-peat and sand media also generated adventitious roots, but the response was most profound in simple water. The rooted cuttings were successfully transplanted in field condition and exhibited 100% establishment. This method is quite simple and allows several advantages. For example, several root traits can be studied even in segregating F_2 plants, as the cuttings represent clones of the original plant. Comparative yield trials with seedlings and cuttings from the same cultivar may establish this unique method as a lucrative approach at the farmers' end.

AISDGONF/ABS/TC/61

Performance of different litchi cultivars (*Litchi chinensis* Sonn.) under *terai* region of West Bengal condition

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Litchi (*Litchi chinensis* Sonn.), belonging to the family Sapindaceae, is an evergreen, round dome-shaped top, polygamous, subtropical fruit tree with spreading branches and dense shining leaves. It is believed to be the native of Southern China. Litchi is also known as 'Queen of sub tropical fruits','Pearl of India' due to its aromatic flavour and sweet aril taste. In West Bengal it is mainly cultivated in Murshidabad, Malda, Nadia, North and South 24 Parganas. An experiment was conducted during 2018- 2019 at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal, India to judge the fruiting characteristics with seven cultivars of litchi viz., Calcuttia, Elaichi, Bedana, Bombai, China, Shahi and Muzaffarpur as treatments in randomized block design. Results indicated that Bedana showed better result in terms of maximum fruit weight (17.88g), lowest seed content (10.84%), maximum fruit diameter (3.01 cm), maximum fruit volume (18.70 ml), highest TSS (15.87^0 Brix), total sugar (15.96%), reducing sugar (12.61%), and ascorbic acid (29.47 mg/100g) content.

AISDGONF /ABS/TC/62

Evaluation of turmeric genotypes based on growth, yield traits

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The investigation entitled Evaluation of turmeric (*Curcuma longa* L.) germplasm for yield and quality in Krishna-Godavari zone of Andhra Pradesh was conducted in the Lam farm, HRS, Guntur District, Andhra Pradesh, during 2018-19. The experiment was laid out in Augmented Block Design (ABD) with forty eight genotypes and six checks. Among 54 accessions of turmeric studied including check varieties, the genotypes, KTS-5(35.5) recorded more number of leaves, CO-1 (4) more number of tillers. Number of mother rhizomes and primary rhizomes recorded

highest in Kasturi (8.8, 19.6) and highest clump yield per plant was recorded in Kasturi (665.4g). More weight of mother rhizomes and primary rhizomes was recorded in kasturi. Thus, these genotypes may be recommended for commercial cultivation in Andhra Pradesh. They can also be further evaluated to identify best genotypes suitable for cultivation at other locations and also in breeding programmes.

AISDGONF/ABS/TC/63

Response of new brinjal varieties to varied doses of nitrogenous and potassic fertilizers

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Brinjal is a long duration crop and highly responsive to fertilizer use. Nitrogenous and potassic fertilizers have immense role in enhancing the yield and attributing traits in brinjal. But the availability of fertilizers is limited in India since the country imports fertilizers worth INR 520.45 billion. Apart from that non-judicious fertilizer application in crop not only increases the production cost, but also causes severe environmental hazards. An experiment was set up to study the effect of varied doses of N and K on the yield and attributing traits of two new varieties, Sabour Sadabahar and Sabour Krishnakali. There were 32 treatments which were the combinations of three factors variety (V), nitrogen (N) and potassium (K) and there were two varieties (V_1: Sabour Sadabahar, V_2: Sabour Krishnakali), four nitrogen doses (N_0: 0 kg/ha, N_1: 100 kg/ha, N_2: 120 kg/ha, N_3: 140 kg/ha) and four potassium doses (K_0: 0 kg/ha, K_1: 60 kg/ha, K_2: 80 kg/ha, K_3: 100 kg/ha, respectively), laid out in factorial RBD with three replications. Analysis of variance suggested significant variation among the different treatments for most of the traits under study except soil pH, electrical conductivity and organic carbon. The treatment $V_1N_2K_2$ (Sabour Sadabahar applied with 120 kg/ha N, 80 kg/ha K) produced the highest yield per plant and total yield. Considering individual effect, Sabour Krishnakali produced higher yield than Sabour Sadabahar with different doses of both N and K, and 140kg/ha N and 80kg/ha K produced higher yield irrespective of varieties. The N x K interaction depicted that 120 kg/ha N + 80 kg/ha K produced greatest yield which was at par with 140 kg/ha N + 80 kg/ha K was most cost effective. Both the varieties were responsive to N and K fertilizer application for yield but Sabour Sadabahar was more responsive. Thus, application of 120 kg/ha N and 80 kg/ha K may be recommended for brinjal cultivation.

AISDGONF/ABS/TC/68

Inexpensive use of hydroponics for coriander growth

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The study was carried to develop coriander through use of hydroponics in laboratory situation. In the experiment no artificial circulation was provided to aid the nutrient flow and neither any mechanized way of aeration was used for the roots. The objective of the study as to use hydroponics for crop development without much of capital investment. Here in hydroponics, we

used the Kartky system, but in a modified manner. Coriander seeds were placed in hydroponic cups having cocopeat as a growing media, which was buffered and sterilized prior use. Thereafter individual hydroponic cups were put in separate beakers containing nutrient solutions. For the nutrient solutions NPK, calcium nitrate and magnesium sulphate were used in variable proportions, as treatments. Thus, the experiment consisted of five treatments which were replicated four times in Completely Randomized Design. Observations with respect to various growth parameters were documented 10-30 days of crop growth. Finally, from our study it was obtained that NPK at a ratio of 15:15:15 and 0.5% each of calcium nitrate and magnesium sulphate was the best nutrient solution for the coriander grown by hydroponics.

AISDGONF/ABS/TC/70

Mulching in vegetable crops: A step towards natural farming

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In vegetable crops various management practices are administered for the optimization of use of natural resources such that it will be sustainable and will remain available for coming generations. Mulching is one such step which may contribute significantly when it comes to natural farming. Organic mulches involve manure, wood chips, seaweed, leaves, straw, grasses, sands, stones (boulders), the rice stubbles, etc. Enormous benefits have been proved regarding the effect of mulching which are moderation of soil temperature, maintenance of soil moisture, reduction in weed population. Mulching increases the germination percentage and reduces germination time during low temperature conditions. It favours the desired sex expression of various cucurbitaceous crops. Yield enhancement in vegetables is noted when various plant growth regulators are coupled with mulching. If proper soil solarization precedes mulching, incidence of harmful insect-pests and diseases may be reduced. Shredded newspaper has been reported to suppress weeds in organic cucumber grown in high tunnels. The future prospects of the mulches are quite impressive, particularly, in natural farming since organic mulches provide wide variety which can be compatible with different crops and don't take much time to get degraded and easily obtained from natural resources which is renewed with time so sustainable.

AISDGONF/ABS/TC/92

Household health security through nutritional garden: a need of hour

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Women and Child Development Ministry of India estimates that over 3.3 million children in India are malnourished, out of them about 1.77 million are severely acute malnourished children and around 1.5 million are moderately acute malnourished children. Role of nutrition in our entire life starts right from neonatal stage to the last moment of our life in the form of nutrients as well as micronutrients. Here, the role of nutrients available in vegetables and fruits plays important role in minimizing malnutrition problem as well as to keep us healthy and fit. A nutrition garden or homestead garden or kitchen garden ensures an inexpensive, regular and handy supply of fresh vegetables which are basic to nutrition. Kitchen gardening is a technology which enables us to

grow fresh vegetables at home providing a good use of empty tins, old utensils and clay flower pots. This study on nutrition garden has been conducted with the help of secondary information available in the different research articles, books and internet. Several case studies have been conducted on nutrition garden developed in rural areas and school premises in different corners of West Bengal. ICAR and central government-led nutri-smart village initiatives are also discussed in this study. The marginal increase in the income of the poor people to enable them to gain access to food and improve their nutrition to lead a healthy life is the need of the hour. As kitchen gardening is a fruitful activity to get fresh and nutritious vegetables so people must adopt it to harness the immense benefits.

AISDGONF/ABS/TC/99

Production and problems in large cardamom cultivation in the Sub-Himalayan region of West Bengal

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Large cardamom (*Amomum subulatum*), locally known as 'alaichi', is commonly referred to as the queen of spices. India happens to be the second largest producer of this age old spice and shares about 37% of its global production. Large cardamom is cultivated as one of the most important cash crops in Sikkim and sub-Himalayan fringes of Kalimpong and Darjeeling districts of West Bengal. The present study attempts to analyze the financial &economic performance of Large Cardamom cultivation with the help of primary data collected from 60 randomly selected sample farmers from Kalimpong district of West Bengal during 2018-2019. Garrett's ranking technique is used to identify the major constraints faced during production of large cardamom. The study finds Varlangey as the most pre-dominantly cultivated variety of large cardamom in the region. Discounted method of financial feasibility analysis explores benefit-cost ratio (BCR) to be 3.01 and Net Present Value (NPV) to be Rs. 1, 99,929.92 (per ha per annum) at 7 percent discount rate confirming the financial viability and profitability of large cardamom cultivation. It is found that this perennial spice crop exhibits upward trend in yield with its age and attains the 'maxima' at 6th year, in general. The net return is found to be highest between the age group of 4 to 6 years, 6th year age garden giving the optimum yield and return. Attack of pest and disease is the major problem expressed by majority of the farmers along with other problems. Proper and timely technical guidance (for knowledge build up) and suitable government initiative for development of 'fore-warning system' may be helpful in this regard. At the same time, establishment of newer plantation need to be encouraged with feasible assistance from the concerned line department(s).

AISDGONF/ABS/TC/111

Physiological growth regulation of cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) under soil-less culture as influenced by different nitrogen concentrations

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Nitrogen has been designated as one of the most significant macronutrients since it regulates not only the vegetative development but also the fruit production of a crop. However, applying the optimum nitrogen rates in vegetable crops such as cherry tomato is difficult due to soil variability, nitrogen leaching, and soil denitrification, especially when most farmers apply nutrients based on epistemological methodologies and fertilizer companies recommendations rather than the specific needs of plants during the growing period. The experiment was conducted to explore the effect of different nitrogen concentration in the nutrient solution on growth attributes of cherry tomato grown under soiless culture in the protected condition. For studying the effect four varying concentrations of Nitrogen (0, 4, 6, 8, 10 mM) were used. Results indicated that increase in nitrogen concentration promoted more vegetative growth. According to the findings, the highest level of Nitrogen resulted in maximum plant height. The number of days required for first flowering and 50% flowering, was shortest when the nitrogen concentration was 8mM. Increase in nitrogen concentration were also found to improve equatorial diameter, polar diameter, total chlorophyll, ascorbic acid, and lycopene content. The nutritional supply through fertilization management stands out among the main technologies applied to increase crop growth and profitability, and nitrogen (N) is one of the main macronutrients responsible for this increase, since it performs structural functions, participating in many organic compounds that are vital for plants.

AISDGONF/ABS/TC/125

Effect of pre-soaking treatments on asexual propagation of passion fruit

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Passion fruit (*Passiflora edulis*) is considered as a high value crop of Passifloraceae family. It is well-received for its exotic flavor and aroma along with amazing nutritional and medicinal properties. It is grown mostly in tropical and sub-tropical parts of the world. For several years, India has witnessed a moderate harvest of purple passion fruit in different states of South, North and North East India. In West Bengal, precisely in the hills of Darjeeling and Kalimpong passion fruit is found to be cultivated. But asexual propagation is not commercially practised and sexual propagation is the major barrier to get the true-to-type progeny. Therefore, to assess the effect of different pre-soaking treatments on cuttings of passion fruit, an experimentwas carried out in Department of Fruit Science and Quality Control Laboratory, Faculty of Horticulture, Bidhan

Chandra Krishi Viswavidyalaya, Nadia, West Bengal during 2017 to 2019 with completely randomized design. Cuttings with 3 nodes were treated with 8 different treatments (NAA @100, 300, 500 and 700 ppm and IBA @ 600, 800, 1000 and 1200 ppm) and assessed on the basis of 5 observations. It was found that pre-soaking with NAA @ 300ppm concentration has been found the best treatment among all. Maximum rooting percentage (66.67%), maximum sprouting percentage (66.67%) and maximum number of sprouting in saplings (21.33) were obtained from the cuttings treated with 300 ppm NAA solution whereas highest survival percentage was obtained from the cuttings, treated with 500 ppm NAA solution (91.67%) and sprouting initiated first in the cuttings, treated with 100ppm NAA solution (9.67 days).

AISDGONF/ABS/TC/129

Nursery management in low-cost plastic tunnel for off-season cultivation of cucumber (*Cucumis sativus* L.) in spring-summer season

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Cucumber (*Cucumis sativus* L.) belonging to the family Cucurbitaceae is an important summer vegetable used to relish in the form of salad with meals and as a source to quench the thirst in hot summer outside while roaming in any tourist places or travelling by bus and trains. Thus, the price of cucumber varies from place to place and it also depends upon its time of availability i.e. as early it is available in the market it will fetch very good price but gradually when it's availability merges with huge supply, farmers get only average benefit cost ratio from cucumber cultivation. In order to strengthen the socio-economic condition of farmers of Jharkhand an 'On Farm Trial' was designed in the year 2019-20 in KVK, Dumka under Birsa Agricultural University, Ranchi). Under this trial the treatments were replicated among 7 farmers from 3 blocks in acidic soil dominating area with two technical options and farmer's practice. The main objective was to fetch remunerative selling price aiming to double the farmer's income. Cucumber cultivation in the month of January by sowing seeds in poly tubes was taken under Tech. Op. 1 and cucumber cultivation in the month of December with seeds sown in polytubes and covered with low cost plastic tunnel framed with the locally available bamboo base was treated as Tech. Op. 2 so that seedlings could be transplanted in the field to initiate early fruiting. On the other hand, direct sowing of seeds in the field in mid February was considered as farmer's practice. The spacing was maintained at 1m x1.5 m. In the farmer's practice, first harvesting of fruits could be done between 25-30 March while, harvesting could be started from 2-5 March under Tech. Op. 2. Mean yield per ha was found highest in Tech. option 2 (311.4 q/ha). Gross return and cost of cultivation showed the benefit cost ratio 64.2% more in Tech. Op. 2 over farmer's practice. The yield data obtained per ha was analyzed for variance and found significant at 5% level of significance.

AISDGONF/ABS/TC/132

Optimization of enzyme assisted juice extraction from banana

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Bananais the largest producer in the world which contributes 25.58 % to the world production of Banana fruit.The losses of banana can be restrained by converting the over-ripe or surplus fruits into value added products such as juices, wine. Less than 1.5% of the total fruits are processed but the demand for processed products always exist so there is a huge opportunity in processing as there is high demand for the process products like juices which are highly nutritious and can be available throughout the year with its original taste and aroma. Due to pulpy nature of banana fruits, the juice extraction is quite difficult, because the pulp has not enough liquid to be extracted into a juice form without adding an additional water which alters the consistency of the juice from a sticky, lumpy mass in to free flowing juicy nature. Enzymatic treatment of fruit pulp is one of the modern techniques where enzymes are used for the extraction of juice.The banana pulp is treated with enzymes like pectinase which results into a free flowing banana juice.The enzymatic juice extraction provides satisfactory quality products as well as increases process efficiency in extraction which have led to expansion of the global enzyme market.Pectinase enzyme breakdown the glycosidic bond between glycouranic acid of monomer present in the cell wall that eventually speed-up the juice extraction process. It promotes juice extraction, improves filterability of juice and reduce viscosity.The study aimed with following objectives:To optimize the enzymatic treatment for facilitating and enhancing juice recovery of banana, to evaluate the physico-chemical and nutritional properties of recovered juice, to evaluate the stability and quality of juice during storage at room temperature.A completely randomized design was used to study the effects of juice yield with the independent variable like enzymatic concentrations (%) i.e., 0.5, 1.0, 1.5, 2.0 for an incubation period of 60 and 120 minutes at RT and dependent variables i.e., TSS, titrable acidity, pH, viscosity, ascorbic acid, antioxidants. The chemical constituents of the juice on 0th days showed significant increased in T_8, with a titrable acidity (0.47 %), Ascorbic acid content (10.68 mg/100 g) and antioxidant activity (13.51 %) when subjected to 2 % of enzyme concentration for 120 minutes, However the Total soluble solid (TSS) was recorded highest for the same treatment on 60th day of room temperature storage. Considering the most important attributes of the juice recovery of $T_8$with 2 % enzyme concentration for an incubation period of 120 minutes was found highest i.e., 79.56 %. In the same way the attributes of juice texture of T8 treatment were also found to be the best among the lot where there is gradual decline in viscosity. The control treatment i.e., T_9 recorded the highest viscosity (226.40 cps) of the fresh juice. The sensory evaluation report on the banana juice stored at RT storage in all the treatments revealed that it was upto the mark till 15th day but later it decreases.

AISDGONF/ABS/TC/139

Crop varieties suitable for organic farming in vegetables

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More than 95% of organic agriculture depends solely on crop types developed for the conventional high-input industry. Recent research has demonstrated that these cultivars lack essential characteristics for organic and low-input agriculture. But the traits related to conventional cultivars that are undesirable for organic production systems need to be modified. Organic farmers lose potential yield because their cultivars don't have enough weed-suppressing, and pest and disease resistance traits. For example, onions don't have enough resistance to downy mildew, and potatoes don't have enough resistance to late blight. Organic plant breeding is a broad approach that respects natural crossing boundaries and is based on fertile plants that can have a viable relationship with the soil. But most commercial cultivars are outcome of production systems using a lot of inorganic fertilizers and crop protection methods. So, these varieties are doing well using traditional high-input methods but fail to perform under organic low-input situations. Organic plant breeding is critical for the production of high-quality organic crops that increase the potential of organic farming and biodiversity in a sustainable manner. Many traits required for varieties for organic and low-input farming systems are required to provide overall yield stability and morphological and physiological characteristics, such as plant canopy and root structure, plant vigour, etc. Furthermore, the focus should be on improving soil processes that affect plant nutrition, soil fertility, and crop resistance to disease. To achieve high yield in organic agricultural systems, the varietal screening should also be carried out under organic low-input conditions is required.

AISDGONF/ABS/TC/143

Evaluation of different levels of NPK and vermicompost on quality of mint (*Mentha arvensis* L.)

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Mint (*Mentha* sp., Family - Lamiaceae), are grown for their leaves which are widely used as a flavouring agent in various types of confectionaries and pharmaceutical industries. Addition of vermicompost and chemical fertilizers to the crop field could be a very good option considering the nutrient availability for maintaining soil fertility and productivity. Keeping this in view an experiment was undertaken on Randomized block design with three replication for two consecutive years (2017-2018 and 2018-2019) in the laboratory conditions of Department of Post-Harvest Technology and in the experimental field of H.R.S., Mondouri under Department of Plantation, Spices, Medicinal and Aromatic crops, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal to evaluate different levels of NPK and vermicompost on quality of mint (*Mentha arvensis* L.).Treatments consisting of T_1 = RDF @120 kg N_2, 60 kg P_2O_5,

60 kg K_2O / ha (100%) , T_2= 100% NPK + 5 t VC / ha ,T_3 = 100% NPK+ 7 t VC / ha , T_4= 100% NPK+ 9 t VC / ha , T_5= 100% NPK+11 t VC / ha , T_6= 75% NPK+5 t VC / ha , T_7= 75% NPK+7 t VC / ha , T_8= 75% NPK+9 t VC / ha , T_9= 75% NPK+11 t VC / ha , T_{10}= 50% NPK+5 t VC / ha , T_{11}= 50% NPK+7 t VC / ha , T_{12}= 50% NPK+9 t VC / ha and T_{13} = 50% NPK+ 11 t VC / ha. The experimental results revealed that mean maximum TSS, titratable acidity, dry matter and essential oil content were recorded under 75% NPK+7 t VC / ha (13.50°B, 0.48%, 31.10% and 0.55 ml / of 100g fresh leaves , respectively) treated plots . It can be concluded that T_7 (75% NPK+7 VC / ha.) was the best treatment as per quality of mint. This result indicated the chance of reduction of 25% inorganic fertilizer, which may lead to reduction of environmental pollution to some extent.

AISDGONF/ABS/TC/144

Efficacy of packaging material, ventilation and storage condition on shelf life and quality of mint (*Mentha arvensis* L.)

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An experiment to study the efficacy of packaging material, ventilation and storage condition on shelf life and quality of mint was undertaken for two consecutive years in the laboratory conditions of Department of Post-Harvest Technology and in the experimental field of H.R.S., Mondouri, BCKV, West Bengal. There were altogether twelve treatments (T_1 = Room temperature + Polyethylene + No ventilation,T_2 = Room temperature + Polyethylene + 0.5 % ventilation,T_3 = Room temperature + Polyethylene + 1 % ventilation,T_4= Room temperature + Polypropylene + No ventilation,T_5= Room temperature + Polypropylene + 0.5 % ventilation,T_6= Room temperature + Polypropylene + 1 % ventilation,T_7 = Refrigerated + Polyethylene + No ventilation,T_8 = Refrigerated + Polyethylene + 0.5 % ventilation,T_9 = Refrigerated + Polyethylene + 1 % ventilation,T_{10} = Refrigerated + Polypropylene + No ventilation, T_{11} = Refrigerated + Polypropylene + 0.5 % ventilation and T_{12} = Refrigerated + Polypropylene + 1 % ventilation) under completely randomized design with 3 replications . Mean analysis data showed that the increase in physiological loss in weight (PLW) under ambient condition was maximum in T_6 (87.49%) and minimum is T_4 (31.85%) on 4 days of storage and after that all the treatments in ambient condition was spoiled. In refrigeration mean maximum PLW in T_7 (68.57%) and minimum in T_{10} (61.10%) on 12 days of storage. In refrigeration mean maximum TSS was found in T_7 (20.01°B) and minimum is T_{10} (15.07°B). An increase in titratable acidity was observed during storage in both in ambient condition and refrigerator condition. In ambient condition mean maximum titratable acidity was found in T_5 (0.58%) and minimum under T_3 (0.43%) on 4days whereas in refrigerator condition mean maximum was T_7 (0.64%) and minimum in T_{10} (0.57%) on 12 days of storage. After 14 days of storage only T_{10} was in marketable condition (50%) and all the other treatments were spoiled. It can be concluded that mint leaves packed in polypropylene bags (100gauge) without ventilation and kept under refrigerated condition found best for storage.

AISDGONF/ABS/TC/148

Studies on phenophase based nutrient scheduling on flower yield and quality in China aster

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China aster (*Callistephus chinensis*), belonging to the family Asteraceae, is an important cut flower in India. Nutrient application at various growth phases is very much important to obtain proper crop growth and good quality blooms. The present experiment on phenophase based nutrient scheduling in China aster was conducted at the Horticultural Research Station, BCKV, Mondouri, West Bengal. Four different nutrient combinations at various crop phenophases were tested along with the fertilizer recommendation of 180:120:60 kg NPK/ha/year as soil application (control, F5) where, 50% of the recommended N and full dose of P & K are applied as basal and remaining 50% N was applied 40 days after transplanting. The treatment combinations were as follows: **F1:** Foliar spray of 33.3:33.3:33.3 % NPK (vegetative phase), 33.3:33.3:33.3 % NPK (bud phase) 33.3:33.3:33.3 % NPK (flowering phase) @ 180:120:60 kg NPK/ha/year (RDF). **F2:** 40:20:20 % NPK (vegetative phase), 30:40:40 % NPK (bud phase) 30:40:40% NPK (flowering phase) @ 180:120:60 Kg NPK/ha/year (RDF). **F3:** 33.3:33.3:33.3 % NPK (vegetative phase), 33.3:33.3:33.3 % NPK (bud phase) 33.3:33.3:33.3 % NPK (flowering phase @ 135:90:45 Kg NPK/ha/year (75% RDF). **F4:** 40:20:20 % NPK (vegetative phase), 30:40:40 % NPK (bud phase) 30:40:40% NPK (flowering phase) @ 135:90:45 kg NPK/ha /year (75% RDF). Based on the two years pooled results it is observed that the maximum plant height (55.2cm) , plant spread (50.40cm) and number of flowers per plant (22.8nos) were recorded highest in treatment F1 { 33.3:33.3:33.3 % NPK (vegetative phase), 33.3:33.3:33.3 % NPK (bud phase) 33.3:33.3:33.3 % NPK (flowering phase) @ 180:120:60 kg NPK/ha/year (RDF)} but lowest plant height (38.20cm) , plant spread (33.40cm) and number of flowers per plant (13.0 nos) were recorded in treatment F4. The hundred flower weight (492.0g) , duration of flowering (31.8days) and shelf life (11.6 days) were noted highest in treatment (F1) but it was recorded lowest in treatment F4{F4: 40:20:20 % NPK (vegetative phase), 30:40:40 % NPK (bud phase) 30:40:40% NPK (flowering phase) @ 135:90:45 kg NPK/ha /year (75% RDF)}. It can be concluded that the treatment combination F1 *i.e*, foliar application of soluble NPK fertilizer @ 33.3:33.3:33.3 % at vegetative phase, bud phase and flowering phase along with recommended dose @ 180:120:60 kg NPK/ha/year (RDF) was better in comparison to the other treatment combinations for better production and quality of flower.

AISDGONF/ABS/TC/150

Diversity analysis of selected *Hibiscus* spp. based on morphological, micro-morphological, and molecular markers

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Hibiscus, belonging to the Malvaceae family is composed of more than 400 species of flowering plants. It is originally native to tropical Asia (China and India). Morphologically, the leaves are often lobed and alternate while the flowers having wide range of colours can be single, semi-double and double. Several varieties, species and germplasms are being identified since recent past that needs precise characterization and documentation as well. During the present experiment 19 germplasms from 3 different species were collected across India and were characterized based on morphological, micro-morphological and molecular markers. There was wide spectrum of diversity based on quantitative and qualitative morphological traits such as flower colour, weight, diameter, type and leaf length, width, leaf blade shape, etc. Flower weight and diameter was highest in 'Eureka' and 'Sudarshan Chakra', respectively, while both traits found to be the lowest in 'Viceroy'. The leaf length and width were maximum in 'Elephant Ear', respectively. The 19 germplasms under study were also analysed for diversity using inter simple sequence repeats (ISSR) and start codon targeted (SCoT) polymorphism marker system. Using 6 primers from each of the 2 marker systems, a total of 135 bands were produced out of which 128 bands showed polymorphism (94.81%) and accordingly 19 germplasms were grouped into 4 clusters where maximum number of germplasms were assembled in cluster-II (11 germplasms) followed by 4 germplasms in cluster-III and only a single germplasm was found in cluster-IV. Maximum inter-cluster distance was recorded between cluster-I and cluster-IV. The germplasms from cluster-I ('Viceroy', 'Celia', and 'Versicolour Pinwheel') and cluster-IV ('Oiseau Blue') can be further utilized in hybridization program for crop improvement.

AISDGONF/ABS/TC/151

Morpho-molecular diversity analysis among selected rose genotypes

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Rose (*Rosa* sp.), belonging to family Rosaceae, is regarded as one of the most beautiful creations of nature and is universally known as "Queen of Flowers". The present study was carried out on assessment of diversity among the selected genotypes of rose on the basis of morphological characters and using molecular markers. The study included 19 genotypes from 3 different species viz, *Rosa hybrida*, *R. damascena*, and *R. chinensis*. The genotypes were evaluated in terms flower size, leaf area, colour intensity and diversity analysis carried out using two different molecular marker systems. From the study it was found that in terms flower diameter, the maximum value was recorded in genotype 'TajMahal', while 'Banjaran' recorded the lowest value. In terms of total chlorophyll content, the maximum value was recorded in 'Mascara' genotype, while the minimum value was recorded in '*R. chinensis* germplasm 2'. Similarly, in terms of leaf area, the maximum

value was recorded in 'Nilambari', while the lowest leaf area was observed in '*R. chinensis* germplasm 1'. Likewise, with respect to colour intensity, the lightness (L*) value of 'Yellow Page' was found to be greater when compared to other genotypes. All the 19 genotypes were also assessed on molecular level using inter simple sequence repeats (ISSR) and start codon targeted (SCoT) polymorphism marker systems. From the results obtained using 10 ISSR and SCoT primers, a total of 198 bands were recorded out of which 188 bands were polymorphic contributing to 94.9% polymorphism. Upon analysing the dendrogram thus obtained, the genotypes under study were grouped into 8 clusters with cluster-III (4 genotypes) and cluster-IV (4 genotypes) having maximum number of genotypes followed by cluster-II (3 genotypes) and cluster-I and VI contain only one genotype each. Maximum genetic distance was recorded between 'Himroz' and 'First Red' and 'Grand Gala', which may be further utilized in hybridization program leading to the crop improvement.

AISDGONF/ABS/TC/172

Effect of organic garden pea cultivation on the performance of succeeding amaranth (sps.) growth and yield

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Organic garden pea cultivation is gaining the popularity among farmers for better economic return and soil quality. A huge amounts of organic manure are added to supply the essential nutrient to the garden pea crop however, a major portion of the organic manures remain unutilized due to slow mineralization and nutrient release process. Cultivation of succeeding crop may be helpful to utilize the nutrient. The present work was aimed to study the performance of amaranth as succeeding crop of organic garden pea. A few works have been done in this direction so this research work will be helpful to find out the growth performance of succeeding amaranth crop and soil quality. Field experiment was carried out at Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar during winter season of the years 2020-21 and 2021-22. The study was comprised of four different main plot factors namely enriched farmyard manure, enriched vermicompost, enriched poultry manure and normal farmyard manure. The subplot factors consisted of four liquid foliar spray {control, jeevamrut (3%), vermiwash (3%) and liquid mustard cake (3%)}. The whole experiment was set up in a split plot experimental design with three replications by using the legume vegetable garden pea (cv. Azad Pea-3). Amaranth crop of local cultivar Jaba Kusum was grown as a succeeding crop. Enrichment of organic manure was done by using Azophos biofertilizer (*Azotobacter* and PSB @ 10gm of each strain of biofertilizers/kg of manure). The results of this study showed that the growth and yield characters of amaranth as succeeding crop of garden pea was significantly influenced by different organic manures. Application of enriched vermicompost recorded highest growth and yield attributing characters however, enriched farmyard manure treated plots recorded better soil parameters compared to other treatment combinations.

AISDGONF/ABS/TC/191

Impact of humic acid bio-stimulant on growth, quality, yield and soil microbial population in chilli (*Capsicum annuum* L.)

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At present, agricultural production management techniques focus on greater commitment to environmental sustainability. Humic Acid (H.A.) not only promotes hormonal activities in plant but also increases plant health, plant growth, nutrient uptake and also improves stress tolerance. Present investigation was carried out at teaching farm, College of Agriculture, BCKV, Burdwan during two successive seasons (*Kharif*, 2020 and 2021) to investigate the impact of H.A. bio-stimulant on growth, yield and soil microbial population in chilli. The experiment was laid out in Randomized Block Design with four replications and seven treatments. The treatments included two level of RDF (100% and 80%) along with H.A. spray with different concentrations at different growth stages of plant (at the time of transplanting, 30 and 60 DAT) and control without any chemical spray. Recommended dose of fertilizer (RDF) for chilli is 150:80:100 N: P_2O_5: K_2O kg ha^{-1}. FYM @ 20 t ha^{-1} was applied along with 1/4 dose of nitrogen through urea (46% N), full dose of phosphorus through Single Super Phosphate (16% P_2O_5) and 1/3 dose of potash through Muriate of Potash (60% K_2O) at basal and the remaining 3/4 dose of nitrogen was applied as topdressing in equal split doses at 25, 55 and 85 DAT and rest 2/3 dose of potash was top-dressed equally at 25 and 55 DAT. From two years pooled data the result indicated that treatment T_4 where 100% NPK + 3 application of H.A. (Soil drench @ 5ml l-1 water at the time of planting and 2 foliar spray @ 2.5ml l-1 water at 30 DAT & 60 DAT) had highest impact on growth, quality, yield attributes and microbial population of soil in chilli which was statistically at par with treatment T_6 (80% NPK + 3 application of H.A. (Soil drench @ 5ml l-1 water at the time of planting and 2 foliar spray @ 2.5ml l-1 water at 30 DAT & 60 DAT). The highest B:C ratio was recorded in T_4 compared to other treatments.

AISDGONF/ABS/TC/196

Effect of the seaweed on growth and flowering of dahlia

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Dahlia (*Dahlia* spp.) is an important flowering crop grown during the winter season in India. Dahlias are grown from seed but commercially propagated through stem cutting or by division of the tuberous root. To study the effect of the seaweed on growth and flowering of dahlia was conducted at the Horticultural Research Station, Mondouri, BCKV. It was laid out in Randomized Block Design with nine treatments replicated thrice. On the 2nd week of December (2021-22), healthy rooted cuttings were planted. The treatments were of seaweed (*Caulerpa racemosa*). The observation was recorded over vegetative parameters and reproductive parameters. The results were statistically analyzed. Plant height, flower stalk length, vase life, and Flower weight with

stalk was highest in treatment @10ml/l (*C. racemosa*). Number of brunches, Number of flowers, Number of leaves, Diameter of the flower, Vase life, and flower weight without stalk were highest in treatment @15ml/l (*C. racemosa)*. So, it may conclude that the treatment @ 15ml/l (*C. racemosa)* gave the best result in both vegetative and reproductive parameters.

AISDGONF/ABS/TC/197

Studies of corm production from cormel in the *Gangetic* plains of West Bengal

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Gladiolus is even called 'sword lily' which belongs to the Iridaceae family. An experiment was carried out on "Studies of corm production from cormel in the Gangetic Plains of West Bengal" in Jaguli Horticulture Instructional Farm, BCKV, West Bengal. It was laid out on Randomized Block Design (RBD) layout system seven varieties i.e. (Pacific, Intrepid, Arti, Acc No- 07, Souvick, Darshan, and Pusa Subham) are used in three replications. All the growth of cormels' diameter and weight are observed after harvest. Upper leaves and spikes are removed after 90 days for better growth in the yield of corms and cormels. The results revealed that the variety Arti found the best diameter and weight and the Darshan variety found the increasing percentage of weight and diameter. The highest no. of cormels was observed in ACC no – 07. And maximum germination percentage was recorded in Intrepid and Darshan. So, it may conclude that among these seven varieties, Darshan is the best variety for corm production from cormel in the Gangetic plains of West Bengal.

AISDGONF/ABS/TC/202

In-situ performanceof some wild edible fruits in red and laterite zone of West Bengal

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Wild edible fruits mean such fruit crops which are not cultivated and harvested from wild, these fruit crops are also called neglected, orphan, forgotten, underexploited and less known fruits. Nowadays human population increasing day by day and therefore need more food. To solve this problem, wild edible fruit species may be a good solution. Millions of people in many developing countries depend on wild resources including this fruits plant to meet their food need especially in periods of food crisis. These fruit plants are a good source of nutrition and can help to overcome nutritional deficiency especially in rural areas. The rural and tribal people of red and laterite zone of West Bengal are partially depended on some wild edible or underexploited fruits which are not taste good unlike cultivated fruits but they hold good proportions of antioxidants, essential nutrients, minerals and vitamins. Therefore a study was conducted during 2018 –2021 to know the in-situ performance of kendu (*Diospyros melanoxylon*), piyal (*Bunchanania latifolia*) and benchi (*Flacourtia indica*). The fruits are collected from some identified plants in different parts of

Purulia, Jhargram and Bankura districts which are considered as a red and laterite zone of West Bengal. Mature and/or fully ripen fruits were collected and carried out physicochemical analysis in the laboratory of Fruit Science Department, BCKV, Nadia, West Bengal. After analysis, it could be inferred that these fruits are a good source of nutrition for the people of these areas.

AISDGONF/ABS/TC/213

Variability of bael grown in new alluvial zone of West Bengal

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Eleven types of bael (*Aegle marmelos* L. Correa) grown in different locations of new alluvial zone of West Bengal were selected for studying the variation of twenty one quantitative fruit characters during 2021-22. An appreciable variation in physico-chemical fruit characters was noted among different types particularly in respect of fruit weight (1.015-1.77 kg), pulp percentage (71.85-88.17%), fibre percentage (0.49-1.03%), number of seeds/ fruit (74-137), TSS (28.7 - 39.8 °Brix), total sugar (10.52-18.18%), ascorbic acid (17.14-28.71 mg/100 ml juice), titratable acidity (0.196 - 0.320%) and TSS/acid ratio (102.18 - 203.6). The principal component analysis (PCA) with eigen values more than one contributed five components with cumulative variance of 85.37% of the total variability among the types evaluated for twenty one quantitative fruit characters. First principal component revealed the highest positive association with seed percentage, followed by number of seeds/sac, number of seeds/fruit, non-reducing sugar and total sugar contents and shell percentage. The scoring and loading bi-plot of PCA for the first two components revealed that majority of the important physico-chemical parameters were associated in the second quadrant with Type-2, Type-6 and Type-11. Cluster analysis by Ward's method categorized the bael types into three clusters with 6 types in cluster 1, 4 types in cluster 2 and 1 type in cluster 3. It can be concluded that there is a wide range of variation among different types of bael.

AISDGONF/ABS/TC/218

Production technology of fruits

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Many new techniques are adopted in the field of horticulture for production of better quality fruits like aeroponics, meadow orcharding techniques, high density plantations, and soilless culture of fruit crops. We also take use of cutting-edge, contemporary, and intelligent information techniques. Faster growth, more adequate mineral nutrient supply, better conditions for plant development, and better control of diseases and pests are all advantages of soilless culture in plant propagation. Aeroponics is the creating employment opportunities plants in a climate without soil or an aggregate material, like a mist or air. The aeroponics method of strawberry Horticulture is adopting a lot of new techniques to grow crops of better quality. These techniques cultivation is far more sophisticated and aids in the year-round production of fruits of high quality but on the inside of protected buildings. This lessens the labour required to grow strawberries in soil and has the added benefit of making it simple to grow fruits that are rich in nutrients without leaving behind

chemical residue or having to deal with fungus illnesses. Both the meadow orchard and the fruit wall are experimental ultra-high density systems for growing apples that provide large yields relatively early in the orchard's life and allow for mechanised trimming and harvesting. In order to obtain the highest profit per unit of tree volume without compromising the soil's fertility, high density planting is defined as accommodating the maximum number of plants per unit of space. It provides easy management and good yields during the early stages of the orchard.

AISDGONF/ABS/TC/232

Response of black turmeric to organic manures, bio-fertilizers and graded levels of fertilizers

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An experiment was conducted during 2020 and 2021 to study the response of black turmeric to organic manures, bio-fertilizers and graded levels of fertilizers at the horticultural research station (HRS), Mondouri, BCKV, Nadia, West Bengal. Total 13 number of treatments including control were imposed in RBD with 3 replications. Three levels of inorganic (100%, 75%, and 50% of RDF: 150:60:150 kg ha^{-1}), four types of organic (compost @ 25 t ha^{-1}, vermicompost @ 5 t ha^{-1}, neem cake and mustard cake @ 3 t ha^{-1} both) and biofertilizers (*Azotobacter chroococcum*, *Bacillus polymixa* and *Fraturia aurantea* @ 20 kg ha^{-1}) were included. Among the different treatments maximum plant height, number of leaves, primary and secondary finger, weight of clump and secondary finger , length of clump, breadth of primary and secondary finger, plot yield and projected yield (24.65 t ha^{-1}) were recorded in NPK (100%) + vermicompost + Bio fertilizer treatment. The plants under NPK (100%) + Compost + BF recorded maximum tiller, breadth of clump, weight and length of primary finger. The yield under control was 18.07 t ha^{-1}. Considering the projected yield the most effective treatment combination was NPK (100%) + vermicompost + Bio fertilizer followed by NPK (100%) + Compost + BF. The results indicated that the chance of reduction of 25% inorganic NPK through application of organic matter along with Bio fertilizer under alluvial zone of W.B.

AISDGONF/ABS/TC/238

Inventions in flower drying and preservation technology – a chronological study of related patents

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Flowers have always fascinated humans and he has an inherent quest to hold on their beauty for eternity. Though fresh flowers are always attractive but are short lived, expensive and available in particular seasons. Dry flower is one of the most widely accepted substitutes. Dry flowers offer novelty, longevity, aesthetic properties, flexibility and year-round availability. They are generally less expensive compared to fresh flowers. The science of drying flowers involves reduction of moisture content to a point at which bio-chemical changes are minimized thereby, maintaining cell structure, pigment level and flower shape. Various methods like air drying, embedded drying,

press drying, freeze drying is employed for drying different flowers. However, the quality and appearance of the dried flowers is greatly influenced by the method used. Retention of colour, texture and shape are the major challenges faced in dry flowers. With drying, colors may fade, change and even sometime intensify due to moisture loss. Similarly, the texture of the flowers alters with drying. Standardization of drying and preservation techniques of flowers and developing in to commercial entity has been a continuous endeavor with the scientists and amateurs alike throughout the world, which are apparent by the quantity of patients filed in different countries.

AISDGONF/ABS/TC/240

Nutrient management of chrysanthemum (*Chrysanthemum morifolium*) cv. Katinka using ecofriendly inputs

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An experiment was conducted to study the effect of different eco-friendly inputs for nutrient management in Chrysanthemum (*Chrysanthemum morifolium*) cv. Katinka during the year 2022 in the experimental farm, Department of Horticulture, SASRD, Nagaland University. A randomised block design (RBD) with 10 distinct treatments, replicated 3 times was used to examine various vegetative and flowering parameters as well as the flower's vase life. T_6 (*Azotobacter* and Phosphotika) recorded maximum plant height (46.5 cm), plant base girth (2.00cm), no. of primary branches (11.13), no. of flowers (35.6) and flower diameter (5.77cm). T_6 also recorded the longest vase life (22 days) along with T_8 (Panchagavya) and days to senescence (65.66 days) along with T_1 (RDF). Plant spread was found to be the widest in the control treatment (T_1) i.e., the treatment receiving the recommended dose of fertilizers. T_8 (Jeevamrutha + Green Leaf Manure) recorded the earliest days to bud emergence (43.93 DAT). Earliest bud burst (76.7 DAT) was observed in T_4 (Panchagavya) and the earliest days to full bloom (84.46 DAT) was observed in T_9 (Panchagavya + Green Leaf Manure). Flower weight (2.01 g) was found to be maximum in T_{10} (*Azotobacter* + Phosphotika + Green Leaf Manure).

AISDGONF/ABS/TC/242

Studies on the effects of different developmental stages on biochemical composition of the rhizome reserves in *Curcuma caesia* Roxb.

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Black turmeric (*Curcuma caesia* Roxb.) is native to North East India. It is a wild rhizomatous plant of the family Zingiberaceae. *Curcuma* is one of the largest genera in Zingiberaceae that covers around 80 species. The plant materials are chiefly collected from hilly tract of Kalimpong district, India in an indiscriminate way. It is claimed as a wonder herb, contains high curcumin and can cure leprosy, bronchitis, asthma, cancer, epilepsy, fever, wounds, impotency, tooth ache, and vomiting *etc*. Little is known concerning the changes in its curcumin accumulation during dormancy,

sprouting, maturation, and flowering in turmeric rhizomes. On this backdrop, the objective of this study was to find out the optimum stage of plant growth with maximum curcumin and other nutraceutical contents in the rhizome of *C.caesia*. The rhizomes were collected from different growth stages to quantify theeconomic yield and the levels ofcurcumin along with some major nutraceuticals via high-performance liquid chromatography (HPLC) and enzymatic methods, respectively. The length of rhizome was recorded maximum at sprouting stage while the minimum was at flowering stage. Among the various developmental stages of rhizomes there was no statistically significant difference in their weight. The maximum weight was found in sprouting stage whereas the least weight was recorded in flowering stage. Likewise, there was no significant change in the harvest index (HI) across the developmental stages of rhizome. Nonetheless, the highest HI was found in flowering stage and the lowest HI was recorded in sprouting stage. Most importantly, among the different developmental stages of *C. caesia* rhizome the active growth stage recorded overall maximum nutraceutical constituents *i.e.* total reducing sugar, and non-reducing sugars, ascorbic acid, total phenols, protein, starch, and curcumin (the key secondary metabolite) content.

AISDGONF/ABS/TC/248

Effect of bio inoculants on growth, yield, quality and disease incidence in Cabbage (*Brassica oleracea* var. *capitata*)

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Cabbage (*Brassica oleracea* var. *capitata*), is one of the most important vegetable of the Brassicaceae family. It is a popular vegetable around the world in respect of area, production and availability, almost round the year. Cabbage varieties are highly sensitive to soil and environmental variation which significantly affect the crop growth and head yield. Several researches suggested that use of bio-inoculants improved plant nutrients availability and encourage plant growth through synthesis of biologically active growth promoting substances, result in better crop growth and yield. The production of plant protection chemicals, tillage and harvest operations and non-judicious use of chemicals are causing havoc in global warming and climate change. Under the consequences, it is the right time to give an insight into the possibilities of bio-inputs as well as bio-inoculants that can perform multifaceted roles by overcoming the issues of contemporary agriculture. Therefore, for proper utilization of such beneficial microorganisms for the sake of fulfillment the demand of population for food along with conserving the environment and as well as ensuring high yield and cost effectiveness, an investigation was carried out in a randomized block design (RBD) with seven treatments and replicated thrice at the "C" Block Farm of BCKV, Kalyani, Nadia, West Bengal. The cabbage crop responded well under dual inoculation of *Trichoderma asperellum* (IIVR strain) + *Bacillus subtilis* (CRB-7) with respect to growth, head yield, nutritional quality, economic return and disease tolerance. The said combination of bio-inoculants could be an alternative control method to check yield losses in cabbage. Use of bio-inoculants in increasing yield and reducing disease incidence in cabbage could also be validated in large scale field trials to get a tangible outcome.

AISDGONF/ABS/TC/253

Phenological growth stages of wax apple (*Syzygium samarangense*) in New Alluvial Zone of West Bengal

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Wax apple (*Syzygium samarangense*; Family Myrtaceae) is a non-climacteric, underutilized but economically potential fruit crop and grows in an unorganized manner in Nadia, North 24 Parganas and South 24 Parganas districts of West Bengal. Lack of information regarding crop phenology is major hindrance for Wax apple cultivation. Phenological studies are very important to understand the crop growth (vegetative and reproductive) phases along with the influence of weather on crop growth. Several scales are used for coding of growth stages but the extended BBCH-scale is the most efficient in fruit crops. So, we used the extended BBCH-scale to study the phenological growth stages of Wax Apple in the new alluvial zone of West Bengal for the very first time. A trial was conducted at the research station, Mondouri, ICAR-AICRP on Fruits, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, to understand the crop phenology of Wax apple along with the influence of weather dynamics on this crop. Seven major growth stages viz. stage 0 (vegetative bud development), 1 (leaf development), 3 (shoot development), 5 (inflorescence emergence), 6 (flower development), 7 (fruit development) and 8 (fruit maturity and ripening) along with 40 meso- stages were described. The duration of stages from 0 to 8 was 2, 3.5, 6, 3.5, 2, 4 and 2 weeks respectively. Fruit development was completed in almost 10-12 weeks. Therefore, codification and description of phenological stages with BBCH scale is required to establish a crop calendar with advanced cultivation practices of Wax apple in West Bengal.

AISDGONF/ABS/TC/255

Effect of biostimulants on fruit crops- an overview

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Plant biostimulants are eco-friendly substances or microorganisms which when applied in small quantity helps in stimulating the natural processes to enhance nutrient uptake, stress tolerance and improves the flowering and fruiting behaviour, plant growth, yield and quality and are an alternative to synthetic agrochemicals. Based on the composition, biostimulants are classified as humic substances (humic and fulvic acid), seaweed extracts, protein hydrolysates, chitosan and beneficial organisms. Humic substances are decomposed products of plant, animal and microbes that enhance the fruit weight, edible rate and quality in fruits like lemon. Seaweed extracts are marine macro algae composed of polysaccharides, fatty acids, vitamins, phytohormones and are used as biostimulants that increases fruit yield in mandarin and effects nutrient content and physical and chemical characteristics in mango. Protein hydrolysates containing peptides and amino acids resulting from enzymatic/chemical hydrolysis of protein enhance disease resistance in citrus and found to enhance biochemical constituents, quality and yield of grapes. Natural polysaccharide chitosan which is a deacylated form of biopolymer chitin, when applied to fruits enhance the shelf life and increases phenolics, ascorbic acids and antioxidants in fruits like litchi.

Beneficial fungi like *Trichoderma* based biostimulants promote root branching and nutrient uptake thereby boosting plant growth and yield. Biostimulants have also been effective in increasing yield, anthocyanin, carotenoid, antioxidant, flavonoid and phenolic compound in strawberry. Biostimulants are extensively beneficial in enhancing fruit quality hence should be commercialized for getting a sustainable and eco-friendly approach of fruit production in natural farming programme.

AISDGONF/ABS/TC/268

Influence of seaweed extract on growth, yield and quality of onion cv. Sukhsagar

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Entitled as "Influence of seaweed extract on growth, yield and quality of onion cv. Sukhsagar", a study was designed and carried out at HRS, Mondouri, BCKV, under NAZ of West Bengal, during November – March of two consecutive years (2020-2021 and 2021-2022).The experiment was laid out in RBD accompanied with 10 treatments of 3 replications viz.,(T_1- seed treatment with SWE (20%) @ 1ml L^{-1}, T_2 - seed treatment with SWE (20%) @ 1.5 ml L^{-1}, T_3 - seed treatment with SWE (20%) @ 2ml L^{-1}, T_4 -seed treatment + root dipping with SWE (20%) @ 1ml L^{-1} , T_5 - seed treatment + root dipping with SWE (20%) @ 1.5ml L^{-1} , T_6 - seed treatment + root dipping with SWE (20%) @ 2ml L^{-1}, T_7 - root dipping with SWE (20%) @ 1 ml L^{-1}, T_8 - root dipping with SWE (20%) @ 1.5 ml L^{-1}, T_9 - root dipping with SWE (20%) @ 2 ml $L^{-1}$and T_{10} - control (seed and root dipping in distilled water).The best performing treatment combination with respect to mean maximum plant height (63.40 cm), leaf length (61.70 cm), leaf width (3.35 cm), neck thickness (3.55 cm), no. of leaves $plant^{-1}$ (5.80), bulb $yield plot^{-1}$ (4.18 kg), projected bulb yield (16.93 t ha^{-1}), dry matter content (8.52 %), TSS (11.63º Brix), titratable acidity (0.42 mg 100^{-1}), ascorbic acid (8.01 mg 100^{-1}), total sugar (12.70 %) , reducing sugar (4.54 %), net profit (Rs. 201608 ha^{-1}) and B:C ratio (1.95:1) was evident under T_6 (seed treatment + root dipping with SWE (20%) @ 2ml L^{-1}).

AISDGONF/ABS/TC/274

Integrated nutrient management of ginger grown as intercrop with curry leaf

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Ginger (*Zingiber officinale* Rosc.) has been prized for its aroma flavour, pungency and medicinal properties. Ginger occupied an important place, among the major spices grown in the country, as it is a valuable source of foreign exchange. Integrated plant nutrient system involving a combination of fertilizers, organic manures and biofertilizers are essential to sustain crop production, preserve soil health and biodiversity. This is especially important for developing countries where farming will continue to be in the hands of small farmers. The present investigation was conducted to study the efficacy of different organic manure, bio-fertilizers along with inorganic nutrition in ginger. An experiment was laid out in a randomized block design with

three replications at MIDH spice field, Teaching Farm, Mondouri, BCKV, Nadia during 2019-20. The treatments under evaluation were compost + K 100% +K mobilizer, compost + K 75% +K mobilizer, compost + K 50% + K mobilizer, vermicompost + K 100% + K mobilizer, vermicompost + K 75% + K mobilizer, vermicompost + K 50% + K mobilizer, compost + K 100%, compost + K 75%, compost + K 50%, vermicompost + K 100%, vermicompost + K 75%, vermicompost + K 50%, recommended NPK (Inorganic). Ginger rhizomes were planted on April, 2019. Maximum plant height (123.25 cm) was recorded with compost + K (100%) + K mobilizer and it was minimum in compost +K (50%) + K mobilizer (88.78 cm). Maximum yield per plot was produced under treatment vermicompost + K (100%) + K mobilizer (7.59 kg) and it was minimum (5.55 kg) under compost + K (50%). The highest yield per hectare (12.95 t/ha) was recorded with vermicompost + K (100%) + K mobilizer followed by compost + K (100%) + K mobilizer (12.56 t/ha) and compost + K (75%) [12.32 t/ha] as compared to lowest yield (9.16 t/ha) under compost + K (50%) combination.

AISDGONF/ABS/TC/282

Dominance of biostimulant on growth and yield dynamics of onion

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Attributed as "Dominance of biostimulant on growth and yield dynamics of onion", a study was framed and enlarged during November – March accompanied with two season (2020-2021 and 2021-2022) at HRS, Mondouri, BCKV, under new alluvial plains of West Bengal. The experiment was headed by RBD assimilated with 10 treatments of 3 replications viz. (T_1- spray with SWE (15%) @ 1ml L^{-1}, T_2 - spray with SWE (15%) @ 2 ml L^{-1}, T_3 - spray with SWE (15%) @ 3 ml L^{-1}, T_4 -soil application of SWG (5%) @ 3 kg ha^{-1} , T_5 - soil application of SWG (5%)@ 4 kg ha^{-1}, T_6 – soil application of SWG (5%) @ 5 kg ha^{-1}, T_7 - spray with SWE (15%) @ 1ml L^{-1} +soil application of SWG(5%) @ 3 kg ha^{-1}, T_8 - spray with SWE (15%) @ 2 ml L^{-1} +soil application of SWG(5%) @ 4 kg ha^{-1}, T_9 - spray with SWE (15%) @ 3ml L^{-1} + soil application of SWG(5%) @ 5 kg $ha^{-1}$and T_{10} - control (spray with distilled water).Among all the treatments, T_9 (spray with SWE (15%) @ 3ml L^{-1} + soil application of SWG (5%) @ 5 kg ha^{-1}) showed best response in terms of mean maximum plant height (59.20 cm), leaf length (57.77cm), leaf width (3.12 cm), neck thickness (3.20cm), no. of leaves $plant^{-1}$ (5.20), bulb yield (4.07kg ha^{-1}), projected bulb yield (16.96t ha^{-1}), dry matter content (6.85%), TSS (11.58ºBrix), titratable acidity (0.42 mg 100^{-1}), ascorbic acid (7.90mg 100^{-1}), total sugar (9.87 %) , reducing sugar (4.46 %), net profit (Rs. 2,03,042 ha^{-1}) and B:C ratio (1.98:1).

AISDGONF/ABS/TC/303

Effects of biostimulants in medicinal and aromatic plants-a review

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Medicinal and aromatic plants are most important plant among the most valuable sources of secondary metabolites. It has a significant source of raw materials for the medicinal, cosmetic and pharmaceutical industries. Due to increasing population and awareness, the utilization and demand of medicinal and aromatic plant has also been increasing in day-to-day life. In recent years, the cultivation of medicinal and aromatic plants has currently gained worldwide attention. So, in order to meet the demand, synthetic fertilizer is being used excessively, which has a negative impact on the environment and residual effect. Biostimulants are environmentally benign compounds that contain one or more substances or microorganisms that can increase plant tolerance to abiotic and biotic stress, promotes nutrient uptake,usage efficiency and improve crop quality.The main active substances used for preparations are humic and fulvic acids, protein hydrolysates,seaweed extracts, beneficial fungi and bacteria.As an alternative to the widely used commercial fertilizers, biostimulants have the potential to increase the production, productivity and quality of medicinal and aromatic plants. Furthermore, they can also assist in decreasing the requirement for agricultural inputs and increasing the ability of crops to withstand stressors. They are able to modify some molecular processes that allow to improve water and nutrient use efficiency of crops, stimulate plant development by enhancing primary and secondary metabolism. Targets of biostimulants are also known to include the primary and secondary metabolic pathways found in leaf and root tissues. Therefore, the review focused on various plant biostimulantswhich can be utilized to promote essential oil content in medicinal and aromatic plants, seeds germination, plant growth and development.

AISDGONF/ABS/TC/304

Effect of foliar application of biostimulants and pinching on growth, flowering and shelf life of African marigold (*Tagetes erecta* L.)

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A field experiment to study the effect of foliar application of biostimulants and pinching on growth, flowering and shelf life of African marigold (*Tagetes erecta* L.) was undertaken at K.V.K Ganjam-II, Golanthara, Odisha during the year 2019-20. This trial was conducted in a randomized block design with ten treatments and three replications by taking Pusa Narangi Gainda cultivar of African marigold. The pinching was carried out at 20, 25 and 30 days after transplanting along with foliar application of different biostimulants on 30 and 60 days after transplanting. From the study it was found that treatment T_1: foliar spray of humic acid @1% on the seedlings which are pinched at 20 days after transplanting showed the best result and significant influence on growth

and flowering parameters *i.e,* number of branches(19.03), number of leaves (188.56), plant spread (44.28cm), stem diameter (1.76cm), days taken for first flower bud appearance (36.8 days), number of flowers per plant (40.2), flower diameter (7.5cm), length of flower stalk (8.6 cm), period of bloom (108.8 days) weight of single flower (9.2g), flower yield per plant (335g). This treatment also showed maximum shelf life (10.5 days). From the present study it is concluded that pinching at 20 days after transplanting along with foliar spray of humic acid @ 1% on 30 and 60 days after transplanting improves growth of plant, flower yield and quality of African marigold.

AISDGONF/ABS/TC/305

Characterization and selection of superior genotypes in jackfruit

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Jackfruit (*Artocarpus heterophyllus* Lam.) belongs to the family Moraceae, is a largest fruit in the world. It is commonly referred to as "poor man's food" as it is cheap and plentiful during the season. Jackfruit is heterozygous in nature and mostly propagated through seeds. As it is highly cross-pollinated, shows high variations among the genotypes.An investigation was conducted at ICAR-AICRP on Fruits, Bidhan Chandra Krishi Viswavidyalaya, Mondouri, West Bengal (where different genotypes are conserved and maintained by collecting from different state of India), during the year 2021-2022 to study the morphological variability of thirty genotypes to identify the superior genotype for commercial cultivation. A wide range of variation in fruit weight (13.7 to 1.64 kg), fruit shape (spheroid, ellipsoid, clavate, oblong or irregular),no. of bulb/fruit(220 to 53), bearing position (main trunk, primary branch or secondary branch), bearing habit (regularor alternate years), fruiting seasons (early,mid or late)and also flake character like flake weight (82.24 to 7 g), flake length (10.17 to 2.9 cm), flake wide (5.03 to 1.92 cm), flake firmness (3.2 to 0.5N) and 100 seed weight (859 to 247.1 g). The results of the study help to attempt crop improvement for bringing to cultivation. Keeping all the aspects, the present experiment was carried out to select superior genotypesbased on overall performance andconsumer preference.

AISDGONF/ABS/TC/333

Induction of *in vitro* microrhizome formation of *Aloe vera* and its application in micropropagation

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India is one of the top exporters of *Aloe vera* leaf in different countries like USA, UK, Vietnam etc. Due to the enormous export potentiality, India needs concerted effort for commercial cultivation of *Aloe vera* plants which is projected to be a rewarding business. Vegetative propagation is not sufficient to supply large numbers high yielding, disease and pest free and true to the type planting materials. The *in vitro* propagation along with high concentration of cytokinin can produce only 5-6 shoots/explant; that may generate somaclonal variants also. On the above background, the alternate *in vitro* propagation technique through microrhizome formation was optimized by manipulating different concentrations of PGRs [BAP (4.44-17.76µM) and IBA

(2.46-4.92µM)] and sucrose (175.28-292.14mM), from varying length (1.5-3.5cm) of *in vitro* grown shoots of *Aloe vera.* Microrhizome formation (≈4cm in length) was observed in average 4.72±0.147 number of shoots after 45 days of culture in MS medium supplemented with 233.7mM sucrose, 17.76µM BAP, and 2.46µMIBA. The highest shoot bud formation (15.62±0.33/explant) from thin cell layers (TCL) (0.4-0.7cm) of microrhizome were observed in MS medium augmented with 8.88µMBAP and 0.53µMNAA after30 days. The shoots were further rooted in MS medium containing4.92µMIBA and 4.44µMBAP and hardened in soilrite substrate. The ISSR marker analysis revealed the genetic homogeneity of the microrhizome generated plants. Each microrhizome produces approximately 100-125 healthy *Aloe vera* plants; therefore, it is inferred that *in vitro* microrhizome formation is an advantageous tool for large-scale multiplication.

AISDGONF/ABS/TC/400

Effect of different growing media on early seedling growth of lettuce and pak choi in hydroponics

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Hydroponics has become one of the most popular approaches in today's agricultural production. In modern hydroponic, substrates have contributed significantly to the popularity and progress of hydroponic cultivations worldwide. Exotics vegetables are commonly grown in hydroponics to get more profit and in as per the estimates, Indian exotic vegetables market is expected to exhibit a CAGR of 13.8% during 2023-2028. Present study was conducted at Hydroponics Unit, M. S. Swaminathan School of Agriculture, Centurion University and Technology and Management, Odisha. Study was aimed to investigate the impact of different growing media on the early seedling growth performance of lettuce and pak choi in hydroponics under protected condition. Growing media constituents such as coco coins, river sand, oasis cubes and potting mix. Data were recorded on the parameters like germination percentage, number of leaves, leaf length, leaf width, leaf area and root length. Results revealed that highest plant growth were recorded in coco coins and was at per with the oasis cubes. Least crop growth was recorded in the river sand.

AISDGONF/ABS/TC/401

Micronutrients potentials of pointed gourd and its benefits in human health

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Nutritional health of human being is entirely dependent on plant foods either directly or indirectly. The silent epidemics of vitamin and mineral deficiencies affecting people in many developing micronutrient deficiency is affecting 2 billion people worldwide. The malnutrition is the result of insufficient intake of micronutrients through staple foods. However researchers have given very little attention to vegetable like pointed gourd which is an important indigenous, nutritious and dioecious cucurbit extensively grown in Eastern parts of India, to fulfil hidden hunger of vitamins and minerals and can be used as medicines. The objective of the present study was to screen the

indigenous pointed gourd clones with nutritional and health claims. Micronutrients were analysed in 34 clones of pointed gourd as per standard methods of AOAC. The elements taken into consideration were P, K, Na, Zn, Cu and Fe which ranged from 31.81-40 mg, 83-117 mg, 2.6-2.29 mg, 0.48-0.23 mg, 0.21-1.1mg and0.22-1.7 mg respectively. The study revealed that RP-2, NP-260, BCPG-25, BCPG-22, BCPG-38 and Kashi Alankar were found rich source of micronutrients and crucial in daily human diet to curb hidden hunger. The selected clones could be utilized in future breeding programme for enhancing micronutrient status of the crop.

AISDGONF/ABS/TC/402

Effect of synthetic auxins 3, 5, 6-TPA, GA_3, and KNO_3 on pre-harvest fruit drop, fruit growth, and yield prospective of litchi (*Litchi chinensis* Sonn.)

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Fruit drop is regarded as a key impediment to the expansion of litchi cultivation in our country. The litchi can suffer from excessive fruit drop, where too much fruit is shed, resulting in crop stresses that are often much lower than the tree's capacity. Keeping this view in mind, an experiment was carried out to study the effect of synthetic auxins 3, 5, 6-TPA, GA_3, and KNO_3 on preharvest fruit drop, fruit growth, and yield prospective of litchi (*Litchi chinensis* Sonn). The objectives of the experiment was to investigate the impact of foliar sprays of plant growth regulators and chemicals on preharvest fruit drop, fruit growth, and potential yield of litchi. The study was laid out in a randomized block design with three replications and fourteen treatments, including foliar application three weeks after fruit set. All the treatments with increasing concentrations of 3, 5, 6-TPA, GA_3, and KNO_3 and their combinations resulted in significantly improved fruit yield and quality characteristics of litchi fruits. However, the treatment T_{13} (3,5,6-TPA 40 ppm + GA_3 100 ppm + KNO_3 2%) was found to be the best in terms of reduced preharvest fruit drop up to 29.67%, increased fruit retention up to 70.33%, highest number of fruits per panicle (24.02), and fruit yield (85.70 kg per tree). The same treatment also recorded the highest fruit weight (26.79 g), fruit volume (25.62 cc), fruit diameter (36.27 mm), fruit peel weight (4.33 g), aril weight (19.40 g), aril recovery (72.42%), and lowest seed weight (3.05 g).

AISDGONF/ABS/TC/403

Integrated nutrient management of French bean (*Phaseolus vulgaris* L.) in subtropical humid zone of Nagaland, India

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French bean is one of the most precious and highly relished widely grown short duration legume vegetable. This investigation is intended to assess the integrated manner of nutrient management for higher productivity of French bean under acidic soil condition in subtropical humid zone of Nagaland. The experiment was carried outduring three consecutive years (2017-2018, 2018-2019

and 2019-2020) of *rabi* season on French bean at Horticultural Research Farm, School of Agricultural Sciences and Rural Development, Medziphema, Nagaland University with the combination of eight treatments. The experiment was laid out in randomized block design with three replications using the variety, Arka Komal. The pooled results of three years revealed that the highest growth, quality and yield parameters were observed in treatment T_3 (75% NPK through inorganic + 25% N through vermicompost) with maximum plant height (35.68 cm), no. of pods per plant (27.77), no. of seeds per pod (7.01), length of pod (13.96 cm), width of pod (10.58 mm), fresh weight of pod (4.22 g), fresh yield (153.61 q ha^{-1}), crude protein content (28.83%) and benefit cost ratio (4.06) of French bean which was found significantly superior over other treatments.

AISDGONF/ABS/TC/404

Influence of micronutrients on sustainable production of pointed gourd (*Trichosanthes dioica* Roxb.) under varied nutrient regime in New Alluvial Plains of West Bengal

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A research work was initiated observe the growth, yield and quality attributes of pointed gourd (*Trichosanthes dioica* Roxb.) under three main factors (macronutrients) and six sub factors (micronutrients), laid out in Split-plot Design with three replications. The treatment macronutrient combinations includes: M1 (farmer's practice, N-P-K dose @ 220-65-85 kg/ha), M_2 (chemical + organic, N-P-K dose @ 134-32-29 kg/ha + 5t/ha FYM) and M_3 (chemical, N-P-K dose @ 147-52-68 kg/ha). Half of N-P-K was applied as basal dose and remaining was applied after 25 and 45days after planting. The micronutrients applied in the study were T_1 (control), T_2 (Fe @ 0.5%), T_3 (B @ 0.25%), T_4 (Zn@ 0.5%), T_5 (Zn @ 0.5% + B @ 0.25%), and T_6 (Fe 0.5% + Zn 0.5% + B 0.25%).Significant difference was observed for most of the parameters of pointed gourd under study. It has been observed that individuals within the main factor M_2 nutrient status (chemical + organic) recorded maximum values in respect of growth, yield and quality parameters whereas in sub factor T_6 (a combination of Fe 0.5% + Zn 0.5% + B 0.25%) was superior followed by T_5 (a combination of Zn @ 0.5% + B @0.25%) for the characters recorded under the trial. M_2T_6 treatment was best in respect of interaction growth, yield and quality parameter. Maximum Benefit: Cost ratio (3.21) was also recorded from M_2T_6 treatment. This study may be repeated for another 2-3 years for conformity of the results.so it may be concluded that combined application of chemical and organic nutrients coupled with foliar spray of 0.5% Fe, 0.5% Zn and 0.25% B may adoptedfor sustainable production of pointed gourd by the farmers of gangetic plains of west Bengal.

AISDGONF/ABS/TC/405

Standardization of propagation techniques of Malay apple through cuttings

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Malay apple [*Syzygium malaccense* (L.) Merr. L.M. Perry] is considered as a non-traditional minor fruit crop under the Myrtaceae family. The succulent delicious fruits have thirst- quenching properties and usually consumed raw and considered as a rich source of minerals and antioxidants. Considering the nutritional, commercial potentiality there is an increasing tendency to grow Malay apple in different parts of West Bengal. The unavailability of genuine quality planting material, is one of the limiting factor for increasing the area under the cultivation. Considering the above fact, an experiment was conducted to assess the effect of IBA on different types of cuttings of Malay apple at the Instructional Farm, Dept. of Pomology and Post-Harvest Technology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal during 2021-22. IBA at 3000 ppm showed better response in terms of days taken for sprouting, number of leaves, sprouting, success and survival rate with least mortality rate.

ASDGONF/ABS/TC/406

Post harvest quality attributes of puree prepared from tomato and cherry tomato genotypes

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The physical and chemical characteristics of tomato genotypes affect the quality of processed product. Very little attempt has been made so far to assess the quality attributes of tomato genotypes having different fruit colours from the point of view of processing and acceptability of processed products. The present study was carried out to evaluate the quality parameters of fresh as well as processed product (puree) prepared from four mutant hybrids, one each of purple tomato and cherry tomato and a processing cultivar, Punjab Chhuhara. The results revealed that processing of tomato caused a dramatic increase in TSS (257 to 323 %) and lycopene (350 to 650 %) contents, and decrease in titratable acidity, ascorbic acid and β-carotene contents of processed product. Tomato genotype, Bidhan Purple and cherry tomato genotype, BC Cherry-1identified as most acceptable for developing processed product.These two genotypes could serve as potential raw materials in processing industries owing to their greater cosmetic qualities.

AISDGONF/ABS/TC/407

Studies on the performance and economic feasibility of guava cultivation intercropped with leguminous vegetables in the Red and Lateritic Zone of West Bengal

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The experiment was carried out on three (3) years old guava cv. Khaza orchard planted intercrops with leguminous vegetables at spacing of 5m×5m apart in the Regional Research Sub-Station, Sekampur, Birbhum, West Bengal during the year 2020 and 2021 to identify the suitable and profitable leguminous vegetables intercrops. The results of investigation indicated maximum increase in plant height (27.27%) in guava intercropped with beans and cowpea intercropping systems closely followed by pea and cowpea cropping systems (26.32%). The yield per plant was noted highest in guava intercropped with pea and cowpea cropping systems (29.24kg/plant). The highest benefit: cost ratio was calculated in guava + pea + cowpea intercropped (3.23) followed by guava + French bean + cowpea intercropped (3.21). From the present investigation, it was evident that the guava + pea + cowpea or guava + French bean + cowpea intercropping might be considered suitable for the red and lateritic zone of West Bengal.

AISDGONF/ABS/TC/408

Productivity trends of cucurbit vegetables in West Bengal as influenced by weather variables

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West Bengal is a pioneer vegetable producing state in different types of diverse agro-climatic areas. The present study was conducted to analyse the changing trend of cucurbit cultivation in West Bengal and to assess the relationship between weather parameters and cucurbit productivity at the state level during 2010-11 to 2019-20 by analysing the spatiotemporal trend of area, production and productivity in 18 districts of West Bengal with delineation of the crop production zones. The official published data from books & reports, relevant sites of the Economic Wings of Government of India, NHB, Department of Food Processing Industries and Horticulture, Government of West Bengal, and West Bengal State Marketing Board, 2020 were used. The polygon weather data of daily maximum & minimum temperatures and precipitation of different districts were collected from ERA5-reanalysis at 0.25˚ resolution and CHIRPS-daily precipitation at 0.05˚ resolution satellite imagery using Google Earth Engine and Climate Engine Research App. Trend analysis was performed by Mann-Kendall test & Sen's method. To select the significant variables, the stepwise multiple linear regression analysis was conducted between different weather parameters and production-productivity of important cucurbits. Weather variables used were maximum (T_{max}) (˚C) and minimum temperature (T_{min}) (˚C), mean temperature [(T_{max}+ T_{min})/2] (˚C), diurnal temperature variation [(T_{max}-T_{min})] (˚C) and total precipitation (mm). The

result showed that at the state level, the cucurbit acreage increased during 2010-11 to 2019-20 time-span with an overall Sen's slope of 0.69 thousand hectares per year. 10 out of 18 districts exhibited a significant increase in acreage. At the state level, the production and productivity were also increased during that decade with an overall Sen's slope of 13.69 thousand MT per year and 0.021 MT per hectare per year, respectively. 11 out of 18 districts exhibited a significant increase in cucurbits production, only 3 districts exhibited a significant increase in cucurbits productivity, while four districts recorded substantial decreasing trend. The productivity of cucurbits was significantly positively influenced by the total precipitation during the growing period of the crop (February to the end of August). However, the other weather variables showed no significant relationship with the productivity of cucurbits due to the shift in date of sowing and cropping window at the farmers' level over the years.

AISDGONF/ABS/TC/409

Growth and yield of tomato (*Solanum lycopersicum*) under integrated nutrient management in red and laterite soils of India

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Soils of Red and Laterite zone of West Bengal are very poor in fertility and farmers are forced to apply huge amount of inorganic fertilizer for higher produce, resulting into degradation of soil health and decline in crop production. An experiment was conducted to find out the influence of different level of inorganic fertilizer and biofertilizers on nutrient uptake, crop growth and productivity of tomato under Red and Laterite soils of Jhargram during Rabi season of 2021-2022. Nutrient uptake, crop growth and yield were found to vary significantly under various treatments. NPK uptake was found to vary from 90.1 to 155.2 kg ha^{-1}, 9.1 to 25.7 kg ha^{-1} and 60.1 to 90.5 kg ha^{-1} respectively and was highest under plots when boron and lime was applied alongside organic, inorganic and bio-fertilizer (A_2B_6). Liming was found to increase NPK uptake significantly. Similar trend was noticed for crop growth and yield parameters. Plant height and no of branches per plant varied from 46.7 to 66.1 cm and 7.3 to 13.3 at 30 DAE and 52.5 to 91.5 cm and 11.1 to 25.2 at DAE respectively. Plant dry matter accumulation was found to vary from 22.8 to 58.4 and 43.3 to 166.1 gm m^{-2} at 30 DAE and 60 DAE, respectively. Tomato yield was found to vary from 8.4 to 22.0 t ha^{-1} and highest yield was recorded under A_2B_6 treatment. It was concluded that application of boron and *Trichoderma* significantly enhanced nutrient uptake thereby tomato yield and may be recommended for this zone.

AISDGONF/ABS/TC/410

Potential and importance of underutilized cucurbitaceous crop spine gourd for food and nutritional security

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The spine gourd (*Momordica dioica* Roxb.) grows as a wild perennial cucurbitaceous crop in the tropical and subtropical regions of India.This medicinally important and nutritionally rich

vegetable is known by different names like kankada, kakrol, kantola, etc. in different parts of India.This tuberous cucurbitaceous vegetable grows as wild plant in the forest areas of Chhattisgarh, Jharkhand and Odisha where it is regularly consumed by the native tribals.Due to lack of awareness among farmers this gourd crop remain as underutilized crop.It is well known as traditional medicine and nutritious vegetable as it contains various nutrients and phyto-chemicals withlotoff medicinal properties. The fruits have diuretic, laxative, antidiabetic and antidepressant values. The leaves have antiasthmatic, antibronchaitic and analgesic values spinegourd can withstand both biotic and abiotic stresses, and can easily grow with low cost of cultivation. However this underutilized gourd crop remain still neglected due to lack of availability of good quality planting materialsand lack of complete knowledge about their performance In this context the present study was carried out to explore thediversity, potential and importance of this underutilized cucurbitaceous crop with special reference to provide food and nutritional security.

AISDGONF/ABS/TC/411

Effect of organic mulching, vermicompost and organic manures on physico-chemical qualities of dragon fruit (*Hylocereus costaricensis* L.) cv. Royal Moroccan Red grown under New Alluvial Zone of West Bengal

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By 2050, the population of the world is anticipated to surpass about 9.7 billons. To carry out all kind of field-level activities in sector of horticulture in a sustainable manner have recently become an urgent need. Keeping this view in mind an investigation was carried out during 2019-2022 at the Horticultural Research Station of BCKV, Mondouri, Nadia, WB to represent the best performing combined effect of different organic mulching along with vermicompost and farm yard manures on dragon fruit (*Hylocereus costaricensis* L.) cv. Royal Moroccan Red with seven treatments. Treatments include T_1- Geotextile mulch 500 GSM + vermicompost @ 2 kg/plant , T_2- Geotextile mulch 750 GSM + vermicompost @ 2 kg/plant + FYM @ 3 kg/plant, T_3- Straw mulch+ FYM @ 3 kg/plant, T_4- Dry banana leaf mulch+ vermicompost @ 2 kg/plant + FYM @3 kg/plant, T_5- Water hyacinth + vermicompost @ 3 kg/plant , T_6- Black polythene + FYM @3kg/plant, and T_7- Untreated control. The experiment was laid out in Randomized Block Design with three replications. There was significant difference in terms of plant height (cladode length), number of fruits, individual fruit weight, length, breadth, TSS, other quality attributes and fruit yield. The maximum number of fruits per pillar (41.16), average individual fruit weight (295.65 g), TSS (14.10° Brix) and fruit yield (8.00 kg/pillar) were observed under T_2 while minimum was recorded in untreated control. Among different treatments, T_2 comprising of geotextile mulch 750 GSM + vermicompost @2kg/plant + FYM @ 3 kg/plant exhibited superiority in growth and yield of dragon fruit.

AISDGONF/ABS/TC/412

Influence of potassium on kharif onion (*Allium cepa* L.)

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Onion (*Allium cepa* L.), a member of family Alliaceae, is one of the most important vegetablecum condiment crops grown throughout the world.The present study was undertaken to evaluate the effect of different doses of potassium on growth parameters of Agrifound Dark Red and to study the effect of different doses of potassium on yield and quality parameters, along with this to determine the best dose of potassium on onion. The experiment consisted of 7 treatments *viz*., K 40 kg/ha from KCl (T_1), K 80 kg/ha from KCl (T_2), K 120 kg/ha from KCl (T_3), K 40 kg/ha from K_2SO_4 (T_4), K 80 kg/ha from K_2SO_4 (T_5), K 120 kg/ha from K_2SO_4 (T_6) and control (only NP, without any potassium fertilizer). The results indicated that the maximum plant height, number of leaves per plant, polar diameter of bulb, equatorial diameter of bulb, average bulb weight and yield/plot were obtained from K 80 kg/ha (SOP). Among all of the treatments the highest bulb yield (214 q/ha) was obtained with K80 kg per ha and the lowest (174.2q/ha) from the control. The lowest C graded bulbs (21.06%) were recorded from K 80 kg/ha from SOP treated plot. The highest TSS (12.65°brix) were recorded with K120 kg/ha (K_2SO_4). However highest percentage of total sugar (7.603), reducing sugar (3.66) and non-reducing sugar (3.83) were obtained from the plots treated with K 80 kg/ha (K_2SO_4). Application of 80 kg K/ha from K_2SO_4 along with a blanket dose of N100 kg/ha and P 60 kg/ha appeared to be the optimum dose for improving growth, yield and quality parameters of *kharif* onion.

AISDGONF/ABS/TC/413

Studies on the impact of nutrient management on growth and yield of lemon grass (*Cymbopogon flexuosus*) var. Krishna

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Lemon grass is one of the essential perennial aromatic oil-bearing crops and is ranked among the top ten oil bearing crops in the world. The plant possesses strong lemony odour due to its high content of aldehyde citral, which has two geometric isomers, genarial (citral A) and neral (citral B). Essential oil is used in perfumery, medicinal, cosmetic, cooking, pharmaceutical industries and also as an insect repellent and in an aroma therapy. An experiment based on simple RBD with 3 replications was undertaken with effects of different levels of NPK with FYM on growth and yield of lemon grass variety Krishna at HRS, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. Eleven treatments consisting of three levels of N, P, K along with 10 tonnes of FYM per hectare i.e., T_1(120:60:60 kg NPK+10t FYM), T_2(100:60:60 kg NPK+10t FYM), T_3-(80:60:60kg NPK+10t FYM), T_4(120:50:50 kg NPK+10t FYM), T_5(100:50:50 kg NPK+10t FYM), T_6(80:5050 kg NPK+10t FYM), T_7(120:40:40kg NPK+10t FYM),T_8(100:40:40

kg NPK+10t FYM),T_9(80:40:40kg NPK+10t FYM),T_{10}(10t FYM) and T_{11}(Control) were used. The experimental results revealed that maximum plant height (197.56 cm), number of tillers (59.17), number of leaves (326.17), projected fresh herbage yield (21.48 t/ha), projected dry herbage yield (7.19 t/ha), projected hydrosol yield (1299.47 l/ha) and projected oil yield (80.58 l/ha) were evident under T_1. The results also revealed the most promising treatment in terms of higher projected yield of essential oil (80.58litres/ha), net profit (Rs. 138153.59/ha) and maximum cost benefit ratio (2.18) was recorded under T_1. It can be concluded that T_1(120:60:60 kg NPK + 10 t FYM) may be applied in lemon grass cultivation under NAZ of West Bengal for fetching higher herbage and oil yield and may be recommended for the farming community.

AISDGONF/ABS/TC/414

Correlation analysis for fruit yield and its related traits in okra [*Abelmoschus esculentus* (L.) Moench]

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Okra [*Abelmoschus esculentus* (L.) Moench] is a prominent species of *Malvaceae* family with chromosome no. 2n=130. It is also commonly called bhindi or lady's finger. Okra is one of the commercially important annual vegetable crops in tropical and subtropical and Mediterranean regions of the World. The study of character association revealed that the fruit yield per plant was strongly associated with all the character except days to first picking both at genotypic and phenotypic levels. The results clearly indicated that fruit yield per plant was strongly associated with all the character except days to first picking suggested the importance in characters like number of fruits per plant, fruit length, fruit weight, fruit diameter, number of nodes per plant, plant height, number of branches per plant, and internodal length through selection is expected to results in improvement of fruit yield per plant. The experimental material comprising 42 genotypes including one check were evaluated in Randomized Block Design with two replications at Breeder Seed Production Unit, VNMKV Parbhani (MS) (E2) during *kharif* 2021-2022. Observations were recorded on ten quantitative characters *viz*., days to first picking, number of fruits per plant, fruit length (cm), fruit diameter (cm), fruit weight (g), plant height (cm), number of nodes per plant, internodal length (cm) and fruit yield per plant (g). Days to first picking showed significant correlation fruit weight at genotypic level. While positive but non-significant association with fruit length, fruit diameter, number of branches per plant and fruit yield per plant both at genotypic and phenotypic level. Number of fruits per plant showed positive significant correlation for number of nodes per plant, plant height, Number of branches per plant and internodal length both at genotypic and phenotypic level. The results of the present investigation of character association, it was concluded that fruit yield per plant can be increased by improving number of fruits per plant, fruit weight, fruit length, number of nodes per plant, fruit diameter, plant height, number of branches per plant and internodal length.

AISDGONF/ABS/TC/415

Ensete glaucum, affiliation of musaceae family: A threatened wild taxa on the soil of Nagaland

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Ensete glaucum (2n=2x=18) is a giant waxy herbaceous monocotyledonous plant in small musaceae family under section *Ensete* and affiliation of banana (*Musa*). The findings contribute to the species knowledge insighting into its morphological features and structural variation, conservation efforts to safeguard these primitive and unique taxa from regional extinction, understanding environmental responses, highlighting its importance for biodiversity conservation and potential ethnobotanical utilization and involvement in local tribal community of hill region in Nagaland. Enough swollen light green colour girth variation (111 cm at collar, 69 cm in middle and 52 cm near leaf junction) gives an aesthetic appeal along with ornamental blooming inflorescence and used as landscape architecture. It is mainly propagated through seeds after proper level of seed maturity but suckers produce very rarely. The waxy inflorescence consists of female (basal), hermaphrodite (in middle, very few) and male (at distal). The very strong persistence and broad light green bracts (27.5 cm length and 16.5 cm breadth) of inflorescence protect the fruits conspicuously from adverse climatic condition. The male flowers consist of 4 curled stamen (4.23±0.15 cm) and creamy white at basal and light pink colour in top, one fused tepal, one free translucent white tepal and one rudimentary creamy white stigma (1.5±0.1 cm). The fruits are full of seeds (16 to 18 no.) along with three locules. Yellowish orange pseudostem sap was extracted from *Ensete glaucum* and used in specially in treating diarrhoea and dysentery by traditional information from unlicensed village folk healer. Seeds has been documented for various human illnesses, including diabetes, leucorrhoea, kidney stone, dysuria and others. Starch was extracted from the corm and stem and it is used in staple recipes. The stems and male bud are eaten as vegetables. *Ensete* sap is rich in potassium and total phenols. This documentation and evaluation can provide the basic knowledge for modern ethnopharmacological research which can eventually catalyse the development of new drugs.

AISDGONF/ABS/TC/416

Studies on top working of old, senile, seedling originated mango trees with scions of commercial mango varieties

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The present investigation was carried out during 2021-22 to 2022-23 at Fruit Crops Breeding and Multiplication Centre (FBMC, RIDF-23 project) of Bidhan Chandra Krishi Vishwavidyalaya, Dharampur, North 24 Parganas, to study the success rate of top working of old, senile, seedling originated mango trees with scion of six commercial varieties and shoot growth of top-worked varieties. Experiment was laid out in randomized block design (RBD) with 6 treatments (scion varieties), 4 replications and 10 top working per replication. Observations were recorded on date of

scion bud break, scion survival rate and growth of scion shoots (length, girth, leaf number, leaf area) at monthly interval. Results showed that time taken for bud break at 2 weeks after top working varied from 5.30 days in Totapuri to 8.08 days in Himsagar, which appeared due to difference in varietal response. Scion survival rate was recorded from 1st week to 18 weeks after top working. There was no mortality at 1st week of top working, but mortality rate gradually increased in following weeks, in case of Amrapali, Fazli, Chausa and Totapuri. It was concluded that top working technique was an useful tool for converting the seedling originated, old, senile mango trees (with inferior fruit quality) into desirable variety through top-working (veneer grafting method in July) of desirable scion varieties onto the shoots, produced by its rejuvenation (in December), with success rate of 80.00% in Himsagar, 66.00% in Amrapali and Chausa, 50.00% in Fazli, Alphanso and Totapuri and satisfactory growth of scion shoots.

AISDGONF/ABS/TC/417

Introducing organic/ natural farming in schools

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Children are future of a nation. One of the most effective ways to encourage growth of the organic sector is to include organic agriculture in vocational and higher education systems. Gardening with children provides them skills to help child's physical development activity. We build bonds with children and create memories from our experiences in the garden. *School organic Gardens and curricula have strong potential not only to teach fundamental lessons about biology, ecology, food and nutrition, but can play a direct role in training the future growers and farmers.* This has the potential to shape the values and expectations of the children and their families about Natural Farming system and food supplies. *Invariably the solution to our problems lies under our noses-cow based farming, yet we scramble to find them elsewhere*. Cow based farming aims to empower farmers to become self-reliant and financially independent by using traditional, farm-based agricultural solutions. Students need to be exposed to such practical knowledge to act towards reducing negative impacts on the environment. Learning about how food is produced at an early age will improve their knowledge on the environment and ecosystem and they will also learn how to become more responsible when it comes to food. Environmentalism is not a choice, but a necessity today. With increased organic gardening systems being implemented across schools, this will increase awareness and demand for organically grown food across the area and help development of organic sector in states and beyond, attract involvement of the district administration and department of Education in developing the Bio-Intensive Gardens.

AISDGONF/ABS/TC/418

Effect of cormel size on growth and corm yield of gladiolus

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A major bulbous ornamental crop, gladiolus is valued for its wide range cultivation potential. Generally, corms and cormels are used for commercial cultivation. Although cormels are a more affordable source and multiply more quickly (10–15 cormels per mother corm each year), they

take one or more growth seasons to reach flowering size. In order to understand how genotype and cormel size affect gladiolus growth and corm yield, an experiment was carried out between 2021 and 2022 at the Department of Floriculture, Medicinal and Aromatic Plants, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal. Six genotypes (Arka Darshan, Arka Amar, Arka Pratham, Arka Aarti, Arka Tilak, and Arka Aayush) of cormels in three sizes of diameter (S_1 = 0.5-1 cm, S_2 = 1.0-1.5 cm, and S_3 = 1.5-2 cm) were investigated in this experiment with a Factorial RBD design. Among cormel sizes and genotypes, the results revealed a considerable difference in every parameter. Large cormels reached greater plant height, produced more than 50% of the plants sprouting, and even more than half of the plants producing flower spikes. Arka Darshan had a sprouting rate of more than 70%, 5.59 leaves per plant, and 3.22 cormels per clump. Regardless of the size of the sowed cormel, every genotype produced corms that were standard for commercial use.

AISDGONF/ABS/TC/419

Assessment of the influence of seed priming on germination and seedling growth of tuberose

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Tuberose, a bulbous ornamental crop, is grown for its lovely and fragrant white flowers. However, its seed output is irregular and germination rate is low. Seed priming is one of the methods that has been highly advocated for bringing improvement in the germination emergence, synchronization and uniformity in seedling growth. An experiment was laid out in Bidhan Chandra Krishi Viswavidyalaya, Mohanpur with an objective to study the effect of different priming chemicals on seed germination and early seedling growth of tuberose. For priming, seeds were soaked in 0.25 and 0.50% KNO_3, 0.50 and 1% Thiourea, 250 and 500 ppm GA_3, 2 and 4% Ethanol, 0.25 and 0.50% EMS and water for 16 hours at room temperature. The experiment was laid out in Completely Randomized Design with three replicates for each treatment. The findings gathered throughout the investigation showed that the priming of tuberose seeds with these priming agents had a substantial impact on seed germination and seedling development. In comparison to other priming agents, priming in a solution of 500 ppm GA_3 resulted in faster emergence and higher germination rates. With reference to the seedling development, when compared to other priming agents, seedlings primed with a solution of 500 ppm GA_3 had better shoot and root length, shoot and root weight, seedling vigour index, and total dry matter production. And seedlings treated with Thiourea 0.50% was recorded to have performed better following the performance of GA_3.

AISDGONF/ABS/TC/420

Evaluation of some promising gladiolus cultivars in *terai* region of West Bengal

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Gladiolus is a high value bulbous ornamental crop with extensive potential for cultivation in Terai region of West Bengal. To determine the suitable cultivars for thisregion, 23 promising Gladiolus cultivars were assessed using three replications in randomized block design in Uttar Banga Krishi Viswavidyalaya, Pundibari during 2021 to 2022, based on some importanthorticultural characteristics: spike length, number of spikes/corm, number of florets/spike, vase life, days to first flower opening, number of corm/clump, diameter of corm etc. Snow Princess, Arka Amar, Arka Tilak and Pusa Red Majesty had produced tall spikes and were recommended to be used as cut flower purpose and dwarf cultivars, *viz.*Arka Darshan, Pusa Subham and Arka Aarti were recommended for landscaping purpose for the region. The major flower colour, an element that determines client desire, was identified as an important character based on Shannon's Diversity Index (H) in the current trial. Therefore, the cultivars were divided into eight colour categories, including white (pure), yellowish-green, yellow, orange, pink, red, purple-red, and violet-blue, in accordance with the DUS test guidelines for the predominant colour of gladiolus flowers. The outstanding cultivar for each colour group was then determined based on crucial horticultural factors for growing in the area. Snow Princess, a white cultivar, Arka Sapna, a yellowish-green cultivar, Punjab Lemon Delight, a yellow cultivar, Arka Kesar, an orange cultivar, Priscilla, a pink cultivar, Arka Amar, a red cultivar, Arka Naveen, a purple-red cultivar and Arka Pratham, a violet-blue cultivar, performed well and were recommended for this agro-climate.

AISDGONF/ABS/TC/421

Assessing the production and evaluating the marketing channels of garden pea in different markets underneath assorted blocks of Hooghly region, West Bengal

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West Bengal has been bestowed with a range of climate over Physio geographical condition and such is most suitable for growing various kinds of Horticultural crops such as fruits, vegetables and flowers. The first rank of West Bengal for vegetables production than the other states in India. West Bengal produces 144.25 thousand tonnes garden pea and hold the rank 6th position all over India (NHB, 2020-'21). As the potential belt of garden pea production and also for the good demand chain from consumers, the districts Hooghly create a phenomenon periphery for producer, buyers and in between of consumer also. The present study has been performed in various markets under different blocks of Hooghly district. The study was carried out to estimate the production and marketing channel of garden pea through the various markets of Hooghly district. From the

entire study, we find out the overall marketing adaptability, marketing scenario of garden pea along with socio-economic attributes of the respondents of the Hooghly district. All types of farmer's *i.e.,* small, marginal and large farmer taken it with a greater importance because of large scale of adaptively of garden pea. In the survey four types marketing channel and their disposal patterns. We can conclude that–marketable surplus was 5.47 q in large farmers whereas it contrasted with 2.59 q for small and 1.58 q marginal farmers. It also showcased that marketed surplus of 5.44 q for large farmers. The producers offers customer's share were 97.7%, 59.65%, 43.90% and 42.35% in channel I, II, III and IV in garden pea individually. The marketing cost was must most worthy in Channel - I (2.30%) trailed by Channel - II (17.15%). From the observation we clearly identified various stages where how much amount post-harvest losses were occurred in the different channels, so the findings of the current investigation is construct with the examination directly by the crop in different stages too. Originality of this study is that the viewpoints of farmers-cum-sellers' and the viewpoints of consumers are integrated for strategy formulation to make the vegetable marketing efficient in the current State scenario. So, the managerial implication refers that strategic decisions must be taken by integrating both the viewpoints, not by isolating them. These findings will be helpful for developing a policy framework and relevant guidelines for promoting in the state.

AISDGONF/ABS/TC/422

Effect of different growth hormones on the hardwood cuttings of *Bougainvillea* var. Partha

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Bougainvillea is a hardy and evergreen plant that belongs to the Nyctaginaceae family. The present investigation was carried out to study the effect of "different growth hormones on the hardwood cuttings of Bougainvillea Var. 'Partha'' in the subtropical zone under a naturally ventilated polyhouse at Mondouri Research farm of Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, Nadia. The field experiment was carried out from the month of March to June. The experiment was laid out in Randomized Block Design (RBD) with three replications. Significant differences among the treatments (IAA @500ppm, IAA @1000ppm, IAA @1500ppm, IBA @500ppm, IBA @1000ppm, IBA @1500ppm, NAA @500ppm, NAA @1000ppm, NAA @1500ppm, and Control) on root emergence and proliferation were noticed. Data were collected on the days of first root initiation, days of first bud initiation, no of roots, length of roots, number of leaves per cutting, and number of buds per cutting. The results showed that the treatment of cuttings IBA (1500 ppm) and NAA (1500 ppm) had a significant effect on the root initiation and root growth of *Bougainvillea* spp. Var. Partha compared to the other concentrations used and growth is also enhanced by propagation with hardwood cutting.

AISDGONF/ABS/TC/423

Green chilli powder- A promising value addition to extend storability of green chilli

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The shelf-life of green chilli (*Capsicum annuum* L.) is very short due to its high moisture content which accelerates microbial activity and deteriorates quickly. Value addition of green chilli in the form of powder can extend the shelf life to a great extent. The present investigation was carried out to evaluate the quality and storability of green chilli powder prepared from three commercial cultivars (Beldanga, Bidhan Chilli-4 and Bullet). The effect of different drying methods (sun drying, hot air drying, osmo-hot air drying with different concentrations of salt, sugar and vinegar) and packaging materials (glass bottle and poly packaging) on physico-chemical changes of powder was studied at different intervals of ambient storage. The results reveal that hot air drying and glass bottle packaging can be an effective postharvest treatment to maintain low moisture and high capsaicin contents in green chilli powder. On the other hand, osmo-hot air drying with salt plus sugar or salt plus vinegar followed by glass bottle packaging can be an alternative and cost effective postharvest treatment to maintain or improve other bioactive compounds in green chilli powder up to 180 days. The present findings will add valuable information to the current knowledge of the nutritional properties in green chilli powder, which might open the scope for commercial production of green chilli powder with adequate nutritive values. The generated technology can be adopted on large scale by the SHGs, women entrepreneurs and farm women in order to ensure more income and occupy a space in the market.

AISDGONF/ABS/TC/424

Study the performance of banana (AAB) under *Gangetic* plain of WestBengal

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The AAB genomic group of banana comprises all the cultivars that have two sets of chromosomes donated by *Musa acuminata* and one by *Musa balbisiana.* The experiment was conducted to study the growth, yield and fruit characteristics of banana AAB genomic group under gangetic plain of West Bengal. The varieties were Martaman, Martaman Clone, Dudhsagar, Champa Clones, Alpan, Alpan Manohar, Poovan, Matta Poovan, Kalibhog, Manohar, Chang Monoa, Krishna Vazhai, Deshi and Malbhog. Observations were recorded on pseudstem height and girth, leaves/ plant at shooting, days to shooting, days to bunch harvest, crop duration, bunch weight, hands/bunch, fingers/bunch, yield, finger weight, length, girth and T.S.S. The study revealed that the growth as well as yield and fruit characteristics varied significantly among different varieties under observation. Under growth characteristics Kalibhog recorded maximum pseudo stem height (3.25

m), whereas maximum pseudostem girth was found in Alpan (83.10 cm), Martaman variety produce highest leaves per plant. The crop duaration was ranged from 337.30 days (Hill Banana) to 506.7 days (Nendran). Maxmimum bunch weight (22.12 kg) was recorded by Dudhsagar variety whereas Hill Banana produce minimum bunch weight (8.25 kg). Maximum Hands (17.20) as well as maximum finger/bunch (240.3) was produced by Champa Clone I. Highest finger weight (166.3g) was recorded in Dudhsagar, whereas highest finger length (7.98cm) in Martaman and finger girth (7.15cm) in Poovan. Highest peel:pulp ratio was found in Champa clone II (2.77) while highest T.S.S was recorded in Martaman (24.7˚Brix) followed by Sabri (24.5˚Brix). Along with highest bunch weight and finger weight maximum yield was also recorded in Dudhsagar (44.24t/h) followed by Alpan-Manohar (37.3t/h) Champa clone I (33.10t/h).

AISDGONF/ABS/TC/425

Performance and profitability study of ginger cultivars raised through single bud technique under arecanut based high density multi-spices cropping system

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The study was carried out at Uttar Banga Krishi Vishwavidyalaya in an eight years old 2.7m × 2.7m spaced arecanut plantation. Integration of different intercrops of annual and perennial nature were made for effective utilization of 70% left over land area and 40% of the incident solar radiation penetrating down within the canopy of the plantation. Performance of six different ginger cultivar namely Garubathan, Suravi, Surachi, Suprabha, Bhaisay and a Local raised through single bud sprout techniques using 5g cut piece of rhizome were studied under Arecanut based high density crop model with bay leaf, lemon and ginger as component crops. Six ginger cultivars were planted in bed size of 3.0 m x1.0 m at spacing of 25 cm x 25cm and laid in RBD with four replications in the interspaces of alternate rows of Arecanut to judge their growth, yield performance and the profitability of the system. Bay leaf and the lemon were planted alternately at the center of four arecanut palms at a spacing of 5.4m x 5.4m. Recommended package of practices were followed for arecanut and other component crops. Different ginger cultivars showed considerable variation with respect to their growth behavior and yield. Local collection produced for vagarious growth with high average number of tillers (5.83) per plant having maximum height (57.64 cm). The cultivar Suprabha proved its superiority over other cultivar with respect to bulking and yield of rhizome, producing 2.45 tonnes from one hectare of crop model having 11% net cropped area of ginger. The practice of high density of arecanut based model markedly increased of sole crop with higher benefit cost ratio (6.63) of the system.

AISDGONF/ABS/TC/426

Effect of gamma irradiation on multiplication of corm buds of plantain var. Nendran through macropropagation

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An experiment was carried out at FBMC, RIDF-XXIII Project of BCKV, WB during 2020-21 to observe the effect of gamma irradiation (^{60}Co) on survival and sprouting time (days) of corm buds and on number and growth of shoots and leaves from irradiated corm bud of plantain var. Nendran through macropropagation. Six treatments i.e., 10, 15, 20, 25 and 30 Gy doses of gamma irradiation for treatment T2 to T6, respectively and 0 Gy dose for control (T1) were evaluated in RBD with four replicates. Corm bud survival rate was maximum (95%) in control (0 Gy) and minimum (65%) due to highest dose (30 Gy) of irradiation. Bud breaking time was recorded minimum (36.25 days) in control, followed by 37.50 days with 20 Gy dose (T4) and maximum (42.75 days) with 30 Gy dose (T6). Non-irradiated corms (T1- control) also recorded maximum number of primary shoot (2.70), secondary shoot (5.46), tertiary shoot (12.89), height (7.23 cm) and girth (3.13 cm) of tertiary shoot, leaf number tertiary shoot^{-1} (2.15), length (7.65 cm), Breadth (3.80 cm) of leaf and leaf area (29.07 cm^2), followed by 20 Gy dose (T4). The highest dose (30 Gy) of irradiation significantly inhibited plantlet multiplication while among the lower doses of irradiation, 20 Gy dose appeared suitable for multiplication of plantlets through macropropagation from the irradiated corms of plantain var. Nendran.

AISDGONF/ABS/TC/427

Effect of integrated nutrient management on growth and yield of turmeric (*Curcuma longa* L.) cv. Pragati under the New Alluvial area of West Bengal

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Turmeric (*Curcuma longa* L.) is one of the oldest known valuable spice crops in India and having an immense medicinal properties and culinary importance. It is an exhaustive crop and demand higher level of nutrients and soil fertility for its optimum growth and yield development. Hence, Integrated Nutrient Management becomes more relevant of which bio-fertilizers play a major role. By taking of this importance, a field experiment was conducted to assess the effect of Integrated nutrient management on growth and rhizome yield of Turmeric cv. Pragati at H.R.S., Mondouri, BCKV, West Bengal, India, during 2021-22. Experiment was laid out in a complete Randomized Block Design with 7 treatments replicated thrice. This experiment was done under open field conditions and treatments consist of Bio-fertilizers like, Nitrogen fixing bacteria (*Azotobacter*), Phosphorus solubilizing bacteria (*Pseudomonas* sp.), Potash mobilizing bacteria (*Frateuria* sp.) were applied in combination with bio-stimulants like humic acid @ 0.1% and chitosan @ 0.1% (as foliar spray on 60, 90, and 120 DAP). Observation data with respect to growth parameters were collected at different growth stages whereas yield was obtained after harvest. Recorded data were statistically analyzed and observed significantly differences among the treatments. The result of

this study revealed that the treatment *i.e.,* 75% RDF + *Azotobacter* + PSB + KMB+ humic acid has recorded highest plant height, number of leaves per plant, number of tillers per clump, fresh rhizome yield and dry rhizome yield of turmeric.

AISDGONF/ABS/TC/428

Effect of orthosilicic acid on early blight in tomato

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Silicon (Si) is ubiquitous in the Earth's crust and the 2nd most abundant element.The plant bioavailable silicon compounds are silicic acid, calcium silicate with very low concentration in soil. Foliar application of orthosilicic acid is a viable option to improve the growth and morphometric traits of tomato. The present investigation has been planned to draw a profile of the effect of Orthosilicic acid on early blight incidence in tomato.The present study was carried out at Horticultural Research Station, Mondouri, B.C.K.V, Nadia, West Bengal, during autumn-winter seasons of 2019-21. There were six indeterminate F_1 hybrid cultivars viz. Heemsohna (V1), Amlik (V2), PAN-1286 (V3), PAN-3605 (V4), Tanuja (V5), Lucky-259 (V6) sown in factorial randomized block design with three replications and the pooled data over the two years was subjected to statistical analysis. Orthosilicic acid (20.5%) @1500 ml/ha in 3 splits, @2500 ml/ha in 3 splits & @3500ml/ha in 3 splits were applied at 45days after sowing (active vegetative stage), 60 days after sowing (flower initiation stage) & 75 days after sowing(fruiting stage). Observations on different growth and yield attributing & quality parameters along with early blight incidence were recorded and have been statistically analyzed. The lowest AUDPC was recorded in Heemsohna with 3500 ml/ha of Orthosilicic acid, which was closely followed by PAN 1286 with 3500 ml/ha of Orthosilicic acid. Highest early blight severity was recorded in Tanuja when no Orthosilicic acid was applied.

THEME - D

Advances in crop improvement, biotechnological approaches and biotic & abiotic stress management

Plenary Lecture **AISDGONF/ABS/TD/465**

Enhanced selectivity of herbicides in tomato through the safening effects of melatonin and 2,4,6-trichlorophenoxyacetic acid

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Safeners serve as protective agents for crops, acting by enhancing their ability to metabolize various compounds, including herbicides. The primary role of safeners is to bolster a crop's resilience against herbicide-induced damage by triggering the activation of proteins involved in herbicide metabolism and facilitating their detoxification within the crop's system. This study aimed to delve into the biochemical impacts of melatonin and 2,4,6-T safeners on tomato cultivation, including their ability to activate the detoxifying enzyme glutathione S-transferase (GST).Conducted using a randomized factorial design 4x3, the experiment consisted of four replications divided into two factors: (A) herbicides - dicamba, 2,4-D, metribuzin, sulfentrazone, and an untreated control; and (B) safeners - melatonin, 2,4,6-T, and a control group. The treatments were applied to the above-ground portions of tomato seedlings. Visual assessment of injury was performed at 3, 7, 14, and 21 days after application (DAA), and biomass measurement was taken at 21 DAA. Leaf samples were collected at 0, 72, and 168 hours after herbicide application to analyze GST activity. An in-depth analysis of the data reveals that pre-treatment of seeds with safeners led to reduced injury, increased biomass, and a noteworthy elevation in GST enzymatic activity. These outcomes highlight the potential of safeners in enhancing the detoxification process within plants subjected to herbicide exposure. A deeper comprehension of plant defense mechanisms sheds light on how safeners can play a pivotal role in shielding crops from herbicides, thus contributing to the development of more effective weed management strategies.

Plenary Lecture **AISDGONF/ABS/TD/466**

Advances and challenges in the use of RNAi as a tool for weed management

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RNA interference (RNAi) has emerged as a compelling solution for confronting complex challenges in modern agriculture, especially crop protection. This pioneering technique exploits the inherent regulatory mechanisms governing gene expression to induce temporary silencing of specific target genes in weeds. RNAi holds significant promise in the development of precisely tailored and environmentally friendly strategies for managing weeds, particularly in the context of combating herbicide-resistant weeds. However, the practical implementation of RNAi-based weed management approaches is accompanied by complexobstacles.One of the principal challenges lies in formulating an efficacious sprayable RNAi solution that ensures not only storage stability but also sustained stability on leaf surfaces, successful penetration through plant cuticles, and efficient absorption and translocation within plant systems. Equally crucial is the crucial to attain extreme precision in targeting, minimizing the potential for off-target effects while maximizing the risk of

damaging crops. The potential unintended repercussions on ecological systems remain a focal concern, demanding meticulous evaluation.Moreover, the regulatory frameworks governing the deployment of RNAi-based products within agricultural contexts necessitate establishment to ensure this technology's responsible and effective utilization. A pivotal obstacle further complicating the integration of RNAi into agricultural practices is the challenge of scaling up production to achieve cost-effective implementation. In response to these multifaceted challenges, academic groups need to increase their engagement in formulating innovative solutions to transcend the limitations of RNAi technology.This keynote address will examine the contemporary scenery of RNAi technology on weed management and show some recent findings in this area.

Plenary Lecture **AISDGONF/ABS/TD/526**

Futuristic weed management in natural farming

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It has been found that losses caused by weeds far exceed other pests as yield increase by managing insect-pests and diseases account for 32 and 39%, respectively compared to 74% due to weed management. Weed reduce crop yield by 36% in general, and even a modest 10% yield penalty by weeds results in an enormous loss of 278 million tons of cereals in the world. Poverty and hunger have decreased globally, but 800 million people are still chronically hungry and 2 bn suffer from micronutrient deficiencies. There are 200-230 million hungry and malnourished people in India. Land for agriculture is declining due to diversion in different sectors for development and it is a major challenge to meet the food and nutritional requirement of India's burgeoning population. Herbicides were considered best tool to manage weeds in different situation for ease of application and effectiveness. The total world agrochemicals market in 2020 increased to $208.6 bn and is projected to reach $246.1 bn by 2025. The major growth of 5-15% per annum is from Asian countries. After seven decades of herbicide use it has been realized that herbicide alone can manage weeds. The evolution of 271 herbicide resistant weed species spread in 72 countries infesting 98 crops to 170 herbicides belonging to 23 of 31 sites of action is a testimony that herbicide alone will not work in the long run. Global heating and availability of optimum soil moisture have significant impact on crop productivity challenged by robust weed growth, herbicide efficacy and their persistence. Herbicide toxicity, spray drift to non-target species and effect on biodiversity is also causing concern across the globe and are unsustainable in the long run. Agriculture has undergone significant changes in the last 2-3 decades for producing quality and environmentally friendly methods of production. Natural farming need modification in cultivation methods, adoption of stale seedbed to stimulate weed seed germination for exhausting soil seed bank, manipulating sowing time, seed rate, implement crop diversification, crop rotation/mixed farming, use of competitive varieties, intercropping, mulching, straw management, soil solarization, monitoring weed flora shift, harvest weed seed, restricting seed contamination and their movement, exploitation of weed biology knowledge, use of microbes/bioherbicides, soil moisture regulation, micro-irrigation systems adoption, and weed scouting to check seed production, mechanical weeding, cover crops, green manuring, crop residue management, compost, fertilizers, and mulches that are vital non-chemical approaches for sustainable weed management. Evolving new technologies *viz*. indoor/vertical farming, hydroponics, CRISPR-Cas9, phenomics, robots, remote sensing, lasers, electricity, drones and artificial intelligence are becoming the future of weed management for natural farming. Robots are incredibly helpful in not only controlling weeds but also performing other agricultural operations and fits well in natural farming system.

Lead Lecture **AISDGONF/ABS/TD/448**

Weed biology and ecology : The important science to understand behaviour of weeds in agro-ecosystems

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Thorough understanding of weed biology and ecology is important to the ability to develop an effective weed management program. Weed biology is related to the study of weeds in relation to their geographical distribution, habitat, growth, population dynamics and communities, whereas on other hand, ecology is the interrelationship between organisms in terms of their adaptation, distribution, growth, prevalence, competing and survival ability altogether persistence of organisms and their environment. Weed ecology and biology specifically deals with the persistence of weed, which refers its ability to repeatedly invade when it is apparently removed from the scene by the agent. Persistence nature of weeds is controlled by contribution of seeds through seed rain, existing weed seed bank dynamics, expansion of seasonality and also dissemination of seeds from other eco-systems. Weed seed rain is the new weed seeds which are periodically added to the existing seed population in soil by weeds growing *in situ*, wind, water, humans, animals and miscellaneous dispersing agents. Preventing weed seed rain is the novel approach to reduce the strength of soil seed bank/soil seed pool of weeds. The traits which dictate success of weeds in agro-ecosystems are tolerance to disturbance and stress, genetic variation, phenotypic plasticity, variable seed dormancy, rapid seed germination and staggered emergence pattern, faster growth rate and rapid nutrient sequestration, prolific seed production, effective dispersal and production of allelopathic exudates. Through an understanding of weed biology and ecology, it is possible to identify integrated methods and application timings which provide the greatest impact on the reduction of weed seeds which are returned to the soil through seed rain.

Lead Lecture **AISDGONF/ABS/TD/464**

Weeds are not enemies always – their role in ecosystem services for ecological restoration

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Weeds are always being present especially anywhere we really don't want, it is inevitable. When they are present in crop fields, may be defined as an undesirable plant with a negative value which competes with man for the soil (Saha *et. al.* 2021). Man has often condemned the weeds and considered them as enemy. They rarely think of why weeds grow. Weeds are not always our enemies too and deserve at least a fair amount of recognition in the plant society. Weeds are here for a purpose and they have a job to do. Weeds are specialists. They survive under circumstances where our cultivated plants cannot stand up against nature's caprices, often resist conditions such as drought, acidity, lack of humus and mineral deficiencies. They are witness to man's failure to master the soil. They indicate our errors and natures corrections (Walters, 1999). Some potential benefits obtained from weeds are i. it helps in conserving soil moisture and prevent erosion; ii. a ground cover of weeds will reduce the amount of bare soil exposed helping to conserve nutrients, particularly nitrogen which could otherwise be leached away, especially on light soils; iii. it provides food and shelter to natural enemies of insect-pests and even alternative food sources for crop pests; iv. the actual presence of weed cover may be a factor in increasing effectiveness of

biological control of pests and reducing their damage; v. weeds can also be valuable indicators of growing conditions in a field, for example of water levels, compaction, pH etc.; vi. it can also be utilized as green manure or green leaf manure or for composting; vii. some weeds are having allelopathic potential that can be exploited for suppressing certain weeds in crop field. Thus, weeds play an important role in ecosystem services for ecological restoration. Finding a balance between yield loss and excessive management for controlling weeds in crop field is a challenge faced by the farmers. There must be an understanding of how the presence of weeds affects crop yield and for that the threshold limit of weed competition is an important index at which a control measure is economically justified.

Lead Lecture **AISDGONF/ABS/TD/529**

Potential rice genotypes for drought-affected areas of West Bengal

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One of the major extreme climatic events is drought that affects rainfed rice with low and unstable yields in eastern India. Similar aberrant situation prevails in the western tract of West Bengal that represents potential rice growing areas, being frequently affected by drought. In these areas, high-yielding varieties *viz. Ajit*, *Dhiren*, *GB 1*, *IR 64*, *Lalat*, *MTU 1001*, *MTU 1010*, *MTU 1017*, *MTU 1153*, *MTU 1156*, *Pooja*, *Rajendra Mahsuri*, *Sukumar*, and *Swarna* are generally grown under rainfed condition with variable grain yields (3.2-4.8 t/ha) although they were not bred for drought tolerance. On-station and on-farm experiments under ICAR-AICRIP and IRRI-led projects for more than five years revealed that drought-tolerant rice varieties of short duration group (*Anjali*, *CR Dhan 320*, *DRR Dhan 42*, *DRR Dhan 44*, *DRR Dhan 46*, *Puspa*, *Sahbhagi Dhan*, and *Vandana*) could withstand dry spells for 1-2 week(s) during the active tillering stage, yielding 3.2-3.8 t/ha under upland situation, where the majority of farmers' preferred varieties succumbed with nominal or marginal yields. Medium to long duration varieties *viz. Abhishek*, *BINA Dhan 11*, *CR Dhan 801*, *CR Dhan 802*, and *Swarna Shreya* recorded higher yields (3.8-4.5 t/ha) under low to medium land situation with mild to moderate drought. Prominent landraces in these areas were *Asanlaya*, *Aswinsal*, *Bhadoi*, *Chandrakanti*, *Jhulur*, *Kalamkathi*, *Kelesh*, *Lakshansal*, *Lohasal*, *Maniksal*, *Satiya*, and *Vutmuri* with yield potentials of 2.0-2.8 t/ha. Rice hybrids *viz. Arize 6129 Gold*, *Arize 6444 Gold*, *Arize 8433DT*, *Arize Tej Gold*, *27P37* (*XRA 37923*), *28P67* (*XRA 38967*), *25P85* (*XRA 752PJ6*), and *PAN 2423* performed better (4.0-4.8 t/ha) under moderate drought, whereas green super rice (GSR) genotypes produced stable yields under similar condition even with less input (4.2-4.8 t/ha).

Lead Lecture **AISDGONF/ABS/TD/540**

Herbicide tolerant crops as an option of biotechnological approaches for weed management in Indian agriculture

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In view of the importance of the use of biotechnology for effective weed management involving genetically modified herbicide tolerant crops, it is imperative to understand the mechanism of herbicide tolerance in crops, history and development of herbicide tolerant crops (HTCs), and concerns and controversies. Herbicide tolerant genetically modified (HTGM) crops offer farmers a choice of flexible and convenient way of weed management. Herbicide tolerant crops are designed to tolerate specific broad-spectrum herbicides, which kill all the associated weeds without injuring the cultivated crop. Mechanisms which generally occur within herbicide tolerant plants are altered target site, enhanced metabolism, compartmentalization or sequestration and over-expression of the target protein. History of development and current transgenic herbicidetolerant crops and genes responsible for resistance are also discussed. From the genesis of commercialization of GM crops, herbicide tolerance has consistently been the dominant trait deployed in soybean, maize, canola, cotton, sugar beet and alfalfa. Glyphosate and glufosinate are the predominant herbicides employed in the development of HTCs. The major benefits of HTCs are: broad-spectrum weed control, convenient and flexible weed management, reduced crop injury, less herbicide carry-over on the succeeding crops, lower soil run off losses as a result of their use in conservation agriculture and increased farm income. Issues and concerns include: impacts on agro-safety, evolution of herbicide resistant weeds, reduction in herbicide diversity, horizontal gene flow and development of 'super weeds' and displacement of labour and impacts on rural livelihood. Global experiences with commercialisation of HTGM crops in countries like USA, Canada and European countries as well as Indian experiences have been discussed in this paper.

Lead Lecture **AISDGONF/ABS/TD/542**

Intellectual property rights for rice in West Bengal:Scope and achievements

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West Bengal is a rich source of genetic diversity in rice, which needs IPR protection in the form of patent variety registration, geographical indication (GI), trade mark, etc. The Rice Research Station (RRS) of Government of West Bengal (GoWB) improved more than 60 indigenous rice varieties by selection during pre-green revolution period, and thereafter, it developed and released about 40 high-yielding (HYV) and 3 hybrid rice varieties (CNHR 3) during last five decades.Among released HYVs, Shatabdi, Khitish and Sabita from RRS, GontraBidhan1 and BidhanSuruchi from Bidhan Chandra KrishiViswavidyalaya (BCKV), Uttar Sona and Uttar Lakhsmi from Uttar BangaKrishiViswavidyalaya (UBKV) become popular among farmers in the state. The registration of farmers' varieties was initiated by BCKV in collaboration with State

Department of Agriculture, Patent Information Centre and Bio-diversity Board in 2007, and that was extended by UBKV, some individual farmers and a few farmers' organizations in last few years. As a result, a total of 167 varieties have been registered by individual farmers and 40 varieties by farmers' organizations under Protection of Plant Varieties and Farmers Rights Authority (PPV&FRA), Government of India. The RKVY Project on 'Bengal Aromatic Rice' of BCKV extended technical support to farmers' organizations of native areas for registration of traditional aromatic rice varieties *viz*. Gobindabhog (2014), Harinakhuri (2020), LalBadshabhog (2021) and Radhunipagal (2022). With comprehensive efforts, two aromatic rice varieties, namely Gobindabhog (GI No. 531) and Tulaipanji rice (GI No. 530) have been registered as GI products of West Bengal with in 2017.The post-GI activities including the involvement of authorized users have recently been initiated.

Lead Lecture **AISDGONF/ABS/TD/543**

Environmental concern of herbicides and role of phytochemicals as source of bio-herbicides in natural farming

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Weeds are strong competitors against crops and they not only reduce crop yield but increase production and processing cost. Through application of herbicides provide effective weed management, however, adverse effects of synthetic chemical herbicides are often reported on human and environment, such as, degradation in water quality, soil pollution, residues, and the constant incidence of herbicide resistant weeds, which has brought great challenges to agricultural production and hence some synthetic herbicides are under constant scrutiny with forceful restrictions or market removal in many countries. Therefore development of bio-herbicides with environmental compatibility, high selectivity and strong biological activity is urgently needed for sustainable weed management. In India, natural farming is promoted as BPKP under a centrally sponsored scheme– PKVY. Moreover, preference of the heath conscious population to a nutritious and synthetic chemical free diet is increasing the demand for natural/organic products, which promotes the practice of natural farming throughout the globe. The global natural organic food market grew from $259.06 billion in 2022 to $294.54 billion in 2023 at a compound annual growth rate (CAGR) of 13.7% which is further expected to grow $512.01 billion in 2027 at a CAGR of 14.8%. The India organic food market was 1.238 billion dollar in 2022 which is expected to grow at about 22% to reach 4.082 billion dollar by 2028. Vinegar and corn gluten is used for weed management in natural farming since long back. Since the registration of first bio- herbicide DeVine in the US in 1981, the number of newly registered and newly launched bio-herbicides including BioMal, Biochon, EMERION, etc. in the world in last three decades are very limited. Recently, several biological organisms or their extracts are utilized to integrate weed control strategies. The global bio-herbicides market attained a value of USD 1.61 billion in 2020 and projected to reach USD 3.32 billion by 2026. In addition, policymakers in many countries are promoting the use of bio-herbicides. Weed control is one of the most important steps in agricultural production, and apart from use of bio-herbicides, there are several practices that can be adopted for effective weed management in natural farming, like, cultural practices, that includes tillage, crop rotation, green manuring, cover crop and intercropping, selection of climate smart right crop seed, etc. Weed competitor crop to be selected for reduction of crop weed competition

based on history of field. Besides this, mechanical and thermal, microwave ultraviolet radiation, soil solarization, etc., are also be used for effective weed management in natural farming.

Invited Oral **AISDGONF/ABS/TD/286**

Search for fungal pathogensas mycoherbicides against the invasive aquatic plant waterhyacinth

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Invasive alien species are the second most significant threat to biodiversity, after habitat loss.One such invasive plant isWaterhyacinth (*Pontederia crassipes*), a macrophyte ofSouth American origin. It was introduced to various parts of the world as an ornamental plant and is now considered as the most troublesome aquatic invasive weed. Water hyacinthis known for disrupting several social and economic activities with its immense capacity to multiply and to invade despite all the management efforts. Biological control offers a long term solution and additional agents have always been under consideration particularly the specialist herbivore and pathogens. In various parts of the world, eleven arthropod natural enemies of water hyacinth have been released and more are being considered. But hardly any systematic work on indigenous fungi associated with the weed has been conducted. Understanding the need, extensive surveys were conducted from 2014-2020 in various aquatic bodies in and around Kolkata to isolate and identify the fungal pathogens associated with water hyacinth. Diseased plant parts of water hyacinth were collected and attempts were made to identify the isolated fungi.During this period we obtained 250 isolates of fungi belonging to 25 genera, from diseased water hyacinth collected during field trips. The fungi were evaluated for their efficacy against the weed, their potential for commercialization (field performance, host specificity, mycoherbicide production), and their compatibility with insect biocontrol agents of the weed. Around 150 fungal pathogens were evaluated for their disease-causing potential against the weed. The selected fungi were identified using morphological and molecular techniques. *Fusarium* Link followed by *Alternaria* Nees were the highest and most consistently isolated genera. Seven potential fungi that caused more than 90% disease in whole plant pathogenicity bioassay were subjected to host range evaluation against 67 plant species selected based on ecological nearness or economic significance. Although several of these isolates appeared severely detrimental under controlled conditions their inability to serve as stand-alone replacements for chemical herbicides, has probably deterred their earlier commercialization efforts. Among the isolated fungi *Fusarium oxysporum* f. sp. *lycopersici* was found to have a narrow host-range and effective against water hyacinth. With further studies on their impact assessment, environmental viability, and tolerance, few of them, especially *F. oxysporum* may effectively reduce population growth of water hyacinth by themselves or in conjunction with other introduced biocontrol agents, including insects and other plant pathogens.

Invited Oral **AISDGONF/ABS/TD/456**

Chemical and non-chemical weed management options for transplanted finger millet in coastal deltaic ecosystem of Puducherry UT

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Finger millet (Eleusine coracana (L.) Gaertn.) is the most important nutritious food in India. It is an excellent source of calcium, protein and amino acids. Use of herbicides has considered as the easier method of weed management method in finger millet cultivation. However, long-term agrochemicals use negatively affects crops and the environment. Hence, there is a need for developing effective, sustainable and ecological non-chemical weed management methods which reduce the agrochemical load in the environment. A field experiment was conducted during Kharif (June – September 2019) with 7 treatments replicated thrice in a randomized block design to study the effect of non-chemical weed management practices in transplanted finger millet at Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA & RI), Karaikal, Puducherry UT. The result revealed that the weed flora of the experiment field was dominated by grasses (82.94 %) followed by the sedges 14.99 % followed by broad-leaved weeds (2.07 %) in the experimental field. Employing non-chemical weed management option of stale seedbed with or without intercultivation resulted in poor weed control efficiency (4.7 to 35.9%) However, hand weeding twice significantly reduced the weed density (89 no. m^{-2}), resulted in higher weed control efficiency (91.4%) with grain yield (3434 kg ha^{-1} and B:C 2.3). Application of PE butachlor 1 kg ha^{-1} integrated with one hand weeding resulted in higher weed control efficiency (83%) with grain yield (3303 kg ha^{-1} and B:C 2.3, which can be adopted under labour scarce conditions of coastal deltaic ecosystem of Puducherry UT.

Invited Oral **AISDGONF/ABS/TD/520**

Baseline sensitivity of *Ustilaginoidea virens*, a pathogen causing rice false smut disease, to EBI and QoI fungicides in India

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Rice false smut (RFS), caused by *Ustilaginoidea virens* (Cooke) Takahashi, is one of the major diseases of rice throughout rice growing areas of the world. RFS disease is the recognised by the formation of false smut balls in rice grains at the maturity stage of the plant and thus, visible during harvesting stages. The pathogen affects not only production but also cooking and nutritional qualities of rice grains (Bag et.al., 2021). The pathogen produces toxic metabolites, including ustilaginoidins and ustiloxins which threaten food and feed safety (Qiu et al, 2019). Till now, RFS is appeared in almost all HYV and hybrid varieties. In absence of RFS resistant variety, application of fungicides is the best and effective way to manage the disease. In particular, Ergosterol biosynthesis inhibiting (EBI) fungicides like propiconazole, tebuconazole,

difenconazole and Quinone outside inhibiting (QoI) fungicides like azoxystrobin, tryfloxistrobin are more commonly used in rice fungal disease management. However, due to intensive application of fungicides, resistance has been detected in several important pathogens. Zhou et al. (2019) reported propiconazole-resistant isolates of *U. virens* in China. Thus, our objective is to find out the lethal dose 50 (LD_{50}) of tebuconazole, propiconazole (EBIs) and azoxystrobin (QoI) to Indian isolates of *U. virens* and frequency distribution of sensitivity of isolates of *U. virens* from eastern and north-eastern India. All three fungicides were assayed against the *U. virens* culture of native isolate (NRRI-FS-1) following poisoned food technique under ideal laboratory condition. LD_{50} values of azoxystrobin, propiconazole, and tebuconazole for inhibiting mycelial growth of *U. virens* (Isolate NRRI-FS-1) were calculated as 0.08, 0.05, and 0.035 µg/ml, respectively. Frequency distribution of sensitivity of 63 isolates of *U. virens* from eastern and north-eastern India at 5 different concentrations based on the LD_{50} value of tebuconazole standard (0.034), propiconazole standard (0.05) and azoxystrobin standard (0.08). The experiment revealed that 90% isolates are sensitive to below or equal to the LD_{50} values. Only few isolates are sensitive at marginally high concentration of the fungicides, thus less sensitivity to LD_{50} value in compare to NRRI isolate (NRRI-FS-1). This study suggested that *U. virens* in India are highly sensitive to these fungicides.

AISDGONF /ABS/TD/10

Development of a modified QuEChERS method coupled with LC-MS/MS for determination of spinetoram residue in chilli (*Capsicum annuum*) and safety risk assessment

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The present study aims to develop method for estimating spinetoram residues in chilli and to assess safety risk associated with its use. Multi-locational field experiment was carried out in chilli following RBD in which spinetoram (12% SC) was applied thrice at ten days interval and at two doses, i.e., 60 g.a.i. ha^{-1} (T_1) and 120 g.a.i. ha^{-1} (T_2) along with untreated control (T_3), keeping three replications for each treatment. Plant samples were collected randomly at periodic interval after final application and soil at harvest. The method involves an extraction with ethyl acetate followed by dispersive solid phase extraction (dSPE) cleanup with primary secondary amine (PSA), C_{18} and graphitised carbon black (GCB). Final quantitation of spinetoram was done by LC-MS/MS and dietary risk has been assessed based on available toxicological data. Dissipation of spinetoram follows first order kinetics in chilli irrespective of location. The compound dissipated quickly in chilli fruit. No residues were detected in harvested samples of chilli irrespective locations and doses. Risk quotient values were found well below one from the very beginning of sampling irrespective treatment doses.From the toxicological point of view, chilli may be safely consumed after following GAP recommended for spinetoram use.

AISDGONF /ABS/TD/11

Biochemical studies in lentil (*Lens culinaris* Medik.) genotypes under *Stemphylium* blight stress

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Stemphylium blight, caused by the fungal pathogen *Stemphylium botryosum*, is one of the important diseases in lentil, an important rabi pulse grown in the plains of West Bengal. The disease is prevalent particularly in the late flowering stage of the crop. Considering the severity of the disease in the existing cropping system, an experiment was undertaken at the instructional farm of Uttar Banga Krishi Viswavidyalaya during 2021-22 with the objective to study the change in the patterns of various biotic stress related biomolecules among fifty (50) lentil genotypes under the incidence of Stemphylium blight. Disease parameters such as PDI and AUDPC were recorded to measure the extent of disease occurrence under field condition by following Hashemi's disease score. Biochemical parameters *viz*., Phenol, OD Phenol, PPO, SOD and APX were estimated before and after the incidence of disease under artificial inoculation. Statistical analyses of the generated data were performed in R Studio. Analysis of variance indicated significant differences for all the parameters among the genotypes. The genotypes IC620839 recorded the lowest PDI (11.25) with the AUDPC score of 202.41 while IC54456 had the highest PDI (79.37) and AUDPC score (1598.60) respectively. The pirate plots showed that except PPO and OD Phenol all the studied biochemicals increased in artificially inoculated samples. A significant but negative correlation for disease with OD Phenol and SOD was also observed. The genotype IC241072 with the lowest disease score (1.5) and PDI (11.87) along with the highest OD Phenol and SOD content under artificial inoculum was in a separate cluster. The observation could thus be helpful in the future crop improvement schemes as far as disease resistance in lentil is concerned.

AISDGONF /ABS/TD/12

Rice root-knot nematode, *Meloidogyne graminicola* management through bioagents

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Rice is one of the important grains of India. Soil borne diseases caused by plant parasitic nematodes is an emergent problem in rice growing areas of the world. Rice root-knot nematode (*Meloidogyne graminicola*), rice root nematode (*Hirschmanniella oryzae*), white tip nematode (*Aphelenchoides besseyi*) and stem nematode (*Ditylenchus angustus*) are the important nematodes associated with rice based cropping systems. Among them the rice root-knot nematode causes serious concern. A field experiment was conducted at Central Research Farm, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya for two consecutive years during 2018 and 2019 for the management of rice root-knot nematode *Meloidogyne graminicola* using some bacterial bioagents, *Bacillus pumilus, Bacillus subtilis* and *Pseudomonas fluorescence* by soil application in the nursery bed. Chemical nematicide carbofuran was used as standard check. The experiment was

designed in Randomized Block Design using five treatments replicated six times. The result of the experiment revealed that all the treatments were superior over untreated check with respect to seedling height, number of galls at transplanting, root knot index, soil and root population of the nematode at harvesting and yield. Among the bioagents, *P. fluorescence* gave better result than other bacterial bioagents and gave highest yield of 1.26 t/ha & 2.72 t/ha in 2018 & 2019, respectively. However in respect of incremental cost benefit ratio (ICBR) the treatment with carbofuran was highest followed by the bacterial bioagents due to lower cost of the chemical pesticide. To avoid the indiscriminate use of pesticides for the greater interest of the environment as well as soil health, use of biopesticide is more convenient than chemicals. So in this context, management of rice root knot nematode may be recommended through application of *P. fluorescence* @ 20 g/ m^2 in nursery bed.

AISDGONF /ABS/TD/13

Performance of direct seeded rice in Old Alluvial Zone of West Bengal under weed management through different herbicide application

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An experiment was conducted at Regional Research Station, Old Alluvial Zone of West Bengal, Uttar Banga Krishi Viswavidyalaya, Majhian, Dakshin Dinajpur in 2019 and 2020 to observe the performance of rice under weed management with different herbicides. The efficacy of different herbicides was also observed in this experiment. Eleven number of treatments were selected for this experiment which consists of Weedy check (T_1), Hand weeding at 15 and 30 DAS (T_2), Pendimethalin 30% E.C. (PE) @ 5 l/ha (T_3), Pendimethalin 30% E.C. (PE) @ 5 l/ha fb Bispyribac sodium 10% SC @ 250 ml/ha at 20 DAS POE (T_4), Pendimethalin 30% E.C. (PE) @ 5 l/ha fb 2,4-D sodium salt POE @ 1.25 kg/ha at 20 DAS (T_5), Pyrazosulfuron ethyl 10% W.P (PE) @ 150 g/ha (T_6), Pyrazosulfuron ethyl 10% W.P (PE) @ 150 g/ha fb Bispyribac sodium 10% SC @ 250 ml/ha at 20 DAS POE (T_7), Pyrazosulfuron ethyl 10% W.P (PE) @ 150 g/ha fb 2,4-D sodium salt 80% W.P POE @ 1.25 kg/ha at 20 DAS (T_8), Pretilachlor 50% E.C. (PE) @1.88 l/ha (T_9), Pretilachlor 50% E.C. PE@1.88 l/ha fb Bispyribac sodium 10% SC @ 250 ml/ha at 20 DAS POE (T_{10}) and Pretilachlor 50% E.C. (PE) @1.88 l/ha fb 2,4-D Na salt (POE) @ 1.25 kg/ha at 20 DAS (T_{11}). Among these treatments, T_7, resulted with highest number of tillers per m^2, plant height (cm), grain yield, straw yield of rice. Weed count (weeds /m^2) and Weed dry matter (g/m^2) was recorded lowest with the same treatment. Therefore, T_7 treatment can be further recommended for weed controlling in direct seeded rice in Old Alluvial Zone.

AISDGONF /ABS/TD/14

Study on diversity and community structure of mite fauna associated with vegetable in West Bengal, India

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West Bengal is the largest producer of horticultural crops accounting for 9.6% of total horticultural production in the country. The state produces 23.04 m. MT of vegetables from an area of 1.38 m. ha with the productivity of 16.7 t ha. Due to inadequate information regarding mite fauna associated with vegetables, the present investigation was under taken to explore the diversity of phytophagous and their related predatory mites. Mite samples were collected from different agro-climatic zones, beating method was adopted and dislodged mite specimens collected by using a single hairbrush and preserved in a plastic vial containing 70% alcohol. The specimens were brought to the laboratory and poured in a cavity block then mounted by using modified Berlese's medium and identified by a phase contrast microscope. A total of 15 species of phytoseiid mites were recorded belonging to the genera *Amblyseius, Euseius, Paraphytoseius, Typhlodromips, Scapulaseius, Neoseiulus, Phytoseius, Anthoseius* and *Indoseiulus*. The phytoseiid mite, *Amblyseius largoensis* was recorded as predominant mite species followed by *Typhlodromips syzygii* recorded 19.71 and 15.05 per cent of total mite population, respectively. Other predatory mites belonging to the family Tydeidae, Bdellidae, Ascidae, Cunaxidae, Cheyletidae and Stigmaeidae were also recorded. Phytophagous mites, *Tetranychus urticae, Tetranychus ludeni, Schizotetranychus baltazari, Eutetranychus orientalis, Oligonychus andropogoni, Polyphagotarsonemus latus and Brevipalpus phoenicis* were found as destructive mite pests in vegetables. Phytophagous mites are of serious concern for successful vegetables cultivation. Predatory mites were found effective against plant feeding mites and soft bodies insects, they could be utilized for IPM programme.

AISDGONF /ABS/TD/18

Studies on population dynamics and infestation of fruit flies in ash gourd

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Ash gourd is an important cucurbit crop having various health benefits.Ash gourd is attacked by many insects but among them, most destructive insect is fruit fly causing 20-100% damage.The Experiment was conducted during April, 2022 to May, at farmers′ fields of Gangnapur village at Nadia district of West Bengal.The objective was to studythe species diversity of fruit flies on ash gourd, the population dynamics of fruit flies, and the rate of infestation along with benefit– cost ratio in both the trapped and non trapped fields.Four farmers were selected who cultivates ash gourd, facing problem of fruit flies.Two farmers were given traps but rest 2 farmers were not provided traps. Each farmer was provided with 2 types of traps (one cue lure + one methyl eugenol). Highest no of fruit flies were trapped during the 2nd interval (10.04.22-14.04.22). Five species of fruit flies were trapped – *Zeugodocus cucurbitae*, *Zeugodocus tau, Bactrocera dorsalis,*

Bactrocera zonata, *Bactrocera correcta*. Among all, *Zeugodocus cucurbitae* was most abundant.Infestation rate was19.47% and 20.26% in trapped and non trapped fields respectively.The B: C ratio of trapped and non trappedfieldswere3.37 and 3.23 respectively. As we can see that B: C Ratio of trap and non trap group are quite similar. Sousing trap in ash gourd cultivation is not significant for controlling fruit flies.

AISDGONF /ABS/TD/20

Evaluation of infrared thermometry based stress indices for monitoring water stress of potato (*Solanum tuberosum* L.) under irrigation and graded dose of potassium in New Alluvial Zone of West Bengal

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Two years field trials (2018-19 and 2019-2020) were conducted on Regional research station, Gayeshpur, Nadia to evaluate various infrared thermometry based stress indices of potato var. Kufri Jyoti under varied irrigation (IW: CPE= 0.4, 0.8, 1.2 and 1.6) and potassium dose (K_2O @ 100, 150 and 200 kg ha^{-1}). Seasonal evapotranspiration was varied from 121.0 mm to 320.9 mm during the crop growth period. In the first year maximum WUE (12.74 kg m^{-3}) was obtained by IW: CPE= 1.20 × K_2O@200 Kg ha^{-1} whereas in the following year the highest WUE of 9.78 kg m^{-3} was obtained from irrigation at IW: CPE= 1.60 along with K_2O application @ 200 Kg ha^{-1}. The CATD was higher during major part of the growth period where irrigation was applied at IW: CPE=0.4 and 0.8 as compared with higher irrigation level i.e., IW: CPE=1.2 and 1.6 implying the effectiveness of CATD as a stress indicator. The SDD was found to follow the same trend as CATD. 100 kg K_2O ha^{-1} recorded higher accumulated SDD in both the seasons. With increasing irrigation frequency accumulated CWSI decreased almost to one third of that of IW: CPE = 0.40. On the other hand, K_2O application reduced the accumulated CWSI. Both the stress parameters were negatively related with the tuber yield.

AISDGONF /ABS/TD/21

Species richness and emerging insect pests of jackfruit *Artocarpus heterophyllus* (Moraceae) in *Gangetic* basin of West Bengal

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An experiment was carried out to find out the insect pests associated with jackfruit in gangetic basin of West Bengal. 40 roving surveys were done from 2018 to 2022 in jackfruit growing areas of Nadia, Howrah, Hooghly, North and South 24 Parganas and Murshidabad districts of the state in different seasons to cover the different stages of crop growth and incidence of insect pests. Data were also taken from the jackfruit growers through diagnostic guidance regarding incidence of the insect pests in different season. Based on the data and sample collected the diversity indices *viz*., Shannon-Wiener index (Hughes, 1978) and Simpson's diversity index (Simpson, 1949) were done for assessing the species diversity, richness and dominance. The result of field survey revealed six species of insects associated with jackfruit namely shoot and fruit borer, *Glyphodes caesalis* (Walker); aphid, *Toxoptera aurantii* (Boyer de Fonscolombe); spittle bug, *Cosmocarta relata* Distant; mealybug, *Drosicha mangiferae* Stebbins; bark eating caterpillar, *Indarbela tetraonis*

(Moore) and stem borer, *Batocerarufomaculata* De Geer causing damage to the crop in different crop growth stages. The Shannon-Wiener index (H) was maximum for jackfruit shoot and fruit borer (3.632) followed by bark eating caterpillar (3.589) while the Simpson index (D) was also maximum with shoot and fruit borer (0.050) followed by bark eating caterpillar (0.020) as the most rich and diverse species of jackfruit in gangetic basin of West Bengal. Jackfruit shoot and fruit borer observed throughout the year and in absence of fruit they feed on tender shoots and buds. The stem borer observed in almost all the surveyed areas (12.5 % infestation) and emerging pest of concern in the state because of its potentiality to kill the tree and often confused with wilt disease, however, the diversity index is low (H= 3.359 and D= 0.001). Aphid and mealy bug also recorded as emerging pest problem of jackfruit in surveyed areas.

AISDGONF /ABS/TD/34

Assessment of management practices against major insect pests in bittergourd (*Momordica charantia* L.)

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India is the leading producer of bitter gourd (*Momordica charantia*L.) and Odisha ranks 5th in production. This crop is affected by number of insect pests reducing yield and quality of fruits.Onefield experiment was conducted for assessment of management practices against major insect pests in bitter gourd during *Kharif*, 2021 at RRTTS, OUAT, Bhubaneswar. Nine treatments comprising of para pheromone traps with cue lure and food baits along with foliar spraying of the insecticides; emamectin benzoate 5SG@220g/ha, fipronil 5EC@1000ml/ha, cartap hydrochloride 50%SP@1000g/ha, thiodicarb 75WP @ 500g/ha, abamectin 1.8SC @ 300ml/ha, spinosad 45SC @ 200ml/ha, malathion 50%EC @ 1000ml/ha (insecticidal check), neem oil 1500ppm @1500ml/ha and untreated check were tested in hybrid bitter gourd variety 'PALEE (F1)'. The results indicated that, application of food bait @ 20 baits/ha (mixture of cucumber fruit pulp + 100ml cow urine + 0.5 litre water kept overnight and diluted in 15 litres of water)+ Para pheromone trap with cue lure @ 25 traps/ha + foliar spray of spinosad 45SC @ 200ml/ha thrice at 30, 45 and 60 days after sowing' was most effective and reduced 96.34, 81.94, 85.21, 87.03, 79.89 and 60.65 per cent population ofepilachna beetle, red pumpkin beetle, flea beetle, white fly, jassid and green stink bug, 83.17 per cent reduction in fruit damage caused by melon fruit fly over untreated check and obtained maximum fruit yield (5.5t ha^{-1}), monetary benefit (Rs.110973 ha^{-1})and ICBR (8.20). Considering the overall efficacy, eco-safety and economics, this management practice may be considered for management of major insect pestsin bitter gourd cultivation.

AISDGONF /ABS/TD/41

Weed flora and growth of aromatic black rice (*Oryza sativa*) influenced by transplanting date and integrated weed management under SRI

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Heavy weed infestation is a major problem in SRI cultivation due to wider spacing and lack of flooding in the field. Yield losses due to weed infestation amounts to 25-47 %. In this context, a field experiment was conducted in the experimental farm of SASRD, Nagaland University during *kharif* season 2019 and 2020 to study the "Weed flora and growth of aromatic black rice (*Oryza sativa* L.) influenced by transplanting date and integrated weed management under SRI". The experimental design was SPD. Main plot treatment consist of three transplanting date *viz.* D_1-15th June, D_2- 30th June and D_3- 15th July and sub plot treatment consist of five weed management *viz*. W_1- weedy check, W_2- conoweeding at 20 and 40 DAT, W_3- pretilachlor @ 0.75 kg ha^{-1} at 3 DAT *fb* handweeding at 40 DAT, W_4- pretilachlor @ 0.75 kg ha^{-1} at 3 DAT *fb* conoweeder @ 40 DAT and W_5-pretilachlor @ 0.75 kg ha^{-1} at 3 DAT *fb* bispyribac-Na @ 25 g a.i ha^{-1} at 20 DAT. Results revealed that transplanting on 15th June recorded highest growth and yield of black rice. Dominant weed flora observed in the experimental field were *Fimbristylis miliacea, Cyperus esculentus, Cyperus iria, Cyperus kyllingia, Ludwigia linifolia, Mimosa pudica, Mimosa diplotricha, Scorporia dulscis* and *Paspalum distichum.* Pretilachlor @ 0.75 kg ha^{-1} at 3 DAT *fb* handweeding at 40 DAT recorded lowest population and dry weight of grasses, sedges and broad leaved weeds resulting in higher weed control efficiency and grain yield of black rice.

AISDGONF /ABS/TD/42

Effect of Ag-Nanoparticle in biochemical and physiological changes during progress of seed development and maturation in green gram

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Seed development and maturation comprises of a series of events involving cell division/ histo-differentiation, retains deposition and desiccation. Development of green gram seed has been divided into eight consecutive stages; 5, 10, 15, 20, 25, 30, 35, 40 days after anthesis (DAA). During seed development, chlorophyll was declined, while carbohydrate and protein contents were increased, suggesting their supportive role in germination and early seedling growth. As seeds developed upto 30 days after anthesis did not germinate at all, germination potential and seedling parameters including vigour index were considered for the last two stages of development (35 and 40 DAA) only. The highest germination potential was recorded as 81.24 % and 80.99 %, for seeds developed at the stage of 40 DAA in first and second year respectively. Significantly highest vigour was observed at 40 DAA, when average was made over genotypes and treatments. Seeds of Samrat produced after seed treatment with Ag-NP were of highest vigour status when harvested at 40 DAA. So, for seed purpose ideal harvesting time for greengram is 40 DAA as at that time seed vigour maximum.

AISDGONF /ABS/TD/46

Evaluation of different modules for management of maydis leaf blight disease of maize

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Maize is the leading cereal crop in terms of production and productivity. Biotic stresses are posing serious threats to the production and productivity of this crop. In West Bengal Maydis Leaf Blight is one of the most important diseases of maize during kharif season. To manage this menace in an integrated way - chemical, organic and IDM (integrated disease management) modules were tested. Among different management modules evaluated against Maydis Leaf Blight of maize in kharif 2018 and 2019, IDM module (seed treatment with *Trichoderma harzianum* @10 gm/kg of seed + foliar spray of *Pseudomonas fluorescens* @ 10 gm/L of water at 35 DAS + foliar spray of azoxystrobin 18.2 %+ difenoconazole 11.4 % w/w SC @ 1ml/L of water at 40 DAS + foliar spray of cow urine 20 % at 50 DAS) resulted in highest disease control of 52.46 per cent over organic check and 52.50 per cent disease control over inorganic check while 51.82 per cent increase in cob yield over organic check and 40.74 per cent yield increase over inorganic check. It was followed by the chemical module (seed treatment with thiram @ 3gm/kg of seed + foliar spray of mancozeb 75 WP @ 2.5gm/L of water at 40 DAS + foliar spray of azoxystrobin 18.2 % + 72 difenconazole 11.4 % w/w SC @ 1ml/L of water at 50 DAS) which resulted in disease control of 31.47 per cent over organic check and 31.54 per cent disease control over inorganic check while 32.52 per cent increase in cob yield over organic check and 22.85 per cent yield increase over inorganic check.

AISDGONF/ABS/TD/48

Integrated weed management in taro at different agro-climatic conditions of India

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An experiment was conducted in taro to find out an effective method of weed management. The experiment was laid out in RBD with 8 treatments and 3 replications, and conducted at 11 different locations at different agro climatic conditions of India including plains, hills and islands, etc. Among the different treatments hand weeding three times at 30, 60, 90 days after planting recorded significantly taller plants with more number of leaves per plant, leaf area, leaf area index, number of cormels and mother corms per plant, and yield per plant and yield per hectare, gross return and net returns at six locations, another five locations weed control ground cover mat mulch recorded better results. Most of the locations the predominant weed species identified in this crop

were *Parthenium hysterophorus*, *Cyperus rotundus*, *Cynodon dactylon* and *Commelina benghalensis*. Lower weed population and dry biomass, weed index were recorded in treatment with weed control ground cover mat at six locations, which was at par with hand weeding thrice at 30, 60 and 90 days after planting, remaining five locations hand weeding thrice was proven best for better weed control. The weed control efficiency of different weed management methods ranged 50.36-100%.

AISDGONF/ABS/TD/50

Efficacy of fungicides on incidence of maydis leaf blight of maize

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Maize (*Zea mays* L.) is commonly known as corn and its domestication dates back to more than 9,000 years ago in southern Mexico. It is an important cereal crop of the world belonging to the family Poaceae. In India maize is grown in almost all types of agro-ecological regions from plains to Hills. The biotic and abiotic stresses have emerge as one of the limiting factors for the production of cereals in eastern and southern India. Among the biotic stresses, maydis leaf blight disease is one of the most common problems of maize in West Bengal. This disease is caused by the fungal pathogen *Bipolarismaydis*belongs to the class Ascomycetes. New fungicides are successfully managing plant diseases. To manage this threatening disease of maize the efficacy of various fungicides against maydis leaf blight (MLB) of maize was evaluated on Kaveri 50 susceptible hybrid during kharif 2020 & 2021. Application of Azoxystrobin 18.2% w/w + Cyproconazole 7.3% w/w SC @ 0.20% spray at 3 days and 18 days after inoculation at 3 days and 18 days after inoculation gave the highest control with lowest PDI (15.72) and 62.3per cent disease control over the untreated check. The grain yield in this treatment was 93.04 q/ha which was 40.5per cent higher than the untreated check. The second best control of MLB was recorded in Azoxystrobin + Tebuconazolesprayed at 3 days and 18 days after inoculation which resulted in 21.41 PDI with 56.9per cent disease control and 87.25 q/ha of yield.

AISDGONF/ABS/TD/51

Exploring natural resistance alleles and fruit colour mutants in tomato through marker assisted breeding

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The globally important vegetable crop tomato (*Solanum lycopersicum* L.) is a host for several diseases-pests, which often lead to a crop failure. Indiscriminate use of pesticides to combat this situation often leads to environmental and health hazards. Naturally, host's resistance mechanism needs to be explored to develop superior tomato cultivars suitable for natural farming. Interestingly, tomato gene pool contains several natural disease resistance alleles against the major diseases-pests, like leaf curl disease, root knot disease and late blight disease. However, breeding for developing multiple disease resistant tomato lines is difficult owing to the diversified nature of the pathogens and their optimum environmental condition to impart proper selection pressure. Fortunately, diagnostic molecular markers can help in environment independent, early generation selection of resistant lines. Moreover, natural mutant alleles of the genes involved in carotenoid

and flavonoid biosynthetic pathway in tomato lead to panoply of fruit pigment variation that can be explored for nutritional improvement of the crop. Here we report the development of pre-breeding lines with multiple disease resistance alleles through molecular marker assisted breeding. These lines are developed in the background of red and yellow fruited tomato genotypes. These lines are now being utilized as donor for the improvement of a red fruited and an orange fruited tomato genotype. Hence, this study documents the utility of molecular markers in improving fruit quality as well as multiple disease resistance traits in tomato.

AISDGONF /ABS/TD/53

Development of suitable IRM modules to manage the insect pests of chilli

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The experiment was conducted in the pre-*kharif* season during the months of January–June of the year 2021 at Palli Siksha Bhavana, Visva-Bharati, Sriniketan of lateritic zone of West Bengal, India. Six different modules having four IRMs, one non-IRM and an untreated control were evaluated against the insect pests of chilli var. 'Tejaswini. All the modules except untreated control received neem seed cake @ 6 q/ha during transplanting, carbofuran 3G @ 1 kg a.i /ha (20 DAT) as band placement and three sprays of insecticidesat 20 days interval from 35 DAT. Besides, Module 1, 2 & 3 additionally received seedling root dip treatment with imidacloprid 17.8 SL @ 25 g a.i./ha and one blue sticky trap/plot from 30 to 70 DAT. Again, Module 1 received mixture of insecticides during second spraying and Module 2 received Piperonil butoxide during each spraying of insecticides. All the IRM modules (1, 2, 3 & 4) received insecticides of different mode of actions while Non-IRM module received insecticides of same mode of action. Incidence of thrips, whiteflies, aphids and fruit borers (*Spodoptera litura* and *Helicoverpa armigera)*were recorded from 10 randomly selected plants per plot (5.0 x 5.0 m^2)at weekly intervals starting from oneweek after transplanting to harvesting of the crop. Fruit yield was calculated by cumulating the intermittent harvesting and finally incremental benefit cost ratio (IBCR) was analyzed. Experimental findings revealed that the IRM modules proved cost effective and were superior over Non-IRM (Farmer's practices). Module 2 composed of seedling root dip treatment with imidacloprid 17.8 SL, basal application of neem seed cake, band placement with Carbofuran 3G, installation of blue sticky trap and mixing of Piperonil butoxide @ 1 g^{-1} during spraying with Azadirachtin 3% @ 15 g a.i. $ha^{-1,}$ Broflanilid 20% SC @ 25 g a.i/ha andTolfenpyrad 15% EC @ 150 g a.i/ha found lowest populations of different chilli pests which resulted in higher fruit yield (62.33q/ha) and IBCR (2.59) than other modules.

AISDGONF /ABS/TD/56

If 'time' is the concern, it's time to adopt VPCR

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Polymerase Chain Reaction (PCR) has revolutionized the field of plant molecular breeding. In standard PCR, there are basically 3 temperature steps (denaturation at 94 ℃, annealing at a suitable temperature and extension at 72 ℃) having incubations in every temperature for ~30 to 40 s. Naturally, a 35 cycles' PCR takes around 2 h of time. Interestingly, a variant of PCR, termed as VPCR (V-shaped PCR) has been documented to amplify small amplicons through dynamic heating and cooling steps, where only two temperatures (i.e., 94 ℃ and 55 ℃) are used in cyclic manner with incubation for 0 s in both the steps. The time required to reach 94 ℃ from 55 ℃ is supposed to have sufficient *Taq*DNA polymerase activity to ensure amplification of the target genomic region. Thus, the time required to amplify a product through VPCR in thermal cycler comes down to ~30 min. Here we document the applicability of VPCR in genotyping of tomato lines using InDel markers with small (up to ~250 bp) amplicon sizes. The VPCR was effective in pure lines and hybrids of tomato and also worked properly with genomic DNA isolated by different rapid methods. As a proof of concept, VPCR was also applicable to other crops, when small amplicons were targeted.Thus, we advocate the adoption of VPCR in crop genotyping where the target amplicon sizes are small and the priceless input in research, i.e., time, is a constrain.

AISDGONF /ABS/TD/57

Multiplex PCR mediated identification of tomato segregants carrying *ty2, ty3* and *ph3* resistant alleles

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Production of tomato (*Solanum lycopersicum* L.) is jeopardized by the devastating disease leaf curl caused by tomato leaf curl virus (ToLCV) transmitted through white flies. Similarly, the fungal disease late blight caused by *Phytophthora infestans* becomes predominant in cold humid weather conditions. As the proper manifestation of the diseases can cause significant crop loss, development of resistant cultivars is considered the most sustainable eco-friendly approach. Presence of multiple natural resistance alleles in tomato gene pool has paved the way for developing multiple disease resistant tomato cultivars. Moreover, availability of diagnostic molecular markers has eased the breeding process by allowing precise selection of resistant segregants in an environment-independent manner and even in seedling stage. Here we report the identification of F_2 segregants carrying the *Ty2* and *Ty3* (for leaf curl disease) and *Ph3* (for late blight disease) resistance alleles derived from the cross combination Arka Samrat (F_1) x Kashi Chayan. In order to save time, labour and resources in marker assisted selection, a multiplex PCR strategy was optimized, which allowed the identification of allelic status at the aforementioned 3 loci through single reaction. Using this strategy we were able to identify 6 plants with *Ty2* and *Ty3*

genes in homozygous condition. One out of these 6 plants also carried the *Ph3* resistance allele in homozygous condition. Generation advancement and further morphological selection of these selected plants are supposed to give improved tomato genotypes and/or pre-breeding lines with natural resistance to leaf curl and late blight diseases.

AISDGONF/ABS/TD/60

Marker assisted identification of anthocyanin and lycopene rich tomato lines carrying resistance allele for root knot disease

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Breeding tomatoes with improved fruit pigments is a novel area of research targeting nutritional improvement of tomato. Although mature tomato fruits contain lycopene and to some extent β-carotene as the major fruit pigments, the natural gain-of-function mutation in the *Anthocyanin fruit* (*Aft*) gene results in anthocyanin accumulation in the fruit peels in a light dependent manner. Moreover, natural loss-of-function mutation in the *DEETIOLATED 1* (*Det1*) gene of tomato results in *high pigment 2* $^{dark\ green}$ ($hp2^{dg}$) phenotype, where the fruits hyper-accumulate the pigments. Interestingly, the *Aft* + $hp2^{dg}$ double mutant line 'purple tomato' has been documented to contain elevated levels of both lycopene and anthocyanin. Here, we report the utilization molecular markers to identify anthocyanin and lycopene enriched tomato lines carrying root knot nematode resistance allele *Mi1.2* in the segregants derived from of the cross combination IIHR 2614 x 'purple tomato'. For the identification of the single nucleotide polymorphism (SNP) resulting in the $hp2^{dg}$ allele, we employed the tetra primer amplification refractory mutation system (T-ARMS) primers. Similarly presence of the *Aft*mutant allele was detected through a co-dominant and dominant gene-based markers. The allelic status at the *Mi1.2* locus was analysed through Mi23 SCAR marker.Screening of 112 F_2 plants revealed the 11 plants carrying the $hp2^{dg}$ allele in homozygous condition. Allelic status of these 11 plants at the *Aft* and *Mi1.2* loci revealed the anthocyanin and lycopene rich lines carrying the root knot resistance allele. Generation advancement of these lines should generate root knot resistant nutritionally improved tomato genotypes.

AISDGONF/ABS/TD/64

Early generation selection of *Phomopsis* fruit rot resistant brinjal

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Brinjal (*Solanum melongena* L.) is the one of the major vegetable crops in India and world. Brinjal is affected by several diseases of which, *Phomopsis* blight and fruit rot caused by *Phomopsisvexans* is one of the most serious diseases causing high crop damage amounting to about 40-70%. There is need to develop resistant varieties. A cross of susceptible parent Muktakeshi and resistant parent Pant Samrat was done in this direction. The F_1s were selfed to

produce F_2 seeds. F_2 plants of the cross combination Muktakeshi × Pant Samrat were planted in the autumn-winter season of 2021-22 along with each of the *Phomopsis* susceptible parent Muktakeshi and *Phomopsis* resistant parent Pant Samrat. The fruits of these plants were artificially inoculated with pathogen under laboratory conditions, and fruits of 80 plants were found susceptible, while that of 59 plants were found to be resistant, suggesting complementary gene action for the governance. Among the resistant plants, twelve plants were identified as promising having high yield along with other good fruit and yield attributing traits. Advancing these plants will lead to *Phomopsis* resistant brinjal varieties.

AISDGONF/ABS/TD/65

Stimulatory effect of Ag nano- priming as pre-treatment factors on germination and vigour of carrot (*Daucas carota* L.)

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Carrot (*Daucus carota* L.) (2n=18) is one of the most important vegetable crop in India. The carrot is a biennial plant in the Apiaceae family. At first, it grows a rosette of leaves while building up the enlarged taproot. Soon after germination, carrot seedlings show a distinct demarcation between taproot and stem: the stem is thicker and lacks lateral roots. In terms of production area and market value, carrots rank among the top ten most economically significant vegetable crops worldwide (Fontes and Vilela, 2003). Carrot global production on 1.1 million hectares came close to 24 Mt in 2005. The most popularly traded carrot seed crop's overall global market value has been estimated to be in the neighbourhood of $100 million (Simon, 2000), although the real value is probably significantly higher. In 2020, world production of carrots (combined with turnips) was 41 million tonnes, with China producing 44% of the world total. Optimum seed germination is a prime condition in good stand establishment as seed is a fundamental factor in crop production. Nowadays, due to different environmental and abiotic stress, the percentage of seed germination, emergence, and vigour of seedling has been adversely affected, which ultimately results in poor crop yield. To enhance the seed germination process various physiological and non-physiological techniques are available for enhancing seed performance as well as to combat environmental constraints. Seed priming is a low cost effective hydration technique to stimulate seed germination. During priming, seeds go through a physiological process, i.e. controlled hydration and drying which results in enhanced and improved pre-germinative metabolic process for rapid germination. Seed priming can synchronize seed germination, and increase emergence. The present investigation has been carried out to evaluate influence of Ag-nanopriming for different physiological characters during 2021-22 at Seed Testing Laboratory, Department of Seed Science and Technology, F/Ag., BCKV, Mohanpur, Nadia, West Bengal with the following objective of assessment the response of nano-priming in germination, vigour and some other physiological parameters. Result indicated that significantly highest germination index, germination energy, germination percentage, vigour index and lowest mean germination time were recorded in T_3 (Ag Nanoparticle 20 ppm for 6 hr) for nano-priming. So, it could be considered as the best performer treatment considering its performance.

AISDGONF/ABS/TD/66

Evaluation of the effects of seed invigoration treatments with precursor PEG-6000 on quality performance of chickpea (*Cicer arietinum* L.)

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Chickpea is the highly nutritious crop among the pulses. By consumption of crops, it will provide the nutritional security of people as it is a good source of protein and carbohydrate and several essential minerals. Chickpea is slow germinating seed. But, osmo- priming is one of the low cost effective hydration techniques to improve seed germination. The present experiment was conducted in seed testing laboratory, Department of Seed Science and Technology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India during 2020-2021 season following Complete Randomized Design with three replications in order to standardize the best concentration and duration while soaking the seeds withinPEG-6000 solution for screening a range of duration concentrations viz. 10 g L^{-1} for 6 hours,10 g $L^{-1}$for 8 hours, 10 g L^{-1} for 10 hours ; 15 g $L^{-1}$for 6 hours , 15 g $L^{-1}$for 8 hours, 15 g $L^{-1}$for 10 hours; 20 g $L^{-1}$for 6 hours, 20 g $L^{-1}$for 8 hours, 20 g $L^{-1}$for 10 hours; 25 g $L^{-1}$for 6 hours, 25 g $L^{-1}$for 8 hours, 25 g $L^{-1}$for 10 hrs. Untreated dry seeds were considered as Control. It was observed that all the priming treatments showed significance difference in overall including the control. The best performer was shown by T_8 which is 20 g L^{-1}solution with the soaking duration of 8 hrs. It was highest performer in germination percentage (93.77), root length (6.57 cm), shoot length (16.57 cm), seedling fresh weight (1.66 g), seedling dry weight (0.14g), seedling vigour Index-I (2137.07), time to 50 % germination (2.33 days) and germination index (77.82). This study showed that seed priming with osmotic solution could improve some seedling parameters in chickpea seed. In seed priming, its simplicity such as no requirements for extensive equipment and chemicals could be used method for overcoming problems related to a poor germination and further seedling establishment and helps in sustaining agriculture with a cost effective approach.

AISDGONF/ABS/TD/67

Mapping yield-enhancing leaf area expansion ability of rice under low light

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Rice suffers significant yield loss, particularly in *kharif* season, due to low light intensity caused by overcast clouds and global dimming, and is worsened daily. Instead of ample photosynthetic plasticity at various growth irradiance, its mechanisms are not deciphered. Considering twenty-five diverse genotypes, the study identified leaf area expansion in lowlight intensity (400µmol$m^{-2}s^{-1}$ photosynthetic photon flux density, PPFD) reduces specific leaf weight (SLW) consequently, maintaining a high net photosynthesis rate by improving intercellular CO_2 concentration (Ci). Analysis of variance showed that 11%, 16%, and 37% of the total variance inassimilation rate at 400 µmol/m^2/s PPFD, (A400), SLW, and Ci were explained due to differences in growth irradiance. SLW and A400 plasticity in growth irradiance was associated with yield loss alleviation with R^2 values of 0.37 and 0.16, respectively. Thus, limiting specific leaf weight by increasing leaf area accompanied by increased Ci might have allowed rice genotypes to maintain a

high net photosynthesis rate per unit leaf area and high yield under shade.Associationanalysis between 7K SNP-genotyping dataand leaf-related traits of 130 RILs of a cross between Swarnaprabhax IR64identified a major QTL on chromosome one forthe leaf area (*qLAS1.1*) as well as leaf length (*qLLS1.1*) those explainedmore than 10% in two consecutive years. Another QTL associated with leaf width (qLWS9.1) under the shade with a PVE of more than 10%was located on chromosome nine. The genes on qLAS1.1 were tested for their shade responsiveness and two genes were predictedfor the area improvement in rice. The identified shade-responsive leaf area improvement QTLs will alleviate yield and photosynthesis loss under shade in rice.

AISDGONF/ABS/TD/69

Exploration of different diseases of lentil in West Bengal

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Lentil (*Lens culinaris*) is one of the important pulse crops grown in different parts of India. But every year its production is drastically reduced due to different fungal diseases in West Bengal. So, to explore these diseases, an experimentwas conducted at AICRP Fruits, Mondoouri, BCKV, Nadia, West Bengal during rabi season where a few important fungal diseases -leaf rust, fusarium wilt, collar rot and leaf blight and their causal organisms were identified. The leaf rust caused by *Uromyces* sp. produces rusty symptoms having dark yellow to brown in color on the leaf and producing numerous brown circular, thick-walled spores called Uredospore. Another important disease- leaf blight (*Stemphylium* sp.) is characterized by the blighted appearance from the leaf margin of older leaves. The pathogen produces multicellular dark brown to black conidia on multicellular vertical hyphae having both longitudinal and transverse septa. Collar rot, the most harmful disease is caused by *Sclerotium rolfsii*, causing wilting and drying of plants from seedling to maturity stage. This pathogen produces a hard, aggregated, dark-colored, bead-like resting body i.e., Sclerotia. Wilting is another important disease of lentil caused by *Fusarium* sp. produces various types of asexual spores - macro, micro and meso-conidia and resting structure-chlamydospore.

AISDGONF/ABS/TD/73

Performance of lentil genotypes and their screening for *Stemphylium* blight resistance in New Alluvial Zone of West Bengal

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Experiment was designed to screen out lentil genotypes against Stemphylium blight (SB) disease. Thirty-five test genotypes along with one moderately susceptible popular local check 'Moitree' were grown under natural epiphytotic condition in the farm of BCKV during 2020-21 and 2021-22. Genotypes wise crop phenological characters, yield and disease severity data were recorded. The effect of disease severity and different yield attributing characters on yield were studied. The result revealed, genotypes ILL10838/ILWL11/X2016S showed resistant reaction to SB produced highest yield (1184.00 kg ha^{-1}) followed by 8114/10956/16-1 (1112.20 kg ha^{-1}) and IPL 220(ch) (1072.90 kg ha^{-1}) and both showed MR reaction to SB. Among the morpho-phenological character

studied only the number of pods per plant was found to be correlated positively and significantly with the yield of the plant. Pooled analysis of two years experimental data used to develop the model Y=336.21+6.12x [R^2= 0.86] explained that there is an increase of yield 6.12 kg ha^{-1} with every one unit increase in the number of pods per plant proving the feasibility of the model. Considering the aspect of yield and disease reaction to SB it could be inferred that the lentil genotypes ILL10838/ILWL11/X2016S and 8114/10956/16-1 are the best suited for its cultivation under NAZ of WB and may scaled up for future breeding programme.

AISDGONF/ABS/TD/77

Identification of brinjal genotypes resistant to bacterial wilt

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Bacterial wilt caused by the soil born bacterium *Ralstonia solanacearum* has been identified as one of the most disturbing and widespread diseases affecting tomato, eggplant, chilli, and other solanaceous crops worldwide, resulting in significant yield losses. Additionally, many commercial cultivars are vulnerable to bacterial wilt, and there is no other efficient management technique for the disease and developing resistant varieties seems to be the best viable option. Screening of genotypes is the first step in resistance breeding to identify the resistant cultivars. In order to screen out suitable resistant sources for breeding programmes, this study was conducted in which fifteen diverse brinjal genotypes were screened against *Ralstonoiasolanacearum* by using artificial inoculation through axil puncture and leaf puncture method at Bihar Agricultural University, Sabour, Bhagalpur. Six genotypes *viz*., BRBL-04, BRBL-07, Pant Samrat, Muktakeshi, Haritha and IIHR-563 were found resistant to bacterial wilt with reaction percentage 3.00 to 8.66; five genotypes *viz*., BRBL-01, BRBL-02, Rajendra Baigan-2, 71-19 and BRBR-05 found moderately resistant with reaction percentage 12.82 to 20.38; two genotypes, i.e., BRBR-06 (24.68%) and Swarna Mani (21.06%) were found to be moderately susceptible and two genotypes VR-2 (75.32%) and Pusa Hara Baigan-1 (87.39%) were found to be highly susceptible to the disease. The resistant genotypes may be used in breeding programmes for developing bacterial wilt resistant varieties.

AISDGONF/ABS/TD/81

Performance of biointensive module against banana pseudostem weevil (*Odoiporus longicollis* Oliver)

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A field experiment was conducted to evaluate the performance of bio-intensive module for managing banana pseudostem weevil (*Odoiporus longicollis*), during September- November, 2017-19 at the C-Block Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal. Total seven treatments including an untreated control were replicated thrice adopting Randomized Complete Block Design. Treatments include T_1: *Beauveria bassiana* (1×10^7 spores/mL) @ 1.5 L/ha at 5th, 6th and 7th month after planting + stem trapping with *B. bassiana* @ 10 mL/trap (8.33 mL/ha) at 5th MAP; T_2: *Metarhizium anisopliae* (1×10^7 spores/mL) spray @ 1.5

L / ha at 5th, 6th and 7th MAP + stem trapping with *B. bassiana* @ 10mL / trap (8.33 mL/ha) at 5th MAP; T_3: *Heterorhabditis bacteriophora* @ 1×10^9 IJs/ha at 5th, 6th and 7th MAP; T_4: Stem trap with *B. bassiana* @ 10 mL/trap (8.33 mL/ha) at 5th MAP; T_5: Stem trap with *H. bacteriophora* @ 1×10^9 IJs/ha at 5th MAP; T_6: Chlorpyriphos 20EC @ 2.5 L/ha at 5th, 6th and 7th MAP and T_7: Untreated control. Based on pooled data, the maximum reduction of severity of infestation over control to the extent of 77.1% was achieved in the T_1. The growth and yield attributes of the banana cv. Kanthali were also recorded maximum in T_1. Further, the incremental cost benefit ratio (1:14.35) also suggests the economic feasibility of T_1. Hence, the treatment module has the potential to be evaluated further through multi-location trial and on farm demonstration for inclusion in the IPM schedule of weevil management in banana.

AISDGONF/ABS/TD/82

Appraisal of native isolates of fluorescent pseudomonads against wilt diseases of brinjal

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Brinjal (*Solanum melongena* L.) is one of the most common vegetable crops grown in tropical and subtropical regions of the world. Brinjal cultivation is affected by various pest and diseases. The soil borne diseases like fungal and bacterial wilts, caused by *Fusarium oxysporum* f. sp. *Melongenae* Schlecht and *Ralstonia solanacearum* (Smith) Yabuuchi *et al.*respectively are considered as serious constraints for the Brinjal cultivation in India. Although chemicals are widely used to control these diseases, the use of toxic, carcinogenic and environmentally harmful chemicals is discouraged due to increasing health and environmental safety concerns. In this context, biological control is an alternative and environmentally friendly strategy for sustainable management of these economically important diseases. The bacterial antagonist belonging to *Pseudomonas spp.* is well documented for their antagonistic abilities against different diseases under diverse pathosystem. Under the present investigation two isolates of Fluorescent Pseudomonads (FLPs) *viz.*, FLP-Brinjal 2020-1 and FLP-Brinjal 2020-2, were evaluated against these major wilt causing pathogens of brinjal *viz.*, *Fusarium oxysporum* f.sp. *melongenae* Schlecht and *Ralstonia solanacearum* (Smith) Yabuuchi et al. under *in vitro* condition using dual culture and inverted plate assay. Under dual culture assay, FLP-Brinjal 2020-2 gave maximum inhibition over the control followed by FLP-Brinjal 2020-1 against all the pathogens. Further FLP isolates were evaluated for their efficacy under *in vivo* condition. Experiments conducted in pluck trays indicated that FLP-Brinjal 2020-2 was superior with maximum germination percentage (63.75%), vigour index (650), disease control percentage (58.66%), biocontrol efficiency, plant growth (10.20 cm) and minimum disease incidence (%) (20.62%) against bacterial wilt.Similarly, under brinjal-fusarium wilt experiment maximum biocontrol efficiency, plant growth (11.20 cm) and minimum disease incidence (%) (24.81%) among the fusarium challenged treatment was found with FLP-Brinjal 2020-2.

AISDGONF/ABS/TD/83

Genetic diversity, association and principal component analysis of some khesari (*Lathyrus sativus)* genotypes in North Bengal

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An experiment was carried out in the "Agricultural Research and Instructional Farm" in Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch-Behar in 12 genotypes (11 land races and 1 released variety Prateek) of khesari (*Lathyrus Sativus*). 16 quantitative and qualitative DUS descriptors were taken for investigation to find out the genetic variability, diversity, association and principal component analysis of the characters for future crop breeding programme among which 11 physiological characteristics were found to be significant in the mean square of analysis of variance. Days to 50% flowering, plant height, leaf length, pods per plant, seeds per plant, seed index, root length, biological yield per plant, yield per plant, and ODAP were the traits studied. In genotypic correlation study, leaf length, branches per plant, pods per plant, seeds per plant, 100 seed wt. and yield per plant were found to have high positive correlation with biological yield per plant. In GCV, heritability and GAM parameters, root length, ODAP content and biological yield were investigated and considered for effective selection of this crop. PCA analysis revealed the highest value of PCA loading in 100 seed weight, leaf length, pod width, leaf length, biological yield per plant, and yield per plant according ascending order of values for contribution as found by PCA analysis. It indicates maximum variability on 100 seed wt., leaf length, pod width characters in the chosen 11 characters of the genotypes in this region. In dendrogram analysis, Dhupguri local 3, Pundibari 2, Pundibari 4, Pundibari 5 and Coochbehar local were found to be genetically closely related than others. In case of selection, leaf length, pod length, number of seeds per pod, 100 seed wt. can taken into consideration for their influence on biological yield per plant. ODAP and yield per plant, root length can be taken as defining characters for selection due to their high heritability and medium genetic advance with mean for crop improvement programme. Crossing programme between genotypes of different groups should be taken for future breeding programme.

AISDGONF/ABS/TD/89

Standardization of seed germinability of *Solanum torvum* using different concentration of GA3

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To control the bacterial wilt disease of brinjal, a wild variety called *Solanum torvum* has been used as a resistant rootstock for grafting of eggplant. But the intrinsic poor seed germinability of *S. torvum* prevents it from being used as a resistant rootsock. This study aimed for improving seed germination of *Solanum torvum* by using different combinations of GA_3 (Gibberellic acid) concentrations (250- 1000 ppm) and alternating temperatures (15-30°C) for various periods. GA_3 concentration of 1000 ppm and hot water treatment was found to be more effective in enhancing

seed germination than those of 500 and 250 ppm GA_3.The highest germination 90% was obtained by treating seeds with hot water at 50°C for 25 minutes followed by 24 hours soaking of seeds in 1000ppm GA_3. Germinated seeds were stored at 5°C and 10°C for 5, 10, 15 and 20 days on wet Whatman papers. The seed germination test was conducted after each storage combination. Germinated seeds had high germination at 5°C after 5 and 10 days of 86% and 90% respectively. Longer storage of germinated seeds reduced germination percentages to 62% at 5°C, and 60% at 10°C by 20 days. Seedling emergence percentages were also high (90%) after storage at 5°C for 10 days as those germinated and not stored. Results indicated that GA_3 is promoting effect of germination.

AISDGONF/ABS/TD/90

Effect of different pre and post emergence herbicides in *rabi* maize

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Maize (*Zea mays* L.) is being considered as "Queen of cereals" because of its carbon pathway (C_4), wider adaptability, higher multiplication ratio desirable architecture, superior transpiration, high rate of photosynthetic activity, higher grain yield and biomass potential. An experiment was conducted at kalyani D-Block Farm under BCKV, Mohanpur, Nadia district during *rabi* season of 2018, which was laid out in randomized block design with 12 treatments replicated thrice, *viz*., T_1 : Atrazine 1.0 kg/ha PE *fb* HW at 40DAS, T_2 : Atrazine + Pendimethaline (0.50+0.25 kg/ha) PE, T_3: Atrazine 1.0 kg/ha PE *fb* 2,4-D 1.0 kg/ha LPoE, T_4: Atrazine + Pendimethaline (0.50+0.25 kg/ha) PE *fb* 2,4-D 1.0 kg/ha LPoE, T_5: Topramezone 25.2 g/ha EPoE, T_6: Tembotrione 120 g/ha EPoE, T_7 : Topramezone 25.2 g/ha EPoE*fb* IC + HW at 40DAS, T_8: Tembotrione 120 g/ha EPoE*fb* IC + HW at 40DAS, T_9: Topramezone+Atrazine (25.2+500 g/ha) EPoE*fb* IC + HW at 40DAS, T_{10}: Tembotrione +Atrazine (120+500 g/ha) EPoE*fb* IC + HW at 40DAS, T_{11}: IC + HW at 20 and 40DAS, T_{12} : Weedy check. Application of Topramezone+Atrazine (25.2+500 g/ha) EPoE*fb* IC + HW at 40DAS significantly recorded the highest growth attributes *viz*., plant height, DM accumulation, LAI, CGR; yield attributes *viz*., Cob length (16.8 cm), cob girth (15.6 cm), grains cob^{-1} (432.7), 1000 grain weight (237.4 g); grain (7.22 t ha^{-1}) and straw yield (12.5 t ha^{-1}). Among different treatments, application of Topramezone+Atrazine (25.2+500 g/ha) EPoE*fb* IC + HW at 40DAS was found to be the best recording highest weed control efficiency (86.8%), crop productivity and B:C (2.26) through weed management in maize.

AISDGONF/ABS/TD/93

Biochemical characterization of rice genotypes against leaf folder *Cnaphalocrocis medinalis* Guenee

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A laboratory experiment was carried out at ICAR-National Rice Research Institute, Cuttack to assess the reaction of different categories of Odisha landraces *viz.*, resistant, moderately resistant and susceptible categories in response to the infestation by rice leaf folder (RLF), *Cnaphalocrocis medinalis* (Guenee) and to explore the possible use of these genotypes in developing leaffolder-resistant rice varieties. Various biochemical constituents such as soluble protein, phenol, total soluble sugar and enzymes *viz.*, peroxidase, polyphenol oxidase and catalase were assessed spectrophotometrically in all the infested and uninfested landraces. The biochemical components such as phenol has been increased along with enzyme activities of peroxidase (POX) and polyphenol oxidase (PPO) in the infested and resistant category rice genotypes along with standard resistant check TKM6. Likewise lower level of protein and sugar content was observed in all infested and resistant rice varieties whereas substantially higher level has been found in uninfested and susceptible category as well as in susceptible check TN1. The catalase activity was high in uninfested and resistant genotypes as compared to infested and susceptible category. It is evident from the study that the content of metabolite such as phenol was negatively correlated with leaf folder damage. However, soluble protein and total soluble sugar content was positively correlated with the damage by RLF. The present investigation supports that the elevated levels of compounds like phenol and enzymes like PPO, POX and catalase may play a vital role in rice resistance to leaffolder.

AISDGONF/ABS/TD/96

Field efficacy of novel formulated emulsifiable concentrate of essential oil and azadirachtin against insect-pests on *kharif* rice

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West Bengal ranks second in area and first in production of rice in India. A critical analysis of the gap between the potential and actual rice yields, insect-pests contribute substantially to yield loss in rice production and productivity. The yellow stem borer, leaf folder and whorl maggot are the important insect-pests on rice. An experiment was conducted on rice crop (cv. *Swarna*, MTU 7029) during three successive *kharif* seasons, 2018 to 2020 at the Rice Research Station, Chinsurah, Hooghly in RCBD layout with three replications to find out the most effective essential oil formulation in alone and in combination with azadirachtin to minimize the pests by developing a good bio-intensive pest management practice in rice. The trial was set with all recommended package of practices and 11 treatments; foliar sprays of new formulated turmeric (T_1), holy basil

(T_2), eucalyptus (T_3), garlic (T_4) essential oil each @ 5 ml litre^{-1}, azadirachtin 0.3% (T_5) @ 5 ml litre^{-1} of water and tank mix of T_1+T_5 (T_6), T_2+T_5 (T_7), T_3+T_5 (T_8), T_4+T_5 (T_9), cartap hydrochloride 50% SP (insecticidal check) @ 1.0 g litre^{-1} of water (T_{10}) and control (T_{11}). The novel emulsifiable concentrate formulation of essential oil and azadirechtin were prepared by mixing with glycerol and tween-80 in the proportions of 1:2:2. The foliar sprays were done on 40 and 50 DAT. The three years pooled data analysis indicated that the lowest pest infestation was observed in T_9 treatment (1.02% WM, 0.38% LF, 1.66% DH, 2.06% WE) and also obtained the highest grain yield (6389 kg ha^{-1}) with incremental benefit cost ratio (IBCR) of 2.15. The cartap hydrochloride insecticide (T_{10}) application proved the next best performance against leaf folder and stem borer (0.55% LF, 2.79% DH, 4.04% WE), obtaining the next highest grain yield (5861 kg ha^{-1}) with the highest IBCR of 22.22. The T_7 treatment effectively managed all the test insects (1.38% WM, 0.55% LF, 1.98% DH, 2.65% WE) obtaining 6269 kg ha^{-1} grain yield. Among the treatments, the garlic essential oil treatment (T_4) was calculated the highest IBCR of 3.32.It may be concluded and recommended that the foliar sprays by tank mix of novel formulated garlic essential oil @ 5 ml litre^{-1} + azadirachtin 0.3% @ 5 ml litre^{-1} of water at 40 and 50 DAT in *kharif* rice can manage effectively the whorl maggot, leaf folder and stem borer as well as to obtain the highest grain yield.

AISDGONF/ABS/TD/97

Assessment of different weed management practices for increasing the yield of groundnut in farmer's field of Howrah district of West Bengal

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Though Howrah district is basically known for various small-scale industries, but it has a predominant contribution in agriculture in terms of crop diversity and cropping sequences. During summer season, groundnut is one of the major oilseed crops mainly cultivated in Amta-I, Udaynarayanpur and Jagatballavpur blocks of the district. Groundnut (*Arachis hypogaea* L.) is highly susceptible to various weeds and managing this weeds become the prime challenge to the farmers in its initial stages as weed may reduce the yield up to 15-75%. In gangetic alluvial soil of West Bengal *Cynodon dactylon, Chenopodium album, Cyperus rotundus, Euphorbia hirta, Digitaria arvensis, Acalypha indica, Dactyloctenium aegyptium, Tridax procumbens, Digitaria sangunalis, Eclipta alba, Amaranthus viridis, Eleusine indica, Panicum repens, Trianthema portulacastrum, Phyllanthus niruri* and *Achyranthus aspera* were the predominant weed species of groundnut fields in this region.Therefore, identifying the proper weed management becomes the need of the hourin terms of maintaining productivity and maximizing profitability of the crop.Farmers of the locality mainly depend on hand weeding which is very costly affair and reduce the net returns. Keeping this in view, a field experiment was conducted during the summer season of 2019 to 2021 at different farmers' field of Howrah district to study the best weed management practices for controlling the weeds, increasing the pod yield of groundnut and ultimately maximizing the profit. Pendimethalin as pre-emergence herbicide were tested in three different combinations as different technology options with post-emergence herbicide imazethapyr and with quizalofop-p-ethyl along withfarmers' traditional hand weeding practice as control. The experiments were conducted in seven farmers' field each year as replication and the groundnut

variety chosen for the study was Dharani (TCGS-1043). From the experiment it is revealed that pre-emergence application of pendimethalin 0.75 kg ai/ha and in integration with post-emergence application of imazethapyr 10 SL 75 g ai/ha at 20-30 DAS was most effective in controlling the weeds and as well as improving the pod yields (3.35, 3.30 and 3.25 t/ha in three years, respectively) of groundnut with higher Weed Control Efficiency and highest B:C ratio (2.58,2.40 and 2.19). Therefore, after consecutive three years of this on farm trials in farmers' field it can be concluded that, this herbicide combination of pendimethalin along with imazethapyr could became the most effective and economic weed management practices for groundnut for the farmers of West Bengal. The technology became popular among the neighbouring farmers and included in the action plan as FLD for large scale demonstration.

AISDGONF/ABS/TD/101

Population dynamics of pests infesting stored garlic emphasizing garlic mite, *Aceria tulipae* (Acari: Eriophyoidea)

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Garlic (*Allium sativum* L), a member of the Amaryllidaceae family, is one of the most aromatic herbaceous annual spices (Kurian, 1995). Garlic is attacked by a number of insect pests in the field as well as in storage. Some important major pests of garlic are leaf minor, thrips, onion maggot, dry bulb mite, *A.tulipae*, Garlic bulb mites (*Rhyzoglyphus spp*., *Tyrophagus spp*.), Garlic fly (*Suilli aluaida*), in stored condition *Ephetsia* infestation is very important. Apart from insects pests are also very important like mites and nematodes. The present research work deals with the following objectives: to record the arthropod species occur in indigenously stored garlic of West Bengal, to re-describe the dry bulb mite, *Aceria tulipae* Keifer infesting stored garlic and to study on the population dynamics of garlic mite, *Aceria tulipae* infesting stored garlic. The arthropods found on stored garlic were recorded during March, 2018 to February, 2019 in West Bengal were garlic mite, *Aceria tulipae*, Acarid mite, Cheyletid mite and Almond moth, *Ephestia cautella* (Walker). Among the pests, *Aceria tulipae* (Keifer) appeared in larger number. It can be concluded from the taxonomic study that the specimens collected from stored garlic of West Bengal are of *A. tulipae*, although there is remarkable variation in lengths of proximal setae on coxisternum III (3a), Opisthosomal setae (e) and Opisthosomal setae (f). It appears from the present investigation that the garlic mite, *Aceria tulipae* is not the exceptional species but follow the general nature of its kind.

AISDGONF/ABS/TD/105

Isolation, in-silico study, expression analysis and promoter characterization of calmodulin-lysine n-methyltransferase gene (*OsCAM KMT*) from *indica* rice cultivar

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The transgenic approach offers a suitable alternative to conventional breeding, using genes involved in several stress tolerance that have been widely adopted in crop plants to enhance stress tolerance. Thus, the identification and characterization of those genes and their regulatory elements involved in modulating their expression are an important requisite to developing stress-tolerant crops. Earlier studies reported the involvement of Calmodulin (*CaM*) genes in several stress tolerances. The protein calmodulin-lysine N-methyltransferase (CaM KMT) belongs to the lysine methyltransferases family of proteins that apparently methylates lysine present at 116 position in the protein sequence of calmodulin in most species, which is likely to affect its functioning. As it was not characterized in rice, in the present study rice calmodulin-lysine N-methyltransferase (*OsCaM KMT*) gene has been isolated from an *indica* rice variety 'Swarna'. Characterization of the gene has been done through several in-silico approaches such as the construction of a phylogenetic tree to show the evolutionary relationship with other species, motif analysis along with comparative protein modelling to find out the structural relationship with other species, analysis of various transcription factor binding sites in the promoter region, and also for identification of several putative microRNA (miRNA) targeting the (CDS) and UTR region of *OsCaM KMT* gene. Gene expression analysis revealed the highest transcript expression in the root tip followed by the flower, new leaf, and least in the old leaf. Histochemical GUS detection of transgenic rice depicted strong *OsCaM KMT* promoter expression in midribs, stomata, and the tip of leaf tissues, central cylinder as well as tip parts of the main root and lateral roots, along with significant expression in pollen grains, ovary, and vascular bundles.

AISDGONF/ABS/TD/106

Impact of salt stress in black and white rice genotypes at physiological and biochemical level

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Among all the abiotic stresses,salt stress is one of the most predominant stress.According to researchers, every year around 10% more land becomes salinized and by 2050, about 50% of the world's arable land will be affected by salt stress. Rice grain quality and its yield are severely affected by salt stress. Among all the other growth phases of rice, the vegetative and reproductive stages are mostly affected. In the presentstudy thephysio-biochemical response of local land races and modern cultivars have been studied under salts tress.Salt tolerance levels and physiological changes in response to salinity stress at 100 mM and 200 mMNaCl were assessed in twenty rice genotypes comprising twelve whiterice, four brown rice and three black glutinous rice cultivars

during their early seedling stage. Under salinity stress, most of the studied ricecultivars demonstrated a decline in growth parameters and chlorophyll production; conversely an increase in the level of hydrogen peroxide, proline and peroxidase activity levels has beenobserved for most of the genotypes.DAB and NBT staining of different cultivar was evaluated which helped us to detect the hydrogen peroxide accumulation and reactive oxygen species level in susceptible and tolerant varieties. Several calcium signaling genes like calmodulin (CaM), calcium dependent protein kinase (CDPK), calmodulin like protein (CML) and calcineurin-B like proteins (CBL) were found to play essential role in salt stress signaling and further expression studies on these genes are needed among the susceptible and tolerant cultivars to unravel calcium signaling under salt stress in a better way.

AISDGONF/ABS/TD/115

The role of quick photo-protection recovery genes in yield loss alleviation of rice

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The main goal of rice breeding in eastern India is to reduce the yield gap between the *kharif* and *boro* seasons, where low and fluctuating light is the major hindrance to yield enhancement owing to severe photo-inhibition due to non-photochemical quenching (NPQ). Photo-protection and its recovery refer to how quickly the crop can revert to its original rate of photosynthesis and NPQ, after experiencing photoinhibition due to high light intensity (>1500µmolem^{-2}s^{-1}) for a period. The study compared the transcript availability of three photo-protecting genes, PSII core enzymes (*PsbS1*), Violaxanthin de-epoxidase (*VDE*), and Zeaxanthin epoxidase (*ZEP*), in two pairs of genotypes with the contrasting photo-protection recovery times. The comparison of the nucleotide sequence between the two genotypes identified a long stretch of In/Del sequence in *VDE*-intron, but no polymorphism was observed in *PsbS1* and *ZEP*. However, either following In/Del or SSR-based polymorphism near-isogenic lines (NILs) were developed for three allelic pairs of *PsbS1*, *VDE*, and *ZEP* genes of a contrasting pair N22 and IET25701. Violaxanthin and Zeaxanthin were quantified in HPLC to confirm the superior performance of the corresponding alleles in NILs. Additionally, 7K SNP-based genotyping of NILs confirmed more than 99% similar backgrounds among the NILs. The N22-*ZEP* allele containing NIL significantly alleviates yield loss under low light, whereas the *VDE* allele of IET25701 alleviates yield loss under fluctuating light. These findings may provide further insight into using these alleles with good photo-protection recovery in rice breeding programs.

AISDGONF/ABS/TD/117

Fusarium wilt of isabgol (*Plantago ovata* Forsk.) and its management studies: A review

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Fusarium is a soil borne pathogen causing heavy losses in the crop production. Long term survival of pathogen in the soil as chlamydospores has increased its threat making for devastating wilt problem in various crops. *Fusarium* mediated fungal wilt in isabgol (*Plantago ovata* Forsk.) has been considered as one of the economically important disease in India. The primary symptom of Fusarium wilt is characterized by discoloration of the vascular tissue which mostly starts from the ground and expands ascending to the aerial parts, wilting the stem and leaves, sometimes followed by leaf abscission, finally leading to plant death. In this scenario, chemicals management somehow got appreciation to minimize the economic loss. But in contrary, injudicious application of chemicals having residual effects on associated beneficial microbiota in soil and contributing the source of environmental pollution gets augmented severely. To overcome these obligations, using eco-friendly sustainable management strategies (microorganisms and organic amendment) has proved to be useful in plant growth promotion and protection against *Fusarium* wilt in isabgol.

AISDGONF/ABS/TD/120

Development of salt tolerant rice through genetic engineering approach to bring food security in Bangladesh

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The staple food rice is grown mostly in tropical and subtropical locations and feed for more than half of the world's population. Salinity is one of the most important limiting factors for rice production. BRRI Dhan28 and BRRI Dhan 29 are the most widely grown rice in Bangladesh, including the coastal regions. *Agrobacterium*-mediated transformation of Na+/H+ exchanger 1 (NHX1) gene isolated from *Vigna radiata* was transformed in these varieties using in-planta approach. The embryonic portions of matured de-husked rice seeds were injured using a sharp needle and incubated in N6 re-suspension media containing acetosyringone (150µM) and *Agrobacterium* strain (OD 0.5) containing *VrNHX1* gene at 35°C temperature for three days. After regeneration transgenic plantlets showed GUS positive result 3.39±0.28% and 2.74±0.35% for BRRI Dhan28 and BRRI Dhan29 respectively. Appropriate band sizes of PCR products of GUS and target genes confirmed the transgenic plantlets. Data analysis of RT-qPCR (using genes specific primer) results showed successful expression of transgenes. Under salinity stress, T_2 transgenic lines showed higher chlorophyll, relative water content, and decreased electrolyte leakage, proline content, lipid peroxidation level, and catalase enzyme activity which represent better physiology than control plants. Moreover, under salinity stresses in the field, the transgenic lines showed superior physiology over control plants up to 250 mM salinity condition and

produced a significant level of rice grains. In this research, ectopic expression of *VrNHX1* gene in recalcitrant *indica* varieties showed high level of salinity tolerance which could bring food security by bringing uncultivable land under cultivation.

AISDGONF/ABS/TD/123

Nutritional and anti-oxidant study of sprouts and microgreens in selected lentil germplasms

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Lentil (*Lens culinaris* Medik.) is a globally important pulse crop, which is generally consumed as *dal* (boiled soup) by people from all diet groups. Besides these, lentil is also consumed as sprouts and microgreens nowadays because of its outstanding nutritional significance. An experiment was designed tostudy the biochemical profiling of tender sprouts and microgreens from the selectedlentil varieties. Several nutritional parameters like total soluble sugar, total soluble protein, crude fibre, ascorbic acid and minerals like Na, K, P, S, Zn, Fe, Cu, Ca, Mg and Mn were taken into consideration. Moreover, phytochemicals like total phenol, tannin; anti-nutritional factors like saponin, phytic acid were estimated. Anti-oxidant activity was also estimated by DPPH radical scavenging assay. The outcomeof this experimentrevealed a significant difference in terms of biochemical constituents. Upon correlation for finding lineage among the biochemical parameters, few significant correlations were found. Especially protein and few mineral contents were found to be significantly improved than normal seeds. There are scopes for studies for enzymatic activity, vitamin content, phenolic profile, ABTS and FRAP anti-oxidant assay.

AISDGONF/ABS/TD/127

Effect of herbicides on mixed weed flora and productivity of transplanted winter paddy (*Oryza sativa* L.)

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A field experiment was conducted during the *kharif* season of 2018 and 2019 at the Instructional farm, Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia, West Bengal, India ($22^0$56'N and $86^0$48'E, 9.75m above mean sea level) to assess the relative efficacy of several herbicides in transplanted winter rice. Experiment was laid out in Randomized Block Design with ten treatments including one hand weeding (HW) at 40 DAT with application of either pre-emergence [pyrazosulfuron ethyl and bensulfuron methyl+pretilachlor at 2 days after transplanting (DAT)] or post-emergence [bispyribac sodium and bispyribac sodium+penoxsulum at 20 DAT] herbicides; application of both pre-emergence and post-emergence herbicides; two HW (at 20 and 40 DAT) and weedy check, replicated thrice with the plot size of 4m×5m each. Variety 'Satabdi' (IET-4786) was transplanted with the recommended dosage of N:P_2O_5:K_2O @ 60:30:30 kg/ha. HW twice recorded significantly lowest weed density and biomass and registered highest weed control efficiency (%). The ready-mix herbicide bensulfuron methyl 0.6%+pretilachlor 6% at 2 DAT with

one HW at 40 DAT registered comparatively better performance than other herbicides in controlling weeds and recorded higher grain and straw yield (3.76 and 4.69 t/ha, respectively), which were statistically at par with the HW treatment (3.88 and 4.71 t/ha, respectively), and recorded the lowest weed index (1.63%) among all the treatments. Hence, application of bensulfuron methyl 0.6%+pretilachlor 6% @ 0.66 kg a.i./ha (2 DAT) with HW (40 DAT) may be suggested for better weed control and higher productivity which can easily replace the tedious and lingering HW (twice) practice.

AISDGONF/ABS/TD/135

Chemical weed management in chickpea (C*icer arietinum* L.) by imazethapyr under lateritic belt of West Bengal

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A field experiment was conducted at the Agricultural Farm of Palli Siksha Bhavana, Visva-Bharati during *Rabi* 2020–21 to study the effect of chemical weed management in chickpea (*Cicer arietinum* L.) by imazethapyr under lateritic belt of West Bengal. The experiment was laid out in randomized block design with nine treatments and replicated thrice. The treatments were - pre-emergence application of imazethapyr at different doses viz., 30, 40, 50 gha^{-1}, post-emergence application of imazethapyr at different doses viz., 30, 40, 50 gha^{-1}, pre-emergence application of pendimethalin 750 gha^{-1}, weed free check and weedy check. The results revealed that among the different weed management practices, weed free check recorded maximum weed control efficiency, crop growth parameters, yield attributes and yield. However, considering the labour scarcity and economical viability, pre emergence application of pendimethalin 750 g ha^{-1} resulted better weed control as well as higher productivity and profitability of chickpea under lateritic belt of West Bengal which was closely followed by post-emergence application of imazethapyr at 50 g ha^{-1}.

AISDGONF/ABS/TD/142

Present status of wheat diseases prevalent in *Indo-Gangetic* plains of West Bengal

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Owing to climate change, the disease dynamics have been altered across important wheat growing belts of our country. Considering the importance of wheat in West Bengal, a survey was conducted across different districts of the state in the year 2019-20 and 2020-21 for monitoring the present status of foliar diseases of wheat. In the year 2019-20, seven locations across two districts, Nadia and Murshidabad, were surveyed while twenty locations across six districts were surveyed in the following year. In 2019-20, high spot blotch severity (43.21) was observed in four locations of Nadia district, while Karimpur of Nadia (24.69) and Jalangi in Murshidabad district recorded lower severity (24.69). Highest leaf rust severity score was recorded in Jalangi, Murshidabad (100 S), while lowest severity was observed in Karimpur Parisha in Nadia district (20 S). In 2020-21, highest spot blotch severity (68 DD score) was recorded in two locations (Jalangi, Dhanirpur-

Bhaduripara) of Murshidabad district, while lowest disease severity (24 DD score) was observed in Bara Aduliya (Krishnanagar) of Nadia. Highest rust severity (80 S) was observed in Nadia District while lowest severity (20 S) was recorded in four locations of Nadia (Bara Aduliya, Krishnanagar, Magurakhod, Bhajanghat), one in Birbhum (Tarapith) and Murshidabad (Raninagar). Pathogen identification revealed rust pathotype 77-9 (121R60-1) to be the most abundant in both the consecutive years, while isolate BS7 of *Bipolaris sorokiniana (*Accession no. MT804348) was found to be the most aggressive among the isolates collected. The identified pathotypes can be used further for screening of genotypes.

AISDGONF/ABS/TD/146

Development of autotetraploids via *in vitro* colchicine treatmentin gerbera for improved floral traits

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Gerbera (*Gerbera jamesonii* Bolus ex Hooker f.), commonly known as African daisy, is one of the important cut flower plants (family Asteraceae). It is fetching good market value owing to its array of flower colours and long vase life. Polyploidisation can be a way of creating variability in the germplasm of a species for its genetic improvement. A protocol was thus developed for development of autotetraploids via *in vitro* colchicine treatment. Two-week-old *in vitro* regenerated shoot tips were treated with different colchicine solution (0.1%, 0.25% and 0.5%) for 4 h, 6 h, 8 h and 12 h and cultured in Murashige and Skoog (MS) medium fortified with 1.5 mg/l *meta*-Topolin and 1.5 mg/l indole-3-acetic acid (IAA) for shoot and root formation, respectively. Highest percentage of tetraploids were obtained when shoot tips were treated with 0.1% colchicine solution for 4 h. The induced tetraploids were confirmed via flow cytometry analysis and metaphasic chromosome count followed by morphological observations and biochemical analysis. The tetraploids showed delayed fresh shoot initiation, longer but fewer shoots with darker and broader leaves when compared to the diploid ones. From the stomatal study, it was observed that the tetraploids have fewer and larger stomata with more number of chloroplasts as compared to their diploid counterparts. The tetraploids also recorded higher chlorophyll, anthocyanin and carotenoid contents in comparison to the diploids. The tetraploids plants developed larger flower than the diploid ones thereby showing enhanced floral traits and thus validating the protocol for having high commercial value.

AISDGONF/ABS/TD/147

Meta-topolin induced accelerated *in vitro* mass propagation of stevia (*Stevia rebaudiana* Bert.) and its fidelity assessment

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An accelerated, efficient and novel *in vitro* mass propagation protocol was successfully established in stevia (*Stevia rebaudiana*), popularly termed as "candy leaf" or "sweet leaf". It is well recognized for its potential source of natural sweetening compounds (steviol glycosides) and grabs commercial attention in the recent past. However, traditional propagation comes up with several limitations like poor seed setting and germination. In that context, *in vitro* mass propagation via direct regeneration and potential value addition in stevia demands a critical appraisal to meet the requirements of growers and pharmaceutical industries. The disinfected stevia shoot tip explants were inoculated in Murashige and Skoog (MS) medium supplemented with different plant growth regulators (PGRs) *i.e.* 6-benzyladenine, kinetin, *meta*-Topolin (*m*T), thidiazuron, zeatin, indole-3-acetic acid, indole-3-butyric acid (IBA), α-naphthaleneacetic acid in variable concentrations (0.5-1.5 mg/l) along with control (PGR-free) for assessing their effect on multiple shoot and subsequent root formation of stevia. The MS medium with higher concentrations of *m*T resulted in higher number of *de novo* shoots and leaves as well as with longer shoots compared to other PGRs within four-week growth period. During *in vitro* rooting, IBA at 1 mg/l produced maximum and longer roots compared to other PGRs. The *in vitro* regenerated plantlets were successfully acclimatized (95% survival) in sand followed by the sand-soil. The flow cytometry analysis confirmed stability of ploidy level of the *in vitro* regenerants and molecular marker-assisted genetic fidelity assessment using inter simple sequence repeats (ISSR), start codon targeted (SCoT) polymorphism, conserved DNA-derived polymorphism (CDDP), and directed amplification of minisatellite-region DNA (DAMD) primers exhibited monomorphic banding patterns ensuring genetic fidelity within the acclimatized plantlets and with the mother plant. The high-performance liquid chromatographic (HPLC) analysis of acclimatized stevia plantlets produced higher amount of rebaudioside-A in comparison to the mother plant. The present study is first one of its kind using novel cytokinin (*m*T) for large-scale mass propagation of stevia within less time span (4 weeks) ensuring genetic fidelity as well as improving the rebaudioside-A content.

AISDGONF/ABS/TD/149

Genome wide association studies for mapping and identification of novel cold tolerance qtls in rice

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The adaptability of rice in diverse environments is higher than most cereals till it demands more abiotic stress tolerance improvement for augmenting productivity as it is a staple food of the world's fifty percent population. The cold stress, $<15^0$C over a week at the seedling or grain filling stage, hampers the yield significantly. In India, approximately 4 million ha of dry-season photoperiod insensitive rice encounters a month of a cold period in the nursery bed. Unlike *japonica* rice, most of the *indica* germplasm lack seedling cold tolerance resulting in a longer period in the nursery bed and expanding the total duration; finally, farmers failed to harvest the yield potentiality of the varieties. Most of the earlier works identified the tolerance genotypes based on better germination percentage in cold, although farmers experience slow shoot length increases due to cold environment. Three rice landraces were identified as the seedling-cold tolerant due to their >87% mean germination percentage (GP-C) in cold (15^0C/10^0C D/N, 75%RH) temperature inside the plant growth chamber, where the mean of sixty-two genotypes was 41.4 % in cold and 94.7 % in ambient. Similarly, two tolerant genotypes have increased by 4.97 cm shoot length (SLI-C) in 7 days of cold exposure (15^0C/10^0C D/N, 75%RH), where the mean was 1.82 cm and 11.4 cm in the ambient. GWAS analysis using the 7k SNP genotyping data identified twenty QTLs for GP-C in Chr 1, 3, 5, 7,9,11, and 12 and three QTLs for SLI-C on Chr 6, 7, and 8. Sixteen QTLs for the GP-C and one for SLI-C are co-localized with the earlier workers' known positions. Hence, this study reported four new QTLs for GP-C and two for SLI-C, with R^2 values ranging from 0.22-0.28. It requires further fine mapping to identify the candidate gene. The newly identified shoot length increasing QTLs must be considered for fine mapping to decipher the candidate gene and be used for MAS after validation. Genotypes and markers identified in this study will help to transfer the seedling cold tolerance in the high-yielding background vis-à-vis yield improvement of summer rice more efficiently and accurately.

AISDGONF/ABS/TD/156

Efficacy of atrazine herbicide for maize weed control in Red And Laterite Zone Of West Bengal

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There was an field experiment to find out the effect of Atrazine herbicide for maize weed control during summer season of 2020-2021 in Red and Laterite Zone at RRSS, BCKV, Raghunathpur, Purulia, West Bengal spraying 7+1 treatments as pre-emergence herbicide comprising Atrazine 50% WP (Rainbow) @1kg/ha(T_1), Atrazine 50% WP (Rainbow) @1.5kg/ha(T_2), Atrazine 50% WP (Rainbow) @2.0kg/ha(T_3), Atrazine 50% WP (Market sample-Atrataf) @1kg/ha(T_4), Atrazine 50% WP (Market sample-Atrataf) @2.0kg/ha(T_5), Weed free check at 20 and 40 DAS(T_6),

Control(T_7) and Atrazine 50% WP(Rainbow) @4kg/ha for phytotoxicity observation over the weed complex such as *Echinochloa colona*, *Echinochloa formosensis*, *Digitaria sanguinalis*, *Eleusine indica*, *Brachiaria mutica* etc. Two hand weeding treatment gave highest yield (grain yield4.45kg/ha) and the plots treated with Atrazine 50% WP (Rainbow) @2.0 kg/ha as well as market sample of Atrazine 50% WP @2.0 kg/ha recorded the least population of all the weeds. In plots treated with different herbicides, Atrazine 50% WP (Rainbow) @2.0 kg/ha recorded the least Dry Weight followed by plots treated with market sample of Atrazine 50% WP at 2.0 kg/ha and there was no phytotoxicity symptoms observed at any of dose of Atrazine 50% WP (Rainbow).

AISDGONF/ABS/TD/157

Characterization of CAMTA gene family members from rice (*Oryza sativa* L.)

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The transcriptionalfactors called calmodulin-binding transcription activator (CAMTA) can regulate downstream genes involved in calcium (Ca^{2+})/calmodulin signalling pathway in response to stressors by binding to a cluster of calmodulin-binding proteins. Seven CAMTA genes and their alternative transcripts were found in five rice (Oryza sativa) chromosomes. The evolutionary conservation in gene structure and their relationship with other plant species were revealed by phylogenetic trees that separated seven *CAMTA* genes into three distinct clades. Molecular docking was used to examine the interaction between the calmodulin binding domain (CaMBD) of several OsCAMTA proteins and rice calmodulin or calmodulin-like proteins. Analysis of differentially expressed genes revealed the functional diversity of *OsCAMTA3b*, revealing it to be the most significantly regulated gene in response to stresses. Tissue-specific expression analysis through qRT-PCR revealed that all the *OsCAMTA* genes except *OsCAMTA7a* and *OsCAMTA7b* were abundantly expressed in roots of rice plants. Research into one of the most economical food crops, rice, would benefit greatly from the characterization of CAMTA genes through observations of tissue specific expression, followed by the discovery of the link between functional properties and their respective proteins in response to biotic and abiotic stimulus.

AISDGONF/ABS/TD/159

Biofortification of mungbean (*Vigna radiata* [L.] R. Wilczek) for grain iron and zinc enrichment

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Mungbean (*Vigna radiata* [L.] R. Wilczek) is an important food legume crop of South and South East Asia. Being a short duration warm season pulse crop it can fit well with any cropping system. Mungbeancan provide significant amount of protein and an array of micronutrients, vitamins. Owing to its significant role towards nutritional sustenance of developing country, it is an important candidate for biofortification programme. Micronutrient malnutrition or hidden hunger is an alarming health issue of now-a-days, which can be mitigated through genetic biofortification

in a holistic way. Despite, of immense potential of mungbean, the biofortification effort in this crop is still in infancy stage with limited progress. Understanding the genetics of high micronutrient traits and formulation of a breeding strategy for improving micronutrient density is pertinent. Keeping this in the backdrop, present study has been formulated to screen out the mungbean genotypes rich in grain iron and zinc content followed by determining the extent of genetic variability for designing the suitable breeding strategy. A diverse set of 130 mungbean genotypes were grown for preliminary screening and data on various yield attributing traits were recorded. Mungbean genotypes revealed adequate variability regarding grain iron and zinc content and other agronomic traits. Genetic variability was appraised along with correlation study to identify the key traits associated with improving iron and zinc content in mungbean. The identified iron and zinc rich mungbean genotypes can be deployed for future breeding programme to solve the micronutrient bottleneck.

AISDGONF/ABS/TD/160

Elucidating genotype by environment interaction for detection of stable micronutrient rich genotypes in lentil (*Lens culinaris* Medik.)

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Micronutrient malnutrition (MNM) poses a major treat to nutritional security especially in the vulnerable section of the developing countries due to unavailability of balanced daily diets. Over the years, MNM amelioration through supplementation, agronomic fertilization, and food fortification were undertaken but the problem is still persistent. Genetic biofortification may provide a holistic solution to mitigate MNM. Lentil (*Lens culinaris* Medik.) being a globally cultivated cool season food legume having high concentrations of protein with significant concentration of endogenous amino acids, minerals, micronutrients and vitamins is an essential component of daily diets in developed as well as developing countries, thus a good candidate crop for biofortification. However, the inheritance of grain micronutrients concentration is complex with high environmental influence, so stable micronutrient rich genotypes need to be identified for breeding biofortified lentil. This study presented a way to address this situation by evaluating 44 lentil genotypes for richness in grain Fe and Zn content. These 44 genotypes were further tested for their stability across 3 environments over two years. The Genotype by Environment Interactions were dissected using statistical tools to identify the stable genotypes. The results detected VL-156 as the 'ideal' genotype having high Fe and Zn content combined with good stability across the locations and Kalyani as the 'ideal' discriminating environment. The genotypes identified through the study provide a treasure trove for biofortification of Fe and Zn in lentil and alleviation of micronutrient malnutrition in the future.

AISDGONF/ABS/TD/167

Effect of subculture frequncy on enzymatic and non enzymatic responses of ROS in *Withania somnifera*

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Indian ginseng (*Withania sominifera*) is considered as an important medicinal plant in the Ayurvedic and indigenous medicinal system. Different parts of the plant contain various chemical constituents which are highly required in pharmaceutical based industry. The main key components are withanolides A and withaferin A, steroidal lactones, present in roots and leaves are the main source of medicinal properties in *Withania somnifera.* There are several barriers that effect conventional cultivation but tissue culture process offers rapid identical disease-free plantlets. An increase of subculture frequency can affect the in-vitro plants. ROS may produce during long term tissue culture process. To overcome this situation, cells are equipped with enzymatic and non-enzymatic mechanisms to reduce their damaging effect. In this stydy, ROS activity was observed on different stages of in-vitro plantlets - 4^{th}, 6^{th} and 7^{th} subcultured plants, germinated plants from seeds, 2^{nd}, 3^{rd} and 4^{th} subcultured callus, shoots derived from callus and green house plant. Higher concentration of SOD was observed in seed germinated seedlings and callus compared to other plantlets and green house plant. Ascorbate peroxidase and catalase activity was altered among different stages and in-vitro plant. Phenolic content was higher in seed germinated seedlings and 7^{th} subcultured plant compared to other stages and low flavonoid content was found in callus. This result showed that an interplay of enzymatic and non-enzymatic responses constitute a system which can prevent oxidative damages.

AISDGONF/ABS/TD/173

Species and race composition of root knot nematode (*Meloidogyne*) infecting betelvine in *terai* region of West Bengal

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Root knot nematode species pose a significant threat to Betelvine crop production in India as well as West Bengal due to the losses caused by direct and indirect damage. To adequately address the threat of root knot nematode on betelvine crops, an accurate assessment and understanding of the *Meloidogyne* species and races present in the region is important. In this study, the distribution and identification of root-knot nematode species and races collected from different betelvine growing areas in Cooch Behar, Jalpaiguri and Alipurduar district of Terai region were determined by perineal pattern morphology and North Carolina Host Differential Test during 2019-21. A total of 85 collected samples, 65 (76.47%) were found to be infested with root-knot nematode species. Plant root samples (galled roots) were processed in part for identification of species and rest of the sample multiplied on the susceptible host (tomato, chilli, okra) under net house conditions for further detection of races. For race identification purpose, 25 samples were randomly selected for

North Carolina Host Differentials test. Response of nematode on test plant was measured by counting egg mass and root-galling severity index (1-5 scale). Out of the 85 populations analyzed, 59(65.88%) were identified as *Meloidogyne incognita* and 6 (10.59%) as *Meloidogyne javanica*. According to the differential host test, population of *M. incognita* existing in Mathabhanga-I, Coochbehar-II, Dinhata-II, Dhupguri, Coochbehar-I, Maynaguri block of the three selected districts were identified as race 1 (40%) & 2 (44%). However, populations from Falakata and Cooch Behar-II block belong to the race 2 of *M. javanica*. It indicated the presence of *M. incognita* race 1 and race 2 is the most prevalent race throughout the surveyed area.

AISDGONF/ABS/TD/175

Genetic variability, correlation and diversity studies in Tossa Jute (*Corchorus olitorius L.*)

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A set of 50 olitorius indigenous lines along with 2 checks were evaluated at Mandouri research station, BCKV during 2019-20 to delineate the relationship between various yield attributing morphological traits and fibre yield. The analysis of variance indicated that the genotypes varied significantly among themselves for all the considered traits. Plant height showed low, while basal diameter depicted medium and green weight, stick weight, fibre weight had highGCV and PCV. High heritability coupled with high genetic advance was observed for green weight and stick weight, indicating preponderance of additive gene action governing these traits. Plant height showed highest positive genotypic correlation with fibre yield (0.827) followed by basal diameter (0.679), stick weight (0.675) and green weight (0.662). Additionally, plant height manifested highest direct positive direct effect on fibre yield followed by basal diameter. The multiple regression analysis revealed that, about 64% of the variability of fibre yield could be explained through the morphological traits taken into consideration. Among them, plant height had highest influence followed by basal diameter and green weight while stick weight accorded least to fibre yield. The genotypes could be divided into 3 clusters based on D^2 analysis, signifying narrow genetic base among the considered lines. Cluster I consisted of 45 lines, while cluster II had six (OIN 140, OIN 184, OIN156, OIN 159,OIN 163, JRO 524) and OIN 164 occupied the lone cluster III. The highest inter cluster distance was observed between cluster I and cluster III (297.89), while maximum intra cluster distance was estimated for cluster II (43.82).

AISDGONF/ABS/TD/181

Utility of cordyceps as an entomopathogenic fungi to control insect-pests

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Cordyceps, an Ascomycetes (sac-fungi) fungus, has more than 400 species around the globe. Most species of this genus are endoparasitoids, mainly on insects, other arthropods, but few are parasitic on other fungi also. The entomopathogenic nature of this fungi makes it a potential mycopesticide against various important insect pests. The reports clearly support pathogenic activity against various insect orders like Coleoptera, Lepidoptera, Hemiptera, Hymenoptera, etc. The fungus

mostly attacks the caterpillar and converts the inner material of the host into a modified fruiting body. Wide distribution of this fungus is recorded in many Asian countries having hot and humid climate. Some species under this genus include *Cordyceps sinensis*, *Cordyceps militaris*, *Cordyceps javanica* and *Cordyceps fumosorosea*, which produce bioactive compounds like cordycepin and ergosterol. Now *Cordyceps sinensis* have been renamed as *Ophiocordyceps sinensis*. The *Ophiocordyceps sinensis* is one of china's most valued medicinal fungi used for strengthening the bodyand has claims of anti-cancer and immunostimulating properties. In Tibet and China, these are known as Winter-worms, Summer-grass and Caterpillar-fungus. Keeping all these points in consideration this fungus can be utilized in a better way not only for human medicinal purposes but also for the management of various insect pests in an eco-friendly way as an alternative to harmful synthetic insecticides.

AISDGONF/ABS/TD/192

Biology of *Henosepilachna vigintioctopunctata* (Coccinellidae: Coleoptera) on brinjal

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Hadda beetle, *Henosepilachna vigintioctopunctata* (F.) (Coleoptera: Coccinellidae) is one of the major insect-pest and foliage feeder of Brinjal in India. Laboratory studies were carried out in the Department of Agricultural Entomology, Palli Siksha Bhavana, Visva-Bharati (West Bengal) during 2019-20 to study the biology of Hadda beetle from field collected populations from Agriculture Farm of the Institute. Studies related to biology of an insect pest is helpful to understand the pest population dynamics and vulnerable arenas in the life cycle of an insect so as to formulate sound management practices against them. All the parameters pertaining to biology viz; Incubation period, Larval period, Pre-pupal and pupal period, Adult Longevity, Pre-ovipostion period, Ovipostion period, Fecundity and Hatchabilty (%) were recorded on daily basis. The beetle lays bright, yellow-colored eggs in clusters on the under surface of leaves of brinjal. The grub is yellow, elliptical in shape and covered with small, branched bristle having 3 moults. The pupa was yellow, oval along with dark colour marking and spines on posterior side. Newly emerged adults were pale yellowish orange in colour but later turns to dark orange. Body is hemispherical in shape, dorsally convex, ventrally flat having 14 black spots on each elytra. The female insect is larger than the male adult. The incubation, total larval, pre-pupal, pupal, adult longevity (male) and adult longevity (female) period ranged from 3 to 5 days with mean of 3.8±0.83 days, 13 to 23 days with mean of 14.2±1.30384, 1 to 2 days with mean of 1.6±0.547723, 4 to 7 days with mean of 5.8±1.30384, 26 to 35 days with mean of 30.4 ±3.646917 and 29 to 48 days with mean of 35.4 ±7.503333 respectively under laboratory conditions. The entire life cycle is completed within 22 to 29 days with mean value of 25.4 ±2.50998. The fecundity and hatchability percent ranged from 44 to 62 with a mean of 52 ±6.892024 and 64.7% to 83.8% with a mean of 73.916 ±8.282529.

AISDGONF/ABS/TD/193

Off-fieldsucker production of post-harvest banana corms under different hormonal and nutritional regime

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An experiment on post-harvest banana (*Musa* spp.) corm was conducted at the Department of Plant Physiology, BCKV, Mohanpur, West Bengal to study the induction of sucker throughdifferent hormonal and nutritional regimes, which was laid out in Completely Randomized Design and replicated 3 times. The five treatments *viz*., T_1 (Control treatment with water spray), T_2 (Thio-urea 0.15%), T_3 (nutrient mixture of urea @450 mg L^{-1} + Thio-urea @70 mg L^{-1} + Calcium ammonium Nitrate @ 700mg L^{-1}+ Calcium monophosphate @150mg L^{-1} + Magnesium chloride @80mg L^{-1}+ Boric acid @50mg L^{-1}), T_4(Thiourea @0.15% + BAP@ 4ppm), T_5 (nutrient mixture of T_3 + BAP @4ppm). The substrate used for planting the corms were a mixture of sawdust + Trichoderma @ 15gram kg^{-1} of sawdust + vermicompost @ 15gram kg^{-1} of sawdust. Observations recorded were weight of the corm, days to appearance of the first primary suckers, number of primary suckers, number of secondary suckers, number of tertiary suckers and total number of suckers. T_3 observed to be the best treatment in respect to all the response parameters like earliness in sprouting, primary, secondary and tertiary sucker productivity. Macro-propagation management of sucker is a suitable alternative to tissue culture since it is farmer friendly and less expensive. The healthy corms left in the field after harvesting could therefore be recovered and used to produce suckers.

AISDGONF/ABS/TD/194

Bio-intensive insect-pest management on rice

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Rice is the important staple food of West Bengal as well as of India. Insect-pests play major role for yield loss in rice production. The stem borer causing 'dead heart' and 'white ear head' is one of the most damaging insect on rice and the whorl maggot is another frequently occurring pest of rice. A field trial was conducted during two successive *kharif* seasons, 2019 and 2020 at Rice Research Station, Chinsurah, Hooghly. The trial involved mainly two treatment blocks *viz*., i) Bio-intensive pest management (BIPM) with application of vermicompost @ 500 g m^{-2} of the nursery bed; ploughing the field thoroughly to incorporate the -weeds and straw into the soil; 2.5 t vermicompost ha^{-1} half as basal and half as top dressing; clipping of stem borer egg mass from rice seedlings before transplanting; mass trapping of stem borer by installing pheromone traps @ 20 numbers ha^{-1}; growing marigold plants on borders to conserve natural enemies; *Trichogramma japonicum* 5 cc egg cards ha^{-1}, six times weekly from first week after transplanting; need based application of neem formulations and ii) Input intensive pest management or Farmers Practice block (FP) spread over an area of half acre for each block planted with rice cv. *Swarna*. Observations were recorded on the damage of whorl maggot, stem borer and natural enemies. During 2019, at the early crop growth stage, the whorl maggot

incidence was found ranging from 3.94 to 4.09% DL and was at par in both the treatments. The dead heart (DH) and white ear (WE) damage by stem borer was significantly higher in FP plots (13.93% DH & 19.35% WE) than BIPM plots (7.69% DH & 5.47% WE). The spider population in general was significantly higher in the BIPM plots. The population of spiders and coccinellids was also significantly higher in BIPM (1.67 & 2.67 10 hills^{-1} respectively) than that of FP (0.33 & 1.36 10 hills^{-1}, respectively). In 2020, the whorl maggot damage was significantly higher (17.54%) in FP as compared to BIPM (7.92%). Similar trend of DH and WE damage were observed in FP (23.02% DH & 48.10% WE) plots compared to BIPM (7.05% DH & 22.93% WE) plots. The population of spiders and coccinellids (8.83 & 4.83 10 hills^{-1} respectively) was significantly higher than that of FP plots (3.50 & 1.83 10 hills^{-1} respectively). It may be concluded and recommended that the bio-intensive insect-pest management on rice can effectively mange stem borer and whorl maggot insectpests.

AISDGONF/ABS/TD/195

Nanoparticles in plant tissue culture: its beneficial and adverse aspects

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The potent role of plant tissue culture is quite evident in plant conservation, improvement, production of bioactive compound, genetic manipulation as well as mass multiplication. Nanoparticles are characterized by small size (1-100 nm), low molecular weight with a high surface to volume ratio. From the latest researches, nanoparticles are observed to be playing active role as potential biostimulators in enhancing plant propagation, growth and development, economic yield and imparting stress resistance towards various biotic as well as abiotic stress resistance. Apart from these, nanoparticles are also reported reported in augmenting organogenesis, induction of callus, somatic embryogenesis, genetic transformation, somaclonal variation and production of secondary metabolites.Exploiting nanoparticles successful eliminations of microbial contaminants from explants is gaining prime importance lately. However, integration of nanotechnology into plant tissue culture is quite a new and still behind to be acknowledged by researchers round the globe. Several nanomaterials such as TiO_2, Ag, SiO_2, ZnO, Graphene, Quantum dots, Carbon nanotubes, Dendrimers etc. are recorded to impart remarkable effect when used in crop improvement programmes. This review covers the current achievements obtained by using nanotechnology in plant tissue culture along with the beneficial as well as harmful effects of nanoparticles, when used in culture medium.

AISDGONF/ABS/TD/209

Genetic bio-fortification for improving protein content in rice (*Oryza sativa* L.)

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The nutritional sustenance are essential requisites for the development of mankind. Malnutrition, with its two constituents of protein–energy malnutrition and micronutrient deficiencies continue to be a great health burden in developing countries. Protein malnutrition is a predominant problem

around the world, especially in Asiawhere rice is the staple food for more than 70% population. Therefore, supplementing the recommended dose of protein in rice dominated diet is a prerequisite. Rice is deficient in protein but due to the higher digestibility and better nutritive quality supplemented with glutelin, rice storage protein is nutritionally superior to the other cereals. Additionally, rice protein has unique hypoallergenic properties which makes it exclusive comparison to other cereals. Therefore, improving the seed storage protein content has become one of the major breeding objectives for improving nutritional quality in rice. Understanding the genetic basis of seed protein content and mining the favourable alleles governing the trait is pertinent. Keeping these in the backdrop, the present study integrated screening and evaluation of protein content in 100 rice genotypes to identify protein rich line coupled with appraisal of genetic variability concerning various yield-attributing traits. Wide variation in protein content and other yield attributing traits were observed. Moreover, correlation study was undertaken to detect the associationship between seed protein and other yield attributing traits. The identified high protein rice genotypes can be potentially utilized for mapping of key genomic regions underlying protein content in rice and in bio-fortification programs.

AISDGONF/ABS/TD/220

AMMI and GGE biplot analysis of wheat genotypes for spot blotch disease and yield under Indo Gangetic Zone of West Bengal

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The identification of high yielding and spot blotch resistant genotypes is the prime target for Indo Gangetic zone of India. High humidity and high environmental temperature during late grain filling stage is congenial for infection and spread of spot blotch disease. In the present experiment, a set of eighteen wheat genotypes were evaluated in Randomized Complete Block Design (RCBD) in three replication for three consecutive years i.e 2018-19, 2019-20 and 2020-21 under artificial epiphytotic condition of spot blotch pathogen. The objective of this experiment was to identify spot blotch resistant, high yielding genotypes with stable in performance across the environment and estimate the magnitude of genotype by environment interaction for grain yield and spot blotch disease severity. The combined ANOVA for grain yield and spot blotch severity showed significant difference among genotypes, environment and their interaction. The spot blotch disease severity and yield potential of genotypes was measured by AMMI and GGE biplot. The AMMI 1 biplot of PC1 versus AUDPC (Area Under Disease Progressive Curve) found that genotypes HD 2888, K 8027, BH 1146, and CHIRYA 7 have AUDPC value less than grand mean and these genotypes also were found less interaction effect with environment and stable performance with low disease severity over the environment. Some genotypes like Sonalika and HD 3086 have high AUDPC value than grand mean.From AMMI 2 biplot it was found that all three environments have high environment vectors so all are discriminatory with high GX E interaction. The genotypes K 307, K 8027, HD 2888 and Chirya 3 have showed stable disease reaction across the environment. On study of AMMI 1 biplot of PC1 versus grain yield per plant was found that genotypes HD 2888 K 1006, C 306, BH 1146 and BRW 3723 were showed high yield potential as compared to grand mean yield. Among them HD 2888, K 1006 and BH 1146 are less influenced by environmental factors and showed stable performance across the environment while genotypes C 306 and BRW 3723 are high influenced by environmental factors. AMMI 2 biplot of

grain yield represent that genotypes BRW 3723 and C 306 are high yielding as compared to grand mean but more responsive in testing environment. On analysis of eighteen genotypes using GGE biplots, the Which-Won-Where patternrevealed that 18 elite wheat lines fall under single sectors in the polygon. On evaluation of genotypes on the basis of mean performance and stability elite wheat genotypes HD 2888,K 1006 and BH 1146 are above average yielder with high stability while, genotypes BRW 3723,C 306 and HD 3118 are also above average yielder but with lower stability.

AISDGONF/ABS/TD/223

Easy phenotyping methodology for the quick photoprotection recovery trait in rice and their validation by mapping

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Rice receives severe fluctuating light intensity varying from 400-1800 μmol/m^2/sec throughout the growing period in *kharif* season. Like other plants, rice adopts several photoprotection mechanisms in high light intensity (>1200 μmol/m^2/sec) but takes more than half an hour to recover photoinhibition stages even though the light intensity is optimum; consequently, it limits biomass. The study identified a few indica rice with quick photoprotection recovery ability. All the published methodologies to identify rice genotypes with quick photoprotection recovery ability require cumbersome steps including complete dark acclimation for a more extended period, which is not possible in field grown crops and unsuitable for a larger population. The study developed a rapid and easy method for phenotyping the trait in field-grown standing crops. The newly developed methods showed a strong significant ($r= 0.81^{**}$) positive correlation with the existing dark adopted methodologies. The photoprotection recovery ability was estimated in a panel of 96 genotypes of released cultivars, landraces, aus, and aromatic for two seasons using a photosynthesis analyzer with chlorophyll fluorescent attachment. Genome-wide association study using 7K SNP-based genotyping and TASSEL software identified associated SNPs. The location of several known genes like *PsbS1, ZEP, VDE, RCA, osbZIP72, osMYBS2, and SAPK1* vicinity to the associate markers confirm that the newly developed methodology is efficient to replace the published cumbersome methodology for the quick photoprotection recovery. Additionally, when a RIL population of Swarnaprabha x IR64 is used to map the trait, a number of QTLs with known photoprotection recovery genes are present. The identified easy-to-use methodology will be useful in identifying more efficient genotypes, superior alleles, and the transfer of the traits into high-yielding cultivars.

AISDGONF/ABS/TD/231

Incidence of arthropod natural enemy complex in pulse crops ecosystem during winter season in lower Gangetic plains of West Bengal

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A precise idea about the natural enemy complex of every crop is necessary for managing insect pests in an ecologically and economically sound bio-control manner and pulse crops are not an exception. The present study has been conducted at District Seed Farm (AB Block) of BCKV located at Kalyani, Nadia, West Bengal during the *rabi* season of 2021-22 to study the incidence pattern of the natural enemies recorded in five different pulse crops viz. chickpea (var. KWR 108 and JAKI 9218), fieldpea (var. Rachna and VL 42), lentil (var. IPL 220 and L 4727), grasspea (var. Prateek and Ratan) and pigeonpea (var. UPAS 120) during winter months. The highest population of natural enemies as well as species variation was recorded in pigeonpea ecosystem, where eleven different species of Coccinellids and fifteen different species of spiders were noticed along with Syrphid fly, dragonfly, damselfly, rove beetle, parasitic wasp, Reduviid bug, preying mantid and green lace wing.Sporadic incidence of Coccinellid beetles was recorded in chickpea whereas, the occurrence of Coccinellids, spiders and rove beetle were noticed on fieldpea. Incidence of Coccinellids, spiders, rove beetle and Ichneumonid wasp was observed on lentil while, grasspea ecosystem showed the occurrence of Coccinellids, Lynx spider and Reduviid bug. The regression studies involving the weather parameters reveal that maximum temperature exhibited the most influence on the population intensity of Coccinellids in fieldpea, whereas in grasspea, rainfall and bright sunshine hours were the most influencing factors over the population buildup of Coccinellids and spiders, respectively. However, in pigeon pea, rainfall was the sole governing factor over the Coccinellid population.

AISDGONF/ABS/TD/234

Haploid embryogenesis from in vitro cultured anther of limonium misty blue

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In conventional breeding approach, the homozygous line development will take much longer time than *in vitro* haploid breeding. Moreover, *in vitro* anther or microspore culture is the only way to get haploid clonesofheterozygous plants that do not form viable seeds. On the above background, the *in vitro* haploid embryogenesis was carried out in a heterozygous *Limonium* Misty Blue, an interspecific hybrid of *Limonium latifolium* and *L. bellidifolium*, which is very much popular as both fresh and dry flowersthroughout the world for its stunning purple-blue blooms. The genetic reprogramming of haploid microspore through embryogenic pathwaywas optimized by manipulating different physical, chemical parameters and sorting out the suitable developmental stage ofmicrospores in anther. After incubating the flower budsat 4°C for 7 days the dissected antherswere cultured in three basal media (MS, 1/2 MS, N6) supplementing with different PGRs (BAP 2.22 µM - 8.88 µM and NAA 1.07 µM) and sucrose (87.41 mM & 175.28 mM). The highest percentage (10.70) of culture establishment from anther was recorded in N6 medium supplemented

with 2.22 µM BAP, 1.07 µM NAA and 87.41 mM sucrose; and around47 % ofembryogenic calliwere noticedfrom the established culture after sub-culturing in the same basal mediumcontaining 175.28 mM sucrose, 8.88 µM BAP and 1.07 µM NAA. The highest regeneration frequency (5.36±0.05[a]/anther) through haploid embryogenesis was achieved in ½ MS basal medium having 175.28 mM sucrose, 4.44 µM BAP and 0.53 µM NAA. The histological observation, chromosome study and ploidy analysisby flow cytometry revealed the haploid plant regeneration through embryogenic pathway.

AISDGONF/ABS/TD/237

Insect pest problem in stored pulses with special reference to *Callosobruchus maculatus*

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Bruchids are the most serious pest of pulses worldwide. Keeping in view the importance of pulses the study was aimed to know the insect-pest attacking in different stored pulses and host preference, biology of *Callosobruchus macultus* in different stored pulses. Sixteen different types of pulses were taken for the investigation. It was found that *Callosobruchus* sp was higher in number in every month and other species was *Sitophilus oryzae*, *Tribolium castaneum*, *Rhizopertha dominica* and *Liposcelis* sp. The most preferable host for oviposition of *C.maculatus*was horse gram (83.67 eggs/10 g seed), soya bean (83.17 eggs/10 g seed) in no choice test and cowpea (61.50 eggs/10 g seed)) and mung (60.67 eggs/10g seed) bean in free choice test. Highest adult emergence, damage percentage was observed on cowpeaand no adult emergence from kidney bean, soyabean, horse gram, lentil, split lathyrus, split pea. It was recorded that incubation, larval-pupal period was significantly higher in winter than summer season. Incubation period ranges from 10.93-12.13 days in winter and 4.17-6.13 days in summer. In winter lowest, larval pupal period was found on mung bean (49.47 days) and in summer season on cowpea (17.73 days), while the period was longest on split black gram (85.27 days) and pea (64.33 days) in winter and summer season respectively. Considering the longevity, the female longevity (9.70 -13.72 days) was higher than the male (10.90-13.17 days).

AISDGONF/ABS/TD/246

Compatibility of entomopathogenic nematode (*Steinernema* sp.) and coccinellid (*Cheilomenes sexmaculata*) with some insecticides used against fall army worm (*Spodoptera frugiperda*)

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Infestation of *Spodoptera frugiperda* in corn can be chemically controlled by cyantraniliprole, chlorantraniliprole, emamectin benzoate, spinosad, flubendiamide, teflubenzuron, novaluron + indoxacarb, broflanilide, chlorafenapyr and azadirachtin. Bioagents like entomopathogenic nematodes (EPNs) and lady beetles have also role to reduce its population. Integration of bioagents with chemical insecticides is current need for sustaianable pest management. So, the present evaluation was conducted at laboratory condition to knowhow the fate of EPN, Steinernema sp.

and coccinelid (*Cheilomenes sexmaculata*) after their exposure with above mentioned insecticides used for S. frugiperda. Except Emamectin benzoate, all the chemicals were proved to be safe to Steinernema sp. E. benzoate caused 100 % reduction to insect infectivity by EPN, followed by chlorafenapyr (80%). Slightly harmful effect for grubs (*C. sexmaculata*) was noted in cyantraniliprole and emamectin benzoate and for pupa in emamectin benzoate and novaluron + indoxacarb. Otherwise all others were harmless both for grubs and pupal stage of *C. sexmaculata*. These pieces of information might be practical in decision making for IPM of *S. frugiperda*.

AISDGONF/ABS/TD/254

Evaluation of a set of newly bred lines of cowpea and their response to foliar application of ethylene at pre-harvesting crop stage

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Cowpeas [*Vigna unguiculata* (L.) Walp ssp. *unguiculata* (2n=22)] are multi-purpose crops and may be grown as a vegetable, pulse, fodder, or a pasture crop. They are drought tolerant, short duration crop of African origin, permitting multiple cycles in a year. An investigation was carried out with the objectives of i) characterization of a set of newly bred cowpea genotypes; ii) their evaluation for yield and yield attributes; and iii) assessment of the impact of pre-harvest foliar application of ethylene on a cowpea genotype. The experiment was conducted in zaid season of 2023 at the Jaguli Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya with nine genotypes, *viz*., CST-1, CST-2, CST-3, CST-4, CST-5, CST-6, CST-7, CST-8 and CST-9 in a Randomised Complete Block Design with four replications. The characterization of the cowpea genotypes was done with twenty five morphological descriptors: nine vegetative (plant's growth habit, plant's growth pattern, twinning tendency, etc.); 9 reproductive (pigment pattern of flower, days to flower, flower colour, etc.); and 7 seed (seed shape, testa texture of seed, eye pattern of seed, etc.) morphological descriptors. Every genotype was described with the above descriptors and each of the genotypes was given identity with single or combination of morphological descriptors. All the genotypes were evaluated for their performance in yield attributes like plant height, main stem nodes plant-1, primary branches plant-1, leaf length, leaf width, clusters plant-1, pod length, pods plant-1, seeds pod-1, test weight of seed, chlorophyll content and yield as well as quality parameters seed grain like sugar, starch and protein content. The genotype CST-1 was evaluated to be best performer in respect of its yield and yield attributes like number of nodes on main stem plant-1, pod length, above average performer in respect of number of primary branches plant-1, number of clusters plant-1, number of seeds pod-1; and below average performer in plant height, leaf length and width, number of pods plant-1.The response the cowpea genotype CST-1 was tried with five treatments of ethylene treatments [Control (ethylene@ 0 ppm), one spray of ethylene @ 500 ppm, two sprays of ethylene @ 500 ppm, one spray of ethylene @ 1000 ppm, two sprays of ethylene @ 1000 ppm) applied at the pre-harvesting stage and observations were recorded on post-treatment performance in number of flowers plant-1, number of pods plant-1, pod length, number of seeds pod-1, test weight of seeds, and seed and stalk yield. The highest post-treatment seed yield and yield parameters and lowest stalk yield were obtained in the treatment of two sprays ethylene @ 1000 ppm at pre-harvesting stage (after second plucking of mature pods) at five days interval. It can be concluded from the experiment that the cowpea descriptors were effective in putting identity to the newly bred genotypes; CST-1, among set of nine new genotypes, was the highest yielder; pre-harvest foliar application of ethylene could effectively

improve the seed yield; and among the ethylene treatments, two spray of ethylene@ 1000 ppm applied at pre-harvesting was most effective.

AISDGONF/ABS/TD/256

Abundance and diversity of insects associated with tomato in the Lower *Gangetic* Alluvial Plains of West Bengal

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A fixed plot study was conducted to explore the abundance and diversity of insect fauna associated with tomato in two selected locations *viz*., Kalyani C-Block Farm of BCKV, Nadia and Islampur, Uttar Dinajpur in the lower *Gangetic* alluvial plains of West Bengal from November 2019 to April 2021. Altogether 721 insects belonging to 11 species under 6 orders from the Kalyani C-Block Farm of BCKV and a total of 520 insect specimens belonging to 10 species under 5 orders have been recorded from Islampur. The most abundant order was hemiptera in both the sites while the least abundant orders were neuroptera and thysanoptera. The dominant species recorded was *Myzus persicae* (Sulzer) in both the areas. Diversity of the insect fauna in both the study sites was found to be maximum during the mid-growth stage of the crop. The species richness reached maximum after sampling of 207 (2019-'20) and 288 (2020-'21) insect specimens in Kalyani, and 395 specimens in Islampur during 2020-'21. The relative abundance as well as diversity of the insect predators was very low as compared to the pest. The stability of the pest guild increased over time but the temporal change of the predator guild did not follow the similar trend keeping parity with the rise of pest population. Meticulous analysis of the entomofauna existed in two study sites for comparing the community unveiled that the Simpson's Index and Shannon-Winer Index of diversity as well as the Evenness value were higher in Kalyani, whereas the insect population of the tomato field in Islampur had the highest Margalef's species richness. This study may provide a useful foundation for designing the integrated production and pest management for tomato. The artificial agro-ecosystems, under constant human intervention, favour pest density over predators. Thereby, manipulation of the crop architecture, hedgerows and diversification within the field helps build up predator population. It is recommended that to conserve insect species in tomato, management tactics which have less or no negative effects on natural enemies, pollinators and other insects but can effectively suppress insect pest populations (use of biological control agents, restriction of herbicides and pesticides use) should be adopted. On top of that, the occurrence of the latest invasive lepidopteran pest of tomato, the south American tomato pinworm has also been encountered for the first time in West Bengal and it is expected to assist the research and extension personnel in exploring the pest on tomato in this very state.

AISDGONF/ABS/TD/257

Field screening of faba bean (*Vicia faba* L.) genotypes against leaf miner and pod borer

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Legumes are the valuable plant source of protein to meet the dietary requirement of people across the world in general. Faba bean, a protein rich (30%) minor leguminous crop, is usually used for

human consumption and as animal feed in both developed and developing nations. The productivity and marketability of faba bean are decreasing considerably due to infestation of leaf miner and pod borer in West Bengal. Chemical insecticides have been used by farmers all over the world as a reliable technique for controlling pests. It has so many adverse effects like environmental pollution, destruction of natural enemies, and development of resistance in insects against insecticides and change in the pest scenario. Thus, host plant resistance is often promoted as an approach of integrated pest management strategy for controlling destructive pest population while eliminating the use of broad spectrum insecticides. Keeping all these information in backdrop, a field experiment was conducted to find out sources of resistance in faba bean genotypes against leaf miner and pod borer at the AB Block Farm and Research Station of BCKV during Nov 2019 - March 2020. Observations were recorded on plant growth attributes, seed yield, per cent leaf mining and per cent pod damage. Out of forty four genotypes of faba bean, six genotypes of faba bean FLIP15-159FB, FLIP15-197FB, L-2013-014, L-2013-060 (S4), L-2013-092 (S4), and L-2014-137 were identified as highly resistant genotype against leaf miner. The genotypes Ahmednagar Local, Bangla Gangachar, EC-25085, FLIP15-196FB, FLIP15-197FB, Gazipur Local, HB-15, HB-90, and L-2013-060 were very highly resistant to pod borer. If these promising faba bean genotypes revealed consistent result in different growing regions then they could be exploited in near future for the development of leaf miner and pod borer resistant variety.

AISDGONF/ABS/TD/258

Identification of aphids and their distribution in the Lower *Gangetic* Plain Region of West Bengal, India

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Extensive field surveys were carried out during 2018 and 2019 in the Lower *Gangetic* Plain Region of West Bengal for collection of aphid specimens. Aphids were collected from 16 locations spreading over three districts of West Bengal. The host plants from which the specimens were collected include pulse crops, cereal crops, vegetable crops, oilseed crops, fruit crops and weed. A total of 13 plant species belonging to eight families were sampled. Morphometric analysis of the slide mounted specimens revealed the presence of seven species of aphids under six genera of the family Aphididae. The recorded aphid species include *Aphis gossypii*, *Aphis spiraecola*, *Greenidea psidii*, *Hysteroneura setariae*, *Lipaphis erysimi*, *Myzus persicae* and *Rhopalosiphum rufiabdominalis*. The diagnostic morphometric features of apterous or alate viviparous female of the identified aphid species, their appearance in field and under microscope and their distribution in West Bengal were documented in this study. A detailed host catalogue of the aphid species and aphid catalogue of the host plants have been prepared.

AISDGONF/ABS/TD/259

Occurrence of chilli gall midge, *Asphondylia* sp. (Diptera: Cecidomyiidae) in Gangetic Alluvial Zone of West Bengal

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Chilli (*Capsicum annuum* L.) is infested with many insect pests and diseases. Out of which, chilli thrips and mites are ranked as major pests of chilli in West Bengal, India. In the present investigation, infestation of dipteran gall midge, *Asphondylia sp.* was recorded in chilli from Gayespur region of Gangetic Alluvial Zone of West Bengal. The pest was observed during October, 2021 to January, 2022 with peak infestation during December. Following which the population declined gradually. The incidence of gall midge was also studied during rabi season, 2022- 2023. It is observed to be serious pest of chilli during the reproductive stages causing deformation of flower buds and bud drop. The noted damage symptoms include gall like malformed ovaries, flowers dried but intact to the plant until adult emergence, whilemalformed infested fruits, break the color overall except for the curved portion where the larva is developing which remains greenish.Usually, one yellowish-orange dorsoventrally flattened maggot was observed per opened gall. Pupation occurred within the fruit and adult emerges from the weakest point of the fruit using the pupal antennal horns. The adult midge is a dark, reddish brown, mosquito like adult, measuring 3mm length. Male and female are differentiated by presence of long ovipositor. Along with gall midge in chilli galls, few hymenopterans were also found in the galls.

AISDGONF/ABS/TD/263

Enhancing plant growth by restricting chromium translocation through organic manure application

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Heavy metal contamination becomes one of the serious global problems that affect both environmental safety and human health. The exposed chromium (Cr) ores and metals present in mine in overburden soil are leached during rainy season which contaminate the nearby soil and water bodies; ultimately ruining the agricultural fields and slowly poisoning the local flora and fauna including human population. Keeping these points in mind, a pot experimentwas carried out at ICAR-IIWM Bhubaneswar in order to establish an appropriate remediation strategy to minimize Cr translocation in rice. The treatments comprised of two levels of Cr stress [natural and elevated (20 mg/kg soil)], three levels of organic amendment [without amendment, biochar (5 t/ha) and vermicompost (10 t/ha)] and two methods of irrigation practice [irrigation applied at 3 days after disappearance of ponded water and continuous flooding]. It was observed that the elevated level of Cr significantly reduced the plant height and tiller numberand delayed flowering of rice plant by 6 days as compared to natural level of Cr stresswhereas, elevated level of Cr had no significant impact on panicle number, panicle length and seed weight of rice. The addition of Cr (20 mg/kg

soil) diminished the plant biomass, root length, root volume, leaf area and flag leaf length by 26, 16, 29, 21 and 10%, respectively. The rice plant grown under Cr spiked soil produced higher level of chaffy grain which ultimately reduced the grain yield. Vermicompost application improved the plant growth with respect toplant height, tiller number, plant biomass, root length and volume, leaf area and flag leaf length. The rice plant grown without organic amendment took longer days to bloomand produced lesser panicle number and grains per panicle with shorter panicle length s, more chaffy grains and lower grain and straw yield. The addition of organic amendments significantly reduced the Cr content in plant.

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Evaluation of toxicity of some newer insecticides against Bihar hairy caterpillar (*Spilosoma obliqua* Walker) infesting black gram under laboratory condition

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Black gram is one of the important kharif pulse crop grown throughout India. In some parts of India, Bihar hairy caterpillar has been recorded as major pest of black gram though 18-20 insect pests damage the crop. The pest is developing resistance against the conventional insecticides so that new generation chemicals are required to be evaluated for controlling the pest. Experiment on leaf dip bioassay using black gram leaves was carried out in the laboratory ofAICRP on MULLaRP, BCKV, Nadia, WB during kharif 2022. Five newer insecticide viz. teflubenzuron, alpha cypermethrin, afiodopyropen + abamectin, chlorantraniliprole and *Bacillus thuringiensis* was evaluated in this experiment using the laboratory reared larvae collected from infested urdbean field. Among three doses used in this experiment, one was recommended dose and other two were 25% below and 25 % above the standard dose including one control. Larval mortality was recorded at 12 HAT (Hours after treatment), 24 HAT, 48 HAT and 72 HAT. Among all the treatments, all the three doses of alpha cypermethrin caused highest larval mortality during 12 HAT, 24 HAT, 48 HAT and 72 HAT, followed by teflubenzuron, chlorantraniliprole and afiodopyropen + abamectin. Lowest larval mortality was recorded from *Bacillus thrungiensis* treated leaves. From this experiment it was observed that the alpha cypermethrin hadhighest toxicity compared the others. Chlorantraniliprole also caused highest mortality after 72 HAT and afiodopyropen + abamectin had less toxicity during the entire observation interval. From this experiment it can be concluded thatalpha cypermethrin, teflubenzuron and chlorantraniliprole are the most effective chemical for managing the pest even if applied in lower concentration also.

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Validation of drought responsive microrna in a drought tolerant rice cultivar

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Drought like situation in non-irrigated agriculture system often limits rice production, necessitating introduction of drought tolerance trait into the cultivar of interest. In Assam**,** effect of dry spells on varieties cultivated on low lands was reported to be reduced up to 43.07%. miRNAs, a class of abundant small noncoding RNAs, have been identified as important regulators of gene expression in both plants and animals and are involved in many aspects of plant development, including the modulation of plant response to stress. Despite technical hurdles to miRNA functional analysis, there is a growing body of evidence that alteration of miRNA accumulation plays an important role in reprogramming plant responses to biotic and abiotic stresses. Assam having a diverse germplasm of rice, might have evolved an unique response to various stress. ARC-10372, a proven drought tolerant landrace may be a good source of drought related miRNAs and can provide insight into the role of miRNA in drought stress. In a previous effort in the Dept. to identify novel variety specific miRNA, small RNA sequencing had been employed to systematically investigate the tissue specific miRNAs responsible to drought stress, which are understudied in rice. The study revealed few novel miRNA in addition to known under drought stress. Differentially expressed miRNA as revealed by sequencing data are confirmed experimentally under drought situation using qRT-PCR. Out of 31 miRNAs, 7 known and 5 novel miRNAs were found to respond to drought stress. The identified target for these miRNAs revealed several conserved miRNAs targeting transcription factors like homeodomain-leucine zipper, MADS box family protein, zinc finger protein and Myb, well known for their importance in drought tolerance in plants. Drastic decrease in abundance of a few of the members of the novel miRNA (nmiR4, nmiR25, nmiR32, nmiR84 & nmiR86) might suggests important role of these miRNAs in drought tolerance. Further work on revealing its confirmatory role shall yield more information in this regard.

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The quality assessment of starch in different genotypes of greater yam (*Dioscorea alata*)

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Greater yam (*Dioscorea alata* L.) is a very important tropical tuber crop vastly cultivated in different districts of south Gujarat. Greater yam tubers are very rich in starch. The experiment was conducted with the objective to test the tuber starch quality of different germplasm. A total of fifteen germplasm was collected from different local places of south Gujarat was named as NGY1 to NGY 14 and were tested against Da-199 as check.Among all fifteen genotypes, NGY 3 had

highest amount of starch (79.68%) at per with Da-199 (78.56%). Regarding the amylose and amylopectin Da-199 produced the lowest ratio (0.23) at par with NGY12 (0.24). Water absorption capacity (WAC) was found to be highest in Da-199 (3.58 g water/g starch) at par with NGY12 (3.47 g water/g starch). The synersis % from this experiment showed significant increase upto 3rd day. The lowest synersis % had been revealed in NGY8 (22.70%) @ with NGY3 (22.80%) in 1st and 2nd day, NGY 8 (51.71%) @ NGY3 (52.10%). In 3rd day NGY8 (67.25%) synersis was found lowest. In 4th and 5th day while NGY 3 showed the lowest synersis (70.58%) and (73.73%) respectively. The gel clarity depicted by transmittance% was highest in NGY1 which is at par with NGY 9 in all from 1st to 4th week of study among the fifteen different genotypes. It can be inferred that greater yam genotypes NGY9, NGY3 and NGY1 had highest resistant starch, refrigeration stability (synersis %) and starch gel clarity (transmittance %), respectively.

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Comparative studies of phenotypic yield attributes in okra [*Abelmoschus esculentus* (L.) Moench]

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The present observations on phenotypic variables connected to seed traits was conducted at C-Block Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani during pre-kharif and post-kharif of 2022. Eight Okra genotypes from various sources were grown in RBD fashion with three replications. The observations were made on days to first flowering, days to 50 percent flowering, plant height, capsule length, capsule diameter, seeds per capsule, capsules per plant and seed yield. Statistical analysis revealed that there was a significant effect on growing season highlighting seed yield and yield attributes.The data considering days to first and 50 percent flower showed significant earliness during pre-kharif season. But therest parameters *viz.*plant height, capsule length and diameter, seeds per capsule, capsules per plant and seed yield recorded significant advanced values during post-kharif.The most prominence was observed in seed yield indicating 8.54 and 11.67 q/ha for during pre-kharif and post-kharif respectively. The performance of genotypeswas differing significantly for all considerable traits. The pooled seed yield value of Arka Anamika (11.90 q/ha) followed by Prabhani Kranti (11.8 q/ha) washighest comparing theleast value of Kasi Kranti (8.77 q/ha). The interaction of growing season and genotype was found significant positive for capsule length and diameter only.Irrespective of higher seed yield during post-kharif, all seed yields related parameters recorded higher percentage of genetic gainduring pre-kharif. Similarly, most of the traits showed high heritability (broad sense) except capsule diameter and capsule per plant during post-kharif. Correlation data also reported significant association to seed per capsule with seed yield. On considering of heritability, genetic advance and correlation, it isreasonable to infer that seed per capsule itself gives highest contribution to improve seed yield.

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Genotypic variability in yield attributing seed traits in okra [*Abelmoschus esculentus* (L) Moench]

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An investigation investigation was carried out at Research Farm (C-Block) of Bidhan Chandra Krishi Vishwavidyalaya, Kalyani during post-kharif, 2022 with the objective to study phenotypic variations in seed yield attributing characters. The eight genotypes of okra collected from various sources weregrown in randomized block design (RBD) with three replication and observations were recorded on days to first flowering, days to 50 percent flowering, plant height, capsule length, capsule diameter, seeds per capsule, capsules per plant and seed yield. Analyzed data revealed that there were significant differences in seed yield related parameters among the genotypes. Days to first and 50 percent flowering was found earlier in Hisar Unnat considering 42.67 and 46.67 days respectivelywhich were extended in Gujrat Okra-5 (49.67 days) for first flowering and Arka Anamika (53.00 days)for 50% only. Maximum 100 seed weight was recorded in Arka Anamika (7.62g) followed by Pusa Bhindi-5 (7.58g) and minimum in Kasi Pragati (5.91g). Highest seed yield was reported in genotype Arka Anamika (13.96 q/ha), followed by Hisar Unnat (13.12 q/ha) and minimum in Pusa Bhindi-5 (10.12 q/ha).Correlation data showed that Seed yield per plant hadsignificant positive association with capsule length and seeds per capsule, whereas it exhibited significant negative association with days to first flowering. The 100 seed weight, capsule diameter and capsules per plant show non-significant positive correlation where, asplant height and days to 50 percent flowering show non-significant negative correlation. This suggests that the two attributes have a strong influence on seed yield. Path coefficient analysis revealed that seed per capsule had the highest direct effect on seed yield indicating highest heritability and genetic advance.Hence, number of seed per capsule is the main determiners for qualitative and quantitative improvement ofthe okra genotypes.

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Weed management in summer sesame sown before and after irrigation

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A field experiment was conducted during the pre-*kharif* season of 2020 at Agricultural Farm of the Institute of Agriculture, Visva-Bharati, West Bengal with sesame variety 'Rama' to study the weed growth and productivity of summer sesame sown before and after irrigation with different weed management practices. Two methods of sowing comprising of sowing after pre-sowing irrigation (soil mulching) [M_1] and sowing followed by irrigation [M_2] were allocated in the main plot and six weed management practices viz. W_1-pre-emergenceapplication of pendimethalin at 1.0 kg ha^{-1}, W_2-early post-emergence (PoE) application of fenoxaprop-p-ethyl at 60 g ha^{-1} at 18 DAS,W_3-pre-emergence application of pretilachlor at 450 gha^{-1}, W_4-early PoE application of propaquizafop at 60 g ha^{-1} at 18 DAS, W_5-untreated control and W_6-weed free check in sub-plot in a split-plot design replicated thrice. The grassy, broadleaved, sedge and total weed density and biomass at 45

DAS was 24.39 and 27.63%, 25.86 and 21.79%, 19.84 and 23.61% and 24.70 and 25.18% lower under M_1than M_2, respectively. W_4 and W_2 registered lower density and biomass of grassy and total weeds at 45 DAS. Seed yield of sesame under M_1 was about 12.99% higher than M_2. Seed yield was the highest with W_2 which was statistically on par with W_1 and W_4. The treatment M_1W_2 fetched the highest gross return, net return and return per rupee invested. So, M_1W_2 or M_1W_4 appeared as effective in terms of weed control, yield, gross and net return of sesame in lateritic soil of West Bengal.

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Identification of resistant sources against anthracnose disease of chilli under both field and artificial conditions

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Chilli (*Capsicum annuum* L.) is a remunerative vegetable, spice cum cash crop worldwide. Chilli is grown in tropical and sub-tropical climates. Among the fungi, *Colletotrichum capsici* cause the most devastating anthracnose disease of chilli in India. It causes pre- and post-harvest fruit rots and reduces their quality and marketability. About 53 chilli genotypes were screened for anthracnose disease resistance during autumn-winter season, 2020-21. The disease development started at 3 days after inoculation (DAI) but 9 DAI was found to be more appropriate for recording disease severity. Anthracnose symptoms were visible in both matured green and red ripened fruits and the disease resistance was assessed by using 0-5 disease severity scores. Screening results revealed four resistant (BCCH Sel-4, Chilli 38-Ragi, Pant C-1 and Chinese bona), seven moderately resistant, five susceptible and thirty-sevenhighly susceptible genotypes under both field and artificial inoculation conditions against *C. capsici* pathogens causing anthracnose disease. Hence, the newly identified resistant genotypes can be recommended as donors in the breeding program for anthracnose resistance in chilli.

AISDGONF/ABS/TD/285

Residue kinetics of the insecticide pymetrozine in soil

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Soils are the most diverse and complex ecosystem providing humanity with 98.8% of the food. It is also considered as the ultimate sink of the pesticides applied for crop protection. The pesticide Pymetrozine is used in rice fields for control of aphids and whiteflies. In India, two formulations of Pymetrozine (50% WG) are registered for use in Paddy. The present study was conducted for risk assessment of Pymetrozine residues in new alluvial and red lateritic soils under laboratory conditions in the Department of Agricultural Chemicals, BCKV, West Bengal. Pymetrozine was applied in both the soils @ 0.75 µg/g (T_1) and 1.50 µg/g (T_2) followed by its residue analysis at 0, 1, 3, 5, 7, 10, 15 and 30 days intervals using liquid chromatography with tandem mass spectrometry (LC-MS/MS). The initial residue of pymetrozine (0.61-1.50 µg/g) was dissipated by more than 95% after 15 days of application which reached below LOQ (0.02 µg/g) after 30 days. Statistical interpretation of data revealed the first order reaction kinetics of the pymetrozine

residues. Dissipation rate was higher in new alluvial soil than the red lateritic soil. Calculated half-life value was lower in new alluvial soil (2.85-2.88 days) than the red lateritic soil (3.12-3.47 days). The observed pH value (7.25), organic carbon content (0.65%) and water-holding capacity (92%) was significantly higher in new alluvial soil compared to the red lateritic soil. The study revealed the significant effect of soil physico-chemical properties on dissipation kinetics of Pymetrozine residues in soil.

AISDGONF/ABS/TD/306

Screening salinity tolerance lentil and expression analysis of *NHX1* gene

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Lentil, a most important pulse crop of India, is highly affected by the salinity stress. Around 6.727 million ha area in India, which is around 2.1% of geographical area of the country, is salt-affected which shows that the present trend of degradation continued, the projections are that India will have 11.7 M ha area affected by soil salinity and alkalinity (2025). Vast area under rice fallow in the coastal areas of Bengal can be a potential area for lentil expansion.Thus, this study compared the seedling and reproductive salinity tolerance among a set of early duration high yielding genotypes, suitable for a short-season growing environment. Based on shoot water content and seedling vigour index, BM6, NDL11-1, BM7 showed seedling tolerance but seed yield performance of NDL11-1 and BM7 is not as good as BM6 in the saline coastal fields. Seedling tolerance indices, either in the glass plate experiment or in the saline field is not correlated with seed yield potentiality in the coastal saline field. So, it is hypothesized that two different sets of genes are responsible for seedling and reproductive tolerance in lentils. The lentil genome carries three NHX1 genes but only one showed salt responsive expression. Salt responsive higher transcript availability of Na^+/H^+ antiporter gene, NHX1, in a tolerance line confirm the partitioning of toxic Na^+ ions from cytosol to vacuoles has a role in tissue tolerance of lentil.

AISDGONF/ABS/TD/307

Multiple stress gene pyramiding for abiotic and biotic stress in rice through marker-assisted backcross breeding

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Rice production is adversely affected due to biotic and abiotic stress, which limits global rice production. The best way to alleviate this issue is to evolve resistant cultivars. However, targeting a single resistant gene quickly results in the breakdown of that resistance. In addition, rapid climate change triggers the increasing impact of biotic and abiotic stress on rice production. The conventional breeding program aimsat the development of resistant varieties that provide wide-scale protection from different types of biotic and abiotic stress simultaneously by pyramiding multiple resistant genes. Although scientists have significant success in the field of breeding by employing conventional approachesthese techniques are very time-consuming, expensive, and labor-intensive and it is ineffective since plants are mostly selected based on their morphological characteristics. Recently the advancement of molecular tools has initiated a new revolution in the

genomic era which has overcome most of the limitations of conventional breeding. This presentation will focus on the pyramiding of 7 major quantitative trait loci (QTLs) that control two abiotic stress and three biotic stresses from different donor parents into a recurrent parent using Marker Assisted Selection. This strategy is strongly believed to increase productivity and maintain the food security of India.

AISDGONF/ABS/TD/308

Genotypic and seasonal variation for hard seededness and related physiological parameters in mungbean [*Vigna radiata* (L.) Wilczek]

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Mungbean [*Vigna radiata* (L.) Wilczek] is considered as one of the important sources of dietary protein. Seeds of many leguminous crops are affected by physical dormancy often known as hard seededness. It causes failure of seed germination and also leads to non-uniform seedling establishment. Hard seededness is controlled by genetic factors and its expression is also governed by environmental factors.The present experiment was envisaged to study the genotypic and seasonal variation in mungbean genotypes for hard seededness alongwith studies on few important biochemical parameters in selected contrasting genotypes for this trait. Thirtyseven genotypes were sown on 17thAugust, 2021 for *kharif* season and on 30thMarch, 2022 for summer season in randomized block design with three replications.Screening of genotypes for hard seededness was done in the laboratory by petridish method maintained at 28°C and relative humidity of 80±1 %. The results indicated that the occurrence of hard seeds in summer season was considerably low as compared to *kharif* season.The genotypes also showed considerable seasonal variations for other morpho-physiological characters like seed germination, pod wall thickness, pod and seed imbibition, shelling percentage, size and density of seed. KM-21-136 and BCM-20-2 consistently recorded very low or no occurrence of hard seeds in both the seasons, while the genotype KM-21-140 with very high percentage of hard seeds resulted in poor germination.Percentage of hard seed showed negative correlation with the activity of amylase enzyme at 24 and 48 hours of germination, while it registered positive significant correlation with seed coat phenol.

AISDGONF/ABS/TD/309

Evaluation of ginger (*Zingiber officinale* Rosc.) germplasms for its growth, yield and quality in New Alluvial Zone of West Bengal

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Ginger is an important spice crop widely grown in India and different parts of the World for culinary purposes and medicinal uses as well. Varieties of genotypes were available in the different growing areas of ginger, which needs tobe evaluated in other growing areas for better yield and quality. An experiment was conducted to evaluate the ginger germplasm for its growth, yield and quality parameters at Horticulture Research Station, Mondouri, Bidhan Chandra Krishi

Viswavidyalaya, Mohanpur, Nadia, West Bengal during 2019-2021. Experiment was laid out in Randomised Block Design and replicated thrice. Eighteen germplasms of ginger collected from different parts of India were evaluated under this experiment in the new alluvial zones of West Bengal. Recommended cultural practices for the area was followed and accordingly recommended dose of fertilizers were applied. Rhizomes were treated before planting in the field during end of April. Recommended plant protection measures were also undertaken in the field, as and when necessary. Important growth and yield attributes *viz.*, plant height, number of leaves, leaf area, tillers per clump, fresh rhizome yield per hectare, dry recoveryand quality parameters like essential oil and oleoresin were recorded. The result revealed that cv. Gorubathan has recorded maximum plant height, number of leaves and dry recovery. Whereas cv. Surabhi recorded maximum number of tillers, rhizome yield, essential oil and oleoresin content followed by Hui local. Maximum leaf area was observed in Hui local. The studyshowed that the genotypes namely Surabhi, Gorubathan and Hui local produced the overall better performance in terms of growth, yield and its quality among the germplasmsunder New alluvial Zone of West Bengal.

AISDGONF/ABS/TD/310

Physiological approach for studying the variation in mungbean genotypes for toleranceto pre-harvest sprouting

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Mungbean [*Vigna radiata* (L.) Wilczek] is considered as one of the important pulsesglobally.Short spells of rain and high relative humidity during pod maturity, leads to pre-harvest sprouting (PHS) of seeds, resulting in reduced yield and quality of seed in this crop. Nearly 60-70% of yield losses have been reported in mungbean due to pre-harvest sprouting. The present experiment was envisaged to study the genotypic variation in mungbean genotypes forPHS tolerance and its related parameters alongwith studies on few important biochemical parameters in contrasting genotypes. Twenty-six genotypes were grown in spring 2022in randomized block design with three replications. Screening of genotypes for PHS was done in the laboratory by providing inducive condition for PHS to the mature pods. The results indicated that PHS varied from 1.02 to 51.26% among the genotypes. The genotypes also showed considerable variations for other morpho-physiological characters related to PHS. SPM-22-58, 63, 64, and 74scored low level of PHS, while SPM-22-57, 65, 73and 79 registered high mean values of PHS.In general, the genotypes having low PHS showed high content of total phenol in pod wall and seed coat and high activity of α-amylase enzyme in germinating seeds.

AISDGONF/ABS/TD/312

Biochemical and bioinformatical characterizationof two enzymes involved in lignin biosynthesisin *tossa* jute

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The ligno-cellulosicjute fibre is very popular for it's commercial uses. The fibre is not only cheap, but it is also biodegradable and renewable in nature. Lignin is a polymer which is important for the plants' mechanical support and defense. Higher amount of lignin in jute fibre makes it coarse, creates difficulties in fibre separation and lowers the quality. The aim of the present work was to assay two enzymes, Phenylalanine Ammonia Lyase (PAL) and Cinnamyl Alcohol Dehydrogenase (CAD) which are involved in lignin pathway and bioinformatically characterize these two genes. Here, two *tossa* jute varieties named JRO 524 with coarser fibre and JBO 1 with finer fibrewere selected. The acid detergent lignin contents were estimated and the PAL and CAD enzymes were assayed from the fibre samples of those two varieties at 30 and 60 Days after germination (DAG). The fibre of JRO 524 had significantly higher acid detergent lignin content as well as more activities of both PAL and CAD enzymes compared to JBO 1 at two growth stages. The amino acid sequences of PAL and CAD genes of *Corchorus olitorius* were retrieved, their molecular properties were estimated and phylogenetic analysis were carried out with the same proteins of various other species for understanding the evolutionary relationship with other species. Based on the result, it can be assumed that both PAL and CAD gene can be used as targets for lowering lignin content in jute.

AISDGONF/ABS/TD/313

Infection and transmission of seed-borne pathogen

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In agricultural crop technology the mechanism of transmission and infection of seed-borne pathogen is a significant aspect. Seeds are reservoirs of nutrients (carbohydrates, proteins, and minerals) and play a primary role in the production of crops. Seed plays an important role in association with microorganisms that cause hazardous effects on the new plant that it produces. The important seed-borne pathogens are fungi, bacteria, nematodes, viruses, etc., which survive by using the nutrients of seeds and attack the seeds at various stages of development. They may present on seeds either externally or internally and cause infection during or before germination. Seed-borne pathogen as concomitant contamination as sclerotia, fungal cells, bacterial ooze, galls, soil particles, etc., are attachedwith the seeds. When the infected seed has grown, the infection will transfer to the roots then the infection canspread within the plant. Seed-borne pathogens usually cause harmful losses in agricultural crop production as well as in humans. Most of the fungal pathogen produces mycotoxins in the infected seed that cause deleterious effects on the human population. Several factors such as pathogen inoculums, host genotypes, and environmental factors play a necessary role in the infection by a seed-borne pathogen.

AISDGONF/ABS/TD/314

Integrated weed management strategies in jute crop

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A field experiment was conducted to study the performance of integrated weed management strategies in jute crop at the Mandouri Teaching Farm of BCKV, Nadia, West Bengal during *pre-kharif - kharif* season of 2022. The experiment was laid out in a RBD design with three replications comprising the treatment combinations as: T_1 – Post emergence spraying of Quizalfop ethyl 10% EC @ 38g/ha at 15 DAE + one hand weeding (HW) at 30 DAS; T_2 – Pre-emergence spraying of Pendimethalin 35% EC @ 525 g/ha (48 hrs after sowing with irrigation or sufficient rain) + one hand weeding (HW) at 15 DAE; T_3 – Jute + mung intercropping (1:1); T_4 – Jute + red amaranthus intercropping (broadcasting of red amaranthus seed @ 10 kg/ha in inter-row space of jute); T_5 – Mulching with rice straw @ 7.5 t/ha + one hand weeding (HW) at 15-21 DAS; T_6 – Nail weeder at 4 & 8 DAE (soil moisture must be at FC) + scrapper at 21 DAE; T_7 – Unweeded check; T_8 – Two hand weeding (HW) at 15-20 DAE and 35-40 DAE and the sowing was done on 27.04.2022. The dominant weed species of the experimental field were grasses namely *Cynodon dactylon, Echinochloa colona, Digitaria sanguinalis, Eleucine indica,* sedges namely *Cyperus rotundus, Cyperus difformis* and broad leaves namely *Alternanthera sessile, Cleome viscose, Digera arvense, Phylanthus niruri, Physalis minima, Sida acuta, Sida rhombifolia, Solanum torvum, Ocimum gratissimum etc.* Almost all the growth and yield attributing characters of jute crop were significantly influenced by the adopted treatments. The highest plant height (324 cm), basal diameter (1.53 cm), plant population (2,92,000.00 nos/ha), green weight (29.56 t/ha), fibre yield (2.50 t/ha) and B:C ratio (1.56) was recorded in T_8 treatment and was closely followed by T_6 treatment. The said treatments were statistically at par with the T_5 treatment. Among chemical treatments, T_2 showed better result. The maximum WCE being, 71.11 was recorded in T_8 treatment and was followed by 50.19 under T_6 treatment.

AISDGONF/ABS/TD/315

Applied mutagenesis to develop YVMV resistance in okra (*Abelmoschus esculentus* L. Moench)

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Wide variability does not exist in okra [*Abelmoschus esculentus* (L.) Moench], requiring induction of genetic variability. The present investigation was outlined for applied mutagenesis in the variety Pusa Sawani having excellent fruit quality but highly susceptible to YVMV disease. Seed germination/seedling emergence and seedling growth were evaluated under laboratory and field conditions by imposing 300 to 1000 Gy gamma radiation to determine median lethal (LD_{50}) and median growth reduction (GR_{50}) doses with Co^{60} gamma rays. The LD_{50} and GR_{50} doses varied for both growing conditions. The LD_{50} and GR_{50} doses of gamma radiation determined under field condition exhibited close correspondence and presented a reliable picture regarding lethality and injury in the M_1 generation. The R^2 for the linear model for seedling emergence, shoot and root length, fresh and dry weight of seedlings under field condition were 0.908, 0.902, 0.911, 0.983 and 0.972, respectively. Radiation dose should be optimized through use of LD50 and GR50 under field condition and the dose between 350 Gy and 450 Gy was optimum. Two selected putative mutant families in the M_5 generation *viz*., 350//10///3-9////28 and 450//66///2-4////39 showed resistance to yellow vein mosaic virus disease. Five characters *viz*., plant height (cm), branches per plant, fruit diameter (cm), fruit weight (g) and trichome density of fruits differed significantly among the two putative mutants and Pusa Sawani. Content of ascorbic acid and total phenol and activity of two enzymes viz, peroxidase and polyphenol oxidase in leaf was high the two promising putative mutants which deserve due attention to be developed as a YVMV resistant variety or to be utilized as resistant genetic resources in future breeding programme of okra for resistance to YVMV disease.

AISDGONF/ABS/TD/316

Effect of Teflubenzuron 75 g/L + Alphacypermethrin 75 g/L 150 SC against fall army worm (*Spodoptera frugiperda*) in maize

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One of the most destructive insect pests on maize worldwide is the fall armyworm (FAW), *Spodoptera frugiperda* (Smith) (Noctuidae: Lepidoptera). Recently so many chemicals are spraying to control the FAW from damaging the maize crop but few are reported to control FAW properly. The present study was conducted to evaluate bio-efficacy of four different concentrations of Teflubenzuron 75g/l + Alphacypermethrin 75g/l 150 SC (200, 300, 400 and 500 ml/ha) during *rabi*, 2019-2020 and kharif, 2020 against fall army worm on maize. The premix formulation of this

chemical @ 500 ml/ha gave highest larval population reduction (84.69-81.13 %), lowest leaf damage scoring (1.06-0.83 at 10 days after 2nd spray), highest green cob yield (147.67-133.00 q/ha) and satisfactory adult coccinellids (1.67-2.00/5 plants at 10 DAS) for both season of trials. The other two next lower doses i.e. @ 400 and 300 ml/ha of the said chemical were also good and they were followed by Thiamethoxam + Lambda cyhalothrin 9.5 % ZC @ 125 ml/ha. Considering best result from the present experiment, the premix formulation of Teflubenzuron 75g/l + Alphacypermethrin 75g/l 150 SC @ 500 ml/ha may be recommended to use by the farmers to combat *S. frugiperda* in maize.

AISDGONF/ABS/TD/373

Control of post-harvest anthracnose and stem end rot disease of mango fruits (*Mangifera indica* L.) by some yeast based bio-formulations along with hot water treatments

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Anthracnose of fruit caused by *Colletotrichum gloeosporioides* and stem end rot caused by *Botryodiplodia* sp. are the important post-harvest diseases of mango. An experiment was conducted with an aim to reduce post-harvest loss of mango due to anthracnose and stem end rot using healthy and environmentally safe bioformulations of two yeasts (YDP27 and YDP41) along with post-harvest hot water treatment at 52°C for 10 minutes. YDP27 and YDP41 reduced the radial growth of *Colletotrichum gloeosporioides* on laboratory culture medium by 12.93% and 15.52%, respectively and also reduced the radial growth of *Botryodiplodia* sp. on laboratory culture medium by 3.03% and 39.39%, respectively. YDP27 and YDP41 were formulated with different ratio of *Aloe vera* juice along with NaCl, Sorbitol and Ascorbic acid as additives. The yeast bioformulations were applied as pre harvest spray @ 10 ml/lit at 30 days before harvest followed by post-harvest hot water treatment at 52°C for 10 minutes with or without combination with post-harvest dipping in yeast bioformulations. The pre and post-harvest application of yeast bioformulations along with post-harvest hot water treatment at 52°C for 10 minutes successfully reduced the incidence and severity of post-harvest anthracnose and stem end rot diseases of mango compared with the fungicide treatment (Hexaconazole @ 0.1%). The findings of the present experiment indicates the high potentiality of yeast bioformulations to minimize plant diseases particularly under post-harvest transport and storage condition and could be developed further as safe and alternative plant disease management strategy.

AISDGONF/ABS/TD/374

Genetic evaluation and selection of sunflower hybrids (*Helianthus annuus* L.) based on economic heterosis

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Sunflower (*Helianthus annuus* L.), known as 'Surajmukhi', is a member of the crop family Compositae and is the third major oilseed crop in the world after soybean and rapeseed & mustard. Due to its high poly unsaturated fatty acid (PUFA) and vitamin E content, sunflower oil is considered premium. However, the crop's area, production and productivity are low because of the lack of high yielding hybrids/ varieties. To address this, the present study was conducted on sunflower at Teaching Farm, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia in two consecutive years 2020-21 & 2021-22 for selecting high yielding hybrids on the basis of yield related traits and economic heterosis analysis from 33 experimental sunflower hybrids developed at AICRP-Sunflower, Nimpith centre (ICAR-IIOR, Hyderabad). The experiment was designed in RBD with three replications. The economic or standard heterosis of the newly developed hybrids is of prime importance for its adoption by farmers. The present attempt has been made in the estimation of economic/standard heterosis for oil yield. The results of the Economic heterosis study indicates that the research work should be focused on the development of new high yielding stable sunflower hybrids which might be based on the hybridization between the best combiner.From the study of economic heterosis,the national check hybrid, LSFH-171 was outperformed by the hybrid CMS-103A x R-6D-1 in terms of seed yield, however, higher oil contentandoil yield (kg/ha) were also seen in CMS-38A x R-297, CMS-103A x R-6D-1, P-89-1A x R-1-1, CMS-302A x R-297, CMS-38A x TSG-289 and CMS-38A x EC-603021. The results indicated the superiority of CMS-38A, P-89-1A, TSG-289, R-1-1, EC-603021 over the parents for improved oil content trait in sunflower under present study. Therefore, the said sunflower hybrids may be selected for Sate Multilocation Trial for further evaluation of their yield performance in different Agro Climatic region of West Bengal.

AISDGONF/ABS/TD/375

Physico-biochemical properties of a few aromatic rice landraces of the eastern India

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Traditional non-Basmati short-grain aromatic rice landraces of India have gained increasing interest and preference of the consumers for their impressive aroma and soft consistency after cooking. The present experiment was aimed at evaluation of the nutritional and antioxidative properties of a few selected aromatic rice landraces with coloured husk, cultivated in the eastern India. The kernel and bran of the harvested grains of the landraces 'Kalojira', 'Kalonunia', 'Tulshibhog' and 'NC365' (WB), 'Kolajoha' (Assam) and 'Cha-khao' (Manipur) were analyzed for the different indexes related to their physical (hulling%, milling%, head rice recovery%, colour

quest, length-width ratio) and cooking quality (alkali spreading value, volume expansion, aroma, kernel elongation) and also for the nutritional and antioxidative properties. The range of values obtained from the analyses of the kernels for the nutritional quality indexes (%) *viz*., starch (44.22-91.47), amylose (5.6-28.8), protein (5.76-7.74) & fiber (1.6-2.3); microminerals (ppm) *viz*., Fe (107.33-177.88), Zn (16.6-43.32) and those for the antioxidant principles *viz*., free (0.73-8.33) & bound (1.28-9.58) phenols (mgTE/g) revealed significant genotypic variation. The brans exhibited comparatively higher range of values for protein (7.87-8.97%), Fe (217.71-291.18 ppm), Zn (86.91-136.33 ppm), fiber (3.3-4.9%) and phenol (free: 6.54-18.82 & bound: 2.32-18.74 mg TE/g), and also contained 0.36-2.28 and 1.22-2.79 mgTE/g of free & bound flavonoids respectively with none in the kernels. Analysis of the antioxidant activity under three different assay systems (DPPH, FRAP & ABTS) produced values with significant variations in both kernel and bran. Important significant correlations were found between paired variables. Following PCA 'Kalojira' was found most promising among the six landraces studied considering both the kernel and bran properties.

AISDGONF/ABS/TD/376

In vitro evaluation of Antioxidants and Nutritional components of wild medicinal mushroom *Ganoderma* spp./ isolates from West Bengal

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Ganoderma is a genus of wood decaying polypore fungi of economic importance. *Ganoderma* P. Krast is one of the most popular mushrooms in oriental medicine (Stamets, 2001). In this present work, wild macro fungi *Ganoderma* spp. from West Bengal was studied about its phytochemical and potential food additives, namely antioxidants activities and their nutritional properties. The total phenolic contents of *Ganoderma* isolates experimented ranged between GDA17 and GDM8 (30.48mg and 2.01mg GAE/g dw), the isolates GDJ8, GDH4 and GDHL6 had comparatively higher than the other collected samples whatever, the isolate GDHL6 had the highest content of flavonoids (43.54mg QE/g dw), followed by GDJ8 (22.56mg QE/g dw), and GDM4 (20.83mg QE/g dw), with GDB21 showing the lowest amount of flavonoids (3.13mg QE/g dw), while other studied species had significantly lower and their differences were statistically significant ($p< 0.05$). The highest protein content was observed in the studied isolate GDH4 (16.28 g/100g.dw), followed by GDM8 (15.81 g/100g.dw) and GDHL14 (15.76g/100g.dw), whereas other studied isolates had lower protein content, with GDHL6 showing the lowest amount of protein content (1.41g/100g.dw) respectively and their differences were statistically significant ($p<0.05$). It is clearly indicated that the various solvent extracts of wild mushroom species showed higher amount of antioxidants and nutritional components for use in foods. The mushroom species can be used as an easily accessible source of natural antioxidants and their nutritional values as a possible food supplement or in pharmaceutical industry.

AISDGONF/ABS/TD/377

Occurrence and distribution of entomopathogenic nematodes from West Bengal and their pathogenicity against insect pest

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A study was carried out for the isolation and identification of entomopathogenic nematodes (EPNs) along with their occurrence and distribution in the three different agro-climatic zones of West Bengal, India. A roving survey was conducted in 11 districts from three agro-climatic zones of West Bengal during 2015-2016. Altogether 334 samples we//>.re collected randomly for extraction of EPNs. EPNs were recovered from twenty-four samples of eight districts. The frequency of occurrence of EPNs in different districts of West Bengal varied from 2.8 to 15.5%. The relative frequency of occurrence of *Heterorhabditisbacteriophora*Poinar was 58.7%; in contrast, relative frequency of occurrence of *H. indica*was 37.2% and *Heterorhabditis* sp. (unidentified) was 8.33% in the state. Recovery of both the species of *Heterorhabditis* is the first of its kind from West Bengal. *H. bacteriophora* (WB-1 isolate) @ 50 IJs/larva exhibited 91.2% mortality of *Helicoverpa armigera* after 72h of exposure and the LD_{50} value was 2.57 IJs/larva. In contrast, the mortality of *H.armigera* due to *H. bacteriophora* (WB-2 isolate) and *H. indica* (WB-3 isolate) @ 50 IJs/larva was86.0% and 92.2%, respectively; whereas, the corresponding LD_{50} value of the EPN was 12.10 IJs/larva and 9.31 IJs/larva.

AISDGONF/ABS/TD/378

Study of genetic diversity of some wheat (*Triticum aestivum* L.) genotypes by multivariate analysis

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An experiment was carried out with forty four genotypes of wheat (*Triticum aestivum* L.) collected from CIMMYT, Mexico in Randomized Block Design (RBD) with two replications under late sown condition to determine the genetic diversity existing among these genotypes. Eight different quantitative characters namely plant height, days to 50% heading, days to 50% flowering, 1000g seed weight, spike length, number of effective tillers/ square meter, grains per spike, grain yield/plant were considered for analysing the data by D^2 analysis. The results revealed that the genotypes could be grouped into seven different clusters indicating ample magnitude of diversity present in the experimental materials. The plant height contributed maximum value (28.01%) towards divergence followed by 1000g seed weight (24.31%), spike length (20.40%) and grains per spike (13.95%). Highest inter cluster distance was observed between cluster V & III followed bycluster between III &VII and cluster between IV & VII suggesting the genotypes selected from these clusters can be used for hybridization program to retrieve high potentially desirable lines.The PCA analysis also confirmed the genetic diversity was present among the genotypes.

AISDGONF/ABS/TD/379

Acaricidal resistance and activity of detoxifying enzymes in *Oligonychus coffeae* (Nietner) (Acari: Tetranychidae) on tea

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Regular monitoring of acaricide resistance in economically important plant feeding mites is important for effective management of acarine pest. *Oligonychus coffeae* is one of the most important mite pests of tea and acaricides are frequently used to manage this pest, yet control failures sometimes occur at recommended doses. Hence, bioassay experiments were conducted to confirm whether such control failures were caused by resistance development in populations collected from major tea growing areas of Sub-Himalayan West Bengal, India. The adult females of *O. coffeae*were bio-assayed with commonly used six acaricides *viz.*,dicofol, ethion, fenpropathrin, fenpyroximate, fenazaquin and propargite. Moreover, we estimated the activity of general esterase (GE), glutathione *S*-transferase (GST) and cytochrome P450 monooxygenase in the field collected samples as well as laboratory reared susceptible population. Based on the LC_{50} values, the resistance ratio of the field collected populations compared to the laboratory reared susceptible population varied from 3.29-5.85-fold, 4.13-11.21-fold,12.07-28.28-fold,1.19-1.67-fold,1.12-1.77-fold, 2.73-5.34-fold for dicofol, ethion, fenpropathrin, fenpyroximate, fenazaquin and propargite, respectively. General esterase, GST and MFO activities of the tested populations were in the ranges of 5.69-16.54 mOD/min/mg protein, 91.51-319.91 μM/min/mg protein and 0.040-0.071 mOD/min/mg protein, respectively. The highest activity of enzyme was detected in Naxalbari population which was one of the most resistant populations to all the tested acaricides. The findings will be useful to the tea industry for selection of most effective chemical for successful management of this pest. Use of fenpropathrin and ethion should be discontinued for tea pest management and use of other chemicals having different mode of actions may be continued with rotation.

AISDGONF/ABS/TD/380

Exploring the potential of phytochemicals by *in silico* method for controlling *Xanthomonas campestris* pv. *campestris* in Brassicaceae

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The use of antibiotics in crop production has been associated with acute toxicity, long degradation period, accumulation in the food chain and antibiotic resistance development, making the search for new and eco-friendly alternatives an important area of research. This study aims to investigate the potential of phytochemicals for controlling the plant pathogenic bacteria *Xanthomonas campestris* pv. *campestris* (*Xcc*), which causes black rot disease in plants of the Brassicaceae family. The study consists of several stages, including selection of phytochemicals from literature,

toxicity analysis and molecular docking analysis. 50 phytochemicals were indentified from different plants that have been reported to have antibacterial properties. These compounds were subjected to toxicity analysis to understand their pharmacokinetic and pharmacodynamic properties, as well as their potential toxicity.The selected eco-friendly compounds were docked against the target protein of *Xcc* (DsbB, an effector protein) to understand the protein-ligand interaction and binding energy of the protein-ligand complex. The most potential phytochemicals that can inhibit the growth of *Xcc*were identified through *in silico* method by comparing their toxicity study and molecular docking analysis.The *in vitro* and *in vivo* activity of the potent phytochemicals will be further tested to confirm their effectiveness for controlling *Xcc*.

AISDGONF/ABS/TD/381

Molecular identification of aphid species affecting cowpea (*Vigna unguiculata*)

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Cowpea is an important grain legume crop with high protein content (28%) as well as minerals. It is considered to be a rich man's vegetable and a poor man's meat crop. It is shade-tolerant, fixes atmospheric nitrogen, and works well in a variety of low-input agricultural farming systems.However, among the biotic stresses, aphids hinder cowpea development, growth and production. They primarily infest seedlings, although large populations also infest flower buds, flowers and pods.Due to vectoring of the potyviruses cowpea aphid-borne mosaic virus andblack-eyed cowpea mosaic virus aphid causes significant damage to cultivated cowpea even at low population levels. The viruses induce cowpea mottling, chlorosis, and seed shriveling, which directly decreased yields up to 20% to 40%.Aphid has a complex life cycle with distinctive morphologies, diphenism, social behavior, ability to generate galls in plants, and has tight obligate associations with bacterial endosymbionts; all these reasons make this group of insects intriguing for future study. The intra-ordinal relationships and identification of strains among aphid species is incomplete and quite difficult only by morphological identification, On the other hand, molecular data have provided information that has resolved such problems.In this study DNA was extractedby using CetylTrimethyl Ammonium Bromide method, a fragment sized 658 bp of the Mitochondrial Cytochrome Oxydase I gene was amplified using primersCO1-LepF (5'ATTCAACCAATCATAAAGATATTGG-3') and COI-LepR (5'TAAACTTCTGGATGTCCAAAAAATCA-3') and sequencing was done by Sanger sequencing method for molecular study of Aphid. BLAST results confirmed the species as *Aphis craccivora.*

AISDGONF/ABS/TD/382

Performance of weed management practices on growth, yield and economics of green gram (*Vigna radiata* (L.) Wilczek)

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Pulses are the second most important group of foodgrain crops essential for nutritional security, soil health and sustainable agriculture. The low production and productivity of pulses is mainly due to several biotic and abiotic constraints in which weed is a major biological stress. At present, there is need to develop long-term strategic research for weed management in pulses. A field experiment was conducted at KVK, Ganjam-II instructional farm during *rabi* season of 2019 & 2020 with an objective to evaluate the effect of weed management practices on weed control, yield and economics of greengram by KVK, Ganjam-II. The soil of experimental site was sandy loam in texture having neutral in soil reaction. The experiment was conducted with six treatments i.e. T_1: No weeding,T_2: Hand weeding 20 & 40 DAS, T_3: Pendimethalin @1 kg ai/ha,T_4: Imazethapyr @ 50 kg ai/ha, T_5: Quizalfop-p-ethyl @ 75.00 g ai/ha and T_6: Pendimethalin+ Imazethpayr (Vellore 32) @ 1.00 kg ai/ha and laid out in RBD with 3 replications. The green gram variety used was IPM-2-14. Most of the herbicides were found effective in controlling weeds and maximizing seed yield of green gram. Application of Pendimethalin + Imazethapyr (Vellore 32) @ 1.00 kg a.i/ha at 2 DAS significantly reduced the dry weight of weeds (81.2%) and also provided highest weed control efficiency and was proved practically more convenient and economically best feasible weed management practice for green gram considering the present condition of scarcity and high cost of labours, quality of weed control, yield and B:C ratio of cultivation of *rabi* green gram

AISDGONF/ABS/TD/383

Effect of crop establishment methods and weed management practices on growth and yield of transplanted rice (*Oryza sativa* L.) under coastal and saline belt of West Bengal

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A Field experiment was conducted to evaluate the effect of crop establishment methods and weed management practices on growth and yield of transplanted rice (*Oryza sativa* L.*)* at Instructional Farm, Sasya Shyamala KVK, Arapanch, South 24Parganas, West Bengal during *kharif* season of 2022 in Split-Plot design replicated thrice. Conventional and System of Rice Intensification (SRI) were taken in main plot treatments and Pretilachlor 1000 gm *a.i.* ha^{-1}, Pretilachlor 1000 gm *a.i.* ha^{-1}*fb* one hand weeding at 30 DAT, Na-bispyribac 25 gm *a.i.* $ha^{-1}$and Pretilachlor 1000 gm *a.i* ha^{-1}*fb*Na -bispyribac 25 gm *a.i.* ha^{-1} were taken in sub plot treatments. Pretilachlor 1000 gm *a.i.* ha^{-1}*fb* one hand weeding behaving statistically similar with the weed free plotsresulted in significantly lower total weed count and total weed dry weight. The treatment also recorded the highest plant

height, tillers hill^{-1}, panicle length, grain yield and B:C ratio and the data was at par with weed free plots followed by Pretilachlor 1000 gm *a.i* ha^{-1}*fb*Na -bispyribac 25 gm *a.i.* ha^{-1}. System of Rice Intensification (SRI) recorded the highest grain yield than the conventional system. Ultimately the result revealed that Pretilachlor 1000 gm *a.i.* ha^{-1}*fb* one hand weeding at 30 DAT in System of Rice Intensification was the best treatment combination for reducing total weed population and weed dry weight and increasing grain yield in transplanting *kharif* rice.

AISDGONF/ABS/TD/384

Biopriming and integrated management of major diseases of sesame (*Sesamum indicum* L.) in Coastal Saline Zone of West Bengal, India

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Field trials were conducted for adjudging the effect of biopriming and integrated disease management (IDM) practices in combating root rot and foliar diseases (*Alternaria* and *Cercospora* leaf spot) and in increasing the seed yield of sesame during two consecutive summer seasons of 2020 and 2021 at Agricultural Experimental Farm, Institute of Agricultural Science, University of Calcutta, West Bengal. The results reveled that seed treatment with *Trichoderma asperellum* @ 10 g kg^{-1}, along with furrow application of enriched *Trichoderma* (2.5 kg *Trichoderma asperellum* + 100 kg Vermicompost) @ 250 kg ha^{-1} and spraying of combi-product (Tebuconazole 50% + Trifloxysrobin 25%) @ 0.5 g l^{-1}at 30-35 days after sowing (DAS) and again at 50-60 DAS was found to be significantly effective by recording minimum disease incidence of root rot (17.9%), *Alternaria* leaf spot (10.6%) and *Cercospora* leaf spot (7.5%) coupled with maximum seed yield (586 kg ha^{-1}) with higher benefit:cost (B:C ratio). The module M_2 consists of seed treatment with Carbendazim @ 2 g kg^{-1}, Spray of combi-product (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.5 g l^{-1} at 30-35 DAS and second spray 2 g l^{-1} at 50-60 DAS recorded significantly higher seed yield and B:C than M_1.Not ample research work was carried out particularly on root rot and two fungal leaf spot diseases of sesame in coastal belt of West Bengal. Hence, the findings of present research may throw some light in this black- box of disease management in sesame and provide alternative option like biopriming and IDM for chemical pesticide management in sesame.

AISDGONF/ABS/TD/385

Screening of mungbean [*Vigna radiata* (L.) Wilczek] genotypes against mungbean yellow mosaic virus (MYMV) under field condition

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Mungbean [*Vignaradiata* (L.) Wilczek] is a very important short duration grain legume grown throughout the country. It is a good source of easily digestible proteins with low flatulence, which balances the staple rice diet in Asia. Mungbean yellow mosaic disease (MYMD) caused by whitefly (*Bemisia tabaci*) and transmitted by mungbean yellow mosaic virus (MYMV) which seriously hampers production of mungbean in India. Sixty mungbean genotypes were evaluated to identify the source of resistance against MYMV during *kharif* 2020 and 2021. The per cent disease incidence (PDI) of MYMV among sixty mungbean genotypes was worked out at maturity stage of the crop and it varied from 0 to 98.96%. Out of sixty mungbean genotypes, six were found highly resistant, four were resistant and six were moderately resistant. While, three genotypes were found moderately susceptible, eight were susceptible and thirty three were highly susceptible. Among the six resistant genotypes namely, Ashamung, EC-520029, IPM-5-3-22, IPM-2-19 and KM-21-109 used as donor to hybridize with susceptible genotype Sonamung and developed mapping population to retrive MYMV resistant lines.

AISDGONF/ABS/TD/386

Evaluation of genotypes and variation in grain filling characters under terminal heat stress in wheat [*Triticum aestivum* L.]

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Wheat experiences heat stress to varying degrees at different phenological stages, but heat stress during the reproductive phase, *i.e.* terminal heat stress, is more harmful due to its direct effect on grain number and weight. The present experiment was envisaged to evaluate some wheat accessions for existing variation in terms of grain yield, important reproductive attributes and grain filling pattern in selected genotypes under the terminal heat stress in late sowing condition. Twenty-eight genotypes (including five check varieties) of wheat were sown in November (timely sowing) and December (late sowing) in 2018. From the evaluation studies, two genotypes (NEST 1 and NEST 31) and one check variety (DBW 107) for late sowing were selected for physiological studies on grain development, grain filling rate, grain duration and grain weight in 2019. First year experiment results indicated that late sowing affected majority of parameters. Perusal of data of the second year of experiment revealed that the comparatively higher air temperature during grain filling in late sowing led to significant reduction of individual grain weight, days taken for grain maturity, grain filling duration, grain filling rate and grain yield/spike in the three genotypes of wheat under study. DBW 107 recorded the minimum reduction in grain dry weight under late sowing while NEST 1 registered maximum reduction for this character. The data on lipid peroxidation and chlorophyll content indicated a quicker progress of senescence of flag leaf at higher air temperature during grain filling in late sowncrop.

ASDGONF/ABS/TD/387

Glucosinolates in mustard: A signalling component to biotic stress

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India is anticipated to generate more than 11 million metric tonnes of rapeseed and mustard by the end of the fiscal year 2022. Compared to the prior fiscal year, this was a rise. India generated more than 35 million metric tonnes of oilseeds in fiscal year 2021. The dominant secondary metabolites in cruciferous crops are Glucosinolates, which are anionic thioglycosides rich in sulphur. The glucose group of a glucosinolate is removed by the enzyme myrosinase in the presence of water. The non-sugar component of the molecule, the resultant aglycone, undergoes a rearrangement when the sulphate is removed, resulting in unpleasant and chemically reactive compounds including isothiocyanates and nitriles. The "mustard oil bomb," or hydrolysis by-products created because of cell rupture, acts as a defence against biotic stress. The metabolism of glucosinolates responds to a variety of external and internal factors, including sugar, salicylic acid (SA), ethylene, jasmonic acid (JA), pathogen challenge, herbivore damage, wounding, mineral nutrients, and other phytohormones. Understanding these defence mechanisms may enable us to both transfer the "mustard oil bomb" to crops that donot produce glucosinolates, strengthening their defence and reducing the need for chemical pesticides while also maximising the benefits of this set of natural metabolites for improving pest control in Brassicales crops.

AISDGONF/ABS/TD/388

Identification of superior allele and development of gene based marker for DEP1 gene for rice yield improvement

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After green revolution rice yield has been improved marginally. To feed the increasing global population gene pyramiding is a must for keeping best suited source and sink balance in rice. Several QTLs have been studied for gene identification and as reported earlier an inactive natural mutant of DEP1 gene has shown to increase primary and secondary branch number per panicle leading to improved rice yield. DEP1 gene sequence among 20 diverse rice genotypes comprises of indica, aus and aromatic subtype for primary and secondary branch number has been compared. Total four different allelic forms of DEP1 were identified and two were actually found to change two amino acids at protein level. Patnai-23 DEP1 allele was favorable one based on its amino acid change and lowest transcript availability. A SNP (A/G) present on exon 5 was used to design a PCR based co dominant marker and this marker has been validated in RIL and NIL populations developed by a cross between Patnai23 and N22. Therefore, this allele-specific PCR based marker identified in this study will be useful in the incorporation of yield-enhancing alleles into the background of other genotypes more easily and accurately and the cross compatible landraces with this allelic variant can be used for improving the present day varieties lacking these alleles.

AISDGONF/ABS/TD/389

Morpho-molecular evaluation of segregating lines of *Lathyru*s for low ODAP and resistance to downy mildew

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Grasspea (*Lathyrus sativus* L.) belonging to the family Fabaceae having chromosome number (2n = 2x = 14). India is the largest producer of lathyrus which is one of the most important climate resilient crops that can combat extreme weather and poor soil conditions. The cultivation of this crop is neglected due to the presence of anti-nutritional compound β-N-oxalyl-L-α, β-diamino propionic acid (BOAA), popularly known as ODAP, the causative agent of a paralytic disorder neurolathyrism. Downey mildew, a fungal disease caused by *Perenospora lathyiipalustris* is the another biotic factor responsible for low yield in lathyrus. The present work was aimed to screen out the segregants, from F2 and F3 population derived from two different cross combination, Mahateora x Bio L-212 and Berhampore local x Mahateora, respectively attributed with high grain yield coupled with zero/negligible ODAP content and resistance to downy mildew. Simple Sequence Repeats (SSR) marker-based assessment was done for parents and segregating populations in search of trait associated marker. A total of 30 EST-SSR were used for screening for association with ODAP and /or downy mildew. From the study, a total of seven promising lines showed low ODAP content (≤0.1%) and six lines were identified having resistance to downy mildew with respect to the percent disease incidence (PDI). Based on highest seed yield/plant (>20 g), low ODAP (≤0.1%) and PDI (<12%), four most promising segregants of F3 were identified. Two EST- SSR markers were found putatively associated with low ODAP content from both F2 and F3 population. Also, in F3 two markers showed association with downy mildew resistance.

AISDGONF/ABS/TD/390

Impact of etoxazole on two-spotted red spider mite (*Tetranychus urticae* Koch) and its natural enemies in brinjal ecosystem

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Brinjal (*Solanum melongena* L.), an important vegetable crop of West Bengal, is attacked by several pests; among which, two-spotted red spider mite is important one. Spider mite, *Tetranychus urticae* Koch. Is one of the most destructive pests causing severe damage in brinjal. Therefore, management of this mite pest is urgent to secure the qualitative and quantitative yield of brinjal. Therefore, bio-efficacy of a new age acaricide molecule, etoxazole was tested against the red spider mite. In order to conduct the study, a field experiment was set upin the District Seed Farm, BCKV, Kalyani on brinjal cultivar Muktakeshi during Kharif, 2018-19. The study was conducted considering eight treatments replicated thrice in Randomized Block Design. Five doses of etoxazole 10% SC (w/w), one dose of fenpropathrin 30% EC, and one dose of fenazaquin 10% EC were sprayed twice during the season including one untreated check plot. Observations were taken before spraying to collect the pre-treatment population data, and after spraying the counts were taken at 1, 3, 7 and 15 days after spray. Statistical analysis of the data revealed that etoxazole

10% SC (w/w) @ 800 ml/ha was the most effective to suppress the populationof red spider mite. No mortality of predatory mites and phytotoxic effect of etoxazole was observed at the aforementioned dose. On the contrary, fenazaquin and fenpropathrin caused severe mortality of the predatory mite fauna.

AISDGONF/ABS/TD/391

Chemical management of sheath rot disease complex in rice

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Sheath rot disease of rice is now getting momentum as an important rice production threat. Major pathogens associated with rice sheath rot are fungi such as *Sarocladium oryzae* and *Fusarium* sp. belonging to the *Fusarium fujikuroi* complex. Sheath rot infection results in chaffy, discoloured grains and affects the viability and nutritional value of seeds. Most of the time, panicle mite infestation is also found to be associated with sheath rot disease. A field experiment was conducted during 2018-19 and 2019-20 for the management of rice sheath rot complex with fungicides alone and in combination with acaricide at AICRIP, RRTTS, Chiplima, Odisha, India. The experiment was laid out in Randomized Block Design with nine treatments and three replications. The testing chemicals were applied twice; first at panicle initiation stage and 15 days after the first spraying as foliar spray. Among the different chemicals tested against sheath rot disease, seed treatment with carboxin + thiram @ 2 g/kg seed along with spraying of propiconazole 25 EC @ 1 ml/l followed by fenpyroximate @ 1 ml/l twice at 15 days interval starting from panicle initiation stage was effective in reducing sheath rot disease incidence by 67.6 %and increasing the yield by 35.3 % over control with highest BC ratio (2.24).

ASDGONF/ABS/TD/392

Cultivar-specific mono-phasic protocol development for micropropagation of indigenous potato and their genetic fidelity assessment

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Potato (*Solanum tuberosum* L.) is an herbaceous temperate crop belonging to the family Solanaceae. It is monitored as a critical food security crop due to its consumption as an alternative to many cereals in low resourceful areas. Beside the popular genotypes, multiple indigenous cultivars of potato (e.g., Ambari, Pilak, etc.) are highly rich in nutrients and have an untapped source of wild genes; nonetheless these are cultivated in patches only in North-Eastern region of India. There is a need for interventions to bring these cultivars into mainstream cultivation. Modern plant tissue and organ culture techniques can be used to improve these cultivars and commercialize their production. On this backdrop, cultivar-specific mono-phasic protocols for micropropagation and assessment of the genetic fidelity of the *in vitro* regenerants were established for the first time. Multiple shoot and root formation were achieved simultaneously in Murashige and Skoog (MS) medium with addition of 0.5-1.5 mg/l 6-benzyladenine (BA), kinetin, *meta*-Topolin (*m*T), thidiazuron, or zeatin along with 1-3 mg/l indole-3-acetic acid (IAA) or

indole-3-butyric acid (IBA). Higher concentrations of *m*T and IBA showed promising results for mono-phasic shoot-root formation of Ambari cultivar whereas, that of kinetin and IAA showed the best results for Pilak cultivar. The *in vitro* regenerated plantlets were acclimatized in cocopeat with around 90% survival. To ensure the true-to-type nature of the plantlets, molecular markers-based genetic fidelity assessment using inter simple sequence repeats (ISSR), start codon targeted (SCoT) polymorphism, conserved DNA-derived polymorphism (CDDP), and directed amplification of minisatellite-region DNA (DAMD) primers were carried out. Not a single instance of genetic variation was found between the mother plant and the *in vitro* regenerants. The present protocols would be of high commercial importance as this will be first of a kind report for these two indigenous cultivars.

AISDGONF/ABS/TD/393

Combining ability study for yield traits in cucumber (*Cucumis sativus* L.)

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Cucumber, an ideal summer vegetable crop is chiefly grown as an edible tender fruit. The genetic improvement of yield and its contributing characters are largely depending on the study of general combining ability (GCA) of the parents andspecific combining ability (SCA) of the hybrids. GCA in respect to characters is the manifestation of additive gene action for the selection of parents, while SCA in respectto a particular character is the capitalization of non-additive gene action in the hybrids.The combining ability of parents depends upon the nature of the genetic system operating in the parent, which predicts the efficiency of selection. The materials for the present investigation comprised Twenty monoecious cucumber genotypes collected from different parts of India exhibited wide range of variations in seventeen quantitative traits. Based on D^2 statistics, *per se* values and desirable fruit characters, seven diverse parents namely, BCCU-1, BCCU-3, BCCU-4, BCCU-7, BCCU-12, BCCU-13, BCCU-16 were selected and crossed in half diallel fashion.Combining ability analysis was performed according to Model - I, Method - II proposed by Griffing (1956). On the basis of gca effects, two parents BCCU-3 and BCCU-12 appeared consistently superior in respect of fruit yield per plant and other important horticultural traits including tolerance against downy mildew, and could be used as potential donors in future breeding.The estimates of *sca*effects revealed that the cross combinations BCCU-3 × BCCU-16 and BCCU-1 × BCCU-12 were observed most promising for fruit yield per plant along with PDI of downy mildew and some of yield related traits where both of the cross combination involved one of the parents as good general combiner for fruit yield per plant and other desirable horticultural traits.These parents and cross combinations could be exploited commercially for the development of hybrids/ varieties in cucumber.

ASDGONF/ABS/TD/394

Eco- friendly management of collar rot of chilli (*Sclerotium rolfsii*)

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Chilli is one of the most important vegetable and popular for its pungency, colour, aroma, and flavour. The collar rot of chilli (*Sclerotium rolfsii* Sacc) is one of the important diseasewhich causes up to 16- 80 % yield reduction. Management of this disease is difficult due to soil borne nature and wide range of hostof the pathogen. Keeping these in view, an experiment was undertaken to evaluate the effectiveness of disease management strategies involving bio-control agent and organic amendment.The trial was conducted at five adoptive villages of North 24 Parganas district namely Mena, Goaldaha, Cola, Janaphul and Ichhapur during kharif season of 2018-19 to 2020-21 to find out the beneficial disease management module for collar rot of chilli. The farmers were trained to implement the designed treatment details along with standard agronomic practices as **Farmers' practice:** No use of biological pesticide for seed and seedling treatment, soil application of organic resources; **Technology Option I:** Seed treatment with *Trichderma viride*and garlic bulb extract + seedling treatment with *Trichderma viride* + soil application of neem cake (15g/pit) and *Trichderma viride* (5g/pit); **Technology Option II:** Seed treatment with *Trichoderma harzianum* and garlicbulb extract + seedling treatment with *Trichoderma harzianum*+ soil application of neem cake (15g/pit) and*Trichoderma harzianum*(10g/pit); **Technology Option III:** Seed treatment with*Trichderma viride, Trichoderma harzianum*and garlic bulb extract + seedling treatment with *Trichderma viride, Trichoderma harzianum*+ soil application of neem cake (15g/pit),*Trichderma viride (5g/pit) and Trichoderma harzianum*(10g/pit). The data were recorded at 10 days interval and percentage of disease infestation was calculated with the formula - % of I = No. of Plants infected /No. of plants infected in control x 100. The data revealed that the highest chilli yield of 5.32 t/ha along with lowest percentage of disease incidenceof 21.7% and highest B:C ratio of 2.97 was recorded in Technology Option III which might be due to suppression ofgrowth of the pathogens through parasitism, production of antagonistic chemicals, competition for the nutrients and induction of disease resistance in plants.The technology Option III needs more extended area specific trial to observe its greater effectiveness.

AISDGONF/ABS/TD/395

Comparative efficacy of post-emergence herbicide mixes in weed management, yield intensification and economics in summer black gram (*Vigna mungo* L. Hepper)

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Inadequate weed management often makes summer blackgram susceptible to severe yield losses because the shorter crop duration offers limited temporal flexibility to recover from the weed

induced setbacks. Hence, the present experiment was conducted to find aneconomically viable post-emergence herbicide management strategy in summer blackgram. The crop as well as weed growth in response to application of post-emergence herbicides viz. Imazethapyr, Clodinafoppropargyl + Aciflourfen sodium, Propaquizafop + imazethapyr, Quizalofop ethyl + imazethapyr, and Imazamox+ Imazethapyr was studied for two consecutive years in 2020 and 2021 at AB Block farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani. Either ready or tank-mixes of the herbicide formulations were applied on 20 days after sowing. Monocots, especially grasses were the pre-dominant weed flora during the experimental period. Combined application of Propaquizafop or Quizalofop ethyl with Imazethapyr reduced monocot weed density by 37.7-45.0 % compared to weedy check. These herbicide mixes alsorecorded substantially higher weed control efficiency (56.2-70.8%) , weed control index (68.9-76.5 %) and herbicide efficiency index (1.72-2.37) during the crop growing period, which eventually manifested in significantly higher crop yields (1207-1264 kg ha^{-1}). Economic viability of these herbicide mixes was apparent from their improved gross returns: cost of production (2.04-2.20). Thus, ready or tank mix ofImazethapyr with either Propaquizafop or Quizalofop ethyl might be a promising weed management strategy to control diverse weed flora especially grasses in black gram tofavour its inclusion as a summer crop in the grass-limited rice-wheat systems of the tropical Indian plains.

AISDGONF/ABS/TD/397

Elytral polymorphism of *Cheilomenes sexmaculata* (Fabricius), *Harmonia octomaculata* (Fabricius) and *Coccinella septempunctata* (Linnaeus) (Coccinellidae: Coleoptera)

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Ladybird beetles (Coccinellidae: Coleoptera) are a classical group for studying the local and temporal trends in elytral polymorphism within and between the species. The study of polymorphism related to *Cheilomenes sexmaculata* (Fabricius), *Harmonia octomaculata* (Fabricius) and *Coccinella septempunctata* (Linnaeus) was conducted during the year 2021-2022 in Nadia district of West Bengal, India. A large number of specimens were hand-collected from the agricultural crop fields as well as from the forested areas of Nadia district. Eight distinct morphs of *Cheilomenes sexmaculata* and seven distinct morphs of each of *Harmonia octomaculata* and *Coccinella septempunctata* were identified. The different morphs of these three species were identified on the basis of their external characters and the shape of male genitalia. In the study of polymorphism, ladybird beetles has occupied a special position which is related to pattern of dorsal surface of the head, scutellum and elytra. The pattern on the pronotum was similar while the pattern of the elytra was quite variable in all types of the morphs. In its polymorphs, the melanic morphs adjust better in cold condition than the non-melanic forms. Therefore, the changes in the environmental conditions provide an opportunity to the study of morphs. So, polymorphism may explain the relation between different environmental factors and characters of the living organisms. The study of available literature revealed that the information related to polymorphism in the coccinellid beetles in West Bengal is very scanty, with no specific previous record of polymorphism in any ladybird species from Nadia district of West Bengal, India. The present

study documented variable elytral colour polymorphism within *C. sexmaculata, H. octomaculata* and *C. septempunctata* in Nadia district of West Bengal, India.

AISDGONF/ABS/TD/429

Combining ability analysis for yield and its contributing traits in Bottle Gourd [*Lagenaria siceraria* (Molina) Standl.]

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Bottle gourd, a monoecious cucurbit, has prolific bearing habit and low cost of growing options. The tender fruits are variable in size, shape and have considerable genetic diversity. Thirteen inbred lines (10 lines & 3 testers) of bottle gourd were crossed in line × tester mating design and evaluated for eleven characters during 2021-22. The analysis of variance due to line, tester and line × tester were significant for most of the characters excepting vine length, fruit weight, number of fruits per plant and total soluble solids. Variances due to SCA were considerably higher than that of GCA for all the characters. BCBG-17 registered significantly positive GCA effect for fruit yield per plant, quality, earliness and maturity traits. BCBG-7 and BCBG-34 also found good combiner for growth and quality parameters including fruit yield per plant. Among the parents, BCBG-16 and BCBG-33 recorded early female flowering. The hybrids BCBG-4 × BCBG-33, BCBG 34 × BCBG-33 and BCBG-7 × BCBG-3 registered higher SCA effects for yield per plant and associated traits. BCBG-7 × BCBG-33 showed early flowering and harvesting compared to other crosses. By selection of desirable parents Good combiners can be used for development of hybrids through breeding programmes and beneficial promising crosses can be used as hybrids considering their heterotic vigour and stability in multilocation trials and development of hybrid seed will be a approach for resulting progenies to develop and execute effective breeding programme to evolve earliness and high yielding varieties.

AISDGONF/ABS/TD/430

Evaluation of some bio-rationals to mitigate the pest problems in grasspea (*Lathyrus sativus* L.)

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Instead of on-field burning, rice straw ashes could be utilized for preventing insect pests in subsequent crops. In this backdrop an experiment was conducted to evaluate the potentiality of rice straw ashes for mitigating the pest problems of grasspea (*Lathyrus sativus* L.), a subsequent crop of winter paddy. Efficacy of rice straw ashes (sole and mixing with fine stand at 5:1) along with other treatments comprising botanical insecticide (Azadirachtin 10000 ppm) and chemical insecticide (Imidacloprid 17.8 SL) was evaluated against pulse aphid (*Aphis craccivora*) on grasspea cv. Nirmal during *rabi* season of four consecutive years from 2018-19 to 2021-22 at District Seed Farm (AB Block) of BCKV located at Kalyani, Nadia, West Bengal. The results

reveal that amongst all treatments, spraying with Imidacloprid 17.8 SL @ 0.3 ml l^{-1} was found significantly superior over rest of the treatments in terms of per cent reduction of aphid population over control both at 7 days after treatment (DAT) and 15 DAT followed by dusting with mixture of rice straw ashes and fine sand @ (25+5) kg ha^{-1} where the later one was statistically at par with spraying of Azadirachtin 10000 ppm @ 2.5 ml l^{-1}. Significantly highest crop yield was also obtained from the treatment of Imidacloprid followed by dusting of sand mixed rice straw ash. Therefore, the treatment comprising of dusting with mixture of rice straw ashes and fine sand @ (25+5) kg ha^{-1} may be recommended to reduce aphid problems in grasspea as the most effective non-chemical approach.

AISDGONF/ABS/TD/431

Enhancing food security and doubling farmers' income through adaptation of conservation agriculture in rice-based cropping systems in *Gangetic* inceptisol

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Sustainable green agriculture involves skilfully managing agricultural resources to meet evolving human needs, while simultaneously preserving or enhancing the environment's quality and conserving natural resources. Conservation agriculture contributes to increased productivity through practices like early sowing and efficient resource management, leading to a substantial boost in farmers' income. Field experiment was conducted during 2016-18 and 2017-18 to find out the variations in weed dynamics in rice-based crop sequence under conservation tillage and weed management practices.During *Kharif* season before rice transplanting the weed seed bank was reduced by using safe herbicide. The results revealed that in all treatments the biological yield was improved in 2017-18 than that of 2016-17. Further in respect of pooled data 5.70 % in lentil and 4.96% in mustard higher yield was obtained in those treatments where SSP was used instead of DAP. In weed management combination of botanical and chemical herbicides showed 14.19 % in lentil and 6.53% in mustard over only chemical herbicides treatments. The higher biological yield plots as recorded lower weed density and biomass that helps in increasing both crops growth and yield parameters by increasing nutrient availability and population of soil microflora. Both reduced and zero till cultivation showed superiority over conventional tillage in respect of economics of lentil and mustard in this experiment. This implies moving beyond mere production cost savings to natural resources savings and using zero tillage + botanical herbicide with SSP as a steppingstone to conservation agriculture. Considering all it can be concluded that zero or reduced tillage with conservation technology in rice follow up lentil or mustard will be better to reach the goal of nation's food grain & oilseeds production target, sustainable green agriculture and doubling farmers' income.

AISDGONF/ABS/TD/432

Screening of some wheat (*Triticum aestivum* L.) lines for yield and yield attributing traits grown under late sown condition in *Gangetic* plain of West Bengal

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An experiment was conducted among 60 advanced breeding lines of wheat in RBD with two replications in late sown condition of West Bengal. The analysis of variance showed highly significant differences among the genotypes for all the characters. The wide range of the phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) was found among different traits indicated sufficient genetic variation present. The narrow differences between GCV and PCV for all characters suggested less influence of the environment. High heritability coupled with high genetic advance as a percent of the mean observed in harvest index and yield per plant indicated traits were governed by additive gene and direct selection may be effective. The strong corelationship was found between number of effective tillers per plants and harvest index with yield per plant at genotypic level. The number of effective tillers per plant contributed highest direct effects at both the levels.

AISDGONF/ABS/TD/433

Crop parameters of groundnut (*Arachis hypogaea* L.) as influenced by foliar application of boron and zinc

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Groundnut (*Arachis hypogaea* L.) is an important oil seed legume of the world and generally grown in light soils. The light soils generally are deficient in boron and zinc. Boron and zinc play very important roles in determining the seed yield and its quality (Meena *et al.*, 2007). In this experiment, six groundnut genotypes (TG 26, TG 51, TG 71, TG 72, BARC 150 and BARC 200) were tried with nine different foliar treatments combinations with three levels of each of boron (boric acid) and zinc (zinc sulphate) [B0=no boric acid, BL=boric acid @ 0.25% and BH=boric acid @ 0.5%, Z0=no zinc sulphate, ZL=zinc sulphate @ 0.5% and ZH=zinc sulphate @ 1%]. All together nine treatments were: B_0Z_0(T1), B_LZ_0(T2), B_HZ_0(T3), B_0Z_L(T4), B_LZ_L(T5), B_HZ_L(T6), B_0Z_H(T7), B_LZ_H(T8) and B_HZ_H(T9). Crop parameters were observed and analyzed and estimated. There was different combination of treatments of boron and zinc which was effective in all the genotypes but not one particularly. For TG 26, B_LZ_H was the best treatment and significantly better than the control in yield and yield parameters. The treatment B_HZ_0 was better in case of TG 51, B_HZ_L in case of TG 71; B_LZ_0 and B_HZ_0 in case of TG 72; B_LZ_0 and B_HZ_0 in case of BARC150 whereas B_LZ_L, B_HZ_L and B_LZ_H was better than the control in respects of yield and yield parameters in case of BARC 200.

AISDGONF/ABS/TD/434

Diversity assessment through microsatellite markers in cultivated finger millet [*Eleusine coracana* (L.) Gaertn.] genotypes

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Finger millet [*Eleusine coracana* (L.) Gaertn.] with 2n = 4x = 36, is a major millet of tropical Africa and South Asia. It is a nutri-cereal, rich in protein and calcium and is gaining popularity for its multiple health benefits, hence a potent crop for food security and good economic returns, though only negligible research is observed for its improvement so far. Diversity assessment is a basic requirement for crop improvement for which simple sequence repeat (SSR) molecular markers are the most feasible technologies for specificity and cost-effectiveness. In the present investigation divergence in 25 finger millet genotypes was assessed through 19 SSR markers, of which eight showed polymorphism. A total of 25 SSR amplicons (72 to 291 base pairs) were observed. Major allele frequency per marker (MAF), effective allele frequency per marker (A_e), heterozygosity (H_e) and Polymorphic Information Content (PIC) had an average of 0.48, 2.91, 0.63 and 0.61, respectively. A_e was negatively associated with number of genotypes responding per marker and MAF, but had positive association with H_e and PIC, which factually confirmed that A_e leads to higher H_e and PIC. Six markers with higher heterozygosity and PIC could be exploited for agro-economic trait association studies. Euclidean distance ranged between 1.751 and 4.406, indicating considerable divergence exploitable further through various breeding techniques. Dendrogram revealed two clusters; white seeded cultivars formed one cluster and the rest formed another, indicating distinct gene expression for grain colour. The national checks, PR-202 and VL -149, appeared in different clusters confirming their broader genetic base.

AISDGONF/ABS/TD/435

Hybrid vigour and inbreeding depression for yield and yield attributing traits in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.)

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The present investigation was carried out to study the extent of heterosis and inbreeding depression through generation mean analysis (P_1, P_2, F_1, F_2, BC_1 and BC_2) of four crosses (Pusa Naveen x Local Round, Pusa Naveen x Pusa Santhusti, Pusa Sandesh x Punjab Bahar and Pusa Sandesh x Arka Bahar) for yield and yield attributing characters in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.). Relative heterosis and heterobeltiosis were found significant and negative for node number at which first male flower appeared, node number at which first female flower appeared, fruit diameter and vitamin-C content for most of the crosses. Significant positive relative heterosis and heterobeltiosis were observed for fruit length, fruit yield per vine, fruit yield per plot, fruit yield per hectare, number of seeds per fruit and total sugar content for majority of the crosses. Significant heterosis coupled with significant inbreeding depression was observed for most of the characters in majority of the crosses indicated non-additive gene action in the inheritance of these

traits. The cross, Pusa Naveen x Pusa Santhusti exhibited significant negative heterosis followed by negative inbreeding depression for some economically important characters like fruit yield per vine and fruit yield per plot indicating transgressive segregation in F_2 generation and thus this cross can be utilized for development of pure lines.

AISDGONF/ABS/TD/436

Evaluation of pre and post emergence herbicides for chemical weed management in sesame

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The field experiment was conducted at Agricultural Experimental Farm, University of Calcutta, Baruipur, Kolkata-700144 during summer season of 2020. The experiment was held out in a Randomized Block Design (RBD) with three replication and 8 treatments T_1- Weedy Check,T_2- Weed Free,T_3- Pendimethalin 30EC (Pre-emergence) @0.50 kg a.i/ha (R) /0.75 kg a.i/ ha (I),T_4- Quizalofop-ethyl (Post emergence) 50g a.i /ha at 20 DAS after sowing,T_5- Sodium Acifluorfen 16.5% + Clodinafop -Propargyl 8% EC (Premix) @100g a.i/ ha at 20 DAS,T_6- T_3+ Hand weeding at 20 DAS,T_7- T_3 f b T_4,T_8- T_3 f b T_5.The variety used for this experiment was Savitri. Among the different herbicidal treatments, the lowest weed density, dry matter and weed index was recorded in treatment T_6 due to lower weed population, prevention of germination of weeds seed. The weed control efficiency was highest at weed free plot followed by pendimethalin 30EC pre emergence @ 0.50 kg a.i./ha + hand weeding at 20DAS (T_6). Among the herbicidal treatments T_6 recorded significantly higher yield components viz; no. of seeds/capsule (78), no. of capsules/plant (58.23), Length of capsule (3cm), breadth of capsule (2.44cm) and seed yield (760 kg/ha) due to lower weed density, higher weed control efficiency and application of herbicide + cultural practices resulted higher yield when compared to all other treatments but it was on par with T_8 (T_3 + T_5). The highest B : C ratio of 0.20 were observed in T_3 followed by B:C ratio 0.14 in T_8 (Pendimethalin 30EC@ 0.50 kg a.i./ha + Sodium acifluorfen 16.5% + Clodinafop-propargyl 8% EC @100 g a.i./ha).

AISDGONF/ABS/TD/437

Analysis of yield stability of brinjal landraces under normal and biotic stress environments

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Stability and adaptability of a brinjal genotype is crucial to release it as a variety for commercial cultivation in a wide range of growing conditions. The experiment was conducted at the Instructional farm RRS (OAZ), Majhian, West Bengal, under different environmental conditions: (1) normal condition at an irrigated lowland field and (2) biotic stress condition, wherein artificial inoculation of *Ralstonia solanacearum* provided at vegetative stage in the field condition. The

present study was conducted during 2017-19 to assess the Genotype×Environment (G×E) interaction and to identify the stable brinjal genotypes under normal environment and a biotic stress environment. A set of thirty landraces of brinjal along with checks were investigated for stability in fruit yield across different environments by Additive Main effects and Multiplicative Interaction (AMMI) and the Genotype Main Effect and Genotype by Environment interaction effects (GGE) analyses. AMMI and GGE analyses revealed significant G×E interactions indicating the variability among the genotypes and environments. The artificial inoculation of *R. solanacearum* in the field condition among all the landraces, six genotypes viz. Singhnath, Bolanath, UBB-8, Balasi, Pundibari local 2 and Joshna were found promising with respect to resistant against bacterial wilt and also shown good *per-se* performance with quality traits such as OD phenol, total phenol and anthocyanin content. Results showed that Kokila and Pundibari local 2 was the most stable genotype in both environments. As per AMMI1 and AMMI2 biplot models the genotypes Balasi and Bolanath were identified as the best performer and suited for the biotic stress environment.

AISDGONF/ABS/TD/438

Degradation and persistence of rice herbicides and its impact on enzymatic activity in clay loam soil

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Weeds have been a major problem for rice production and sometimes can result in more than 50 % paddy yield loss (Hill *et al*. 1985). Thus, farmers rely heavily on the use of herbicides. Pesticides may remain in plants, soil, or water after application and lead to risk for environment (Cheng 1990). Field experiment was conducted in wetland, Tamil Nadu Agricultural University, Coimbatore during *Rabi* 2020-21 to study the persistence of herbicides in soil, its residues in transplanted rice and its impact on soil enzyme activity. The treatments constituted of low dose herbicides *viz*., Pyrazosulfuron ethyl bispyribac sodium, Penoxulum**,** Pretilachlor, Bensulfuron methyl and Cyhalofop-p-butyl in different combinations. Soil samples were collected at 0,1,3,5,10,15,30, 45 and 60 days after herbicide application (DAHA) to find out the persistence of herbicides in soil using HPLC equipped with PDA detector. The dissipation of all the molecules was found to follow first order reaction kinetics (R^2 >0.90) with the half-life of 8.71-8.82 days for pyrazosulfuron ethyl, 10.9-11.2 days for bensulfuron methyl, and 8.24 days for bispyribac sodium, 14.1 days for cyhalofop-butyl, 10.0 days for penoxulum. The residues of all the herbicides in grain and straw from different plots were below 0.01 mg/kg in both the seasons. Among the herbicide treatments, bensulfuron- methyl + pretilachor fb HW and bensulfuron□methyl +pretilachor fb bispyribac sodium recorded maximum soil enzyme activities. Lower dehydrogenase activity was observed with pyrasosulfuron ethyl compared to other herbicides and higher urease activity was recorded with pyrazosulfuron ethyl. However, higher dehydrogenase activity was recorded with Pyrasosulfuron- ethyl fb Bispyribac sodium as against other herbicide combinations.

AISDGONF/ABS/TD/439

Correlation and path analysis in rice genotypes for yield contributing traits

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The current study involved 40 rice genotypes including 13 characters carried out at Agriculture Research Station, Vadgaon Maval, Pune. Correlation study revealed that, test weight (0.6757) showed highly significant positive relationship with grain yield followed by spikelet fertility % (0.3793), flag leaf breath (0.3461), productive tillers per plant (0.2710) and panicle length (0.2596). The characters days to 50% flowering showed positive significant correlation with days to maturity. Similarly the character number productive tillers per plant show significant positive correlation with total spikelets and spikelet fertility. Total spikelets per panicle showed significant negative correlation with test weight but it had positive correlation with spikelet fertility. Spikelet fertility % showed positive correlation with test weight. Path analysis indicated that, the character test weight (1.5760) showed highest direct positive effect on grain yield per plant. While test weight of grains had showed positive significant correlation with grain yield along with positive indirect effect flag leaf breath and panicle length. So trait test weight and spikelete fertility showing positive correlation along with direct effect on yield then selection for such trait was rewarding to improve yield. Correlation and path analysis together may thus provide a better understanding of the causes and effect relationship among various character pairs. Thus, direct selection for these traits will be beneficial in yield improvement programme by studying correlation and path analysis.

AISDGONF/ABS/TD/440

Character association studies among yield contributing traits for improving grain yield in sorghum (*Sorghum bicolor* L.)

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Out of 25 species of sorghum, *Sorghum bicolor* and *Sorghum vulgare* are the cultivated species with 2n =20 for diploid species and 2n=40 for tetraploid species. Sorghum is an often cross pollinated crop. A field experiment was undertaken in RBD with three replications to study the character association between different characters in sorghum. At genotypic level, days to 50 per cent flowering had a highly significant and positive association with traits such as, days to maturity, panicle length, panicle width and number of primary branches per panicle. Positive but non- significant associations was recorded for two traits like, test weight and grain yield per plant. This character had positive and significant association with the character days to maturity at the phenotypic level. Genotypic correlation of character plant height showed highly significant and positive association with two traits *viz*., number of grains per primary branches and fodder yield per plant. Phenotypic correlation of plant height showed a highly significant and positive association with the number of grains per primary branches and fodder yield per plant. Grain yield per plant indicates positive significant correlation at genotypic level with the traits *viz*., panicle

length, panicle width, days to maturity, number of primary branches per panicle and test weight while positive non-significant correlation was observed for all the remaining traits. Negative significant correlation of this trait was recorded with field grade score and threshed grade score. Grain yield per plant exhibited positive significant association at phenotypic level with the given traits such as panicle length, panicle width, days to maturity, number of primary branches per panicle, number of grains per primary and test weight. Fodder yield per plant showed positive significant association at genotypic level with plant height and number of grains per primary branches. This character showed positive significant correlation at phenotypic level with plant height and number of grains per primary branches. Correlation studies indicated the importance of the character *viz*., panicle length, panicle width, days to maturity, number of primary branches per panicle and test weight which shows significant and positive correlation with grain yield per plant. Hence, these traits could be considered as important for improving grain yield in sorghum.

AISDGONF/ABS/TD/441

Weed dynamics and management studies under conservation tilled potato in *Gangetic* alluvium: A path to enhance food security and double farmers' income in India

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Potato grown after *Kharif* rice, is an important cash crop having 19 m ha area with average productivity 17.5 t ha^{-1} in the world. Rice-Potato system is one of the most promising cropping system in the lower Gangetic plains which supports a sizeable livelihood in the delta. *Kharif* transplanted rice grown under puddled condition is rendering the system unsustainable. Conservation approaches serve as a useful tool for sustainability in restoring system productivity. Reduced tillage as a conservation practice along with proper ecosafe weed management may address the changing weed dynamics and composition of weed pressure in potato after rice. Experiment conducted in 2016-18 at BCKV, West Bengal in split plot design with three main tillage and six weed management sub plot treatments showed reduced tillage provides a higher winter window for about 7-9 days in minimum till and 13-15 days in zero till over conventional tillage. Potato crop grown under minimum till facilitate relatively more horizontal root distribution over conventional planting and significantly increases crop growth and yield attributes. Minimum till with PE application of Metribuzin 70 WP @ 300 g ha^{-1} + *Bambusa vulgaris* aqueous extract @ 100 ml lit^{-1} water resulted improved soil health by reducing weed intensity through improving soil physico-chemical, biological properties along with 6.03 % higher tuber yield, 23.10 % higher water use efficiency and better financial outcomes with B:C ratio of 2.52, indicating its superiority in long run over conventional. Therefore, improved sustainability attained yardsticks and soil parameter increments in repetitive cycles contribute to pronounced benefit for our farmers in long run, fostering the national goal of sustainable green agriculture along with helps to achieve doubling farmers' income.

AISDGONF/ABS/TD/442

Prevalence of rice yellow stem borer, *Scirpophaga incertulas* Walker population and extent of crop damage in relation to agro-ecological conditions at Hooghly, West Bengal during *boro* crop season

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Rice yellow stem borer (YSB), *Scirpophaga incertulas* Walker (Pyralidae: Lepidoptera), a monophagus insect pest claims about 10-35% average grain yield loss annually. Damage to stem at early and late growth stage of rice plant causes dead heart (DH) and white head (WH), respectively. Best control of YSB damage requires accurate describing and forecasting of population dynamics at regional level. Variability of different agro-climatic parameters during *boro* crop season unevenly imparts conducive effect on YSB growth and development depending on situation. To envisage the extent of impact of agro-ecological conditions on YSB incidence at Hooghly, West Bengal, an experiment for three consecutive *boro* rice-crop seasons (2019-2022) was carried out. Modified Robinson light traps with 18-watt LED bulb were installed in the rice field with *Lalat* (IET-9947) rice cultivar having no history of insecticide application. Collectively, three light traps/acre each with four replications were set up at 7-days intervals having operational time from 7 pm to 5 am. YSB adults trapped were counted and segregated by sex at regular basis. The peak YSB infestation with 9.33% DH was observed at 4 SMW (Standard Meteorological Week). The average catch number was 132 individuals/catch. The second peak with 8.59% WH was noted during 11th SMW. The average catch number was 107 individuals/catch during 7 SMW. Correlation between the extent of YSB incidence and agro-ecological parameters during *boro* season had envisaged significant results. RHmax (morning relative humidity) had negative correlation (r=-0.21), while Tmax (maximum temperature) (r=0.08), Tmin (minimum temperature) (r=0.63), RHmin (evening relative humidity) (r=0.47) and Rfall (rainfall) (r=0.35) had positive correlation with YSB incidence at early growth stage. Tmin (r=-0.39), RHmin (r=-0.43) and Rfall (r=-0.24) had negative correlation while Tmax (r=0.18) and RHmax (0.17), had positive correlation with YSB incidence at late growth stage. Collectively, YSB incidence during *boro* crop season had shown non-significant and positively correlated with Tmin and RHavg while the incidence expressed non-significant and negative with Tmax and Rfall respectively. Among the climatic parameters, Tmin, Rfall and RHmax were more relatable to YSB incidence as evicted by stepwise regression as evicted by the present study.

AISDGONF/ABS/TD/443

Incidence and abundance of mustard aphid, *Lipaphis erisimi* (Kalt.) in relation to agro-climatic conditions at Uttar Dinajpur, West Bengal

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Lipaphis erysimi (Kalt.) causes significant damage to the growing mustard crop rendering huge damage. Occasionally complete crop failure was also noted. A field experiment, by randomized block design (RBD), for two consecutive *Rabi* crop seasons (2021-2023) was carried out at

Delwarpur, Uttar Dinajpur, West Bengal aiming to assess the seasonality and relative abundance of *L. erysimi* at 7-days intervals. Accordingly, impact of climatic parameters on the aphid population was also noted. In each occasion, *L. erysimi* population was estimated after assessing growing top 10 cm apical shoot of mustard plant. Average value of five observations in each occasion was considered. Initiation of *L. erysimi* population was first noted at 51 SMW (Standard Meteorological Week) with 4.06 aphids/ with a gradual increase up to 7 SMW with 37.60 aphid individuals. Maximum population with 76.87 individuals was recorded during 8 SMW. The population then subsumed at first slowly with 42.11 aphid individuals at 9 SMW. After 11 SMW, a drastic fall of aphid population was noted with 1.67 aphid individuals. *L.erysimi* showed significant positive correlation with maximum temperature and negative correlation with relative humidity. The observations on aphid incidence were carried out simultaneously Aphid population showed significant negative correlation with minimum and maximum temperature, whereas significant positive correlation with relative humidity, and non-significant negative correlation with rainfall. The effects of other climatic factors on population of mustard aphids

AISDGONF/ABS/TD/444

An evolutionary 'footprint' developed at vascular sap in million years' of plant-aphid interaction biology

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Plant-insect association was evolved as well as continued since million years. Aphid, as a special class of insect having piercing and sucking habit of mouth part successfully stabilized a compatible association in the susceptible host plant with its slender and long stylet to the sieve element cell sap in phloem tissue for siphoning sucrose enriched sap for nutrition and proliferation. Therefore, vascular sap was an attractive and targeted sap for an evolutionary 'footprint' analysis at the earliest time point when aphid proliferation was significantly higher as compared to an initial aphid release on leaf foliage. The parameters were identified as a host susceptibility factors in reducing host resistance to achieve the time duration as minimum as possible for achieving a significant aphid proliferation. In the present study, the *Brassica napus* and *Lipaphis erysimi* interaction was explored for developing an 'interactome' in the vascular sap at the early time point when aphid proliferation was depicted as significant exploring optimum host susceptibility factors. The result indicated that a third organism is involved in *Brassica napus-Lipaphis erysimi* interaction. Therefore, a novel perspective is open for further research for aphid proliferation by controlling third organism tire in vascular sap. The details finding will be presented as a first report in plant-aphid interaction biology.

AISDGONF/ABS/TD/445

Determination of antagonistic effect of bioagents on seed mycoflora of okra (*Abelmoschus esculenta*) and effect on seed health

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This study evaluated the potentiality of the three bioagents *Trichoderma harzianum, T. viride* and *Pseudomonas fluorescens* against the seed borne fungi and its effect on seed health parameters. The collected seeds were coated with spore suspension of each strains of *Trichoderma* supplemented with 2% of starch (w/v) as an adhesive at the rate $5x10^5$ conidia/ml and talc powder formulations of *P. fluorescens* ($1x10^8$) at the rate 5g/kg seed. Antagonists reduced the seed mycoflora incidence, significantly increased seed germination, root and shoot length although the results varied with different bio agents treatments. The treated seeds were evaluated for reduction of *Helminthosporium* sp., *Aspergillus flavus, Fusarium sp., Curvularia lunata* and *Rhizopus stolonifer*. The experiment indicated that *T. harziznum* was more effective in reducing the seed associated fungi and proved to be superior for inhibition of the above pathogen as compare to *T.viride* and *P.fluorescens.* Less association of seed borne fungi was exhibited by pre treated seed samples over untreated ones (control). *T. harziznum* proves to be effective bioagent against seed borne fungi. However further investigations is required to study *in vivo* effect of *Trichoderma* strains on morphological characteristics in okra plant and fruit production.

AISDGONF/ABS/TD/446

Studies on gamma rays induced mutation in mandarin orange

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An experiment entitled was carried out during the year 2021-22 at Centre of Excellence for Citrus, Nagpur, PDKV, Akola, with the objectives to study the effect of gamma irradiation on budding success and growth performance of mandarin orange budgrafts varieties *viz.,* Nagpur mandarin and Nagpur seedless and to find out the effect of gamma irradiation for induction of variability in mandarin orange. For mutagenic treatment, bud sticks of 12-15 cm length containing 4-6 healthy buds were collected and irradiated with five doses of gamma rays *viz*., 10 Gy, 20 Gy, 30 Gy, 40 Gy and 50 Gy. On rough lemon rootstock shield budding was performed. 500 budgrafts per treatment were raised in polyhouse for its growth and performance at 30 to 180 days after sprouting. The experiment was conducted in non- replicated trial. Increase in dose of gamma rays resulted in delayed sprouting of budgrafts and decreased sprouting percentage, shoot length, plant height, and survival percent. Whereas, branches plant^{-1} recorded maximum variation at 30 Gy, 40 Gy and 50 Gy. No sprouting seen in Nagpur mandarin treated with 50 Gy. As regards leaf abnormalities and variations was found in high doses and showed induced changes in leaf colour, shape. High mortality with increasing doses of irradiation indicates limiting the doses of irradiation in future studies. Variations in leaf characteristics suggest mutagenic effectiveness of irradiation on budwood which may have potential for further studies.

AISDGONF/ABS/TD/447

Morphological and *in vitro* efficacy studies on plant extracts and fungicides against *Alternaria* spp. causing early blight disease of potato, tomato and purple blotch disease in onion

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Alternaria is one of the most widespread fungus in the world. *In vitro* experiments with five different plant extract and fungicides were used to determine the best suitable growth medium and management of *Alternaria* spp. from different hosts. The experiments were conducted at Jaguli farm, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur campus during the year 2020-2021. Of these five different solid media, maximum mycelial growth was observed on PDA (86.67mm) for potato isolates (*A. solani*), (87.17mm) for tomato isolates (*A. solani*) and (83.83mm) for onion isolates (*A. porri*). Mycelium with Irregular and white margin colony was recorded for the potato isolates, irregular smooth margin for tomato isolates and a characteristically smooth margin was observed for the onion isolates. Morphological studies revealed that maximum conidial length was recorded for potato isolates from Kalyani 230.95±47.10µm (ranges from 202-230.95µm) followed by tomato isolates (222.50±45.87µm) and least was recorded in onion isolates (210.01±20.42µm). There is a clear variation in beak length, ranging maximum in onion isolates 87.20±11.39µm, and 55.80-68.52µm in potato isolates and least in tomato isolates. *In vitro* efficacy of plant extracts exhibited a maximum percent inhibition by *Datura* (55.80%) against potato isolates and by garlic for both tomato (39.94%) and onion isolates (59.75%), while fungicide studies exhibited maximum inhibition by Hexaclonazole 5% EC (85.19%) followed by Ridomil (78.15%) in in potato isolates, Hexaclonazole 5%EC (82.47%) followed by Carbendazim 50%WP (81.67%) in tomato isolates and Difeconazole 5EC (81.91%) followed by Hexaclonazole 5%EC (69.32%) in onion isolates.

AISDGONF/ABS/TD/449

Genetic variability studies in yard long bean (*Vigna ungiculata* (L.) Walp. ssp. *sesquipedalis* Verdc.)

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Yard-long bean [*Vigna unguiculata* ssp. *sesquipedalis* (L.) Verdc], belongs to family Fabaceae. The Analysis of Variance revealed that, significant differences among all the characters studied indicating that there is considerable amount of variability among 24 genotypes of yardlong bean. The phenotypic coefficients of variation for all the characters studied were higher than the genotypic coefficients of variation indicating the masking effect of the environment to some degree. High PCV and GCV were recorded for number of primary branches per plant, pod length, number of pods per plant, ascorbic acid content, 100 seed weight, pod yield per plant, pod yield per plot, pod yield per hectare suggesting the existence of high degree of genetic variability and thus there is great scope for selection. High heritability coupled with high genetic advance as *per cent* of mean were recorded for the characters like vine length, number of primary branches,

number of nodes per plant, pod length, number of clusters per plant, number of pods per plant, ascorbic acid content, 100 seed weight, pod yield per plant, yield per plot, yield per hectare indicating the preponderance of additive gene action making selection effective. High or medium heritability and moderate genetic advance as *per cent* of mean recorded for the characters like terminal leaf breadth, pod girth, length of cluster stalk, number of pods per cluster, TSS and protein percentage revealed the presence of both additive and non-additive gene action. Genetic divergence assessed using Mahalanobis' D^2 statistics revealed pod yield/plant contributed maximum towards divergence.

AISDGONF/ABS/TD/451

Genetic evaluation and screening of diverse wheat (*Triticum aestivum* L.) genotypes for spot blotch resistance

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Production of wheat (*Triticum aestivum* L.) in South Asian countries including India faces several constraints including spot blotch caused by *Bipolaris sorokiniana* resulting in yield lossof 25-43 % depending upon the stage of infection. Fifty genotypes were evaluated for nine quantitative characters and area under disease progress curve (AUDPC) to identify superior genotype with spot blotch resistance. High heritability coupled with moderate to high genetic advance as percent of mean was registered for grains per spike, tillers per square meter, days to 50% heading and days to 50% flowering indicating the characters to be governed by additive genes. Correlation and path coefficient analysis favored days to 50% heading, days to 50% flowering and grains per spike since they had significant positive correlation with yield and simultaneous negative correlation with AUDPC and also conferring highest positive direct effect towards yield. D^2 analysis grouped the 50 genotypes into 10 clusters suggesting presenceof diversity among the genotypes. Frequency distribution of AUDPC among the genotypes showed more or less normal distribution of the character. Low AUDPC score with acceptable level of yield performance were recorded for the genotypes 29882, 29610, 29473, 29940, 29477, 29748 and 30081. Identification of high yielding and less susceptible genotypes for spot blotch disease in the present investigation will greatly enhance the genetic resource of wheat which will offer an opportunity for wheat improvement through selective breeding.

AISDGONF/ABS/TD/452

Heterosis and combining ability study for fibre yield in tossa jute (*Corchorus olitorius* L.)

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Jute is a member of Corchorus genus, in the family Malvaceae, and is one of the most important bast fibre crop in the world. It consists of nearly 40-100 species, out of which the commercially cultivated species are *Corchorus capsularis* (*Tita/white jute*) and *Corchorus olitorius* (*Mitha/dark jute*). Present study was carried out to estimate the combining ability and heterosis for fibre yield and yield attributing characters among diverse tossa jute germplasm lines. The six C. olitorius lines were selected and a crossing programme in 6x6 half diallel mating design was carried out following with the 15 F1s along with 6 parents (OIN163, OIN164, OIN184, JRO204, JRO524, JRO8432) and one standard check (BCCO-6) for combining ability analysis and estimation of heterosis. Six parents, 15 F1s and standard check were sown in randomized block design with three replications at the Teaching farm of Mondouri of Bidhan Chandra Krishi Viswavidyalaya. Recommended package and practices were applied to raise the healthy crop. Crop was harvested at 120 days after sowing. The SCA components of variance (σ2 SCA) were larger than gca components of variance (σ2 GCA) for all of the five characters which indicated the preponderance of non-additive variance of gene action in these traits. As dry fibre yield is our main areas of interests overall 3 hybrids OIN 163 X JRO 8432, JRO 204 X OIN 164 and JRO 8432 X OIN 164 were identified as they were superior over their better parent as well as standard check for dry fibre weight per plant. Asdry fibre yield is our main areas of interests overall 3 hybrids OIN 163 X JRO 8432, JRO 204 X OIN164 and JRO 8432 X OIN 164 were identified as they were superior over their best parent as well as standard check for dry fibre weight per plant and they also showed positive significant SCA effects. So, it can be stated these 3 cross combinations can be advanced to get better lines for better economicreturns.

AISDGONF/ABS/TD/453

Effect of tillage and weed management practices on direct seeded rice (*Oryza sativa* L.) under coastal and saline belt of West Bengal, India

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The field experiment was conducted to find out the effect of tillage and weed management practices on direct-seeded rice at Shasya Shyamala Krishi Vigyan Kendra, West Bengal, during the kharif season of 2022. The experiment comprised of two tillage management practices (zero tillage and conventional tillage) as the main plot factor, as well as six weed management treatments (pre application of pendimethalin 1000 g *a.i.* ha^{-1}, growing sesbania with rice followed

by application of 2,4-D 1000 g *a.i.* ha^{-1}, pendimethalin 1000 g *a.i.* ha^{-1} followed by one-hand weeding at 25 and 45 DAS, pendimethalin 1000 g *a.i.* ha^{-1} followed by Na-bispyribac 25 g *a.i.* ha^{-1}, weed free and weedy check) as sub-plot factor. The results revealed that two-hand weeding at 25 and 45 DAS was found to be better in terms of weed control and grain yield than other weed management practices. Conventional tillage recorded more growth and yield attributes, as well as a higher grain yield of rice, than zero tillage practices. Amongst the different weed management practices, application of pendimethalin followed by one-hand weeding recorded higher plant height, tiller $hill^{-1}$, grain yield, and B:C ratio than the other treatments. Growing sesbania along with rice and then applying 2,4-D and 1000 g *a.i.* ha^{-1} surpasses the other treatments in both conventional and zero-tillage situations. Pre-emergence application of pendimethalin 1000 g a.i. ha^{-1} in combination with conventional tillage was found to be ideal weed management practices for improving the rice grain yield by eliminating crop-weed competition in direct-seeded rice.

AISDGONF/ABS/TD/454

Stability analysis for pod yield and its contributing component traits in groundnut (*Arachis hypogaea* L.)

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Groundnut (*Arachis hypogaea* L.) is an important oilseed crop. It is a self-pollinated, auto tetraploid plant with chromosome number 2n = 4 x = 40. To study the stability of yield and yield components, sixteen genotypes including two checks were planted in a randomised block design with three replications under three environments during *kharif* season. Observations were recorded on days to 50 per cent flowering, days to maturity, number of mature pods per plant, pod yield per plant (g), kernel yield per plant (g), shelling percentage (%), 100- kernel weight (g), sound mature kernel (%), oil content (%) and pod yield per plot (g) from five randomly selected plants. Analyses of variance exhibited highly significant positive difference among the genotypes for all characters under different environments. Genotype x environment interaction was also highly significant for shelling percentage, 100-kernal weight, kernel yield per plant and pod yield per plant. Whereas, for environment + environment x environment interaction was also highly significant for shelling percentage, 100-kernal weight, kernel yield per plant and pod yield per plant. The highest 100-kernal weight recorded by the genotype LGN-236 recorded highest oil content. None of the genotypes was stable for all the selected characters; however, the genotype LGN-218 exhibited average stability for kernel yield per plant, ICGV-00919 for days to maturity, LGN-176, LGN-227 and LGN-218 for shelling percentage. The component characters like number of mature pods per plant, kernel yield per plant, 100-kernal weight and kernel exhibited positive and significant interaction with pod yield.

AISDGONF/ABS/TD/455

Identifications of brinjal genotypes for mosaic disease tolerance in the *Gangetic* plains of West Bengal

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Mosaic disease in brinjal is one of the most destructive and serious disease during recent past in the Gangetic plain of West Bengal, which causes substantial loss in yield. The disease may appear at any crop growth stage, from transplanting to the crop cycle is over. Field experiments were conducted during 2019 to 2020 at "C" Block Farm under the research plot of AICRP on Vegetable Crops, B.C.K.V, Kalyani, Nadia, West Bengal, with 29 brinjal genotypes. The most effective means to control mosaic disease is the development of stable high yielding tolerant varieties/hybrids with acceptable fruit quality. The severity of mosaic disease was observed from 29 brinjal genotypes starting from 30 days after transplanting (DAT) up to 120 DAT and their cumulative values in term of area under disease progress curve (AUDPC) were analyzed to identify genotypes that can be utilized in future breeding. Genotypes were grouped into 6 clusters. In general, random distribution of genotypes from diverse geographical region into different clusters was noticed. Fruit diameter, plant height, fruit weight and mosaic disease severity emerged as the most contributing characters towards the genetic divergence. Based on D^2 statistic, principal component analysis, and *per se* performance on total fruit yield per plant and mosaic disease severity, six genotypes (2020/ BRR Var-7, 2019/BRR Var-11, 2020/BRL VAR-1, 2020/BRL VAR-5, 2019/BRR Var-7 and 2019/BRL Var-7) possessed the optimum combination of all variables and could be potential donors for mosaic disease resistant breeding.

AISDGONF/ABS/TD/457

Morphological and molecular characterization of spotblotch disease resistance in diverse genotypes of wheat (*Triticum aestivum* L.)

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The spot blotch disease caused by fungus *Bipolaris sorokiniana* (Sacc.) Shoem. is an economically important disease in Eastern India including West Bengal which is the natural hotspot of the disease. Eighty wheat genotypes consisting of cultivars, advanced breeding lines and exotic germplasms were screened for spot blotch disease resistance in two consecutive years 2019-20 and 2020-21. Based on the AUDPC value, derived from double digit scoring, 11 genotypes were categorized under highly susceptible, 47 genotypes under moderately susceptible, 16 and 6 genotypes under moderately resistant and resistant category respectively. Analysis of variance revealed that significant differences were observed for all the disease related and yield attributing traits like- flag leaf area, maximum daysto greenness, AUDPC value, days to 50% heading, 1000 grain weight and yield among eighty genotypes. Eighty genotypes were evaluated for presence of

three spot blotch resistance QTLs viz., *Sb1*, *Sb2* and *Sb3* by using markers Xgwm 148, Xgwm 639 and XWGGC 12282 respectively. 3 genotypes were found to possess three QTLs, 7 genotypes with two QTLs and 11 genotypes with single QTL. Thus the potential resistance sources of spot blotch disease identified from this experiment can be used further in transferring QTLs in desirable genetic background or in hybridization programme for selection of superior transgressive segregants.

AISDGONF/ABS/TD/458

Effectiveness of plant growth promoting rhizobacteria on growth and reduction of root-knot nematode infestation in brinjal

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Brinjal is a prime vegetable in India, securing handsome return to the farmers. The crop is often devastated by root-knot nematode infestation - an issue to be addressed with priority. A net house pot experiment was carried out in the Department of Nematology, OUAT, Bhubaneswar during *kharif*, 2021 to evaluate the effectiveness of Plant Growth Promoting Rhizobacteria (*Pseudomonas fluorescens, Pseudomonas putida, Bacillus subtilis, Bacillus pumilus*) on brinjal cv. BB-67, inoculated with Root-Knot Nematode, *Meloidogyne incognita*. The experiment comprised of six treatments including untreated uninoculated and inoculated controls with three replications following Complete Randomized Design. PGPR treated plants recorded significant increase in growth parameters and reduction in nematode damage over untreated inoculated control. Among all the treatments, soil application of *P. fluorescens* @ 2.5 kg/ha significantly increased plant height (41.2%), dry shoot (11.9%) and root weight (86.27%) and decreased root galls (74.9%), number of egg masses (79.7%), nematode population (49.4%) in soil over untreated inoculated control with the lowest Root-Knot index (3), which was significantly different from other treatments, followed by the soil application of *Bacillus pumilus* @ 2.5 kg/ha. It was also noticed that both PGPR and nematodes infestation altered the biochemical parameters of brinjal. Plants treated with *P. fluorescens* @ 2.5 kg/ha during sowing recorded maximum carbohydrate content (69.1%), potassium content (55.1%) and proline content (72.35%) respectively, in shoots over untreated inoculated control, which was significantly different from other treatments. Soil application of *P. fluorescens* @ 2.5 kg/ha can be used for reduction of root-knot nematode infesting brinjal.

AISDGONF/ABS/TD/459

Silicon amendment in rice for enhanced plant defense against yellow stem borer, *Scirpophaga incertulas* (Walker) and increased grain yield

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Two organic sources of silicon, diatomaceous earth (DAE) and rice husk ash (RHA) were evaluated at 100, 200, 300, 400, 500 and 1000, 1500, 2000, 2500, 3000 kg/ha, respectively for their resistance inducing ability against rice yellow stem borer and its role in altering various yield attributing characters in susceptible (TN1) and moderately resistant (GNR-3) cultivars. Irrespective of varieties the supremacy of DAE at 400 and RHA at 2000 kg/ha was established in arresting the borer damage to 20-21% attributing to about 49% decline over control. The dose-response was positive in most of the treatments except the highest doses of both the test products with a low incremental benefit. Silicon amendment had no perceptible effect on number of panicles, panicle length and thousand grain weights but resulted in significant increase in number of filled grains (139-141) per panicle compared to control (120) and reduced chaff per cent from 26% in control to about 21% in the best performing treatments. Silicon addition resulted in increased plant yield at all the test doses, the highest (18.9 g/plant) being in DAE at 400 kg/ha compared to untreated check (9.9 g/plant). Results of this study confirmed that Si amendment with DAE at 400 kg/ha or RHA at 2000 kg/ha can provide substantial protection to rice plant from stem borer damage besides contributing to yield increase. The findings of the investigation support the recommendation of silicon amendment as eco-holistic approach in the management of rice yellow stem borer.

AISDGONF/ABS/TD/460

Persistence, dissipation dynamics and end-point residue estimation of fomesafen + quizalofop-ethyl in soybean agro-ecosystem

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The herbicide mixture of fomesafen + quizalofop-ethyl is a newly introduced ready-mix formulation and information regarding its persistence and residual fate in soybean under tropical conditions is still in scanty. Therefore, a field crop simulation study was conducted in two recurring seasons (2017-18) to explore the dissipation dynamics of fomesafen 12% + quizalofop-ethyl 3% at 225 and 450 g a.i. ha^{-1} doses in soybean agro-ecosystem. Residual concentration of fomesafen and quizalofop-ethyl was estimated in LC-MS/MS and GC-MS/MS, respectively through the in-house developed and validated analytical methods. Fomesafen exhibited greater stability (plant half-life:2.84-3.81 and soil half-life: 4.23-5.62 days) as compared to quizalofop-ethyl (plant half-life: 1.76-1.96 and soil half-life: 1.63-1.83 days) under open field conditions. The persistence of both the molecules presented a significant seasonal variation due to fluctuations in

climatic parameters except for quizalofop-ethyl in soil. A relatively shorter persistence of fomesafen in Season I resulted from faster photo-degradation followed by accelerated soil and plant enzymatic metabolism than Season II. The shorter persistence of quizalofop-ethyl in Season I may have resulted due to increased de-esterification rate in soybean plant due to elevated atmospheric temperature as compared to Season II. Moreover, absence of end-point residues in harvested soybean products and cropped soil indicated that the application of the ready-mix formulation will impose no threat against food as well as environmental safety.

AISDGONF/ABS/TD/461

Studies on the comparative biology of *Spodoptera frugiperda* (J. E. Smith) and *Spodoptera litura* (Fab.) on different hosts

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A study was conducted to evaluate the biological growth parameters of fall armyworm, *Spodoptera frugiperda* and Tobacco caterpillar, *Spodoptera litura* on two different crop hosts viz. maize and castor in two different crop seasons, winter and summer, at laboratory conditions. The study was implemented in the Department of Entomology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal. Both the pests *Spodoptera frugiperda* and *Spodoptera litura* are economically important in various field and cash crops. The growth parameters like fecundity, larval period, adult longevity, and numbers of adult emerged and total duration were recorded. Fecundity of both the pests varied significantly irrespective of crops and the growing seasons. The highest fecundity of both the pests *S. frugiperda* and *S. litura* was noticed on castor in winter season recording 1788.5 and 2186.17 eggs/female. The fecundity of *S. frugiperda* was drastically reduced in summer season on castor (68.87%) than winter season. However, such reduction was comparatively less (33.67%) when reared on maize. However, the larval period and total life cycle of these two pests showed significant variation on both the host crops in summer season only. Both the pest were taken longer duration to complete their life cycle in winter than the summer season. The larval duration was almost half in summer season as compared to winter season irrespective of the crop hosts. Similar trend was observed in total duration of the life cycle showing almost 37% to 38% reduction in duration. The numbers of adult emerged of both the pests varied significantly in all seasons except winter maize. Though, highest fecundity was observed on castor in winter season, the highest percentage of adult emergence was observed on maize in the same season. Adult longevity was only noticed significant variation on castor in summer. Therefore, it can be concluded that summer season had more influence on the growth of both the pests irrespective of the hosts. However, the maize might be the good food source to both the pests than castor.

AISDGONF/ABS/TD/462

Influence of integrated nutrient management along with foliar spray of zinc in nano form on soil fertility, nutrients uptake and productivity of winter rice

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A field trial was carried out during *Kharif* seasons of 2018 and 2019 to study the response of rice variety IET 4786 to integrated nutrient management triggered by nano zinc application at Kalyani (Nadia) in new alluvial zone of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India. The experiment was laid out in a randomized block design with three replications possessing eight treatments viz. T_1 - control ($N_0P_0K_0$), T_2 - 100% RDN (recommended dose of nitrogen) from commercial chemical fertilizer, T_3 - 75% RDN from commercial chemical fertilizer + 25% RDN from FYM, T4 - 50% RDN from commercial chemical fertilizer + 50% RDN from FYM, T_5 - $N_0P_0K_0$ + nano zinc spray, T_6 - 100% RDN from commercial chemical fertilizer + nano zinc spray, T_7 - 75% RDN from commercial chemical fertilizer + 25% RDN from FYM + nano zinc spray, T_8 - 50% RDN from commercial chemical fertilizer + 50% RDN from FYM + nano zinc spray. The maximum grain yield (5.06 t ha^{-1}) was obtained from T_7treatment exhibiting the maximum number of panicles m^{-2} and a higher number of grains $panicle^{-1}$ that increased the grain yield by 8.82% than that of the T_2 (4.65 t ha^{-1}). Sole application of nano zinc resulted in 4.01 t ha^{-1} grain yield that was 17.6% improved over control. Application of zinc in nano form under INM system not only enhanced the productivity of rice and crop nutrients uptake but also ameliorated soil health by improving soil chemical properties.

AISDGONF/ABS/TD/463

Weed management studies in white jute (*Corchorus capsularis*)

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A two year field experiment was carried out at Jute Research Station,Kendrapara during Kharif 2021and 2022 for a comparative study of the effects of different chemical and mechanical approach of weed control with that of conventional manual weeding to manage the weeds in white jute.Seven different treatments with variety JRC -698(Shravanti) consisted of two no.s of pre emergence herbicide application treatments viz. Pretilachlor and Pendimethalin *fb*one hand weeding at 15 days after sowing, Two no.s of post emergence herbicide application treatments with Quizalofopethyl and Propaquizalofop*fb*one hand weeding at 30 days after sowing, one mechanochemical weed control with Nail weeder at 7 days aftersowing + Quizalofop ethyl 5 EC at 60 g/ha at 30 days after sowing, along with un-weeded check and two hand weeding at 15 and 30 days after sowing, were laid out in a randomized block design replicated thrice.Among the treatments, twice manual weeding recorded maximum fibre yield along with maximum weed control efficiency, Crop resistance index , weed control index and minimum Weed Index and was followed by pre emergence application of Pretilachlor 50% EC @ 900 ml /ha with sowing +one hand weeding at 15DAS.However, nailweeder operation during the initial crop growth stage

,integrated with post emergence application of Quizalofop ethyl 5EC 60g/ha, at 30DAE resulted in a comparable weed control indices and fibre yield as that of manually weeded treatments with a higher net return of Rs 66815/ha and a cost benefit ratio of 2.3. Hence, inclusion of nail weeder with post emergence herbicide application may be considered as a better option for minimization of weed in white jute considering its cost effectiveness.

AISDGONF/ABS/TD/514

Estimation of heterosis and combining ability in bitter gourd (*Momordica charantia* L.) using line x tester analysis

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In this study, combining ability analysis and heterosis was carried out with the help of fifteen bitter gourd characters to understand the gene action. Specific characteristics such as days to the first female flower, the node at the first male flower, average fruit weight (AFW), fruit yield per vine (FYPV), and fruit yield per hectare (FYPH) were observed to be controlled by non-additive gene action. High specific combining ability effects for FYPV and AFW were manifested in two crosses, IC 50520 x Co-1 and IC 470553 x Pusa Do Mausami (PDM). The cross IC 50520 x Co-1 (15.59 %) recorded positive and highly significant heterobeltiosis for fruit yield. The crosses IC 470553 x PDM, IC 470553 x Pusa Vishesh (PV) (1.36 %), and IC 505637 x PDM (0.30 %) recorded positive standard heterosis (5.45 %) over VNR 22 for fruit yield. The parental lines, IC 505637 and IC 470553, PV, and PDM were observed to be the best general combiners. Therefore, the promising crosses were identified as IC 470553 x PDM and IC 50520 x Co-1 for better yields.

AISDGONF/ABS/TD/523

Weed management in sweet corn under conservation agriculture

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Sweet corn, scientifically identified as *Zea mays* var. *saccharata*, stands as a distinct and delightful member of the maize family. Unlike conventional field corn, this maize variation distinguishes itself through elevated sugar levels, a consequence of specific genetic attributes. Its tenderness, juicy consistency and subtle sweetness contribute to its widespread use in diverse culinary creations. Sweet corn encounters challenges, particularly during its growth as a rainy season crop with generous spacing. The presence of a diverse range of weeds poses a significant threat, often leading to substantial yield losses ranging from 28% to 100%. Effective weed control not only prevents yield diminution but also optimizes the application of fertilizers. Adopting zero tillage practices often translates to improved economic returns compared to conventional tillage systems. A field experiment was conducted during the *rabi* season of 2022-2023 at the Agronomy Research Farm, situated within the Department of Agronomy at Orissa University of Agriculture and Technology in Bhubaneswar, on a split-plot design, comprising 4 tillage operations in the main

plot and 3 weed control treatment in the subplot in sweet corn. The main plot treatments were comprising of (M1:CT)-Conventional tillage, (M2:ZT)-Zero tillage, (M3:CT+R)-Conventional tillage along with rice residue incorporated from previous season, (M4:ZT+R)-Zero tillage along with rice residue incorporated from previous season and the subplot treatments consisted of H1: Atrazine 1 kg/ha (2 DAS) fb tembotrione 25.2 g/ha (20 DAS), H2: Atrazine 1 kg/ha (2 DAS) fb tembotrione 25.2 g/ha (20 DAS) fb hand weeding (40 DAS), H3: Partially weedy (weeds removed after critical period). The effect of the treatments was thoroughly noted. Weed count and weed dry weight was significantly lower in M4:ZT+R among the main plot treatments over other treatment and within the subplot treatments, Atrazine 1 kg/ha (2 DAS) fb tembotrione 25.2 g/ha (20 DAS) fb hand weeding (40 DAS) gave better results than Atrazine 1 kg/ha (2 DAS) fb tembotrione 25.2 g/ha (20 DAS) and Partially weedy (weeds removed after critical period). Weed count at 40 DAS was lower in M4:ZT+R (7.26/m^2) over other main plot treatments and among subplot treatments it was found to be lowest in Atrazine 1 kg/ha (2 DAS) fb tembotrione 25.2 g/ha (20 DAS) fb hand weeding (40 DAS) (6.90/m^2) compared to Atrazine 1 kg/ha (2 DAS) fb tembotrione 25.2 g/ha (20 DAS) (7.87/m^2). The highest cob yield was recorded in M4:ZT+R (14.16 t/ha) compared to other main plot treatments and among the sub-plot treatments it was found to be highest in Atrazine 1 kg/ha (2 DAS) fb tembotrione 25.2 g/ha (20 DAS) fb hand weeding (40 DAS) (16.70 t/ha) than Atrazine 1 kg/ha (2 DAS) fb tembotrione 25.2 g/ha (20 DAS) (14.81 t/ha). Same trend was found with the results of green fodder yield. In conclusion, the ZT+R demonstrated itself as the most effective among the main plot treatments, while Atrazine 1 kg/ha (2 DAS) fb tembotrione 25.2 g/ha (20 DAS) fb hand weeding (40 DAS) (H2) produced the best outcomes within the sub-plot treatments.

AISDGONF/ABS/TD/525

'Tembotrione' – a new generation herbicide for integrated weed management in conservation agriculture based maize (*Zea mays* L.) in maize -wheat -mungbean cropping System

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The rice-wheat cropping system is prevalent in India, particularly in the Indo-Gangetic plains, covering a substantial 10.5 million ha. However, this system faces challenges in terms of declining productivity and sustainability. Both rice and wheat yields have stagnated, and factor productivity is diminishing. To address these issues, adopting an alternative cropping system like maize-wheat-mung bean within the framework of conservation agriculture presents a solution. In India, maize productivity remains relatively low at 2689 kg/ha, well below the global average of 5500 kg/ha, highlighting a significant disparity between potential and actual production. Among the various factors contributing to low yields, weed-related yield reduction is particularly noteworthy. In the kharif seasons of 2022-23, a field experiment was conducted at the ICAR-Indian Agricultural Research Institute in New Delhi. The experiment utilized a split plot design and aimed to explore weed management strategies using different pre and post-emergence herbicides within the context of CA for maize (*Zea mays* L.) cultivation within a maize-wheat-mung bean cropping system. The treatments were comprising Conventional tillage maize (M1:CT-M),Conventional tillage maize with green manure frompreceding green gram (M2: CT-M+GM), Zero tillage maize with residue retention at 3t/ha (M3: ZT- M+R), Zero tillage maize with *Sesbania* co-culture as brown manuring (M4: ZT-M+BM) in main plotand five weed control

treatments, *viz* S1: Un-weeded check, S2: Pre +1 HW, S3: Pre + Post (Tembotrione) @120g/ha, S4:Pre+ Post (Premix Meso+Atra) @120g/ha, S5: Weed free check in sub- plots were evaluated in split-plot design. It was observed that M4: ZT-M+BM caused a considerable reduction in the population of broad-leaf weed, narrow leaf weed with sedges and total weeds (28.4% reduction at 60 DAS) compared to M1:CT-M. Results also revealed that the sequential herbicide application of Atrazine @750g/ha+Pendimethalin @750g/ha(pre) as pre emergence followed by (*fb.*) Tembotrione (34.4% SC) @120 g/ha (post) among the herbicide options reduced the weeds population(78.5% reduction) and dry weight (81.3% reduction) significantly than the un-weeded control (UWC).The decreased weed density and dry matter observed in these treatments could be attributed to the enhanced efficacy and extended impact of the applied HPPD-inhibiting herbicides. The highest grain yield was achieved with ZT-M+BM applied plot (6.72 t/ha), 17.7% increase in grain yield compared to CT-M. Additionally, the weed-free check plot exhibited a 25.43% increase in grain yield compared to the un-weeded check plot., which remained notably higher than other weed management methods. ZT-M+BM demonstrated higher values for cobs length, cob girth, cob weight, shelling percentage, numberof grains per cob, and 100 grain weight. On the other hand, the CT-M plot showed the lowest values for these yield attributes. The treatment receiving sequential application of atrazine at 750 g/ha with pendimethalin at 750 g/ha (pre) *f.b*. Tembotrione at 120 g/ha as postemergence recorded significantly higher grain yields (6.32 t/ha) after WFC. The findings reveal that a combination of ZT with brown manure and sequential application of Atrazine @750g/ha+Pendimethalin @750g/ha(pre) *f.b.* Tembotrione (120 g/ha) can be recommended for betterweed control and high maize productivity in CA based system of North-Western Indo-Gangetic plainsof India.

AISDGONF/ABS/TD/528

Biology and distribution of *Bemisia tabaci* (Genn.) (Aleyrodidae: Hemiptera) on brinjal

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Brinjal or eggplant (*Solanum melongena* L.) is an important vegetable crop of tropics and sub-tropics. In recent years new geminiviruses belonging to genus *Begomovirus* vectored by *Bemisia tabaci* posed a new challenge for brinjal production in India. An investigation was carried out at Kalyani, Nadia, West Bengal during *rabi* 2021-22 and pre-*kharif* 2022 to study the biology and distribution of *B. tabaci* on brinjal. Brinjal varieties Muktakeshi-124 and Royal Bengal were planted in *rabi* 2021-22 and pre-*kharif* 2022 respectively. Studies on biology revealed that life cycle of *B. tabaci* completed in 15.20±0.83 days at 27-33.8°C and 80-88% RH on brinjal. Length and width of the egg were 0.18 mm and 0.06mm, respectively. Length of first instar nymph was 0.32 mm and width was 0.20 mm and length of puparia was 0.63mm and width was 0.52mm. Total body length of adult was 0.96 mm and antennae was 0.28mm long. The shape of puparia (pointed posteriorly) and dorsal setal enlargement of *B. tabaci* on brinjal indicate influence of hirsute leaves on morphology of whitefly puparia. Overall distribution of adult whitefly approached towards random to regular pattern in both the seasons as indicated by all the distribution indices. Adults of *B. tabaci* were most abundant on the middle stratum of brinjal plants throughout the seasons. Since geminiviruses are continuously evolving and *B. tabaci* are also invading frequently, it is important to devote attention to characterize the whitefly population and their new interaction with geminiviruses on brinjal.

AISDGONF/ABS/TD/531

Comparative efficacy of some insecticides against thrips and mites of chilli (*Capsicum annum* L.) in *Gangetic* plains of West Bengal

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An experiment was conducted at C Unit farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal to study the relative efficacy of some insecticides against thrips (*Scirtothrips dorsalis* Hood), and mite (*Polyphagotarsonemus latus* Banks) infesting chilli (variety- Bullet) during two consecutive *kharif* season of 2018 and 2019. Eight treatments *viz*., Fipronil 5% SC @ 50 g a.i/ha, Diafenthiuron 50% WP @ 300 g a.i/ha, Propargite 57% EC @ 850 g a.i/ha, Spiromesifen 22.9% SC @ 96 g a.i/ha, Diflubenzuron 25% WP @ 100 g a.i/ha, Deltamethrin 2.8% EC @ 12.5 g a.i/ha, Diflubenzuron 20% + Deltamethrin 2% SC @ (100+10) g a.i/ha including one untreated control were considered for the experiment. From the pooled data of two year it was evident that among the different insecticides, Propargite 57% EC @ 850 g a.i/ha against mite (72.43%) and Diflubenzuron 20% + Deltamethrin 2% SC @ (100+10) g a.i/ha against thrips (77.58%) were found to be the most effective treatments. The highest yield of green chilli fruit (7.30 tonnes per hectare) was harvested from crop treated with Diflubenzuron 20% + Deltamethrin 2% SC @ (100+10) g a.i/ha.

AISDGONF/ABS/TD/532

Evaluation of yield of okra [*Abelmoschus esculentus* (L.) Moench] with associated traits using correlation analysis

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Okra [*Abelmoschus esculentus* (L.) Moench] is a prominent species of *Malvaceae* family with chromosome number 2n=130. Okra is basically self-pollinated crop. However, occurrence of out crossing ranges from 0.34-27.30 per cent with maximum 42.20 per cent is noticed in insect assisted pollination. In the present investigation experimental material comprising 42 genotypes including one check (Parbhani karnti) were evaluated in Randomized Block Design during two crop seasons i.e., *Kharif* -2021 and Summer-2022 at two locations i.e., Latur and Parbhani comprising three different environments *viz.*, E_1 (Latur *Kharif*-2021), E_2 (Parbhani *Kharif*-2021) and E_3 (Latur *summer*-2022). Data were recorded on ten quantitative characters *viz*., days to first picking, number of fruits per plant, fruit length, fruit diameter, fruit weight, plant height, number of nodes per plant, internodal length and fruit yield per plant. Analysis of variances revealed that genotypes were found highly significant for all the characters in all three environments. Analysis of variance pooled over environment also revealed significant differences among genotypes for all the characters indicated significance variation among the genotypes irrespective of environment. Estimates of environmental indices showed that E1 found environment favorable for traits such as days to first picking, fruit weight, fruit diameter, plant height and number of branches per plant.

Whereas E2 environment was found to be good for number of fruit per plant, number of nodes per plant and fruit yield per plant and E3 environment for the character internodal length found superior. The character association studies indicated that fruit yield per plant was strongly associated with all the character except days to first picking suggested the importance of improvement in characters like number of fruits per plant, fruit length, fruit weight, plant height, number of branches per plant and internodal length through selection is expected to results in improvement of fruit yield per plant. The study also explained the character association in individual as well as pooled over environments revealed that the fruit yield per plant was strongly associated with all the character except days to first picking both at genotypic and phenotypic levels.

AISDGONF/ABS/TD/546

Genetic diversity assessment and synthetic seed development in potato

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Potato (*Solanm tuberosum* L.) is globally the most important crop after wheat and rice. Among Indian states, West Bengal ranks 2nd after Uttar Pradesh in terms of potato production. In view of screening diverse parental pairs from 20 popular potato genotypes in West Bengal, DUS testing, using 34 morphological characters and molecular analysis, utilizing 12 SSR loci with high PIC value, were performed. Diversity matrix was obtained and dendrogram was generated using the collected data. Morphogenetic relationship among these potato genotypes would be useful for the potato breeders. An ideal form of synthetic seeds was developed from *in vitro* shoot tips of *Kufri* Chandramukhi which is the most popular and demanding potato genotype in West Bengal. The synthetic seeds were germinated into full strength MS solid medium. In potato cultivation, the synthetic seeds could be an alternative form of seed material that could produce virus free and true to the type quality plants.

AISDGONF/ABS/TD/547

Evaluation of seed inoculation, post-emergence herbicide mixes and foliar nutrition on black gram (*Vigna mungo* L.) in the *Gangetic* plains of West Bengal

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Blackgram, an important Indian pulse, often faces difficulties in growth especially in the rice-based cropping systems. Crop-weed-microbe competition is severe due to the crop's slow early growth and short life cycle. This is aggravated by decreased rhizobial activity causing poor nodulation due to P-fixation in tropical and sub-tropical soils and prolonged submergence conditions. Herbicide management with broad-spectrum ready-mixes with balanced nutrition is a cheap and flexible alternative to control weed and facilitate nodulation by reducing weed-microbe competition. Thus, a field experiment was conducted during the summer of 2022, to evaluate the

effects of seed inoculation (S1-*Rhizobium* + PSB and S2-*Rhizobium* + *Stenotrophomonas maltophilia*), herbicide management (W1- weedy check, W2- Propaquizafop 2.50% + Imazethapyr 3.75% ME (125g a.i./ha) and W3-Fomesafen 11.1% + Fluazifop-p-butyl 11.1% SL (440g a.i./ha)), and foliar nutrition (F1-2.0 % urea, F2- 2% NPK (19:19:19)) on weed dynamics, growth, nodulation and productivity of urdbean. The experimental design was factorial randomized complete block design replicated thrice. Both W2 and W3 effectively controlled grasses, sedges and broad-leaves and recorded WCE and WCI of 53.8-60.8 % and 58.2-66.7 %, respectively. A significantly higher seed yield of 1149.0 kg ha^{-1} in S2F2 and 1315-1357.0 kg ha^{-1} in W2F3 and W3F3 was noted. *Rhizobium* + *Stenotrophomonas maltophilia* in conjunction with Propaquizafop 2.50% + Imazethapyr 3.75% ME (125g a.i./ha) or Fomesafen 11.1% + Fluazifop-p-butyl 11.1% SL (440g a.i./ha) and 2 % NPK (18:18:18) fetched the highest economic return. Hence, adequate seed inoculation in conjunction with an effective eco-safe herbicide and foliar nutrient management strategy can lead to the successful adoption of black gram in rice-based systems.

THEME - E

Role of farm mechanization, IT, bioinformatics, postharvest technology, big data management in agriculture, livestock farming, fisheries, sericulture, apiculture etc.

Plenary Lecture **AISDGONF/ABS/TE/471**

Potentialities for natural farming

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Many countries in the globe are currently facing to the vagaries of the climate and weather unpredictability has been intensified making the situation worse for crop production. Farmers across the globe are already practicing regenerative agriculture in the form of either organic or natural farming. Natural farming, being a cost-effective and eco-friendly alternative, would be a catalyst in achieving the SDGs. The Natural farming would thus ensure food security and zero hunger through better yield, diversity in cropping and access to nutritional sources and income-generating crops through an eco-friendly approach.In Sri Lankan context, organic based farming was conventionally practiced mainly before the dawn of Green Revolution, where there was an integrated approach of crop husbandry and livestock management. However, with the green revolution the whole agriculture sector moved towards the usage of chemical fertilizer and pesticides etc. and as a result, farmers gradually moved away from organic based farming practices. However, with the outbreak of Covid-19 pandemic followed by the economic crisis faced by the country, the government banned artificial fertilizer and agro-chemicals and in turn it attempted to popularize organic agriculture in the country, but it was failed. However, some positive tendency towards reinstating the organic agriculture is visible in the country thereafter. Furthermore, so called 'organic farming', which undertakes following IFOAM guidelines aiming at international market for the produce is also practiced at a very lower rate (2-3%) in Sri Lanka over the last two decades. Meanwhile, being a country which has also been faced to the climate change impacts particularly on the agriculture sector, since last two decades, Sri Lanka is preparing to face to the situation. Almost 2/3 of the land area is under the dry and intermediate zone, where agriculture is mainly based upon tank irrigation, crops are easily prone to the vagaries of intermittent drought as well as floods. Some areas, which are highly vulnerable to severe drought, experiencing a minimum annual rainfall of <1200 mm have been reported from 11 districts of the country. Hence, introduction of Climate Smart Agriculture (CSA) namely, practicing of all eco-friendly Good Agricultural Practices aiming at crop cultivation using a minimum volume of water in these areas has become pivotal. Various eco-friendly practices are adopted to conserve soil, soil moisture and to improve soil fertility level and to enhance the ecological resilience, while increasing the maximum land use efficiency thereby an increased crop production. Natural Farming (NF) is a chemical-free agro-ecology based diversified farming system which integrates crops, trees, and livestock with functional biodiversity. In here, ensuring a good health through prevention from use of various agro-chemicals is therefore highlighted. Number of pesticides have been banned ensuring exporting of pesticide residue-free end products such as tea and vegetables, to other countries. Parallel to such ban, traditional indigenous practices are also to be promoted. Various plant extracts are tested against various insects and weeds and some plants are used as repellents for various insect pests. Introduction of high yielding new grass species for feeding cattle and; silvo pastoral system for rearing cattle are continued. The natural farming interventions have thus been intensified as a means to face to the challenges of environmental (Climate change), political and social issues in the development of the agriculture sector.

Plenary Lecture **AISDGONF/ABS/TE/472**

Effects of pesticide and heavy metal toxicants on fish and human health

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Sample of water pollution, pesticides and health hazards heavy metal were collected through different stakeholder and tested in the Fish Inspection and Quality Control (FIQC) laboratories of Department of Fisheries and Bangladesh Council of Scientific and Industrial Research (BCSIR) laboratory and secondary data were collected mainly relevant literature and internet sites. With the increase in the human population, many types of organic and inorganic contaminants such as pesticides, and heavy metals are released by humans into the environment, both aquatic and terrestrial. Pesticides are used very extensively in agriculture, forestry, public health and veterinary practices. The survival of terrestrial, aerial, and aquatic organisms including human beings has been endangered by pesticides and heavy metal. The three major pesticides are herbicides (weed control), insecticides (insect control), and fungicides (Mycotic control), but the more acute toxicity are insecticides. The major Chemical groups of insecticides that are usually applied Organophosphate, Carbamates, Organochlorine, Pyrethroids, and Necotenoides. The insecticidal residues and heavy metal contaminate the water are mainly due to the intensive agriculture combined with surface runoff and surface drainage. Insecticides lead to decrease rate of growth, reproductive disorders, and causes spinal deformities, effects on gills, liver, spleen, kidney, brain, neurological, behavioral disorder and genetic defect of fish. The persistent toxicity and the ability of higher concentrations of heavy metals, metalloids, and pesticides to accumulate in water and sediment allow them to become severe poisons for all living organisms including human being.

Plenary Lecture **AISDGONF/ABS/TE/527**

Livestock production and productivity in Indian context

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India is basically an agrarian country and livestock rearing is an important sub-sector of Indian agriculture. This sector plays a significant role in supplementing family incomes and generating gainful employment in the rural sector, particularly among the landless labourers, small and marginal farmers and women. It provides nutritious food through milk, meat and egg to the millions of people. Poor farmers can enhance their family nutrition status by allowing domestic consumption of these products. Most of the rural families belonging to socio-economically weaker sections of the society maintain different species of livestock like cattle, buffalo, sheep, goat, pig and poultry to supplement their income. While the land owners prefer cattle and buffaloes, the landless poors prefer to keep goat, sheep and poultry. Livestock act as the best insurance against the crop failure and vagaries of nature like drought, famine and other natural calamities. The livestock sector not only provides nutritious food but also plays an important role in utilization of agricultural by-products. Livestock also provides raw material by-products such as hides and skins,

blood, bone, fat, feathers *etc*. for various industrial uses. As the ownership of livestock is more evenly distributed among landless labourers, and small and marginal farmers, the progress in this sector will result in a more balanced development of the rural economy in our country. India has vast resources of livestock and poultry. The total livestock population including cattle, buffalo, sheep, goat, pig, horses & ponies, mules, donkeys, camels, yak and mithun in our country is 536.76 million numbers, and total poultry population including chicken, duck, turkey and other avian species is 851.81 million numbers in 2019 (20th All India Livestock Census, 2019). India ranks first in respect of buffalo population, second in cattle and goat population, third in sheep, fourth in duck and fifth in chicken population in the world. India has 12.8% cattle, 54.4% buffalo, 13.4% goat, 6.0% sheep, 2.4% chicken and 2.8% duck in respect to world's population. India is also very rich in animal genetic resources having 212 registered breeds of livestock and poultry (53 cattle, 20 buffalo, 44 sheep, 37 goat, 13 pig, 7 horse & pony, 3 donkey, 9 camel, 1 yak, 19 chicken, 2 duck, 1 geese and 3 dog) according to the ICAR-NBAGR, Karnal (as on 31st August 2022), in addition to many more not characterized and accredited so far. India has world's best dairy buffaloes, draught cattle, carpet wool sheep and prolific goat breeds. India continues to be the largest milk producer country in the world, 209.9 million tonnes with an annual growth rate of 5.81% (2020-21). Present per capita milk availability (444ml/day) in our country is more than the ICMR nutritional requirement of 300 ml per day. India ranks third in the world in egg production with 4.96% of world share, after China (40.64% of world share) and USA (7.85% of world share). According to the National Statistics Office's (NSO) detailed crop-wise estimates of the value of output from agriculture and allied sectors, during 2014-15, the contribution of milk alone (Rs.4,95,841 crore) was higher than the total value of food grains (cereals plus pulses), which stood at Rs 4,86,846 crore, and was way above paddy (Rs 2,26,481 crore) or wheat (Rs 1,28,998 crore). However, the Indian livestock productivity is very low in comparison to many developed countries, which needs a focus for its improvement.

Plenary Lecture **AISDGONF/ABS/TE/533**

Transforming sustainable rice-based agri-food systems: Recent innovations and interventions

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Rice is the major staple food for more than half of the world's population. Currently, around 90% of the world's rice production and 95% each of the world's consumption and exports are from Asia. The rice-based systems have been facing a daunting challenge in meeting future food demand due to growing population, climate change, and related concerns, including monsoon variability and occurrence of abiotic stresses (flood, drought, salinity, etc.), particularly in South Asia. Developing and scaling the stress-tolerant rice varieties are fundamental when it comes to climate risk management in rice-based systems. Leveraging information and communications (ICT)-based tools, internet of things (IoT), geospatial technologies, drones, scale-appropriate mechanization, etc., hold huge promise for engineering smart innovations and sustainable solutions to combat climate change. In this context, the International Rice Research Institute (IRRI) has developed a number of ICT tools, IoT solutions, and digital databases (e.g., AutoMon^{PH}, CF-Rice, COMPARE, Crop Manager, Rice Doctor, RIICE, RKB, MapAWD, SECTOR, Seedcast, EasyHarvest, PRiSM, WeRise, etc.), designed to support the scientific research and development needs in a holistic approach from the crop planning to the post-harvest processing phase of

production. Empowering smallholders, especially women farmers and rural youths, with recent innovations is imperative. Technological innovations alone cannot help achieve the adaptation of agriculture to climate change. To catalyze wide-scale adoption of improved varieties with appropriate establishment methods and conforming management practices, there must be a strong social networking and partnership for community-based adaptation and region-specific interventions. Considering social, economic, and environmental sustainability with regard to food and nutrition security, IRRI has been working in collaboration with national agricultural research and extension systems (NARES) partners, policymakers, and other stakeholders in South Asia to deliver consolidated research and education support services for transforming rice-based agri-food systems that are more resilient, more equitable, and more sustainable.

Lead Lecture **AISDGONF/ABS/TE/468**

Implementing of ecological restoration and achieving ecosystem services in traditional way: A case study

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Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed, and ecosystem services are seen as 'the benefits ecosystems provide'. There have been debates and arguments regarding the definitions of these two, and these have been experienced and examined from different angles. These lead to the dynamic development of the concepts as there are evidences of implementations and evaluations by different workers in their respective fields. Accordingly, the interpretations of the concepts have been looked into differently from different angles of thought. I attempt here to put a showcase where rural people have been working for conservation of nature without understanding these technological terms, but theories have been practised in the same direction as it should have been. Shankarghola is a village in Bongaigaon district of Assam dominated by Rabha tribe at the foothills of Bhairab Chura hills and at the bank of Doloni*beel*. The people are mainly agriculturists, paddy is the main crop, and few betel nut trees are produced as cash crops. They have been growing paddy purely organic way depending on the natural manure by the litter falls of the hills that drain to the crop field. They inhabit with the wild animals in harmony, the endangered and endemic golden langur is the village pride. The utilization of ecosystem service by the Kanglikati stream, the mini dam they build with innovative knowledge to do irrigation, the fish and other aquatic food they get from the wetlands, the pollution free village life they live, are being done by the traditional knowledge only. The restoration of the stream by protecting the forest is another good example of community participation in conservation.

Lead Lecture **AISDGONF/ABS/TE/534**

Hunger-poverty-silence: The lethal combination that keeps adding entropy to agrarian ecosystem

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Hunger is the sauce of life that drives us to the golden harvest; it's the fire either, that destroys socio-ecological balances to invite ever increasing entropy. The UNO in its recent press release express concerns that more millions will die not due to COVID pandemic only, it is because of

hunger and poverty. The humongous up surging of joblessness, economic disaster and social disorder due to this pandemic, the poor, hungry and voiceless people are going to die, a repetition of social Titanic episode can be as worst as an analogy! In India only close to 10 million migrant workers have become re-migrant for the worse destiny, a close to five million have lost their job or extremely vulnerable to a sudden joblessness due to economic apocalypse as reflected in a appalling -23 per cent growth revealed by the ministry of finance, India. The need of the our is to elicit the factual data on the damaged and vulnerability status with an immediate restart of economical repairing and social healing process. We have no choice but to make people, those who are reeling under dire marginalization, free from fear psychosis by restoration of both economy and morals. Silence is the most lethal inputs that make poor the poorer, deprived with a stubborn silence and the hungry with an unacceptable negotiation with social hegemony and extortion inflicted on the poor by the mighty richer community. So, a comprehensive research offers an inevitability of a study that would delineate and decipher the lethality of a venomous combination amongst and between hunger-poverty-silence, the trio that causes deadening consequences of deprived people and the civilization at length. Even with the swashbuckling claim on growth and prosperity on the present civilization, the other side of this prosperity is so bleak and disastrous that has no match for the past centuries even. Out of around 7 billion population of the world, 1.5 billion are hungry. They don't have adequate access to food, if it is there, the quality doesn't stand anywhere near to fulfil their calorie requirement. In India 350 million people are living below the poverty line and of them, 200 million people have become victim to moderate to extreme hunger indexes. 42 per cent of the new born babies are under weight. 60 per cent of the children are suffering from moderate to high level of anaemia experiencing stunted growth. Beyond the curtain of hunger, there is another problem that is chronic hunger. Based on hunger index we the nation is occupying 100th position in the world (IFPRI Report, 2017). The scenario of chronic hunger is even worse and astoundingly it is worse than African nations as well. Quoting back of Gunner Myrdal, a German analyst (Wrote 'Asian Drama'), the reasons for sluggish growth of Indian Agriculture is her Agricultural work force, who themselves are suffering from malnutrition, hunger and social impoverishment. Indian agriculture is the largest but unorganised economic sector of the world. The farm entrepreneurs, are suffering from both the vagaries of nature and market. The decelerating agricultural economy has thrown the growers into a vicious cycle of hunger, poverty and silence. Hunger here has been denoted by the level of food, calorie and nutrition intake by human bodies within the framework of minimum requirement set by World Health Organisation (WHO). Poverty here has been measured in terms of per capita income per month from a unit of holding, which is 121 million in India (NSSO data, 2014-2015).The silence here is measured in terms of ability and permeability to communicate with others or availing communication from others as to their need for survival and growth. The unique character of studying silence 'uninformed diaspora' in India is that for farmers huge pile of information are there, but only a minuscule proportion is being accessed by the farmers. The voice for Minimum Support Price, crop insurance, health and nutrition, security and sustainability, is either plan fully unheard or they are refrained from uttering their voices to defend their stakes. The silent killer is the lethargy of uninformed life, when an individual is restrained either from accessing information or uttering opinion. So, the combined three lethality are both technically and operationally combined together. Simply enough it is to withstand the corollary that states Indian farmers are poor and that is why they are hungry; they are both poor and hungry because they are silent. With this background, an empirical study has been carried out by engaging one scholar with the following objectives: i) To organize selected base line survey for delineating the present scenario of hunger, poverty and voice. ii) To organize participatory analysis of poverty, hunger and voice to generate primary and qualitative information on the issues mentioned. iii) To analyse and

estimate the intra and inter level relation and interaction by taking poverty hunger and voice as dependent variables to be predicted and elucidated from a score of socio-ecological and techno-economic variables selected for the study. iv) To generate a micro level policy based on empirical study and thereafter to create experimental paradigm for its further replication. A score of 150 rural women from North 24 Pgs, selected both random and non- random sampling respondents have been interrogated through a structured schedule. The revelation, as depicted by multivariate analyses, showed that poor access to information, ignorance about welfare projects and poor information seeking behaviours had been the culprits to refrain target women from availing the desired benefits of projects meant for them. The role of socio-political brokers had been a barrier to attaining distributive justice.

AISDGONF /ABS/TE/15

Technology assessment of pulses and oilseeds in eastern India over last decade

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The present study attempts to assess and quantify technological change and multiple factors responsible behind the production of pulses and oilseeds in eastern India over last decade (2009-10 to 2018-19). Output-oriented DEA-Malmquist technique has been computed for the entire study. Technological change (TFPCH) in pulses and oilseeds is mainly guided by the technical substitution of input use (TECHCH) and not by efficiency and knowledge gaining of the farmers (EFFCH). The state West Bengal dominates in Chickpea (TFPCH quotient 1.127), while Bihar dominates in Lentil (TFPCH quotient 1.306) and Mustard (TFPCH quotient 1.528) cultivation. Orissa features dominancy in Groundnut (TFPCH quotient 1.247) cultivation over the year. Overall TFPCH may be guided by the suitable plant protection measures, proper method of sowing followed by adequate supply of inorganic fertilizer and HYV seeds. Poor quality seed, lack of mechanization with plenty of unskilled labour still prevailed in the eastern states as well. Expansion and utilization of Rice-Fallow areas with *paira* cropping will raise the overall productivity of pulses and oilseeds in Eastern India.

AISDGONF /ABS/TE/25

Forecasting onion price volatility in the presence of long memory using the FIGARCH model

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Fluctuations in commodity prices have always been a major concern of the producers as well as the consumers as they affect their decision-making and planning processes (Allen, 1994). Agricultural commodity prices tend to be more volatile due to seasonality, inelastic demand, production uncertainty and also because many agricultural commodities are perishable. Therefore, the ability to accurately forecast the price behaviour of agricultural commodities over time is an important concern among both policymakers and farming communities. The presence of long memory in volatility was demonstrated in this paper by the significant results of the long memory test. Our study investigates the presence of long memory in onion minimum and modal prices

collected from the Kolkata market for the period January 2014 to March 2020 using the fractionally integrated generalised autoregressive conditional heteroscedasticity (FIGARCH) model. For both price series, the last fifty observations are kept for model validation and evaluation purpose. The AR-FIGARCH model is fitted to the onion price data, and the forecasting performances of the fitted model are examined in terms of RMSE and MAPE. Lower RMSE and MAPE values demonstrate the fitted models' excellent predictive ability.

AISDGONF /ABS/TE/28

A study on impact of climate change on wheat production in Kurukshetra district of Haryana and development of forecast models

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The present paper attempts to study the effect of Wheat production in the Kurukshetra area of Haryana, India, is affected by changes in meteorological conditions. The study examined 35 years of time series data on wheat yield as well as weekly data on five weather variables for the crop season from 1985-86 to 2019-20. Using weather indices and time trend as regressor variables and wheat yield as regress and the effect of various factors was investigated using step-wise regression analysis. It has been found that weighted weather indices of each weather variable including time trend have exhibited significant effect on the wheat yield. It has also been found that rise in all five weather variables except relative humidity has been detrimental to wheat yield during harvesting phase of the crop. The overall results indicate the fact that changes in climatic variables show detrimental as well as beneficial the role depending upon the phases of crop production in getting out its final output.

AISDGONF /ABS/TE/29

Time series analysis and forecasting for major wheat producing states in India using ARIMA and Holt's linear trend method

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The wheat crop dominates Indian agriculture, making it vital for policymakers and food security planners to anticipate wheat production. In order to forecast wheat production statistics for India and five of its major wheat-producing states from 1950–51 to 2019–20, the research empirically compares the two most popular forecasting techniques Holt's linear trend approach and Box Jenkin's Auto Regressive Integrated Moving Average model. Data was used for model construction from 1950–51 to 2014–15 and for testing from 2015–16 to 2019–20. Although each model could independently produce accurate projections, comparative measurements showed that Holt's technique performed better than ARIMA for both area and yield forecasting of wheat crop in this research. Whereas, ARIMA and Holt's method performed equally well for wheat production

in almost all the states. On the basis of the developed models, projections from 2019–20 through 2029–2030 have been made. The effectiveness of statistical tools to forecast wheat production may be further enhanced by the inclusion of production factor input.

AISDGONF /ABS/TE/32

Factors influencing female participation in agriculture in west Bengal

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The vertical backbone of Indian economy depends on Agriculture and it is regarded as the soul of economy. Since the last century, India turns itself from a self-insufficient country to self-sufficient country with the infusion of science and technology. Though the role of women in agriculture remained as 'Invisible Workers' throughout this period. These unsung warriors played an important role in agriculture, as they have absorbed 2/3 rd of total workforce required. Female labours are quite cheap and easily available for various farming activities (viz sowing, nursery management, transplanting, weeding, irrigation, fertilizer application, harvesting, threshing, etc.), management responsibility (viz fuel wood collection, fodder collection), livestock rearing (viz. cleaning of animals, watering of cattle, milking etc.) preparation of dung cake, collection of FYM (Farm yard manure), satisfying family's nutritional security (viz. kitchen garden) as well as children upbringing. The purpose of the present study aims to apply the simple multiple regression analysis to analyze how female work participation rate (dependent variable) is influenced or affected by various factors viz scheduled caste population, scheduled tribe population, literacy rate and shifting towards other job opportunities, which are regarded as independent variable or explanatory variable. In case factors are not found significant, stepwise regression analysis is attempted to identify the most significant factor(s).It has been observed that the fitted regression models can explain the variability of the models sufficiently. Explanatory variables are significantly influencing female work participation rate WPR (F) for West Bengal and its various districts. The study reveals that in most of the districts, increase in percentage (%) of schedule caste and schedule tribe population have positive impact on WPR (F), whereas literacy rate and shifting towards other job opportunities have negative impact on WPR (F) except North 24 Parganas and Bardhaman.

AISDGONF /ABS/TE/36

Role of artificial intelligence in agriculture: current status and future prospects

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Agriculture is the oldest and most dynamic occupation throughout the world. Since the population of world is always increasing and land is becoming rare, there evolves an urgent need to find new affective solutions to farm. Cutting-edge technologies in AI such as Internet of things (IoT), Machine learning (ML), cloud computing, statistical computing, deep learning, virtual reality (VR) and augmented reality (AR) are enabling the sector to overcome the challenges of productivity,

quality, traceability and carbon emission with enhanced profitability. Precision farming, smart greenhouse, drones or unmanned aerial vehicles (UAVs) are being predominantly used in agricultural sectors. Other technological developments, including Big Data Analytics, Robotics, the Internet of Things, availability of cheap sensors and cameras and even wide internet coverage in geographically scattered fields, will allow the introduction of AI in agriculture. IoT-based automation system has successfully controlled temperature, relative humidity and microclimate inside the polyhouse where high value vegetable crops were grown. AI systems can provide predictive insights about which crop to plant crop in a given year and the optimal date to seed / harvest in a given region to increase crop production and decrease the use of water, fertilizers, and pesticides by analysing soil-management data such as temperatures, weather, soil-analysis, soil moisture and historic crop performance. The effect on natural ecosystems can be minimized through the implementation of the AI technologies help in achieving sustainable development goal, thereby keeping the food prices low and ensuring that food production keeps pace with the population increasingly.

AISDGONF /ABS/TE/37

Estimation of raindrop size distribution and kinetic energy of orographic rainfall using one minute resolution spectrum data, Western Himalayas, India: a predictive modeling approach for soil erosion study

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Land degradation due to soil erosion, by water considered to be a major challenge for global food and environmental security. Factor affecting soil erosion was rainfall erosivity, changes in land use, and management effects. Among these factors rainfall erosivity is of high importance as rainfall is the primary cause of soil erosion by water and directly affects the detachment of soil particles, the disintegration of aggregates and the transport of eroded particles via runoff. Reliability of erosivity depends on accuracy in intensity and kinetic energy measurement of rainfall event, that both are vary significantly within a rainfall event from beginning to end, among seasons and geographical locations. Further energy calculation needs sophisticated instrumentation, so it is estimated as a function of the rainfall intensity. Many energy-intensity equations were already developed in India using indirectly estimated energy value instead of actual measured value. Therefore, it's very much need to develop indigenous energy-intensity relationship with directly measure kinetic energy value. To measure kinetic energy a "disdrometer" has been installed in selakui farm of ICAR-IISWC, Dehradun in 2019. The disdrometer provide data of one minute resolution in spectrum frequency matrix form that consists of 24 diameter and 22 velocity class, where value of the diameter and velocity class extended from 0 to 8.5mm and 0 to11m/s, respectively. The data were downloaded, preprocessed and visualized through Theis LNM view software. Kinetic energy was calculated using drop size distribution and velocity, following the approach of Petru and Kalibova (2018). To estimate energy estimation automatically an Algorithm was developed by Integrating Python and R program. Power equation was developed that found to be best fitted energy intensity equation. Further, to estimate average drop size, Gama distribution was fitted monthly basis where shape and rate parameter extended from 0.57-1.29 and 0.66-3.32, respectively. The frequency of raindrop size and velocity was positively skewed i.e., more inclined towards lower diameter and velocity class. Further, results of

raindrop size distribution has seasonal variability, where 93.19% drops comes under less than 1 mm diameter class and approx. 1% raindrops has more than 1.75mm diameter during winter season (Oct-Feb). But for summer and monsoon (Mar- Sep), 95% less than 1 mm diameter class and approx. 1% raindrops has more than 2mm class. Maximum drop size velocity observed as 8.2m/s during winter and 10m/s for both summer and monsoon season.

AISDGONF/ABS/TE/44

Forecasting cash crop production with statistical and neural network model

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Countries can use forecasts to establish data-driven strategies and make educated commercial decisions. In order to minimize rural poverty and unemployment in developing nations, the development of cash crops is a crucial component of agricultural diversification projects. A comparison of the ARIMA, ETS, and NNAR models for forecasting area, production, and productivity of wheat, paddy, maize, jowar, and cotton crops is presented in this study. We used data from 1980 to 2010 to estimate using models (training) and 2011 to 2020 to test the model's validity (testing). On the basis of goodness of fit, the models were contrasted using training and validation data sets (RMSE, MAE and MASE). Forecast values for the years up to 2027 were derived by choosing the best model. Wheat, paddy, and cotton production are predicted to rise, but jowar and maize production are predicted to fall. The outcomes of the current forecast may enable policymakers to create future strategies that are more aggressive in terms of food security and sustainability, as well as better in terms of Indian cash production.

AISDGONF /ABS/TE/47

Developing survey methodology to generate primary level data on female agricultural population in selected districts of West Bengal

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Agriculture is backbone of the Indian economy. In order to achieve overall sustainable development in agriculture the role of women should be properly recognized and documented. Due to the complex social structure, work participation rate of Indian women varies greatly from one region to another. It creates disparity in work participation which is a condition of being unequal and is an observable difference. There is a marked difference in women's agricultural work according to agro-ecologic zones in West Bengal. After the census 2011, we have not got any information or solid frame on present scenario of Women participation in agriculture in West Bengal. The literature survey is made all are based on old dataset. The dataset are not updated. Therefore the present paper is adapted to develop a survey methodology to generate primary level data to get various information on female agricultural population in selected districts of the state of

West Bengal. Multilayer purposive Sampling is applied to select the districts among all the districts of west Bengal on the basis of ranking of female Work Participation Rate (WPR). Then Stratified Random Sampling technique is applied to select blocks of each subdivision. Proportional allocation is the way to allocate the sample to the strata. Hence, proportional allocation is applied to select the no of blocks from each strata i.e. the subdivision. In this method the allocation of a sample of size n to different strata is done in proportion to their sizes, i.e. in the i^{th} stratum, $n_i = nN_i/N$ (or $f_i = f$), where, N_i = total number of units, n_i= number of units in the sample, N= Population size, n= Sample size. which refers to same sampling fraction in all strata which provides a self-weighting sample by which estimates can be made with higher degree of precision. Simple random sampling is used to select villages of each selected blocks. To generate primary level data questionnaires are prepared and on the basis of individual interaction different kind of data are collected to prepare the database.

AISDGONF /ABS/TE/49

Microwave - convective hot air drying of carrot slices

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Carrot is a very popular winter vegetable and one of the important root crops cultivated throughout the world. Microwave - Convective hot air drying method was used for drying carrot slices of 0.5 cm thickness. The influence of power level on drying characteristics of carrot was investigated to optimize the microwave dryer power level. Carrots were dried using four different power levels of 90W, 180W, 600W and 900 W. Depending on power levels the drying was completed between 10 to 22 min. After microwave drying the carrot samples were dried in a convective dryer at 60°C. The drying kinetics was characterized by drying curve and drying rate. The drying curves showed consistent pattern of decrease in moisture content with increasing time period. The maximum reduction in moisture content by convective drying was found for the samples dried at 600W power level. The carrot slices were dried to final moisture content of 8%.Rehydration ratio was found to be highest in case of samples dried at 600W power level. β-Carotene content was highest for the samples dried at 180W power level and was least for the samples dried at 900W power level. Therefore, with respect to moisture content, rehydration characteristics and β-Carotene content, microwave drying at power level of 600 W along with convective drying at 60°C was selected as the best drying condition for carrot slices.

AISDGONF/ABS/TE/52

Predictive analysis of agriculture commodity price using ARIMA and LSTM

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Price fluctuations can have an effect on both producers and consumers. Forecasting agricultural commodity prices is of utmost importance to the government, farmers, and agribusiness companies. With the help of time series data on commodity prices, this study compares traditional models with neural network models. Historically, a number of methods have been used to predict the next lag of time series data, most notably Autoregressive Integrated Moving Average

(ARIMA) and its several variants. Time series data analysis and forecasting algorithms are being created using machine learning techniques like deep learning. This study employed a univariate time series dataset of Bengal gram and lentil prices covering the period from January 2009 to December 2021 of Kolkata market. This article's research question is on whether and how recently developed deep learning-based time series forecasting algorithms, like Long Short-Term Memory (LSTM), outperform more established ones. The actual research carried out and discussed in this article demonstrates that the traditional-based algorithm ARIMA model is outperformed by the deep learning-based algorithm LSTM. For RMSE and MAPE, especially, LSTM produces the greatest results at 345.60 and 4.83, respectively. Additionally, it was found that the trained forecast model behaved truly randomly and that the amount of training cycles, or epochs in deep learning, had no impact on its performance.

AISDGONF/ABS/TE/75

Market cointegration and price transmission in major small cardamom markets of India

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Marketing along with the production of food, is a crucial means to a goal since markets connect production and consumption. As price signals and other information are transmitted between markets, integrated markets help to stabilize prices and ensure farmers' income. The present study seeks to explore the degree of market integration and transmission of price through cointegration analysis on the monthly wholesale prices of major three small cardamom markets in India viz., Kochi, Chikmagalur and Bodinayakanur. The Johansen method of cointegration was used to investigate the interdependence between the markets followed by Granger Causality test to govern the direction of information flow. This study exposed that there is a cointegrating long run relationship between the markets. The price transmission flow is unidirectional from Kochi to Chikmagalur and Bodinayakanur. Kochi is leading in price determination. It is anticipated that these findings will benefit both the producers and the consumers, enable them to increase their profits by hedging against market uncertainty.

AISDGONF/ABS/TE/76

A review on insect meal as alternative feed ingredient in aquaculture

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Demand of fish and fishery products is increasing day by day as a cheap protein source with growing population. But there is a continuous depletion in capture fishery stock globally. So, diversification and implementation of new techniques have been started to increase production in culture sector. Fish meal is one of the most important components in fish diet due to its high nutritional profile. For some environmental and economical issues, there is a search for alternative protein source as a substitution of fish meal protein. Some feeding trials have been made with insect meal as a replacement, resulting a promising alteration. Major group of insects such as black

soldier fly, housefly, silkworm, mealworm, locust etc have been used as they are rich in protein, lipids, vitamins, minerals and poor in anti-nutritional factors. With a high nutritional profile, they have shown easy rearing facilities and better biomass production than any other animal protein source. Low level of insect meal (25-30%) inclusion in fish diet improved growth rate, survivability, feed conversion ratio and immunity of target species. Further research work is needed for industrial production of insect meal by keeping their impact on food safety, environment and society in mind.

AISDGONF/ABS/TE/79

Shelf life of pengba (*Osteobrama belangeri*) under iced and frozen storage

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Osteobrama belangeri, commonly called as Pengba is the state fish of Manipur. Keeping in mind for diversification, there has been enough attempt to intensify the production of Pengba in Manipur and also elsewhere in the country. This initiative will aid in the transport and post-harvest storage which will be necessary for distribution, thus enhancing the acceptability of fish and cold chain establishment. Fishes exhibit large variations in their biochemical composition from species to species and hence, the knowledge of proximate composition of fish is of utmost importance. In the present experiment, Pengba fish (*Osteobrama belangeri*) was collected from a farm in Dwaribera village, West Bengal to study its shelf life in ice storage and also the fish in whole and gutted condition under frozen storage. Higher moisture and ash content was observed with a value of 74.76±0.9 and1.01±0.37%, while lower protein and fat content was recorded i.e., 16.12±0.10 and 6.7±0.15% respectively in all the iced samples during the storage period. The proximate composition of Pengba fish (*Osteobrama belangiri*) under the frozen storage decreased for both Whole and gutted Pengba as storage progressed. The quality indices viz., total volatile base nitrogen (TVB-N), peroxide value (PV) and pH were well within the limit of acceptability for iced, frozen whole and gutted Pengba fish till the end of storage period. Thus, the optimum shelf life of 7-9 days was observed for ice storage and 120 days for frozen stored (-18±2°C) whole and gutted Pengba, raising its potential for marketing in the country.

AISDGONF/ABS/TE/84

Preparation of tea from dry hibiscus powder: A unique source of antioxidants and subsequent storage study

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Tea is an aromatic beverage which is prepared by pouring hot or boiling water over cured or fresh leaves of *Camellia sinensis* (commonly known as tea plant). It contains caffeine which has a stimulating effect on humans. Similarly, hibiscus tea is a herbal beverage prepared by pouring hot or boiling water over the dry petals of hibiscus flowers. It is full of antioxidants and used to treat hypertension, heart diseases and many other diseases. Generally, commercial hibiscus tea is made of *Hibiscus sabdariffa* which is quite expensive (Rs. 250 - 800/kg). On the other hand, *Hibiscus*

*rosa sinensis*is is very common, found in tropical homes abundantly and might be less expensive also for preparing tea. However, there is lack of scientific data on preparation of hibiscus tea and its subsequent uses. Thus, the present study was conducted to evaluate bioactive compounds and antioxidant activity of tea made of *Hibiscus rosa sinensis* and their relative degradation during storage, in comparison with standard Green tea. Monomeric anthocyanin pigment content was determined by pH differential method, total phenols by Folin-Ciocalteau method and antioxidant activity was determined by using DPPH assay. Results depicted that monomeric anthocyanin, total phenolic level and antioxidant activity were directly influenced by storage duration. The total phenolic content and antioxidant activity were higher in mixture of hibiscus tea and green tea along with maximum acceptability proved by organoleptic evaluation.

AISDGONF/ABS/TE/88

Diffusion pathway of mechanical rice transplanter through social network analysis in selected villages of West Bengal

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Diffusion of innovation research has high impact on extension practices. Conventionally and popularly collection of diffusion data is sourced from individual adopters, ignoring their social networks they belong to. Social Network Analysis is a field of data analytics that uses networks and graph theory to understand social structures which has been less tried in interpreting diffusion data.The present study utilized the Social Network analysis as a tool to explore the diffusion pathways of a newly adopted technology in West Bengal. In addition, a comparatively new PRA tool named Innovation Tree has been applied to visualize and analyze the way in which an innovation is spread over time between the community members. It helped in identifying not only to distinguish between various adopter categories, but also as a way of helping both outsiders and the community to understand some of the social and psychological dimensions that influence the adoption and diffusion of an innovation within that community. This study was conducted in Sekati and Chhoto Sehana Village of Gaighata CD block in North 24 Parganas District, West Bengal. The village was selected to study the diffusion of mechanical rice transplanter in the light of social network analysis. Total enumeration of the mechanical rice transplanters in the village was done for the study. Both qualitative and quantitative data were collected from 65 respondents who were the adopters of the mechanical rice transplanter. Data analysis was done using UCINET and NETDRAW software and Innovation Tree was generated with local participation. The study revealed that neighbors, friends, input dealers were the main source of information for the respondents. The results showed that the key persons, around whom the networks are centralized, had higher educational background, high land holding, and high degree of cosmopoliteness. This study helped us in visualizing the diffusion pathway along with the key actors who had emerged as the main source of dissemination of the technology that paves the way for effective extension with limited paid extension manpower belonging to the government system.

AISDGONF/ABS/TE/98

Measuring instability in production of major pulses in India

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In India, gram and arhar are major sources of vegetable protein. Undivided Madhya Pradesh and Maharashtra are major gram producing states. Arhar is largely produced in Maharashtra, Karnataka and undivided Madhya Pradesh. In spite of the fact that India is the highest producer of pulses in the world (18.15 million tonnes) it still imports nearly 6.6 million tonnes of pulses. When there is an imperative need of increasing production of pulses the country is suffering from instable production of pulses due to various reasons. In this study an attempt has been made to measure instability in area, production and yield of major pulses in major producing states of India during 1967-2019 using existing instability indices and a newly developed index. The whole period of study is divided into three sub-periods viz. early and late part of green revolution and period after globalization of trade to study the changing patterns of area, production and yield of pulses during the sub-periods. Kruskal-Wallis test was undertaken to justify the division of sub-periods and significant increases in production of gram and arhar were found across sub-periods in major producing states. Both linear and non-linear trends were observed in area, production and yield of pulses under study. Maharashtra and Karnataka experienced highly instable area, production and yield of gram and arhar, respectively during all sub-periods. As such the study suggests for minimizing instability and augmenting productivity of major producing states of gram and arhar in India.

AISDGONF/ABS/TE/104

Development of a mechatronics-based hill-drop seed metering mechanism for the precise sowing of pre-germinated paddy seeds

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For the sowing of pre-germinated paddy seeds in wetland a precision hill drop seed metering mechanism was developed. A rectangular metering plate with a hole in the middle was placed at the hopper outlet, which was actuated by a push-pull type solenoid to drop the seeds in the form of hill. The triggering of solenoid was controlled by a sensor wheel. The performance of the developed metering mechanism was evaluated using a grease belt. The main operating parameters of the study were forward speed (0.7, 1 and 1.3 km/h), metering plate hole diameter (9, 10, 11, 12 and 13 mm) and speed of the agitator (20, 40 and 60 rpm). The performance parameters were missing index, multiple index, quality of feed index, mean hill spacing, coefficient of hill distribution uniformity and coefficient of seed dropping uniformity in hills. No visible damaged seed was found in any treatment of the laboratory test. The multiple index was found 0% in all the treatments. By applying response surface method, the optimum operating condition was found to be 0.84 km/h forward speed, 11.18 mm plate hole diameter and 37.37 rpm agitation speed. At

optimized operating condition the frequency of occurrence of 3 to 5 seeds per hill was found in 64.8% of the solenoid strokes, germination percentage of hill-dropped seeds was 91%, the seed rate variation was much lower than drum seeder, and the number of seeds dropped per hill was closer to the pneumatic rice seeder.

AISDGONF/ABS/TE/124

An approach towards exotic carp (*Cyprinus carpio, Hypophthalmichthys molitrix and Ctenopharyngodon idella*) identifation using deep learning techniques

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With the advent of technological era, the image processing technique has been used widely in the fields of science and technology. Classical approaches to taxonomy prove to be cumbersome in analysis of extensive data and require a skilful researcher to experiment. The use of image processing technique can support to reduce several of such pre-requisites. The initiative of the use of artificial intelligence and deep neural networks have proved its merit in fish taxonomy. In the present experiment around 1500 images were collected of three widely cultured exotic carps (*Cyprinus carpio, Hypophthalmichthys molitrix* and *Ctenopharyngodon idella*), 500 images of each species. To achieve complete identification of the fishes with the help of different deep learning techniques. The collection of the data set was undertaken from various auction market of West Bengal (Bishnupur Machh Bazar, Annapurna fish market, Moyna, Patipukur Fish Market, Kolkata). Among the collected data set 1225 image data were distributed in 60:20:20 i.e. 3:1:1 ratio for creation of training data set, testing data set and validation data set respectively. The image segmentation was executed manually with GIMP 2.0 application. Pre-trained models like VGG16, VGG19, InceptionV3, Xception, Inception ResNetV2, Mobile Net were used and transfer learning technique was applied, accuracy achieved were 88.16%, 92.65%, 97.55%, 97.55%, 98.77% and 98.36% respectively. With Inception ResNetV2 architecture showing the highest accuracy in identification.

AISDGONF/ABS/TE/126

Flood vulnerability mapping of Dakshin Dinajpur using remote sensing and GIS

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Several North-South flowing rivers like Atreyee, Punarbhaba, and Tangon intercept the Dakshin Dinajpur district of West Bengal. All these rivers are being silted, leading to a gradual reduction of their depth over time. So, flood occurs at frequent interval in this district. Flood vulnerability mapping is essential to identify the flood risk zones and extensive flood risk management. Combining Analytical Hierarchy Process (AHP) and Geographic Information System (GIS), a flood vulnerability map has been prepared for Dakshin Dinajpur district. Ten parameters which are responsible for flooding (slope, elevation, topographic wetness index, drainage density, distance

from the river, distance from the road, Land Use Land Cover (LULC), Normalized Difference Vegetation Index (NDVI), Rainfall, Soil type) were selected for this purpose. Based on their likelihood toward flooding zone, the ranges of all parameters were reclassified into five susceptibility levels (very high, high, moderate, low, and very low). Relative importance was given to each parameter based on their contribution towards flooding and a weightage was given to each parameter using AHP pair-wise comparison matrix (PCM). The most influencing flood-causing parameters were distance from the river (0.167), LULC (0.167), drainage density (0.159) and distance from the road (0.156). Finally, a flood susceptibility map was generated by Weighted Overlay analysis in QGIS software. An area of ≈87 sq. km was located in very high flood vulnerability zone in the proximity of rivers, whereas an area of ≈8 sq. km had very low flood vulnerability and ≈953 sq. km had moderate flood vulnerability.

AISDGONF/ABS/TE/130

Studies on leaf foraging sources of leaf-cutter bees (Megachilidae; Hymenoptera) in West Bengal, India: implications for conservation

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Observation on leaves, cut by leafcutter bees (Megachilidae: Hymenoptera) were performed in West Bengal, India from February to August of 2021- 2022. Usually, these bees cut leaves from various shrubs, trees, wild/ornamental flowers, and weeds to partition and encase brood cells in decaying logs, hollow plant stems, or in the ground. However, we lack in knowledge from the different parts of Wes Bengal on the choice of leaves as nesting materials, which is crucial for the safe completion of their life cycle. To recognize the plant and leaf characteristics of the foraged plants by these bees, we monitored plants and recorded how the *Megachile* bees cut the plant leaves. We studied whether the leaf size explains the cut size and the number of cuts in the leaves. *Megachile* bees gathered leaves from plants belonging to 91 species, 74 genera and 31 families, all of which had different characteristics. 43.47% of the plants in the study had distinguishable cutting marks and the highest number of plant species having leaf cuts were found to be from the family Fabaceae. Bees chose leaves in a wide variety of sizes, and the number of leaf cuts present on those were related to the size of the leaves. We conclude that the choice of plants by the leafcutter bees is adaptable to the local environment by comparing our findings with those of previous studies.

AISDGONF/ABS/TE/134

Nest architecture of the stingless bee *Tetragonula bengalensis* (Cameron) (Hymenoptera: Apidae: Meliponini)

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It has been aimed to study the nesting site characteristics of stingless bees *Tetragonula bengalensis* (Cameron) in the forest and village areas of Jhargram district, West Bengal, India. The colonies were naturally active as seen and recorded from the activity of bees at their entrance gates during day time. During the study, 27 colonies had been found in tree nesting habitat and 5 in artificial

substance. Studies revealed that the natural and artificial nested colonies had been located at the mean height of 129.48 cm and 101.40 cm respectively. The majority of the nests were oriented towards south direction and were of irregular shape. Most of the nests found in our observation consisted of external tunnels (average length- 8.88 cm), covered with wax or cerumen funnel/ tube. The average numbers of guard bees at the entrance of the nests was 8.69 and the maximum number of nests was found in *Shorea robusta*. Internally, the entrance was connected to the brood through a waxy passage of 98.88 ± 41.80 mm length till it reached the involucrum. The honey pot and pollen pots were found separated from the brood area and were connected through numerous small openings in the involucrum. The mean dimension of nesting cavity, brood, pollen and honey cell were 264.14×140.85 mm^2, 2.34×1.86 mm^2, 5.55×4.88 mm^2, 7.09×5.67 mm^2 respectively (for natural nest); and 184.66×176.00 mm^2, 3.66×2.46 mm^2, 6.83×6.20 mm^2, 7.96×6.36 mm^2 respectively (for artificial nest). The findings will be of help in designing suitable bee hive for meliponiculture.

AISDGONF/ABS/TE/182

Block-wise potato crop acreage estimation of Purba Barddhaman, West Bengal using Sentinel-2 satellite data

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Potato as a major supplementary staple food crop plays an important role in the agricultural economy of India. West Bengal is the second largest potato-growing state in India with a production of 10.1 million tonnes from an area of 4.4 lakh hectares, with the productivity of 22.72 tons/hectare. The state accounts for one-third of the country's total potato production. Purba Barddhaman is the second largest potato grower in Bengal after Hooghly. In 2021, the district produced 26.94 lakh MT potatoes. Determining the crop acreage and production, and assessing storage requirement are important for agricultural managers and insurance policy makers, particularly for the high input intensive crop like potato. The study was conducted using mainly Sentinel-2A data in open source software- Quantum GIS and SAGA GIS by decision tree classification. The study involves the generation of NDVI profile of potato fields, delineation of potato grown fields using NDVI threshold (based on training sample) based DT classifier and land use land cover map generation of the district for the winter season of 2021-2022 cropping year. It was observed that about 87 % of the district was agricultural land out of which about 15.5 % was covered by the potato crop. Mainly south-eastern blocks and the north-western blocks accounted for the maximum production of potato. The blocks Ketugram-II, Burdwan-II, Raina-I, Mangolkote, Katwa-II, Ausgram-II, Raina-II, Purbasthali-I and Purbasthali-II showed potato cultivation between 10 to 30 % and Memari-I, Memari-II, Kalna-I, Kalna-II and Jamalpur (largest 48.3%), more than 30% of the agricultural land.

AISDGONF/ABS/TE/183

Accuracy assessment among different machine learning algorithms for estimating *boro* rice growing areas of Haringhata CD Block of Nadia district

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Rice is the world's most important food crop with a global coverage over 164 million hectares. To deal with the hiking population growth, reliable and timely estimates of rice crop areas are essential not only for providing information for planners and decision makers but also for ensuring food security. Summer (*boro*) rice has been emerged as the most popular practice for utilizing rice-fallow condition in West Bengal. Now a days satellite based remote sensing and GIS tools can be efficiently used for cropping window determination and crop acreage estimation whereas machine learning algorithms for cropping area discrimination. Considering above scenario, the present study has been designed to estimate the acreage of *boro* rice in Haringhata CD block from satellite imagery and to evaluate the performance of different machine learning techniques for area mapping. The study was carried out in the year 2021 during the month of January to May using multi-dated Sentinel-2 imageries that were classified using four machine learning algorithms viz. Decision Tree (DT), K-Nearest Neighbour (K-NN), Random Forest (RF), Support Vector Machine (SVM). Among the four Machine Learning algorithms highest overall accuracy of 97.72% and highest kappa coefficient of 97.05 is observed for K-NN algorithm. The highest producer's accuracy of rice was obtained for RF classifier with 97.91% accuracy. Standard error of area estimate of *boro* rice was also least for RF classification. It is observed that the machine learning algorithms can be very useful and accurate to study crop acreage estimation though their accuracies may vary according to the class and the algorithms.

AISDGONF/ABS/TE/185

Analysis of the use of video-conferencing platforms in the learning process by the research scholars

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Digitalization of the education system has created a new genre in imparting knowledge. The concept of online learning has started gaining much popularity after mankind realized its utility during the global pandemic, COVID-19. This emergency situation has established digitalization of education system as the best alternative. In order to continue learning virtually, videoconferencing platforms are of utmost importance. The teachers, students and administration were made to adopt to this new model of virtual learning. In this process, the videoconferencing platforms like Google Meet, Zoom, Cisco WebEx has gained popularity. The objective of this research is to report the impact of student learning through the use of the aforementioned video-conferencing tools. Surveys were conducted among the research scholars which reported that 89% of them are using these virtual meeting platforms for education purposes, from attending and presenting in seminars, workshops or training programmes, attending classes and conferences. Study even shows that

amongst the prevailing platforms, Google Meet is the most used one. Most of the scholars admitted that the incorporation of virtual meeting platforms into academia has enabled them to attain more conferences and seminars both at national and international levels, saving both their time and expenditure. This study also takes into account the views of the scholars for incorporation of such virtual meetings at the grass-root levels in agriculture to impoverish India's extension system which is facing difficulty to flourish due to lack of manpower. This study concludes that the use of video-conferencing platforms are a great help in academia.

AISDGONF/ABS/TE/186

A review on smart farming: the transformation of agriculture from a labour-intensive to a technology-native sector

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Farming is a profession which is playing the ultimate role for survival of this world. As technology has advanced with the development of the Internet of Things, automation (smarter technologies) is replacing old techniques, which has led to a broad improvement in a variety of fields. This technologically-based farming solution will help farmers make informed agricultural decisions by leveraging resource optimization and clever planning. This review emphasizes a modernized technology for smart agriculture management by updating every aspect, including crop field data and application usage. The development intelligent Smart Farming using smart devices is transforming the production of agriculture by improving quality and yield while also lowering costs. By combining various IoT technologies, there are tremendous potentials for automated operations with no oversight. IoT connects sensor devices to carry out a variety of basic functions, making it one of the fundamental cornerstones of smart systems. This work demonstrated how unmanned aerial vehicles (UAV) and robots can be used to perform a variety of tasks in real-time using the Internet of Things, artificial intelligence (AI), and wireless communications, including harvesting, irrigation, spraying for agricultural pests, etc. Moreover, this work also demonstrates the present scenario of smart farming in India.

AISDGONF/ABS/TE/189

Agricultural waste management: a comprehensive review

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Worldwide, a lot of agricultural wastes (AWs) are produced every day to meet the rapidly expanding population's increasing demands. In order to ensure agricultural sustainability and the security of human food and health, it is necessary to develop strategies for their timely usage and valorization. Crop residue, agro-industries, livestock, and aquaculture are a few of the sources from which AWs are produced. The most prevalent biopolymer, cellulose, makes up the majority of crop residue and agro-industrial waste, followed by lignin and hemicellulose (lignocellulosic biomass). Since the most majority of AWs are now burned or buried in soil, producing air, water,

and climate change pollution, their processing is a global problem. Some crop wastes have historically been utilised as fuel, animal feed, roof thatch, compost, soil mulch, matchsticks, and papermaking materials. To counteract the lack of fossil fuels and the effects of climate change, lignocellulosic biomass can also act as a sustainable source of biofuel (biodiesel, bioethanol, biogas, and biohydrogen). Thus, valorization of lignocellulosic residues has the potential to impact the bioeconomy by providing value-added products such as biofertilizers, biobricks, biocoal, bioplastics, paper, biofuels, industrial enzymes, organic acids, etc. This review includes several AW management solutions based on the circular bioeconomy, which include "reduction," "reuse," and "recycling" of AWs to promote sustainable agriculture and reduce environmental pollution.

AISDGONF/ABS/TE/200

Understanding agricultural insurance service system through stakeholders' perspective

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Agricultural insurance or crop insurance is defined as protection against either the loss of the crops due to natural disasters, such as hail, drought, and floods, or the loss of revenue due to declines in the prices of agricultural commodities given to agricultural producers and subsidized by the government. The research desired to find out the stakeholders of agricultural insurance service system, different roles and responsibilities played by them and to measure the knowledge and attitude level of farmers towards agricultural insurance. The study considered set of stakeholders involved in agricultural insurance system namely, such as state agriculture departments (29%), banking institutions (11%), insurance agencies (9%), and farmers (49%). It was found that majority of farmers were knowledgeable (80%) and had a positive attitude (78%) towards the agricultural insurance service system. It was observed that education, income, knowledge about agricultural insurance, risk proneness and cosmopoliteness of the farmers have significant and positive correlationship with attitude of the farmers towards agricultural insurances whereas age and land holding of the farmers have negative and significant relations with the dependent variable. The present study enables the farmers to have a good communication with the extension professionals working in their villages.

AISDGONF/ABS/TE/201

Soil nutrient mapping and spatial variability of soil nutrients in Dhamtari district of Chhattisgarh with machine learning technique

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In the study, soil health card data downloaded from the soil health card portal and satellite data products were used as proxies of soil forming factors to predict soil nutrients at each 30m pixel using various machine learning techniques. More than 1 lakh point data were collected. After omission, for spatial duplication and accuracies approximately 10000 sample points were

identified, varying with the soil parameter. In the study, 12 terrain derivatives, derived from SRTM (30m) DEM was used as the relief factor. Along with terrain attributes, 6 indices derived from Landsat derived as 5 years mean. 19 bioclimatic variables derived from monthly climatic data from worldclim were also used as the climatic covariates. Six machine learning techniques including Random Forest, Support Vector Machine, Partial Least Square Regression, Cubist, Principal Component Regression, and Elastic Net were used for predicting soil nutrient.The soils were slightly acidic to neutral in pH and low in EC. The soils were mostly low in organic carbon having less than 0.5% SOC. Entire district falls under low nitrogen content and high in potassium content. The soils of the district were mostly high in P with a small area under medium category (7.32%). Fe, Mn, and Cu were found high in the entire district. Most of the agricultural areas fall under medium category for Zn. The study identifies that random forest prediction could be used for generating soil nutrient maps at high resolution using the soil health card data to prepare field level nutrient application plans.

AISDGONF/ABS/TE/205

A comparison of ARIMA, SVR, TDNN and Hybrid Models for predicting sugarcane production and yield in Tamil Nadu

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The cash crop was preferred for its potential contribution to economic development, employment generation and overall growth of a country. With Brazil in the first place, India is the world's second-largest producer of sugarcane. Tamil Nadu is the third-largest producer of sugarcane in India and maintained the top record in productivity. With these prospective, the production and yield of sugarcane in Tamil Nadu had been chosen as a study variable. Forecasting was a crucial component of creating an economy so that adequate planning could be done for the long-term, sustainable growth of the nation. In this study, ARIMA, SVR, TDNN and their hybrid statistical models had been employed to forecast sugarcane production and yield in Tamil Nadu. The analysis was undertaken to project the production and yield up to 2025 using time series data (1950-1951 to 2020-21). Empirical findings showed that artificial intelligence techniques and hybrid models outperform the ARIMA model.

AISDGONF/ABS/TE/206

Application of Sentinel-1 SAR data for inundation analysis of Indian Sundarbans

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The Sundarbans, which turns out to be the largest delta of the earth constitute a truly one-of-a-kind ecosystem. Apart from being home to a diverse variety of rare and endangered flora and fauna, it is also the largest mangrove forest in the world. The coastal Sundarbans region, in West Bengal, often experiences high tidal surges, resulting in severe erosion and inundation and falling under a

risk-prone agricultural system. Sundarbans was hit by severe cyclonic storms in every two years. Here rain-water is the prime source of freshwater which was mainly received from South-West monsoon. It usually begins in the middle of June and ends in the second week of October. Rainfed rice-based farming is the general practice of Sundarbans, where rice-fallow-fallow system covers the maximum cropping area. The present study utilised the Sentinel-1 C band Synthetic Aperture Radar (SAR) data to analyse the inundation frequency of the 19 blocks of Indian Sundarbans, taking the threshold value of the VH band ratio of the dry and wet periods. During 2021 and 2022, the seasonal change in surface water resource acreage was estimated using the Google Earth Engine cloud computing platform. Inundation in the majority of the region begins in June (10072.19 ha), peaks in August (19918.44 ha), and then begins to decline after September. The lowest inundation was observed in April of 2021 (187.2 ha). The present study effectively demonstrated the use of Google Earth Engine for inundation frequency mapping in the coastal Sundarbans of West Bengal using open-source SAR data.

AISDGONF/ABS/TE/245

CNN_FunBAR: deep learning technique for fungi taxonomic classification based on DNA barcode sequences

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Fungi are the second most abundant eukaryotic microbial domain playing diversified ecological roles such as symbionts, mutualists, decomposers, antibiotic producers and pathogens. Metagenomics is an important research area to study microbial genomes extracted directly from environmental datasets. Fungal species identification using metagenomics approach is a highly challenging task. Internal Transcribed Spacer (ITS) region is the universally accepted DNA barcode marker for fungi taxonomy prediction. Computational approaches, especially deep learning algorithms are highly efficient for better pattern recognition and classification of large datasets as compared to *in silico* techniques such as BLAST and machine learning methods. Here, we present CNN_FunBAR, a convolutional neural network based approach for the taxonomic classification of fungi using ITS reference sequences. Effects of various parameters on classification performances of CNN models have been assessed at all taxonomic levels (species, genus, family, order, class and phylum). It is observed that CNN models can produce >93% average accuracy for classifying ITS sequences from balanced datasets with 500 sequences per category and 6-mer frequency features at all levels. The study has revealed that CNN_FunBar can outperform machine learning based algorithms (SVM, KNN, Naïve-Bayes and Random Forest) as well as existing fungal taxonomy prediction software (FunBarRF, Mothur, RDP Classifier and SINTAX). The present study will be helpful for the analysis of mycobiome from large metagenomic datasets.

AISDGONF/ABS/TE/250

Integration of indigenous traditional knowledge with modern knowledge system for hill stream fisheries and agriculture

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Traditional knowledge is an extensive body of information, skills, customs, and representations that have been upheld and developed by groups of people interacting with the environment. The indigenous people are the keepers of the knowledge that are influenced by their beliefs, spirituality and cosmology. Numerous indigenous communities live in Himalayan region, and the majority of them have their own distinct traditional knowledge and technological foundation. They have helped the indigenous populations to live comfortably and independently. The entire socio-economic growth of the communities has benefited greatly from this ancient knowledge. Due to their unique biophysical and socioeconomic circumstances, farming communities of the Himalayan area are among the most vulnerable to climate change. The Himalayan economy is based primarily on traditional agriculture. Most of them utilise a rotation of grains and millets including wheat, barley, paddy, finger millet, barnyard millet, soya bean, horse gramme, and a few vegetables and develop three crops in two years. Small farmers may choose to make a living by producing dairy products and vegetables. The small holding farmers in the area currently use a family farming method, but there are some integrations at various levels. Rice and fish can be combined to produce high-quality protein, nutritional security, and income for rural populations on a modest scale. Rice-fish farming reduces the quantity of fertiliser, pesticides, and herbicides used in the rice field by not adding artificial fish feed to the water. The most important aspect of any rice-fish farming system is the quality of the water of the feeder canals and connected rivers. The abiotic conditions of the water in the rice-fish terraces of the regions are favourable for rice-fish farming and within the ideal range. All of these steps will give traditional indigenous knowledge a monetary value and encourage the locals to preserve, practise, and spread their expertise.

AISDGONF/ABS/TE/267

A study on socio-economic profile and knowledge level of farmers towards Kisan Call Center in Manachanallur block of Tiruchirappalli district in Tamil Nadu

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The challenges before Indian Agriculture are immense. This sector needs to grow at a faster rate than in the past to allow for higher per capita income and consumption. With the availability of telephone and Internet, it is now possible to bridge this gap to quite a large extent by using an appropriate mix of technologies. The study attempted to identify the socio-economic profile and knowledge level of farmers towards Kisan Call Center. The study area selected was Manachanallur block of Tiruchirappalli district of Tamil Nadu. Simple random sampling method was used for the selection of the respondents. The result revealed that 47.00 per cent of the respondents were found

in middle age group, 37.00 per cent of the respondents were illiterate, 57.00 per cent of the respondents were from large family, 40.00 per cent of the respondents had marginal land holdings, 40.00 per cent of the respondents were engaged in farming with service and business, 50.00 per cent of the respondents earning annual income up to Rs. 1,00,000, whereas 40 per cent of the respondent had membership in more than one organization and holding position in organization and 37.00 per cent of the respondents had occasional extension contact with different extension agencies. The study also resulted that majority of the respondents (53.00 %) had medium level of knowledge about the Kisan Call Center. Also, it was found that out of eight independent variables, a variable annual income was found positive and significantly correlated and variables namely education and extension contact were highly significant and positively correlated with the knowledge of the respondents about Kisan Call Center.

AISDGONF/ABS/TE/280

Bioinformatic analysis of tomato calmodulin proteins

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Plants, due to its sessile nature, developed sophisticated tolerance mechanisms involving rapid induction of stress response genes for alleviating environmental stresses experienced by them. Ca2+ signaling cascades in the cell through an array of proteins like calmodulin (CaM), Ca2+-dependent protein kinases, and CaM-binding proteins respond to stimulus- induced [Ca2+] cyt increase. The post-translational trimethylation of the lysine residue at position 116 in CaM by calmodulin-lysine N-methyltransferases (CaMKMT) modulates the binding of CaM to its ligands. Moreover, EF hand domain in calmodulins transduces the Ca2+ signals and induces a conformational change of the protein that promotes its interaction with downstream effector proteins inducing stress responsive genes. However, genes encoding for calmodulin proteins in tomato plants are not characterized. In this study, a total of 7 different tomato genes encoding for CaM have been identified in the genome and the tertiary structures of CaM proteins have been predicted through bioinformatic analysis. Out of all the tomato CaM proteins, CaM4 is found to be unique due to its differences in the length and EF hand motifs. Moreover, it is separated from the other clades in the phylogenetic tree of Tomato CaMs. From the phylogenetic analysis of Tomato, Rice and Arabidopsis Calmodulins, it is seen that Tomato CaMs are more evolutionarily related to Rice CaMs. Exceptionally, tomato CaM2 is more related to *Arabidopsis* CaMs than with other Tomato CaMs. Understanding the structure and properties of tomato CaM proteins might help in transgenically overexpressing the candidate genes in other commercially important plants to improve its stress tolerance potential.

AISDGONF/ABS/TE/318

A statistical account of potato production in India: its growth and trend

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Potato being the 3rd most important food crop, after rice and wheat in terms of human consumption and India being the 2nd largest producer, next to China, the study of growth and trend remains one of the important research area to the scientists. In India, the northern and north-eastern states are important contributors to the Indian potato basket. In this study an attempt has been, made to analyse the production behaviour, growth and trend of potato production in the major producing states of India. Time series analysis of data on area, production, productivity along with export (in quantity as well as value) reveals that the non-traditional states like Gujarat and Madhya Pradesh have come up nicely along with the traditional states like Uttar Pradesh, West Bengal, Bihar etc. The study reveals that the maximum growth in terms of area, production, and productivity has taken place in Gujarat with CAGR 6.47, 8.86 and 2.23 respectively. Using the different trend models the study aims at capturing the path of the movement of each series and using the best fitted model predicted the values for 2025 for each series. Though the export to the major importing countries like Nepal, Oman, Saudi Arabia, Sri Lanka and Malaysia during the period 1987-88 to 2021-22 is encouraging but the export in Sri Lanka is of major concern which is declining in nature. The study aims for parity in achieving the highest productivity in major producing states including that of Uttar Pradesh along with the enhancement of export potential.

AISDGONF/ABS/TE/319

Forecasting of *boro* rice yield using multiple linear regression and artificial neural network technique for New Alluvial Zone of West Bengal

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Rice is the most important staple food in Asia as well as providing food for more than half of world's population. Boro rice generally grown under water logged low lying or medium land with irrigation in eastern and North eastern states of India and has got great potential to bring in additional rice to India's food basket.Variability in weather parameters might affect the rice productivity, impacting the food security of increasing population. So, the crop yield forecasting based on weather parameters will help farmers, policy makers and administrators to manage adversities. The present study was undertaken to develop *boro* rice pre-harvest yield forecast models at F1 (vegetative) and F2 (maturity) stages for 4 districts (Burdwan, Hooghly, Nadia and North 24 Pargana) of West Bengal using stepwise multiple linear regression (SMLR) and artificial neural network (ANN) techniques by analysing the yield and weather data for 31 years (1989 to 2020). The results were enumerated based on coefficient of determination (R^2), root mean square error (RMSE) and normalized root mean square error (nRMSE) values. ANN models were found to have greater R^2 values (0.74 to 0.99) over SMLR (0.54 to 0.92) at the two stages of forecast

during calibration and validation of the model.Similarly, remarkable improvement was observed in RMSE and nRMSE values of the forecast models using ANN technique. Analysing the percentage error between observed and forecasted yield, ANN weather-based models (within ±5%) were found to give more accurate yield prediction over SMLR (within ± 20%).

AISDGONF/ABS/TE/321

Extraction of bio-pigment from three blue flowering landscape ornamentals

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India consists of approximately 4,90,000 plant species of which 450 plants were reported as that could yield dyes and over 2000 pigments have been reported to be produced from plants of which nearly 150 have been exploited commercially. Bio-pigments from flowers of landscape ornamentals plant sources being eco-friendly, non-toxic and cost effective, have the potential to replace synthetic hazardous colours in food, leather and textile industries.The present study was conducted with an aim to identify potential sources of natural pigments of blue colour shade from the flowers of plants species occurring in abundance in the Terai region of West Bengal, and standardization of pigment extraction process from these flowers. Flowers of three plant species, *Lagerstroemia* sp., *Clitoriasp and Eichhornia crassipes* were subjected to six methods of pigment extractions *viz*. cold water soaking and maceration, hot water soaking (70-90°C) and maceration, boiling in water (100°C), microwave assisted extraction, soaking and maceration in acidic solution (pH4.5-5) and soaking and maceration in alkaline solution (pH 8). The experiment yielded eighteen pigments with visible difference in colour which was measured by Hunter Colour Meter and corresponding L* a* b* values were recorded and equivalent hue and chroma was also deduced. Result showed that among the eighteen pigments seven pigmentsshowed a hue ranging from 179.23° to 180.87°representing cyan colour, four recorded hue angle ranging from 268.44° to 268.94°, indicating violet hue and rest seven showed redness in hue. The maximum value of L* (39.07) representing the lightest colour was observed in *Eichhornia crassipes* pigment obtained with boiling in water whereas, the minimum value (23.74) representing the darkest colour was observed with *Clitoria* sp. in microwave assisted extraction. *Clitoria* pigments can be used in food and cosmetic industry as the flower is edible. The pigments other two flowers can be tested for use in textile and leather industry.

AISDGONF/ABS/TE/322

Assessing the climate-yield relationship of *boro* and *kharif* rice using CMIP5 GCM simulation over different districts of *Gangetic* West Bengal

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Nowadays, climate change is emerging as one of the most popular environmental issues, which attracts global communities due to its unavoidable impact on all major sectors of society like agriculture, water supply, health, energy, coastal regions, and economics. Climate change and its associated impact on rice yield haveattracted global attention and through the present study, we have attempted to establish a relationship between how the observed and CMIP5 GCMs simulated rainfall has impacted rice yield over 10 districts of Gangetic West Bengal. For the purpose of analysis, the district-wise historical rice yield data for *boro* and Autumn rice from the Government of West Bengal duringtwo types of observation rainfall data, i.e. IMD station data and IMD gridded data along with10 CMIP5 GCMs (HadGEM2-AO, NorESM1ME, CCSM4, GFDL-ESM2G, GFDL-CM3, CESM1-CAM5, NorESM1-M, GFDL-ESM2M, GISS-E2-H, MIROC5) rainfall simulation for a historical run during the period of 1901-2017 were considered. It is noted that the mean autumn rice yield varied from a minimum of 1.68 tons/ha (Purulia) to a maximum of 2.88 tons/ha (Bardhaman), and for the mean *boro* rice yield, it ranges from a minimum of 2.216 tons/ha (Purulia) to a maximum of 3.528 tons/ha (Nadia). During the autumn season, 80% of the districts showed a positive trend, indicating yields of Kharif rice are increasing by 452 kg/ha to 1010 kg/ha during 1997–2017 for Birbhum and Purulia, respectively, whereas Midnapore and Howrah districts indicated a slightly declining trend of yield.In the case of *boro* rice, productivity showed an increasing trend in almost 90% of the districts, with a higher value of 684 kg/ha and a lower value of 63 kg/ha in Hooghly and Murshidabad, respectively.

AISDGONF/ABS/TE/323

Imaging and AI-ML based screening of lentil genotypes

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Lens culinaris Medikus, commonly known as lentil, is a leguminous crop grown in the winter season. It has high nutritive properties and is a potential source of carbohydrates, proteins, minerals and fibres. It is an easily accessible commodity for the people belonging to lower economic classes. It is grown as a rotational crop to reclaim the nutritive values of the soil as it has well known properties of symbiotic nitrogen fixation, carbon sequestration, eradication of insects and pests. Lentil requires cool temperature during its course of vegetative growth and warm temperature during its course of maturation, but due to the adverse effects of global warming leading to altered climatic conditions, the productivity of lentils is also affected. Image processing technology is a rising star in the field of agriculturewhich provides insightful informationeven with a non-destructive approach leading to smart farming. The technology has wide range of applications in areas of crop management, estimation of nutritional content, quality inspection, and

estimation of crops and lands. Roots are the main plant parts providing water and nutrients to the entire plant, plants growing under different geographical locations exhibit difference in their rooting systems which is apparent by root scanning.In the present study 30 lentil genotypes have been screened through image analysis and root scanning method which depicted significant variations which are in correlation with the other yield attributing traits. Further studies are needed to model the yield prediction of lentil through artificial intelligence and machine learning approaches.

ASDGONF/ABS/TE/328

Changing trend of evapotranspirative fraction of net energy gain over Rengali command areas of Dhenkanal district, Odisha

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Water is one of the major limiting factors affecting crop production. Hence, crop water use must be monitored at a regional scale for rational distribution of the limited water resource. The soil and water management practice may be synchronized with location and crop-specific water requirements and the evapotranspirative demand of the atmosphere. Evapotranspiration has been assumed to be a function of available energy (net radiation) at the surface level. It has been hypothesized that a fraction of net radiation (Rn) is utilized for evapotranspiration, called Evapotranspirative fraction (EF) of net radiation. Thus, the EF is an indicator of the water sufficiency of the crop while its inverse denotes stress. The remote sensing techniques provide the opportunity of estimating both Rn and EF at a fair level of accuracy. This technology can apply for monitoring spatio-temporal patterns of crop water stress at a regional scale. A test study was carried out in the Rengali command area of Dhenkanal, Odisha to evaluate the changes in the trend of EF over crop vegetation towards the end of kharif season from 2013 to 2021. For the study, a Landsat 8 image of kharif season was used and data analysis was done in a cloud computing platform (Google Earth Engine). The land surface temperature (LST) and its relation with NDVI are used to estimate EF by defining the limits of hot and cold pixel as corresponding lower and upper limits of ET in the theoretical Trapezoidal method. The result shows the trend of EF over command areas initially in downwards and latter rise. The crop vegetation of some blocks shows increasing trend of EF which indicate less stress condition of the region. Similar pattern in reduction of trend observe for all the blocks of command areas shows stress condition that analyzed in the study.

AISDGONF/ABS/TE/329

Assessing irrigation water requirement of jute grown in New Alluvial Zone of West Bengal under future climate scenario

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Jute is one of the most important cash crops in West Bengal. It is mainly grown as a rainfed crop but over the years, evapotranspirative rates have increased, suggesting the need for frequent irrigation. Assessment of future irrigation water requirement by taking into account evapotranspiration and precipitation will help in understanding water balance during the life cycle of jute for better water management planning. Daily future climatic data containing rainfall, minimum and maximum temperature, relative humidity, and windspeed have been obtained from a CMIP6 model (HadGEM3-GC31-LL). Two scenarios have been considered namely, SSP2_4.5 and SSP5_8.5. All assessments have been done considering three time slices: baseline (1995-2022), mid-century (2040-2050) and end century (2080-2090). Evaluation of crop irrigation water requirement has been done using FAO CROPWAT 8.0. Model-dependent simulations show that the irrigation water requirement (IWR) of jute during its lifecycle is likely to increase from 270mm/dec (baseline) to 385.7mm/dec under mid_4.5 scenario but decrease 319.5mm/dec (late_4.5 scenario). Under SSP5_8.5, however, the rise in IWR is less pronounced with 350.7mm/dec for the mid_8.5 scenario and alarmingly, reduces to just 266.7mm/dec for the late_8.5 scenario. This diversity is an indication of the erraticism of precipitation and also the variation in the difference between evapotranspiration and precipitation throughout the century.

ASDGONF/ABS/TE/331

Fitting probability distributions and statistical trend analysis of rainfall over Lower *Gangetic* Alluvial Agro-climatic Zone of West Bengal

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Analysis of rainfall and study its distribution has been of great concern as rainfall plays an important role in efficient utilization of the water resources. The present study aims to get the distribution of rainfall over the years of lower Gangetic alluvial agro-climatic zone of West Bengal. The secondary data of Rainfall over a period of 120 years (1901- 2021) was collected from IMD, Pune and some data are collected from IMD approved meteorological observatory situated at Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal. The data were analyzed to find out the standard deviation and coefficient of variation during the period of study. Important probability distribution models were used to evaluate the best fit for maximum monthly rainfall (mm). Three statistical goodness of fit test viz., Kolmogorov-Smirnov, Anderson Darling and Chi-squared tests were carried out in order to select the best fit probability distribution on the basis of highest rank with minimum value of test statistic. Also Trend of rainfall parameter were analyzed using Mann-Kendall test and Sen's slope test. The study revealed that in the month of August and September the trend is significant at 1% level and for the month of October the trend is significant at 5% level.

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Applications of artificial intelligence for identifying and mitigating agricultural hazards (floods and droughts)

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The application of Artificial Intelligence (AI) in agriculture has the potential to provide new solutions to long-standing problems faced by farmers. One area where AI can play a crucial role is in detecting various weather hazards such as floods, droughts, and extreme weather events. This research aims to explore the use of AI in early warning systems for weather hazards and its potential benefits for farmers. The research used a combination of literature review and case studies to explore the use of AI in agriculture. Historical weather data, satellite images, and real-time weather reports were analyzed to identify the potential of AI in predicting weather hazards. The results showed that AI can leverage historical weather data and real-time weather reports to provide farmers with accurate and timely warnings of weather hazards such as floods and droughts. In the case of floods, AI algorithms can analyze rainfall patterns and river flow data to predict when and where flooding will occur. For droughts, AI can analyze soil moisture levels, crop water use, and local weather conditions to inform irrigation decisions. The use of AI in agriculture has the potential to improve the resilience of farming communities and reduce the impact of weather hazards on food security and rural livelihoods. However, there are also challenges associated with the implementation of AI in agriculture, such as the availability of data and the cost of implementation. The results of this research demonstrate that AI has the potential to become an indispensable tool for farmers, helping them to better prepare for, respond to, and recover from weather hazards. However, further research and development are needed to refine the technology and address the challenges associated with its implementation. Overall, AI has the potential to revolutionize agriculture and improve the lives of farmers by providing new solutions to long-standing problems.

AISDGONF/ABS/TE/334

Prediction map of soil organic carbon created by an advanced geostatistical technique using remote sensing and terrain data

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Digital Soil Mapping (DSM) of Soil Organic Carbon (surface soil) is one of the key factor for accurate agricultural prediction and future agro-ecological modelling. The study area, Agartala municipality is situated in the flood plains of Haora River covering an area of 76.5km^2 under West Tripura district extending from 23°46'– 23°55'N latitude to 91°13'–91°20'E longitude with lateritic, younger alluvial and red sandy type of soils.The overall methodology of the research isdepicted in Figure below. The work has been divided into three parts, first part deals with data acquisition, derivatives extraction and part 2 deals with Sampling, analysis and geostatistical mapping. Part 3 deals with data extraction, prediction and model validation. Deterministic method and geostatistical method are the two broadly classified interpolation

methods available for mapping of measured data. An advanced geostatistical-based empirical Bayesian Kriging regression (EBKR) method was used and performance was compared with the artificial neural network (ANN) and hybrid ANN, i.e. ANN-OK (ordinary kriging) and ANN-CK (cokriging). The EBKR method outperforms all other methods with the highest R^2 of 0.936. As per DSM map, highest SOC was found in easternmost part of the study area comprises with grass and agricultural land. This work shows the robustness of the EBKR prediction method over other techniques. The study will also aid the policymakers in adopting sustainable land use management.

AISDGONF/ABS/TE/335

Geographically weighted regression based model - calibration approach under two stage sampling design

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In many agricultural, forestry, environmental and ecological surveys, data are often spatial in nature and exhibits spatial non-stationarity. Spatial non-stationarity is a phenomenon where the relationship between the study and auxiliary variables varies across the locations. Geographically weighted regression (GWR) is well-known technique to deal with spatial non- stationarity problem. In sample surveys, one of the most popular methods for incorporating the known population characteristics of auxiliary variables by altering the original design weights is the Calibration Approach. The model-calibration approach (Wu and Sitter 2001) is an improvement over the traditional calibration approach which can deal with diversified working models to produce model-assisted estimators of finite population parameters. In sample surveys, two-stage sampling is one of the most widely used sampling techniques in practice. In the present study, GWR based model calibration estimators of the population total have been developed in the context of two-stage sampling design when the population level complete auxiliary information is available. The asymptotic design unbiasedness as well as model unbiasedness of the developed GWR based model calibration estimators have been evaluated under a set of regularity assumptions. Under the same set of assumptions, the variances and estimators of variances of the developed estimators have been derived. The performance of the developed estimators has been compared with the existing estimators through a spatial simulation study. The performance of the proposed estimator was found to be more precise than the existing estimators under two-stage sampling.

AISDGONF/ABS/TE/340

Post-harvest assessment of physiochemical properties and storage behaviour of arrowroot (*Maranta arundinaceae*) grown in the alluvial soil of West Bengal

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Arrowroot (*Maranta arundinacea*) is an important crop cultivated for its edible starch-rich rhizomes. The aim of the study was to evaluate the nutritional quality and storage behaviour of various cultivars of arrowroot collected from All India Co-ordinated Research Project (AICRP) on tuber crops. Twelve cultivars of arrowroot (TAR-18-1, TAR-18-2, TAR-18-3, TAR-18- 4, TAR-

18-5, TAR-18-6, TAR-18-7, TAR-18-8, TAR-18-9, TAR-18-10, TAR-18- 11, TAR-18-12) were evaluated for their physical attributes such as tuber girth, length, specific gravity, number of tubers per plant, weight of biggest tuber and shelf life. Chemical attributes such as titratable acidity, starch, ascorbic acid, and total sugar content in each cultivar were also studied. Analysis of variance showed significant variation among all the tested cultivars. Yield, starch content and starch recovery were recorded to be highest in the cultivar TAR-18-5 (1130 gm/plant, 20.13g/100g and 17.40g/100g respectively). Highest total sugar was recorded in TAR-18-2 (1.15%), highest ascorbic acid was recorded in TAR-18-1 (4%) and highest dry matter content was recorded in TAR-18-8 (30.56%). During thirty days of ambient storage condition, minimum loss in weight was recorded in the cultivar TAR-18-11 (8.12%). They were observed to vary in tuber length, weight, yield, dry matter, titratable acidity and TSS. The cultivar 'TAR-18-5' was found to be very high in yield and starch content. The shelf life in ambient condition was found to be superior in TAR-18-11, TAR-18-2 and TAR-18-2. Considering all the aspects, the cultivars TAR-18-5 and TAR-18-8 can be commercialised in West Bengal.

AISDGONF/ABS/TE/341

Mechanization of groundnut cultivation for small holder farming community

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Groundnut is one of the world's fifteen leading food crops and cultivated throughout the world. Groundnut is also known as peanut in many countries.It is a cash crop and useful rotation crop, easy to grow, withstands draught to some extent and so a choice crop for dry farming.Groundnut is consumed in many ways such as vegetable cooking oil, kernels, roasted nuts, salted nuts, groundnut milk, groundnut butter, groundnut cheese, bakery products etc. All parts of the plant can be commercially used. Groundnut can be cultivated in kharif, *rabi* and summerseasons. Well drained loose and friable sandy loams and sandy clay loam soils are preferable.Optimum soil temperature for good germination is about 30^0C.Crop rotation is very important in groundnut farming which helps in efficient nutrient utilization and reduces soil borne disease and nematodes.Sowing is the prime operation in cultivation practice of any crop which directly affects production and timely sowing is essential for utilizing available sources of power. Tractor drawn multi-crop planters are not used everywhere in the country for planting of groundnut due to lack of awareness and landholding patterns. Generally farmers plant groundnut seeds in the furrow behind a narrow country plough drawn by a pair of bullocks.It takes more time and labour and also there is wastage of costly inputs.Power tiller operated machines may play vital role in groundnut cultivation for small scale farming system as the average holding size is close to 1 ha and more than 86% of India's farming community are small and marginal farmers.The power tiller with matching implements is cost effective source of farm power and it also enables farmers to diversify cropping pattern and increase in yield of crops. Present efforts was carried out for the adoption of power tiller operated matching implements for groundnut cultivation for the mechanization of pre-harvest and postharvest operations insmall holder farming community.With increasing the level of mechanization by adopting appropriate matching implements for groundnut cultivation in small farming community, the production and productivity could be increased by reducing cost of cultivation and increasing input use efficiency. Efforts are being made to adopt conservation tillage practices with power tiller operated matching implements for small holder farming focusing on groundnutcultivation.

AISDGONF/ABS/TE/342

Comparison of EMD based modelling techniques for improved agricultural price forecasting

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Forecasting agricultural commodity prices is regarded as a challenging task due to its non-linear and non-stationary nature. As agriculture production is highly reliant on various biological and agro-meteorological factors, traditional smoothing techniques as well as statistical models often fail to model such series satisfactorily. To capture such complex patterns effectively, different data-driven and self-adaptive techniques have been developed time-to-time. Against this backdrop, in this paper, we have assessed the suitability of empirical mode decomposition (EMD)-based neural network and support vector regression (SVR) approaches for forecasting wholesale prices of three major potato markets namely, Agra, Bangalore, and Mumbai. As the benchmark models, autoregressive integrated moving average (ARIMA), time delay neural network (TDNN) and SVR models have been employed for the comparative evaluation. The experimental results clearly reveal the comparative superiorityof the EMD-SVR model for the Agra and Bangalore markets and the EMD-TDNN model forthe Mumbai market in terms of root mean squared error values and turning point predictions. Moreover, all the EMD-based models have performed better than the other competing models.

AISDGONF/ABS/TE/467

A discussion on the present status of Krishak Bazaars in Cooch Behar district of West Bengal, India

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Marketing infrastructure acts as a facilitator for carrying out various economic operations, which is essential for the accomplishment of marketing tasks, the growth of the market, and the transmission of suitable price signals, all of which ultimately result in increased marketing effectiveness.The present study is completely based on primary data, for which Multi-stage sampling technique has been followed to select the sample units (Krishak bazaars and traders). The District of Cooch Behar which falls under the Terai zone of North Bengal, has been selected purposively as all the marketing activities have been functioning under only one Regulated Market Committee i.e. “The Cooch Behar Zilla Regulated Market Committee (C.Z.R.M.C)”. A total of 8 Krishak bazaars are situated in the 8 blocks of Cooch Behar District, which are- Sitalkuchi Krishak bazaar, Haldibari Krishak Bazaar, Dinhata-I Krishak Bazaar, Mathabhanga-I Krishak bazaar, Tufanganj-I Krishak Bazaar, Mekhliganj Krishak Bazaar, Mathabhanga-II Krishak Bazaar and Setai Krishak Bazaar. The present study is an attempt to study and evaluate the present status of Krishak Bazaars in the District of Cooch Behar as well as to identify the gap of infrastructural facility (constrains) with respect to the need of the stake-holders present in Krishak Bazaar. Principal Component Analysis (PCA), which entails factor extraction, rotation, and interpretation,

has been used in factor analysis to discover the significant constraints. Variables with factor loadings were taken into account while interpreting the factors. Depending on the high factor loading, the constraints are ordered accordingly.

AISDGONF/ABS/TE/469

Waste valorization: catalyst and traditional soda from post harvested agricultural waste

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The ash of agricultural wastes generally composed of oxides, carbonates and chlorides of metals. In the locality of Assam, India, the tribal peoples have the common practice of utilizing ashes of somespecific agricultural waste plantsas a food ingredient and traditionally used as a soda which can substitute commercial soda. These ash materials are highly basic in nature with very high pH and good mineral content. The ash materials are alsoconventionallyused in cleaning utensils, as a medicine for acidity and gas as well as cleaning agent of hand and hair. *Brassica nigra*, *Sesamum indicum*, *Heteropanax fragrans*, *Vigna mango*, parts of banana, etc. are some of the commonly usedplants. Characterization of the ashes and calcined materials of these agricultural waste plantsshows the presence of high quantity of K along with Ca, Mg, Na, Si, etc.,in the form of oxides and carbonates. K is found to be the key component for their highbasicity.Biodiesel a prominent alternative of fossil fuel is emerging in thepresent-day situation, mostly prepared by catalytic transesterification of vegetable oil. These highly basic waste plant ash materials are tested as catalyst for transesterification of vegetable oil to biodiesel and found very good results. The present study concluded that these traditionally used waste plants ash materials can be popularized as a substituent of commercial soda and be recommend as catalyst in biodiesel industry as well as catalyst to carry out various other organic reaction too,which will valorize these agro-wastes and contribute in waste management.

AISDGONF/ABS/TE/470

Agriculturewaste-based nanostructure for sustainable development

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Agriculture is the key sector for achieving the goals set under sustainable development.It is not only the backbone of economic progress but also for the social harmony of a nation. However, waste regenerated from agriculture (agro waste) is another challenging issue towards the world health and environment. Nanotechnology plays vital role in agriculture waste management and getting superior focus because of the remarkable benefits. Utilizing agricultural waste is a sustainable technique to synthesis nanostructures, which has been attracted the scientific community for its economic, environmental and technological advantages. These nanomaterials offer wide applications in solving environmental issues like wastewater management, antimicrobial protection, crop production and food processing, food safety and so on.This work presents the synthesis of nanostructures in various forms by utilizing different agricultural

wastes like peel and seed of different fruits as well as parts of plants and discuss their potential applications in photocatalytic degradation process plus biofuel production, which are considered as the most promising technique for environmental remedy in connection with fulfilment of the goal of sustainable development. Silk production (sericulture) is a form of agriculture, women friendly agro-industry plays strategic role in modeling the economy by generating vast employment and improving the quality of social life. Silk, the natural protein, mostly derived from silkworms, is a renewable resource for synthesis of nanomaterials of outstanding desirable qualities like biocompatibility, biodegradability, non-toxicity, with excellent thermal and mechanical behavior. This work also enlighten on synthesis of silver nanoparticles (AgNPs) using *Philosamia ricini* (Eri silk) fibroin as reducing as well as stabilizing agent under green protocol in order to study the antibacterial activity as well as photocatalytic activity. The prepared samples are characterized by XRD, SEM, TEM, UV-visible, FTIR, and TGA to understand the crystallinity, purity, morphology, topology, optical behavior and functional groups as well as stability.The photocatalytic process is free from hazardous byproducts as a result of immediate decomposition of intermediate products during photodegradation, hence this study is environment friendly to fulfil the goal of sustainable development.

AISDGONF/ABS/TE/473

Modeling of a solar thermal network attached to a vapor absorption refrigeration system for on-farm cooling of fresh produce

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Harnessing renewable energy such as solar energy has gained a lot of interest in spite of the growing concern of climate change and global warming. Vapor absorption refrigeration system has the advantage for its ability to operate using low grade energy sources such as solar heat for obtaining cooling effect. This study provides an analytical model developed using heat and mass transfer equations to estimate the number of evacuated U-tube collectors for supplying hot water at a target temperature and heat load in the generator of a vapor absorption refrigeration system. Considering the inlet water temperature, flow rate and solar intensity as model inputs, the collector outlet temperatures were evaluated. The model data were analyzed by fitting into Design Expert-12 software using Response surface methodology (RSM). Results showed that lower flow rates provide higher heat transfer between the heat transfer area and water by increasing the residence time inside the tubes resulting in lesser collector requirement. Higher values of inlet temperature and solar intensity for a particular flow rate of water reduces the number of solar collectors required to reach a target outlet temperature. Optimized values of operating parameters were also generated to obtain the target generator temperature for optimum performance of the system.

AISDGONF/ABS/TD/474

Incidence of drought in relation to rainfed rice production in Nadia, West Bengal

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The distribution of rainfall during a season is more important than its amount. It is, therefore, the reasonable balance between the received and the expenditure due to moisture during the growing season, which ultimately creates favorable or unfavorable conditions for successful crop production. Several research workers have attempted to study the various aspects of drought on this basis. Their studies have taken into account crop yields in determining agricultural drought. In the present paper, the data on rainfall (1970-2013) and yield of a crop like rainfed rice in the Nadia district of West Bengal (India) have been analyzed to determine the drought threshold value and characterize agricultural drought. The minimum amount of rainfall for a few consecutive weeks was identified as a drought threshold value in the Nadia district. A negative correlation between grain yield and maximum rainfall was observed during the drought period. The recurrence of drought in relation to rainfed rice in the district has also been analyzed.

AISDGONF/ABS/TE/475

Socio-economic conditions and food security among beedi workers in rural Murshidabad, West Bengal: A comprehensive analysis

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In the rural regions of West Bengal, there exists a significant and unorganized sector dedicated to the production of Beedis. Beedi manufacturing is primarily concentrated in rural areas, and the majority of Beedi laborers are characterized by their low economic status. This research investigates the socio-economic conditions and food security status of beedi workers in the Murshidabad District of West Bengal, specifically in the Suti-II Block. The study is based on primary data collected from 50 sample Beedi workers and encompasses an assessment of two villages in Murshidabad (WB) during the period of 2021-22. The research analyses various factors such as income levels, educational qualification, earnings from beedi, how much consumed food items annually, and their expenditure on food items as well as non-food items. the Core Food Security Model (CFSM) has been used to ascertain the food security level (Bickel et al, 2000). and access to social welfare programs to understand their impact on food security among beedi workers in the region. Additionally, the study also explored the role of government policies and interventions in addressing the challenges faced by these workers in achieving food security. The findings of the study reveal that the age distribution of the respondents is skewed towards the "30-40" age group, comprising 56 Per cent of the total participants, with no respondents below the age of 20. The study also highlights the educational qualifications of the respondents, showing that 50

Per cent were illiterate, while 38 Per cent receives only primary education. In terms of income, 60 Per cent of the respondents have earned between Rs 3001 and Rs 4000 per month, with a mere 6 Per cent earning above Rs 4000. Also, the study found that a substantial proportion of Beedi workers' households were food secure, but some households were "food insecure without hunger," indicating challenges related to the quality and diversity of their diets. The findings hold significant implications for policy and intervention strategies aimed at improving the well-being of Beedi workers in the Murshidabad District. Initiatives focused on income augmentation, skills development, and nutrition programs can enhance overall food security and socio-economic conditions.

AISDGONF/ABS/TE/477

Study artificial ripening treatment on chilling tolerance of mango 'cat chu' at postharvest

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Mango fruit 'cat chu' has many issues due to poor storage capacity, chilling injury by sensitivity to low temperatures and high rot. The objective of this study was to find the effect of artificial ripening treatment on reducing chilling injury and increasing the storage capacity of mango fruit at chilling temperatures. The experiment was a factorial design arranged in a completely randomized design (CRD) comprising five replications. The experiment was a one-factor experiment (treatment including three storage temperatures: 8°C, 10°C and 12°C). Mangoes were fumigated with 800 ppm ethylene at 20°C for 24 hours before storing at low temperatures. Fruits were observed and assessed quality in seven-day intervals for 28 days at *three storage temperatures*, 80-90 % RH and ripening for five days at 20°C each storage period. The results showed that mangoes treated with artificial ripening with ethylene gas before storing at 8°C slowed down the ripening process, maintained quality, were unaffected by chilling injury and ripened naturally at 20°C during storage for 28 days. Ripening treatment of mangoes stored at 10°C and 12°C was only suitable for storage for 14 days and resulted in chilling injury at subsequent storage time.

AISDGONF/ABS/TE/478

The impact of cyclone 'Yaas' on the Sundarban forest ecosystem: A multi-temporal sentinel imagery analysis

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Cyclone disturbances can cause significant damage to forest ecosystem. The Sundarbans, world's largest mangrove forest, is frequently exposed to cyclones of various magnitudes. livelihoods of more than hundred million people depending on this forest ecosystem, is being severely affected due to frequent cyclones. In Indian Sundarbans, several tropical cyclones were observed in recent years. In this study, the impact of cyclone Yaas has been assessed. Yaas was formed over east central Bay of Bengal as a depression and gradually intensified to VSCS and finally made landfall near Balasore of Odisha coast on 26th may, 2021. To fulfil the objective of this present research

work, Time series Sentinel data were used to assess the impacts on forest ecosystem. Ground truth data were collected through focus group discussions (FGD). The extent of inundation has been assessed through RS imagery. The study revealed that cyclone Yaas caused incremental stresses on the socioeconomic conditions of coastal communities through rendering huge areas of land unproductive for a long time, and in some cases forever. People who were dependent on land resources for their livelihoods were forced to change their livelihood on forest resources, which in turn caused increased pressure on already stressed forest resources. A single cyclone episode can damage mangrove cover by knocking down tall trees, killing more salt-sensitive mangrove species such as Sundari. It is concluded that increasing frequency and severity of cyclonic events will certainly increase pressure on forest ecosystem services, which eventually may pose threat of extinction to the biodiversity of Sundarbans.

AISDGONF/ABS/TE/479

Selection of best performing climate models from 37-CMIP6 GCMs over Indian Sundarban for projecting bias corrected future rainfall scenarios

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There are practically no weather stations available over the Indian Sundarbans region, with the exception of Sagar Island. Therefore, using the data from a standard meteorological station makes it impossible to generate rainfall change information in such a remote site. Scientists must rely on alternative data sources, like as simulations of the General Circulation Model, to create block level information about climate change (GCMs). As GCMs have a coarser horizontal resolution than necessary to fully capture the grid or sub-grid scaled complex features, their use in simulation across a limited region like the Sundarbans raises a number of concerns. This study used 37 CMIP6 GCMs and four SSPs (Shared Socioeconomic Pathways) namely, SSP 1-2.6, SSP 2-4.5, SSP 3-7.0, SSP 5-8.5. The goal of the current study was to assess the ability of 37 CMIP6 GCMs to capture the mean seasonal cycles and inter-annual rainfall using a variety of traditional statistical indices, including the correlation coefficient, d-index, normalised root means square error, percent bias, Nash-Sutcliffe efficiencies, Perkin skill score, normalised error variance, Kuiper metric, and inter-quartile relative fraction. This was done in order to increase the confidence in the results and avoid the inherent sensitivity that comes with each method. The evaluation's overall findings show that the model's performance varied depending on the methodology. The study also sought to identify a set of GCMs with higher performance for impact research by assigning each model a reasonable rank in accordance with the various methods of evaluation. After all approaches for replicating seasonal cycles and inter-annual variability had been combined, an overall final rating was given to each model. The study generally showed that the CMIP6 GCMs of the current generation are unable to reproduce the observed mean seasonal cycles as well as inter-annual variability over the reference block of Sagar Island where station data is available as well as other 18 blocks locations where analysis was carried out using IMD-high resolution gridded rainfall data (0.25º x 0.25º). The following CMIP6 GCMs, such as BCC-ESM1, MCM-UA-1-0, CMCC-CM2-SR5, NESM3, and TaiESM1, are ranked in the top of the ranking list based on the values of several statistical indices. Downscaling (Scaling method) had been done before future rainfall change assessment. It was found that 8 out of 12 SSPs demonstrated decreasing rainfall (-1.12 to -6.22%).

AISDGONF/ABS/TE/480

Possibilities of commercial utilization of waste flowers

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Up to 40% of India's entire flower yield is thought to be lost or wasted. Particularly in areas that are regarded as key tourist sites, placing flower waste along roadsides and in open areas gives the area a dirty appearance and harms its reputation. As the fact that flowers are used so frequently—at weddings, religious meetings, hotels, tourist attractions, flower exhibitions, numerous festivals, and other occasions-means that after use, they are thrown in the trash, which has a negative impact on the environment. Flowers that are daily sent to the temple are also squandered because they are never used. Mainly because the degradation of flower waste proceeds so much more slowly than that of kitchen garbage. These flower components that are dumped outside or in the water decompose both aerobically and anaerobically, producing dangerous gases, liquid waste, and offensive odours that are harmful to the population's health. The management of the flower waste produced by such operations has become an emerging problem because it harms numerous life forms. Flower waste can be used to extract dye which can be used as a natural floral dye for colouring textile fibre. These natural dye are cost-effective, eco-friendly and renewable, and has no allergic action on the skin and there are many other others things, where flower waste can be used for production of bioenergy and biofuels, composting, making eco-friendly incense sticks, Natural gulal, resin encapsulation, soaps, rose water, and other etc. and thus floral waste can be converted into wealth.

AISDGONF/ABS/TE/530

Remote sensing and gis application for assessing root-knotnematode infestation in vegetable crops- a brief review

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The basic understanding of spectral reflectance and thermal emittance properties of soils and crops are vital to facilitate the use of various remote sensing (RS) technologies for non-destructive monitoring of plant growth and detection of productivity limiting biotic stresses like plant parasitic nematodes. *Meloidogyne incognita* singly, causes $100 billion annual economic loss globally. Considerably, this polyphagous pest is responsible for an average yield loss of 10%in vegetables crops. The clustered occurrence and low level mobility of root knot nematodes (RKN) in thesoil and production of leaf symptoms make them perfect targets for detection by RS. This review examines the approaches developed and tested for detection of root knot nematodes invegetables. The need for RS of RKN affected clusters and resulting applications of site- specific management is of vital importance. Near-range sensors, infrared photographs, spectrometers, hyper-spectral sensors of ground-based, space-borne and air-borne origin are the major tools to detect RKN infestation. Advanced computing and position locating technologies enable RS from ground, air and space-based platforms to provide

elaborate spatio-temporal information on reduction of RKN infestation and augment yield, thus helping site-specific agricultural management approaches. It has been proved that RS can detect nematode damage early by monitoring changes in infested leaves and other susceptible areas to achieve sustainability.

AISDGONF/ABS/TE/538

Climate smart agriculture (CSA) in India: A possible solution to answer climate change

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Earth's climate is changing rapidly due to natural as well as various anthropogenic activities. The impacts of climate is now visible across the Globe. The Global agricultural sector is facing a tremendous threat in terms of food security and economic safety of the farmers. This paper focuses on the various climate smart agriculture practices in India *e.g.*, rain- water harvesting, green manuring, zero tillage farming etc., to cope up with the changing climate. Different influencing factors of climate-smart agriculture (CSA) and possible outcomes CSA *i.e.*, increased productivity, resilience/ adaptive capacity and mitigation are also emphasized. It further demonstrates the economical benefits of farmers after adopting CSA approaches. It also depicts the gender dimensions of approaching CSA practices in India. It further gives detailed descriptions of various Government schemes for adopting climate smart agricultural practices across India.

AISDGONF/ABS/TE/548

Assessing bottlenecks in the rice-straw value chains and markets in Punjab region

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The sustainable management of rice straw and the efficient cultivation of wheat crops are integral components of agricultural practices in the Punjab region, where rice and wheat are staple crops. However, the management of rice straw remains a persistent challenge. It is estimated that about 20 million tonnes of rice straw are left in the field after the combine harvesting. While farmers do not find a ready economic use of rice straw, wheat straw is preferred for dry fodder or *Bhusa* for feed in the animals. The traditional practice of open field burning of rice straw due to time constraint, adversely affects air quality, soil health, and ecosystem sustainability. Various methods have been employed to address the straw management issue, including soil incorporation, mulching, baling and partial burning. Different machines are available for timely management of rice straw including super SMS, happy seeder, paddy straw chopper/ mulcher, hydraulic reversible MB plough, rotary slasher, zero tillage drill and rotavator, rotary till-drill, strip till seeder, straw baler, etc. However, their adoption remains inconsistent across the region. Understanding the bottlenecks and constraints associated with these methods is essential for devising effective solutions. Therefore, a farmers' survey was conducted in this study to find out the major constrains

to adopt these technologies. It was found that the soil type, rice variety, weather condition, limited financial resources and awareness are the major drivers for the low adoptability of the technology. Assessing the economic viability of these technologies is vital for informed decision-making by farmers and policymakers. The economics of wheat sowing using Happy seeder was found to be cheapest i.e. 1300 INR/acre among all the tested methods. This research aims to provide valuable insights into sustainable agricultural practices in Punjab, fostering a transition toward more environmentally friendly and economically viable straw management and rice-wheat cultivation strategies.

Invited Oral **AISDGONF/ABS/TE/554**

Sustainable utilization of fishery byproducts: A promising post-harvest management

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The fishing industry is a vital component of the global economy, but it also generates a substantial amount of byproducts that have long been underutilized or wasted. Discarding fishery byproducts is not only wasteful but also detrimental to the environment. These byproducts, which include fish heads, bones, skins, and viscera, even 'trash fishes', can be a valuable resource if properly managed. The objective of the review paper is to explore the promising potential of utilizing fishery byproducts as a sustainable resource management strategy. While they may not be traditionally consumed fish wastes can be transformed into valuable products through various processes. Some of the key avenues for utilization include:

a. Fishmeal and Fish Oil- important components in animal feed and aquaculture.

b. Collagen and Gelatin- extracted from fish skins have applications in the food industry, cosmetics, and pharmaceuticals.

c. Fish Bone-derived Hydroxyapatite- a valuable material for bone grafts and dental applications.

d. Omega-3 Fatty Acids- present in fish oil have numerous health benefits

Utilizing fishery byproducts not only benefits the environment but also presents economic and social advantages. It can create new revenue streams for the fishing industry, reduce waste disposal costs, and generate employment opportunities in processing plants. Furthermore, by optimizing the utilization of byproducts, fishing communities can enhance their resilience and sustainability. By transforming what was once considered waste into valuable products, we can reduce waste, minimize the impact on marine ecosystems, and promote sustainable practices within the fishing sector. To realize this potential, collaboration between the fishing industry, government agencies, and consumers is essential.

AISDGONF/ABS/TD/555

Assessing the efficacy of cultural and chemical approaches for managing maize fall armyworm (*Spodoptera frugiperda*) in the old alluvial soils of the eastern Indo-Gangetic Plains, India

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Fall army worm (FAW) is an invasive polyphagous pest widely regarded as a severe threat to maize production. In India, it was initially discovered in the Shivamogga area of Karnataka in May 2019 and has recently caused significant damage to India's maize crop. Using synthetic insecticides to control the pests is just a temporary solution. So, an experiment was conducted at Gopalpur village of Malda, West Bengal, during the pre-kharif seasons of 2020 and 2021 to study the efficacy of IPM component combinations (cultural + chemical)against the pest with five treatments *viz.* T1 = Dry sand to the leaf whorl + Neemoil 10,000ppm @1.5 ml/L; T2 = Dry sand to the leaf whorl + Thiodicarb 75%WP @1 g/L; T3 = Dry sand to the leaf whorl + Spinosad 45%SC @0.2 ml/L; T4 = Dry sand to the leaf whorl + Novaluron 5.25% + Emamectin benzoate 0.9%SC @2 ml/L and T5 = Control and each replicated seven times. The pooled data of the experiment showed the highest plant growth and growth attributes, yield and yield attributes, per cent protection from FAW over control with maximum incremental cost-benefit ratio in treatment T4. It is observed that treatment T4 achieved a 92.23% increased yield and 47.97% avoidable yield loss compared to the control plot. The findings confirmed that treatment T4 has 90.89% more protection over control against the notorious pest and showed a 1:2.31 incremental cost-benefit ratio. This study adds to our understanding of handling fall armyworms, which is crucial for boosting food security.

AISDGONF/ABS/TC/556

Horticulture for sustainable development and livelihood security

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In the changing Global scenario, food, nutrition, healthcare and livelihood security are the matter of great concern to human, social and economic development. Horticultural crops (fruits, vegetables, root and tuber crops, plantation crops, medicinal and aromatic plants, spices and condiments and ornamental crops) have emerged as the best option not only to provide adequate food and nutrients but also to generate employment in rural sector and enhance the profitability from the farm. With increase in *per capita* income and accelerated growth of health conscious population, demand for horticultural produce is on increase which is expected to further accelerate, which will require enhancing both productivity and total production. Although, the country is the second largest production of fruits and vegetables in the world, availability of fruits and vegetables still continues to be much below the dietary requirements. Technology driven horticulture is

expected to address the concern for nutritional and livelihood security, health care leading to ultimately economic development. School level nutrition education with multipronged collaboration based on nutrient potential of vegetables and fruits may be a viable option to improve food and nutritional security for the vulnerable section of the population.

AISDGONF/ABS/TC/557

Ecosystem services for ecological restoration through jute and allied fibre crops

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Natural farming is described as the application of a set of cultural, biological, and mechanical practices that support the cycling of on-farm resources, promote ecological balance, and conserve biodiversity. Farmers use natural processes and materials when developing farming systems; these contribute to soil health, crop nutrition, pest and weed management, the attainment of production goals, and the conservation of biological diversity. Natural fibre crops like jute, mesta, sunnhemp, ramie, sisal, and flax, which have high ecosystem service value and can play an important role in sustainable organic farming in addition to having commercial value, These natural fibre crops can contribute to GHG mitigation because of their capacity to remove carbon from the atmosphere and store it in the soil. They also provide fully biodegradable fibre material to replace polythene bags, plastics, and synthetic materials that are harmful to the environment. They can also be used as green manures to improve soil quality, stop soil erosion, increase soil and water conservation, provide feed for livestock, poultry, and fish farming, and their by-products can be a substitute for wood in manufacturing paper pulp, bio-char, bio-ethanol, etc. Thus, indirectly, these fibre crops are helping to make a clean and green world by saving forests and mitigating climate change through a number of ecosystem services.