Agenda Note

20th RCM, Rabi 2020-21

October16-17, 2020

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Directorate of Research

Bihar Agricultural University, Sabour, Bhagalpur

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Content

BIHAR AGRICULTURAL UNIVERSITY, SABOUR
PROGRAMME SCHEDULE FOR 20TH RESEARCH COUNCIL MEETING
RABI, 2020

Venue: University Auditorium
Day-1(16.10.2020)

Inaugural Session
Rapporteurs: Tamoghna Saha, Tushar Ranjan & Satyendra

Welcome address	I. S. Solanki
Expert Remarks	U.S. Singh
Chairman's Address	Ajoy Kumar Singh
Technical Session I	
Action Taken Report (on the basis of 18th RCM recommendation)	I. S. Solanki
On-going Research Programmes at Regional Research Stations	
R.D. A.R.I., Patna (Zone-IIIB)	Arvind Kumar
ADR, Agwanpur, Saharsha (Zone-II)	Umesh Singh
Principal, BAC, Sabour (Zone-III A)	R.P. Sharma
Discussion	

TEA BREAK

Research Highlights (*Rabi*, 2019) and Proposed Programmes (*Rabi*, 2020)

Venue: University Auditorium
Day - 1 (16.10.2020)
Technical Session I: Crop Improvement Programme
Rapporteurs: T. Chattopadhay, Dharmasheela Thakur, Shirin Akhtar & K. Karuna

I	**Wheat**	
1	Research Highlight of Wheat Breeding	Nitish De
2	Breeding for spot blotch resistance in wheat	T. Chattopadhay
3	Breeding for terminal heat stress	T. Chattopadhay
II	**Pulses**	
4	Research Highlight of Pulse Breeding	Rafat Sultana
5	Identification of heat tolerant and early maturing lies of lentil for late sown condition	Anil Kumar
6	Identification of waterlogging stress responsive in pigeon pea	Dharamsheela Thakur
7	Mutation breeding in lentil	Prakash Singh
III	**Oilseeds**	
8	Research highlights of linseed breeding	R.B.P. Nirala
9	Development of bud fly resistance linseed lines using mutation breeding	R.B.P. Nirala
10	Development of high yield and short duration varieties of sesame for Bihar	Sima Sinha

IV	**Others**	
11	Understanding the bearing habit in Mango using Next Gen. Sequencing	B.D. Prasad
12	Marker assisted breeding for different disease resistance alleles in tomato	T. Chattopadhayay
13	Development of micropropgation device	Ravi Kesari
V	**Vegetable Improvement**	
14	Development of tomato genotypes suitable for processing purpose	Shirin Akhtar
15	Improvement of local onion variety for shape and size through selection	Sangeeta Shree
VI	**Frruit and Fruit Technology**	
16	Survey, collection and charecterization of available minor fruits of Bihar	Samik Sengupta
17	Survey, collection and evaluation of Pummelo in Bihar	K. Karuna

Day -1 (16.10.2020)

Technical Session II: Natural Resource Management Programme

Rapporteurs: Sangeeta Shree, Amit Pradhan, Mainak Ghosh & Manoj Kundu

I	**Agronomy**	
1	Evaluation of different super absorbent polymers as moisture controlled release agents in dry land regions of Bihar	Shashank Tyagi
2	Yield maximization and lodging management in wheat under different tillage options	G.L. Choudhary
3	Effect of pre and post emergence herbicides for control of small melon (Ghurmi) in summer green gram for Koshi region of Bihar	Umesh Singh
4	Effect of feed block feeding on milk yield and milk composition of cross bred cow	Amit Kumar
II	**Soil Science Agricultural Chemistry**	
5	Potential uses of parthenium, bhang and water hyacinth in agriculture	Sankar Chandra Paul
6	National Project on management of soil health and fertility	Sunil Kumar
7	Identification of promising material for controlling algal growth in makhana	Ruby Saha
8	Iron and Zinc biofortification of popularly grown rice and wheat cultivars intensively cultivated in Bihar	Bholanath Saha
9	Evaluatiom of N containing superabsorbent hydrogel in wheat, chickpea, lentil and mustard	Nintu Mandal
III	**Vegetable and Floriculture**	
10	Standardization of cultivation yechniques for summer marigold	Shyama Kumari

11	Standardization of planting dates of exotic vegetables for Zone III B of Bihar	Sangeeta Kumari
12	Effect of potassium and boron levels on yield and quality of potato	Sanjay Kumar

Day-2 (17.10.2020)

Technical Session III: Crop Protection

Rapporteurs: Arshad Anwer, T.N. Goswami, & Abhijeet Ghatak

I	**Pathology**	
1	Survey for emerging insect pests and diseases of maize, pulses, mango and banana in context of climatic change	Arshad Anwer
2	Nanoparticles mediated altered melanin biosynthesis in fungal pathosystems	Abhijit Ghatak
3	Prevention of charcoal rot through mushroom waste amendment in chick pea	Abhijit Ghatak
4	Study on prevalence of foliar blight and head blight diseases of wheat in eastern Bihar	Subhashish Sarkhel
5	Analyzing *Alternaria brassicicola*- mustard interaction at elevated temperature	Chanda Khushwaha
6	Major diseases in boro paddy and their management in Koshi region of Bihar	Anupam Kumari
7	Management of Post harvest diseases of betel leaf and enhancing the shelf life of the leaf	Prabhat Kumar
II	**Entomology**	
8	Network Project on fall armyworm in Bihar	Kiran Kumari
9	Molecular Charecterization of Brinjal shoot and fruit borer	Tamoghna Saha
10	Bio-cology and management of Red banded mango caterpillar	T N Goswami
11	Survey and management og mango bark eating caterpillar in Koshi region of Bihar	S.B. Sah

Day-2 (17.10.2020)

Technical Session IV: Product Development and Marketing Programme

Rapporteurs: Sanoj Kumar, Wasim Siddque & Prem Prakash

I	**Food Science and Post Harvest Technology**	
1	Coupling ultrasound with eco-safe compounds for delaying pericarp browning in litchi	Wahim Siddiqui
2	Development of Real Time On-package Freshness Indicator For Fruit Packaging	Wahim Siddiqui
II	**Agril. Engineering**	
3	Farm machiene testing centre	Sanoj Kumar
4	Fabrication of Ohmic heating unit for liquid foods	Satish Kumar

III	**Floricuture**	
5	Shelf life studies in dry flower products	Deepti Singh

Day-2 (17.10.2020)
Technical Session V: Social Science
Rapporteurs: Meera Kumari, C.K. Panda & S.K. Behera

I	**Extension Education**	
1	Designing and development of branding strategiesfor selected released technologies of BAU, Sabour	Ram Datt
2	Post flood Agro-economic behaviour of farmers in regularly flooded villages of Purnea district	Narendra Sharma
II	**Statistics, Mathematics and Computer Application**	
3	Construction and analysis of Supersaturated designs and their use in Agricultural Research	Basudev Kole
4	Development of weather based forecasting models for food grain production in ZoneIII of Bihar	S.K. Behera

Discussion

Day-2 (17.10.2020)
Technical Session VI: Variety and Technology Release Proposal
Rapporteurs:Chanda Kushwaha, Ajay Bharadwaj &Samik Sengupta

1	Mango Hybrid-140	Dr. Sanjay Sahai
2	BRG-13 (White garlic line)	Dr. Sangeeta Shree
3	BRG-14 (Pink garlic line)	Dr. Sangeeta Shree
4	Management of Armyworm (Mythina separata) in rice	Dr. Shyambabu Sah
5	Management of Red banded mango caterpillar	Dr. T.N. Goswami

Day-2 (17.10.2020)
Valedictory Session
Rapporteurs: Ravi Shankar Singh, Deepti Singh & Nintu Mandal

Concluding remarks	I.S. Solanki
Concluding remarks by Chair	U.S. Singh Ajoy Kumar Singh
Vote of Thanks	Sailabala Dei

2. Action Taken Report (on the basis of 18th RCM, *Rabi* 2019 proceedings)

2. 1. Crop Improvement

Sl. No.	Action to be taken	Action taken
1	Dr. Nitish De presented the research highlights of the Department of Plant Breeding & Genetics, Department of Molecular Biology & Genetic Engineering and Department of Biochemistry & Crop Physiology. He was suggested regarding the following action points: • Dr. A.R. Pathak expressed concerned about the very high number of crosses attempted & the problem in handling the very high number of segregating populations. • Dr. A.R. Pathak suggested for the patenting of developed micropropagation protocol for both bamboo and pineapple. • Dr. Vishal Nath suggested using pineapple genotype which is popular in Bihar for developing tissue culture plants. • Dr. Vishal Nath further suggested for identifying the best genotype and then go for micro-propagation protocol for that genotype. House also suggested for confirming the repeatability of developed micropropagation protocol. **Action: Dr. Nitish De**	• Undesirable populations have been rejected in early generations and limited numbers of desirable plants are selected from desirable segregating populations only. • An efficient micropropagation protocol for bamboo and pineapple has been developed but this could not be patented as there is no changed in the genetic make-up of tissue culture raised plantlets. • Micropropagation protocol has been optimized for the most popular and best suitable pineapple genotype of Kishanganj i.e. Queen. • The same protocol was used for micropropagation of other popular genotype MD2 to check the repeatability of developed protocol. Field trial for tissue culture raised pineapple plantlets are being conducted at Kishanganj and data are being recorded.
2	Dr. P.K. Singh, Chairman (SST) presented the research activities of Department of Seed Science and Technology. There was discussion regarding use of staggered planting of male parent for higher seed set and also about effect of GA3 spray. There was also discussion regarding very low seed set in hybrid rice owing to	Breeder seed production of BAU released variety is being carried out as per the received indent. Certified seed production of same variety is also being taken up to popularize them. The seed production under farmer's participatory mode under Pulse Seed Hub and Linseed seed hub has been undertaken. One project had already

	high temperature and high humidity. Dr. A. R. Pathak suggested that the breeder seed should be produced according to indent, but certified seeds of own varieties should be produced so that more and more seeds reach farmers and the seed production may also be done in farmers' participatory mode with regular visits to farmers' fields for rouging and allied activities. He also suggested for integration of RKVY-RAFTAAR for getting farmer linkage for seed production through the project. **Action: Dr. P.K. Singh**	been submitted in RKVY-RAFTAAR (Ref: L. No. 394 dated 16.04.2020) concerned with seed production of bio-fortified cereals by Farmers on sustainable basis.
3	Dr. Sanjay Sahay, Chairman (Horti-Fruits) presented the research work of the Department. Dr. Vishal Nath pointed outthat the parentage of Sabour Madhu and Sabour Litchi I need to be mentioned and the difference between the two varieties should be clearly defined. He also suggested mentioning fruit size, bearing habit etc along with the quality traits of fruits. It was suggested to go for patenting of ultra-dwarfing mango root stock "Latra" of the University. There was discussion regarding conclusion of experiments of double hedge row system of mango or litchi, but there is lack of dissemination of these technologies at farmer's field. There was also discussion regarding identification of new disease and pest of fruits like mango stem end rot and suggested to identify specific regions from where they are coming and work on their control measures. The house also suggested that the characterization of mango genotypes should be published in good journals **Action: Dr. Sanjay Sahay**	• The parentage of Sabour Madhu and Sabour Litchi 1 is Purbi x Bedana. The qualitative and quantitative characters of both the varieties are already available and being assessed every year. • The dwarfing mango root stock "Latra" cannot be patented as patent act doesn't allow patenting of variety. • The double hedge row system planting in mango and litchi are being popularized through field visits, farmer interaction and imparting training to field functionaries. • For incidence of emerging pest and diseases, survey and surveillance of emerging pest & diseases are being carried out on a regular basis.

4	Dr. Tirthartha Chattopadhyay presented the progress of his project titled "Tomato multiple disease resistance programme". His work was appreciated by the House and there was discussion regarding use of Arka Rakshak in his breeding programme. Dr. A. R. Pathak suggested that Arka Rakshak should not be used as one of the parents in breeding programme **Action: Dr. T. Chattopadhyay**	Arka Rakshak is not being utilized in our tomato resistance breeding programme.
5	Dr. Randhir Kumar, Chairman, Horticulture (Vegetable and Floriculture) presented the departmental progress report for the year 2018-19. During his presentation, Dr. A. R. Pathak., Hon'ble Vice Chancellor, Junagarh Agricultural University, Junagarh, opined that technology for Kharif onion is already there with DOGR, Pune and only validation work for local practices should be carried out. The expert also advised that one early cauliflower variety has already been released by the University and if some other early types are to be released in future, there must be some striking features that would differentiate the two. Dr. Vishal Nath, Director ICAR - NRC, Litchi, Muzzaffarpur suggested that seediness in pointed gourd is rather a desirable character and efforts towards development of seedless pointed gourd should be reviewed. Pertaining to the marigold project, experts were of the opinion that size of marigold blooms need not be large but uniformity in size must be maintained. For the project on French bean, the experts proposed that the checks for the creeping and the bush types beans should be the varieties from their respective types only.	Kharif onion: Kharif onion technology for the state of Bihar with the local practices has been standardized through the project and RPF-III of the project will be submitted next year. Early cauliflower: One Early Cauliflower promising line BRECF-117/13 has been identified for release through AICRP on Vegetable Crops for Zone-V during its 38th Annual Workshop held during 25th – 27th September, 2020. Pointed gourd: The suggestion of Hon'ble member of RCM has been considered and accordingly research works are being coined. Marigold: Marigold genotype BRMG 113, the best genotype identified for summer was selected based on the performance of green and lustrous vegetative growth, more no. of lateral branches, good colour intensity, medium flower diameter (3.6-5.0 cm), uniform blooming character along with high yield/ plant etc. As per recommendation of directorate of research BRMG-113 was sent for testing under AICRP Floriculture DFR, Pune. French bean: Swarn Lata (creeping type) and Arka Komal and Swarn Priya (bush type) varieties as check varieties have been planted for comparison this year

	Action: Dr. Randhir Kumar and respective project scientists	
6	Dr. R.B.P. Nirala was presented the progress of linseed breeding programme. There was discussion regarding promotion of the entries at different zones. **Action : Dr. R.B.P. Nirala**	Linseed entries (*viz.*, BRLS 107-1, BRLS 119 and BRLS 110-4) are being promoted in major zone like Zone II and Zone III of India through AICRP Trials.
7	Dr. Kumari Rajani presented progress of Seed Quality Enhancement using Botanicals. Dr. Vishal Nath enquired if the seeds taken were having low vigour and asked to mention The areas from where the seeds were taken. She was also suggested to identify the reasons for low seed vigour. Dr. A. R. Pathak asked whether priming affects the number of days taken for germination and suggested for recording the observation. He also suggested observing the cost of the botanicals used and correlating with yield in field trials. He also suggested priming of crops that have small seed size such as mustard. Dr. M. Haq (Registrar) queried on the use of parthenium as a botanical since it was supposed to have some allelopathic effects. **Action: Dr. Kumari Rajani**	The lower vigor seed area was already identified and data presented in RCM-2019.The low vigor seeds were having aging and higher moisture content, which is the most probable cause of seed deterioration and low vigor. The other scientific findings also support the reason of low vigor. The seed priming affects the germination time and the data was recorded and presented inRCM-2019. The effect of botanical on yield will be calculated after second year field trail of 2020-21. The costs of botanicals will also be calculated accordingly. Presently, the project research project is only on the priming of pulse crops, we will plan to undertake project on seed priming of crops having small seeds. Definitely parthenium have allopathic effect on seed germination and crop growth at higher concentration. But there are several research reports where lower concentration of parthenium shown better seed germination and crop growth. This was the main reason of including parthenium in the present research work.
8	Dr. Sweta Sinha presented the progress report of project entitled Evaluation of tomato lines carrying different combinations of Ty genes for resistance against begomovirus infection. There was discussion regarding conduction of the experiment in open condition and protected condition and also use of	The experiment was performed as per suggestions by Dr. A R Pathak. The trial was conducted in the open field and protected condition (pot) in February-May 2020 as the peak season for whiteflies and leaf curl disease pressure locally. In order to increase inoculum pressure, two rows of tomato leaf curl virus susceptible varieties (Pusa Ruby and AVTO-01) planted along

	epiphytotic line after every 10 lines. Dr. A. R. Pathak appreciated her work and suggested for not making too many crosses and to focus on gene pyramiding. She was also suggested to count the number of white flies on the leaves and record the morphological traits and correlate them with resistance. **Action: Dr. Sweta Sinha**	the borders of the plot in both open field as well as protected condition. The disease incidence was found low compared to February-May 2019 as whitefly pressure was low with 1 to 2adult per leaf in the beginning of March 2020 and there were no whiteflies during May 2020. There were symptoms of tomato leaf curl virus disease only on susceptible varieties (Pusa Ruby and AVTO-01) both in field and protected condition. It was observed that trichome density were low in susceptible varieties compared to resistant varieties.
9	Dr. Tushar Ranjan presented the progress of pineapple tissue culture programme. It was suggested to use genotypes that are popular in Bihar for developing tissue culture plants. He was suggested for identifying the best genotype and then go for micro-propagation protocol for that genotype. Director Research for suggested growing the plants naturally and comparing conventionally propagated and micro-propagated plants for their performance. **Action: Dr. Tushar Ranjan**	A micropropagation protocol has been optimized for the most popular and best genotype of Bihar i.e. queen Field trial for tissue culture raised pineapple plantlets are being conducted at Kishanganj and data has been recorded.

2. 2. Natural Resource Management

Sl. No.	Action to be taken	Action taken
1	Dr. Sanjay Kumar, Chairman Agronomy presented the departmental progress report. The house suggested to provide the economics and to conduct water and nutrient related experiment in order to save the total water requirement and to increase the nutrient use efficiency of the crop. Expert suggested him to work on millet crops. **Action: Dr. Sanjay Kumar**	In all the experiment economics were calculated. Experiments on nutrient management (Nitrogen, potassium as well as micronutrient) are going on. Experiments on millet crops (finger millet and pearl millet) with respect to plant population, weed management and fertility level are also taken up. Experiment on rain water management was conducted under AICRPDA.

2	Mr. Santosh Kumar, Asstt. Prof. cum Jr. Scientist, Agronomy, RRS, Agwanpur, Saharsa & PI of the project entitled "Effect of pre and post emergence herbicide for control of smell melon (Ghurmi) in summer green gram of koshi region" presented the research highlight. He was suggested by Hon'ble Vice Chancellor that the weed scientists group should sit together to identify the harmful weeds in the experimental area/region for all locations and commented that Smell melon (Ghurmi) may not be the major weeds in green gram. The house also suggested to check, whether the herbicide is recommended by CIBRC or not. **Action: Mr. Santosh Kumar**	The discussion was made with the Agronomists and decided that smell melon can be considered as major weed in green gram. The trial was summer season of 2020. All the herbicides i.e., Pendimethalin (PE) and Imazethapyr (POE) are recommended by the CIBRC.
3	Dr. Shashank Tyagi, Asstt. Prof. cum Jr. Scientist, Agronomy, BAC, Sabour & PI of the project entitled "Evaluation of different super absorbent polymers as moisture controlled release agents in agriculture under dry land regions of Bihar" presented the highlights of the project and the Hon'ble Vice Chancellor suggested to mention the cost of hydrogel and again check the interaction result as there was no significant difference between the treatments. The house also suggested to check, the data of water holding capacity and B:C ratio of mustard crop. The house instructed to measure the water quantity to be provided in each irrigation for all the crops. **Action : Dr. S. Tyagi**	All the suggestions regarding cost of hydrogel, interaction results, water holding capacity, economics and irrigation water quantity have been done and incorporated in the experiment.
4	Dr. Randhir Kumar, Chairman, Horticulture (Vegetable and Floriculture) presented the	Kharif onion technology for the state of Bihar with the local practices has been standardized through the project and RPF-

	departmental progress report for the year 2018-19. During his presentation, Dr. A. R. Pathak., Hon'ble Vice Chancellor, Junagarh Agricultural University, Junagarh, opined that technology for Kharif onion is already there with DOGR, Pune and only validation work for local practices should be carried out. **Action: Dr. Randhir Kumar/ Dr. V. K. Singh**	III of the project will be submitted next year.
	The expert also advised that one early cauliflower variety has already been released by the University and if some other early types are to be released in future, there must be some striking features that would differentiate the two. **Action : Dr. Randhir Kumar/ Dr. Chandan Roy**	One Early Cauliflower promising line BRECF-117/13 has been identified for release through AICRP on Vegetable Crops for Zone-V during its 38th Annual Workshop held during 25th - 27th September, 2020. The suggestion of Hon'ble member of RCM has been considered and accordingly research works are being coined.
	Dr. Vishal Nath, Director ICAR - NRC, Litchi, Muzzaffarpur suggested that seediness in pointed gourd is rather a desirable character and efforts towards development of seedless pointed gourd should be reviewed. **Action : Dr. Randhir Kumar/ Dr. R. B. Verma**	Marigold genotype BRMG 113, the best genotype identified for summer, was selected based on the performance of green and lustrous vegetative growth, more no. of lateral branches, good colour intensity, medium flower diameter (3.6-5.0 cm), uniform blooming character along with high yield/plant etc. As per recommendation of directorate of research BRMG-113 was sent for testing under AICRP Floriculture DFR, Pune.
	Pertaining to the marigold project, experts were of the opinion that size of marigold blooms need not be large but uniformity in size must be maintained. **Action: Dr. Randhir Kumar/ Dr. Shyama Kumari**	
	For the project on French bean, the experts proposed that the checks for the creeping and the bush type beans should be the varieties from their respective types only.	Swarn Lata (creeping type)and ArkaKomal and Swarn Priya (bush type) varieties as check varieties have been planted for comparison this year

	Action: Dr. Randhir Kumar/ Dr. Sardar Sunil Singh	
5	Dr. Sanjay Sahay, Chairman, Horticulture (F&FT) presented the departmental progress report for the year 2018-19. During his presentation, the experts suggested to take initiation for characterization and documentation of mango germplasm available in the centre. Experts also suggested collecting the information regarding International project and taking a start up from there to save the time. Technologies on planting system, canopy management, nutrient management and plant protection in mango are the domains which have the potential of doubling farmers' income and should be reviewed and projects must be planned in these areas. Work on Palmira palm needs to be encouraged. **Action : Dr. Sanjay Sahay**	A non planned project has been approved and work has been initiated for characterization and documentation of mango germplasm available in the centre. Experiments on planting system, canopy management, nutrient management and plant protection etc are being conducted. A number of studies on Palmira palm were undertaken in the department.
6	Prof. Feza Ahemad presented the research highlights of the experiment "Rootstock studies in mango". He was suggested by the expert to check the extent of genetic purity maintained in the open pollinated seeds of Mahmood Bahar and Prabha Sankar varieties through molecular marker. **Action : Dr. Feza Ahemed**	The observation on root stock girth has been taken. As per as genetic purity of open pollinated seeds of mono embryonic varieties is concerned, the seeds were collected and planted in the nursery for further studies.
7	Dr. Feza also presented the research highlights of the ongoing project entitled Survey, collection and characterization of available minor fruits of Bihar on behalf of Dr. Samik Sengupta. During his presentation, experts suggested to go for exhaustive review of each and every character of all the minor fruits taken under this project (research work of ICAR's Horticultural Research Institutes and	The research carried out at ICAR and SAUs have been thoroughly reviewed and benchmark for selecting the Jamun variety on the basis of weight has been fixed. Early as well as late season genotypes were also included in the selection criterion.

	other SAUs of the country) and set the bench mark for all the characters under each minor fruit and then only plan the programme. For example, experts informed that in Jamun standard fruit weight is 19g. Hence during survey and collection of Jamun, 19g fruit weight should be used as standard check and only the superior genotype with fruit weight more than 19g should selected. Similarly for other characters also, they should be compared with standard check. Further, experts also suggested him to collect both early and late season genotypes to expand the availability of those crops for maximum time period in the market. **Action: Dr. Samik Sen Gupta**	
8	Dr. S. C. Paul presented the research highlights of the experiment "Potential use of Parthenium, bhang and water hyacinth in agriculture". He was suggested to conduct an experiment and also suggested to take seeds with poor germination capacity to see the effect of extractant on seed germination. **Action: Dr. S. C. Paul**	For this low germination capacity maize seed (Old seed) was used and in the field it was found that germination percentage was found to be increased by 6-8% in higher concentration of dry parthenium leaf extract where seeds were soaked in extract for overnight only. But germination percentage was similar in raw leaf extract in all concentrations.
9	Dr. Nintu Mandal, Assistant presented the research highlights of the project "Evaluation of N containing superabsorbent hydrogel in Wheat, Chickpea, Lentil and Mustard". He was suggested by the house to conduct field experiment at farmer's field. **Action: Dr. Nintu Mandal**	Nitrogen containing superabsorbent polymer in comparison with 7 other products of commercial firm is being evaluated under multi-location (Banka, Munger and Sheikhpura) trial in rabi crops (wheat, chickpea, mustard and maize) under the project '*Evaluation of different super absorbent polymers as moisture controlled release agents in agriculture under dry land regions of Bihar'* funded by Department of Agriculture, Govt of Bihar. Experimental finding will be presented in this research council meeting.

10	Mr. Jajati Mandal presented the research highlights of the project on "Determination of safe limit of Arsenic in irrigation water. He was suggested to use Indigenous cow's urine and dung for arsenic remediation. **Action: Dr. Jajati Mandal**	An experiment was conducted, soil spiked with 0, 5, 10, 20, 30 ppm of Arsenic in 5 kg of soil and cow urine (@ of 0, 0.5, 1, L pot^{-1}) cow dung (@ of 0, 100, 200 gm pot^{-1}). The results revealed that no significant reduction in available As in soil was observed.
11	Dr. Bholanath Saha the research highlights of the project on "Iron and zinc biofortifcation of popularly grown rice and wheat cultivars intensively cultivated in Bihar". He was suggested to analyze the P content in grain and as well as in plants parts. **Action: Dr. Bholanath Saha**	The phosphorus content in the form of phytic acid has been analysed in grains of rice and wheat as suggested.

2. 3. Crop Protection

Sl. No.	Action to be taken	Action taken
1	Dr. Arshad Anwer, Asstt.Prof.-cum-jr.Scientist, Plant Pathology, BAC, Sabour presented the research highlights of his non- plan project on "Survey for emerging insect pests and disease of maize, pulses, mango and banana in context of climate change". The house for preparation of brief report on status of emerging pests and disease during climate change. **Action: Dr. A. Anwer**	Brief report on the status of emerging pests and disease during climate change has been submitted to the Directorate of Research, BAU, Sabour. However, during this period Fall armyworm (*Spodoptera frugiperda*) has been emerged as the most destructive pest especially for maize crop and Red Banded Mango Caterpillar (*Deanolis sublimbalis*) for mango production. As far as emerging disease is concern, TLB (*Exserohilum turcicum*) and Late wilt (*Harpophora maydis*) of maize are found to be the most serious diseases.
2	Dr. Md. Ansar, Asstt.Prof.-cum-jr.Scientist, Plant Pathology, BAC, Sabour presented the progress report of his ongoing project on "Exploration of viral complexity in papaya plantation". The house suggested for review or to observe the particular stage of papaya crop on which aphids may be escaped. **Action: Dr. Md. Ansar**	Under the project exploration of viral complexity in papaya plantation, reviewed the various stages of papaya plant for aphid infestation or population. In all stages of papaya plant, aphid population was noticed but the population was peak during the middle February to March. The plants almost escaped by aphids during the last week of June to middle of August.

3	Mrs. Anupam Kumari, Asstt.Prof.-cum-jr.Scientist, Plant Pathology,BPSAC, Purnea presented progress report of the project "Major diseases in Boro paddy and their management in Koshi region of Bihar". The house suggested including any available susceptible paddy varieties in the experiment for management of disease. **Action : Mrs. Anupam Kumari**	Among all the locally cultivated available varieties of Boro rice, more disease incidence was found on SNM-25. So SNM-25 variety of Boro rice has been included in the experiment for the management of disease.
4	Dr Tarak Nath Goswami presented progress of the project entitled "Bio-ecology and management of red banded mango caterpillar on mango". The house suggested for biochemical analysis of screened varieties of mango against red banded caterpillar to know the status of phenol contents present in it. The Chairman, Fruit & Fruit Technology was directed to make necessary arrangement for the said analysis. **Action: Dr. T.N. Goswami**	The biochemical work could not taken place due to pandemic covid-19.
5	Dr Suday Kumar presented progress report of the project titled "Assessment of gonadal maturity and spawning behaviour of Indian Major Carp in south Bihar". It was advised to go through the standard protocol prior to developing value added products from eggs of fish in the experiment. The house also advised not to take up any such experiment in the project for which we have no experience/expertise. **Action: Dr. Suday Kumar**	There is no proper facility/faculty to follow the standard protocol for developing the egg of fish in the experiment and it is also not an objective of my project.

2. 4. Product Development and Marketing

Sl. No.	Action to be taken	Action taken
1.	Er. Ashok Kumar presented the progress report of non-plan project entitled "Design development of a self propelled light weight boom sprayer". He was suggested to check the power by which the machine could work in muddy field. He was also suggested to adjust the height considering the height of plant at different stages. **Action: Er. Ashok Kumar**	Power of machine is increased from 3hp to 5hp by replacing the engine and height of the machine is also modified and increased to 96 cm and adjustable height for spraying in under process. This machine is suitable to work in dry land.
2.	Er. Prem Prakash presented the progress report of project entitled "Value addition of onion cultivated in Bihar." He was suggested to incorporate the statistical analyses in the research findings. **Action: Er. Prem Prakash**	The statistical analysis in tables has been incorporated.

2. 5. Social Science

Sl. No.	Action to be taken	Action taken
1.	Dr. A.S. Tigga, was advised to give interventions in group approach mode for sustaining the interventions given by her in Non-plan Project.SHG could develop for motivating tribal farmers. House also suggested her to exempt the study of Impact of farmer's First. **Action: Dr. A.S. Tigga**	As per the suggestions of house, Group approach mode instead of individual approach is being carried out for providing interventions. Tribal farmers of selected villages of Pirpaintee Block are being motivated to develop Self Help Groups (SHGs) /FPOs. Focusing on the activities for sustaining all the interventions already provided to them for the livelihood security of tribal farmers by their own efforts with the available resources.

3. Proceedings of Zonal Research Extension Advisory Committee (ZERAC) Meeting

3.1. Bihar Agricultural College, Sabour

क्षेत्रीय अनुसंधान एवं प्रसार सलाहकार समिति, जोन III (ए) की रबी 2020 की कार्यवाही टिप्पणी ।

COVID- 19 महामारी के कारण 20 वी क्षेत्रीय शोध एवं प्रसार परिषद की बैठक दिनांकः 24.09..2020 को पूर्वाहन 11:00 बज बिहार कृषि महाविद्यालय, सबौर, भागलपुर के मिनी ऑडिटोरियम में विडियो कॉनफ्रेन्सींग के द्वारा बैठक सम्पन्न हुई। इस बैठक में जोन III (ए) के 5 जिलों यथा भागलपुर, बांका, मुंगेर, लक्खीसराय एवं शेखपुरा के कुल 32 किसानों एवं कार्यक्रम ने विडियो कॉनफ्रेन्सींग क द्वारा भाग लिया।

इस बैठक की अध्यक्षता डॉ0 आर0 पी0 शर्मा, प्राचार्य, बिहार कृषि महाविद्यालय, सबौर के द्वारा की गई। डॉ0 राजनारायण सिंह, सह निदेशक प्रसार शिक्षा, बिहार कृषि विश्वविद्यालय, सबौर एवं अध्यक्ष (शाक एवं पुष्प/कीट/सस्य विज्ञान), बिहार कृषि महाविद्यालय, सबार एवं डॉ0 अनिल पासवान, कनीय वैज्ञानिक सह सहायक प्राध्यापक, प्रसार शिक्षा विभाग, बिहार कृषि महाविद्यालय, सबौर इस बैठक में उपस्थित हुए।

इस बैठक में सदस्यों का स्वागत करते हुए डॉ0 शर्मा, प्राचार्य, बिहार कृषि महाविद्यालय, सबौर ने इस बैठक के महत्व पर प्रकाश डालते हए सभी सदस्यों से आह्वान किया कि रबी मौसम की खेती में अधिकतम उत्पादकता प्राप्त करने में किसानों को जिन तकनीकी कठिनाईयों का सामना करना पड़ता है, उनमें से जिन समस्याओं का समाधान अभी तक उपलब्ध नहीं हुआ है उन पर अनुसंधान हेतु परियोजना बनाने पर विचार किया जा सके। डॉ0 शर्मा, प्राचार्य, बिहार कृषि महाविद्यालय, सबौर ने पिछले वर्ष की बैठक में किसानो द्वारा उठाई गई समस्याओं पर प्रतिवेदन प्रस्तुत किया। उन्होंने सदस्यों से आग्रह किया कि किसान अपने–अपने क्षेत्र की रबी मौसम के फसलों की समस्याओं को कृषि वैज्ञानिकों के विचारार्थ रखें । तत्पश्चात् पाँचों जिलों के किसानों ने एक–एक कर अपने–अपने क्षेत्र की रबी फसलो की तकनीकी समस्याओं को समिति के समक्ष प्रस्तुत किया। इस बैठक द्वारा चिन्हित रबी फसलों कि तकनीकी समस्याओं का फसल वार व्योरा यहाँ प्रस्तुत हैः–

क्र•सं•	समस्या	समाधान कर दिया गया	अनुसंधान में प्रगति	अनुसंधान परियोजना बनाना होगा
	गेहूँ			
1.	गेहूँ को नवम्बर के पहले या बाद में लगाने पर उपज कम होता है, उपज कैसे बढ़ेगा ? उपाय बताया जाय।	√		
2.	पहली सिंचाई के बाद गेहूँ का फसल पीला हो जाता है, उपयुक्त समाधान बताया जाय।	√		

3.	बाढ़ ग्रस्त क्षेत्र होने के कारण गेहूँ की पैदावार कम होती है, उपयुक्त समाधान बताया जाय।	√		
4.	सबौर निर्जल गेहूँ के प्रभेद की बुआई करने के बाद पटवन नहीं करने पर पैदावार कितनी होगी?	√		
5.	सूखा रोधी गेहूँ की प्रजाति विकसित करने की दिशा मे अनुसंधान किया गया।		√	
6.	गेहूँ के 7777 प्रभेद की तुलना में बराबर उपज देने वाले प्रभेद के बारे में जानकारी उपलब्ध कराया जाय।	√		
7.	गेहूँ की बॉयो–45 प्रभेद विश्वविद्यालय में उपलब्ध है, कृप्या बताया जाय।	√		
8.	क्या गेहूँ के बंशी प्रभेद की बुआई इस क्षेत्र में की जा सकती है?	√		
9.	गेहूँ के कम समय वाले प्रभेद के अच्छे बीज पर अनुसंधान किया जाय। खेत में पानी की समस्या होती है।		√	
	मक्का			
10.	दियारा क्षेत्र में मक्का के खेती में कम लागत और ज्यादा मुनाफा के लिए उन्नत प्रभेद एवं तकनीक बताया जाय।	√		
11.	मकई के पोधों में पिलापन क्यों हो जाता है और मकई की खेती में खरपतवार को नियंत्रित करने के लिए दवा का नाम बताया जाय।	√		
12.	मक्का का पौधा जड़ से ठीक ऊपर सड़ जाता है और पौधा गिरकर मर जाता है। कारण और निदान बताया जाय।	√		
	मसूर			
13.	टाल क्षेत्र में मसूर की फसल बुआई के पश्चात जड़ गलन एवं पाले की समस्या के कारण फसल की पैदावार कम होती है, समाधान बताया जाय, एवं अगेती बुआई हेतु इसके प्रभेद के बारे में जानकारी उपलब्ध कराया जाय।	√		
14.	मसूर के लिए लेट वैरायटी के बीज उपलब्ध कराये जाय।	√		
15.	मसूर का पौधा सुखता है, सामाधान बताया जाय ।	√		
16.	मसूर का पौधा कुछ बड़ा होने के बाद मर जाता है। इस बीमारी से बचाव के उपाय बताया जाय।	√		
17.	मसूर में फूल आने से पहले बहुत संख्या में मर जाता है और फल कम आता है।	√		
18.	मसूर में उकठा रोग लग जाते है और पीले–पीले जाले जैसा धाँस होते हैं, जो की अमरलत्ता जैसा होता है, उसका उपाय बतायें।	√		
19.	मसूर की कौन सी प्रभेद लगाई जाए, जिससे उत्पादन ज्यादा हो सके एवं लगाने का तरीका भी बताया जाए।	√		
	चना			
20.	लेट वैरायटी चना के बीज के बारे में जानकारी उपलब्ध कराया जाय।	√		
21.	टाल क्षेत्र में चना की फसल बुआई के पश्चात जड़ गलन एवं पाले की समस्या के कारण फसल की पैदावार कम होती है, सामाधान बताया जाय, एवं अगेती बुआई हेतु इसके प्रभेद के बारे में जानकारी उपलब्ध कराया जाय।	√		
22.	धान कटनी के बाद चना बुआई के पश्चात अंकुरण अच्छा नहीं होता है, सिंचाई करने के पश्चात वानस्पतिक वृद्धि अधिक होने के कारण पैदावार घट जाती है, समाधन बताया जाय।	√		
23.	चना के फसल में पिल्लु की समस्या है, समाधान बताया जाय।	√		
24.	चना के फसल में उक्टा रोग लग जाता है। कारण एवं समाधान बताया जाय।	√		

25.	चना का पौधा 30 दिनों के बाद सूखने लगता है, उपाय बताया जाय।	√		
26.	धान के फसल के बाद चना का पौधा सुखता है। समाधन बताया जाय।	√		
27.	चना की कौन सा प्रभेद लगाया जाय जिसकी उपज अच्छी हो। उन्नत प्रभेद का बीज उपलब्ध कराया जाए जिसमें की पौधों को सूखने की समस्या न रहे।	√		
28.	बीज उपचार के लिए फफूदनाशी, कीटनाशी एवं राइजोबियम (जैव उर्वरक) को प्रयोग करने की विधि के बारे में बताया जाय।	√		
	मूंग			
29.	मूंग के कम समय में पकने वाले प्रभेदों के बीज उपलब्ध कराये जाय।	√		
	सरसों			
30.	सरसों में पैदावार कम होता है, अधिक पैदावार के लिए बीज उपलब्ध कराया जाय।	√		
31.	सरसों की बुआई 30 नवम्बर के बाद करने पर अच्छा उपज नहीं मिलता है, समाधान किया जाय।	√		
32.	सरसों के फसल में दाना नहीं बनता है, उपयुक्त समाधान बताया जाय।	√		
	सब्जीयाँ			
33.	प्याज में गलन की समस्या है इसके उन्नत प्रभेद का बीज उपलब्ध कराया जाय तथा सुखसागर प्रभेद का बीज उपलब्ध कराया जाय।	√		
34.	गोभी का पत्ता सड़ एवं जल जाता है। समाधान बताया जाय।	√		
35.	प्याज का बीज (जिराट प्रभेद) की बुआई का उपयुक्त समय क्या है, एवं इसका बीज किसानो को उपलब्ध कराया जाय।	√		
36.	प्याज का अगात प्रभेद के बारे में उपयुक्त जानकारी हेतु शोध किया जाय।			√
37.	प्याज बहुत सड़ता है, ऐसे प्रभेदों का बीज उपलब्ध कराया जाय जो सड़े नहीं।	√		
38.	बैंगन का पौधा फल लगने के पहले ही सुखने लगता है, उपाय बताया जाय।	√		
39.	टमाटर एवं बैंगन की बीज उपलब्ध कराया जाय।	√		
40.	बैगन का गोल और लम्बा दोनो प्रभेद के बारे में बताया जाय।	√		
41.	प्याज रोपने के बाद पत्ती में सिकुड़न होने के कारण प्याज को काफी नुकसान होता है। उपाय बताया जाय।	√		
42.	बैंगन, टमाटर, नींबू का फल अधिक मात्रा में फटने की समस्या होती है। उपाय बताया जाए।	√		
43.	बैंगन में कीट प्रबंधन की व्यवस्था की जाय ।	√		
	<u>फल</u>			
44.	पपीता में भुंगरी रोग लगता है, कारण एवं समाधान बतायें।	√		
45.	हरिछाल अमरूद का प्रभेद उपलब्ध कराया जाय। क्या लखीसराय क्षेत्र में यह प्रभेद होगा?	√		
46.	आम के पेड़ की तरह शीशम की टहनी में लट्ठा निकल जाता है जिससे पौधा सूख जाता है, उपयुक्त समाधान बताया जाय।	√		
47.	आम के कलमी पेड़ में गाँठ बनकर छाल फटने लगता है, समाधान बताया जाय।	√		

अन्य				
48.	औषधीय पौधों की खेती करने के लिए प्रयाप्त जानकारी उपलब्ध कराया जाय।	√		
49.	दियारा क्षेत्र में उत्पादन लागत अधिक होने के कारण बचत कम होती है, अधिक मुनाफा पाने के लिए तकनीकी की जानकारी दी जाय।	√		
50.	कम पानी होने पर भी जीरो टिलेज से खेती कर सके, ऐसी जानकारी उपलब्ध कराया जाय।	√		
51.	खेत में अधिक पानी होने के कारण कोई फसल नहीं ले पाते, उपयुक्त समाधान बताया जाय।	√		
52.	रबी की फसल में नील गाय से बचाव का उपाय बताया जाय।	√		
53.	बिहार में हर तरह की जलवायु होते हुए भी मसाले (गोल मरीच, ईलायची आदि) की खेतो क्यों नहीं कर सकते?	√		
54.	विश्वविद्यालय द्वारा अनुमोदित तकनीकीयों एवं प्रभेदों का प्रदर्शन प्रत्येक प्रखण्ड़ स्तर पर किया जाय।			√
55.	प्रत्येक प्रखण्ड़ में बीज बिक्रय केन्द्र की स्थापना की जाय।			√
56.	इमिडाक्लोरोप्रीड और साइपरमेथिलिन में अंतर बताया जाय।	√		
57.	टाल क्षेत्र में हम किसान भाई एक हीं फसल लेते है। क्या चना और गेहूँ के बाद कोई और फसल लगा सकते हैं ?	√		

3.2. Agricultural Research Institute, Patna

क्षेत्रीय शोध एवं प्रसार सलाहकार समिति (कृषि जलवायु क्षेत्र, जोन 3बी बिहार) की 20वीं रबी 2020 की बैठक, दिनांक 03.10.2020 को कृषि अनुसंधान संस्थान, पटना में डॉ० अरविन्द कुमार, क्षेत्रीय निदेशक, कृषि अनुसंधान संस्थान, पटना की अध्यक्षता में सम्पन्न हुई। बैठक में कुल 54 व्यक्तियों ने भाग लिया।

कृषि अनुसंधान संस्थान, पटना एवं इसकी वाह्य इकाईयों के वैज्ञानिको एवम् कृषि विज्ञान केन्द्र, बाढ़, जहानाबाद, औरंगाबाद, अरवल तथा आमस (गया) के वरीय वैज्ञानिक–सह–प्रधान एवं अन्य वैज्ञानिकों ने इसमें भाग लिया। कृषि विज्ञान केन्द्र, मानपुर (गया) के वरीय वैज्ञानिक –सह–प्रधान के प्रतिनिधि ने इसमें भाग लिया।

वीर कुँवर सिंह कृषि महाविद्यालय के सह अधिष्ठाता एवम् प्राचार्य तथा वहाँ के वैज्ञानिकों एवम् कृषि विज्ञान केन्द्र, रोहतास के वैज्ञानिको ने भी इस बैठक में भाग लिया।

उद्यान महाविद्यालय, नूरसराय के प्राचार्य डॉ० पंचम कुमार सिंह ने कृषि विज्ञान केन्द्र, हरनौत, नालन्दा के वैज्ञानिकों के साथ इस बैठक में भाग लिया।

डॉ० संगीता कुमारी, कनीय वैज्ञानिक (उद्यान) ने समस्त सभासदों का इस बैठक में स्वागत किया एवं इस बैठक की महत्ता पर प्रकाश डाला।

डॉ० अरविन्द कुमार, क्षेत्रीय निदेशक, कृषि अनुसंधान संस्थान, पटना ने कृषक बन्धुओं का स्वागत किया तथा आग्रह किया कि वे अपने–अपने क्षेत्रों की रबी मौसम की खेती से जुड़ी समस्याओं का जिक्र करें, जिसके समाधान सम्बन्धित वैज्ञानिक सुझायेंगे।

बैठक में अनेक कृषक बन्धुओं की सक्रिय रूप से भागीदारी रही, उन्होंने अपनी विभिन्न समस्याओं का जिक्र किया एवं कतिपय सलाह भी दी :

(1) श्री रामराज सिंह, राणाबिगहा, बाढ़ पटना ने बताया कि उनकी मसूर की फसल में भुलसा रोग लग गया था। वे उसके नियंत्रण के उपाय की जानकारी चाहते थे। साथ ही, वे विलम्ब से बुआई की जाने बाली एवं अधिक उपज देने बाली मसूर की किस्मों की भी जानकारी चाहते थे।

(2) श्री अवध किशोर वर्मा, बैदराबाद, अरवल ने धान की बाली में सुखड़ा रोग लगने की जानकारी दी एवं उसके नियंत्रण के उपाय जानना चाहा।

(3) श्री आशीष कुमार सिंह, टेकारी ने जानकारी दी कि वे काले धान की खेती करते हैं लेकिन फसल में दाने भरने के समय ज्यादा वर्षा हो जाने के कारण, उसके दाने पतले हो गये थे।

(4) बिल्लौर के श्री प्रमोद कुमार सिंह ने बताया कि उन्होंने मसूर की खेती की थी लेकिन फसल में पुष्पण (Flowering) के समय अधिक बारिश हो जाने के कारण छिमियां नहीं बन पाईं।

उन्होंने अनुरोध किया कि मसूर के येसे प्रभेद विकसित किये जायें जिसमें, इस तरह की विपरीत परिस्थिति उत्पन्न होने के वाबजूद छिमियां एवं दाने बन पायें।

(5) श्री रामदीप शर्मा, बगहाकोल, बिक्रम प्रखंड, पटना ने बताया कि गेंहूँ की फसल तैयार होने के बाद पछुआ हवा के चलने से गिर जाती हैं। उनका सुझाव था कि गेंहूँ के येसे किस्म विकसित किये जायें जो येसी विपरीत परिस्थिति में भी गिर नहीं पायें उन्होंने जानकारी दी कि वे अपनी खेतों में Happy Seecer Machine से गेंहूँ की बुआई करते है। इस मशीन को चलाने के लिये 50 HP से ऊपर की क्षमता के ट्रैक्टर की आवश्यकता होती है, जिसके मिलने में काफी कठिनाई होती है। उनकी सलाह थी कि 35 HP के ट्रैक्टर से संचालित हो सकने बाले Happy Seecer का इजाद किया जाय।

(6) श्री सुभाषचन्द्र प्रसाद चौरसिया, इस्लामपुर नालन्दा ने बताया कि पान की फसल ठंढ़ एवं तूफान से बर्बाद हो जाया करती है। सरकार इसका मुआवजा देने की व्यवस्था करे एवं पान की खेती को कृषि का दर्जा दिया जाये।

(7) श्री संत कुमार सिंह, सकरौढ़ा, जहानाबाद ने बताया कि धान की प्रमुख किस्मों की तुलना में गेंहूँ की प्रमुख किस्मों की उपज क्षमता काफी कम है।

अतः अधिक उत्पादनशील गेहूँ की किस्में विकसित की जायें। साथ ही सरसों की ऐसी किस्में विकसित की जायें जो अधिक वर्षा की स्थिति को सहन कर सकें।

(8) श्री संजीत कुमार सिन्हा, हरनौत, नालन्दा ने बताया कि अधिक वर्षा हो जाने के कारण, धान की खेतों में अभी काफी जल जमाव है, उन खेतों में 15 जनवरी के बाद ही गेंहूँ की बुआई संभव हो पायेगी। ऐसी परिस्थिति में, किसान भाईयों के लिये गेंहूँ की नई किस्में विकसित की जानी चाहिये।

(9) श्री सच्चिदानन्द सिंह, पिंजोर, जहानाबाद ने बताया विगत दो वर्षों से खरीफ मौसम में अधिक वर्षापात होता है, जिससे खड़ी फसलें खराब हो जाती है।

अतः येसी फसलें विकसित की जानी चाहिये जो अधिक वर्षा की स्थिति में भी अच्छा कर पायें।

(10) श्री संजीत कुमार, हरनौत ने पुनः बताया कि आलू एवं प्याज के मूल्य में दिनानुदिन वृद्धि होती जा रही है। अतः इन दोनों फसलों की अधिक उत्पादनशील प्रभेदों को विकसित किया जाये।

सभागार में उपस्थित विशेषज्ञ वैज्ञानिकों के द्वारा कृषक बन्धुओं की संबंधित समस्याओं के समाधान सुझाये गये, साथ ही बैठक में भाग ले रहे श्री राजीव कुमार, सहायक निदेशक–कृषि, बिहार सरकार ने कृषि विभाग, बिहार सरकार के द्वारा कृषकों के लाभ के लिये चलायी जा रही योजनाओं की जानकारी दी।

नवीन शोध कार्य संपादित किये जाने हेतु समिति के समक्ष निम्नलिखित प्रस्ताव प्रस्तुत किये गय :

- मसूर की फसल में पुष्पण के समय अधिक वर्षापात हो जाने की स्थिति में फसल में छिमियां (Pods) नहीं लग पाती हैं। मसूर की येसी प्रजाति विकसित की जाये जिसमें वर्णित परिस्थिति के उत्पन्न होने पर भी छिमियां बन पायें एवं फलन हो पाये।
- गेहूँ की फसल की परिपक्वता की स्थिति में पछैती हवा के झोंके से खेत में फसल गिर जाती है। येसी किस्में विकसित की जायें जो येसी परिस्थिति के प्रति सहनशील हों।
- Happy Seeder Machine को Modified कर उसे 35 HP के ट्रैक्टर से operated हो सकने लायक बनाया जाये।
- गेहूँ की येसी उन्नतशील प्रजातियां विकसित की जायें, जिनकी उपज क्षमता धान की उन्नतशील प्रभेदों के समतुल्य हो।
- सरसों एवं तोरी की येसी किस्में विकसित की जाये जो अधिक वर्षा की स्थिति के प्रति सहनशील हों।
- आलू एवं प्याज की अधिक उपज देने बाली किस्में विकसित की जायें।
- गेहूँ की विलम्ब से बुआई के लिये HYV & Heat folerant varieties विकसित की जायें।
- ग्रीष्मकालीन मक्का की फसलमें अधिक क्षति पहुंचाने बाले नये कीटः Stink bug एवं Fall Army Worm के बेहतर प्रबन्धन के उपाय विकसित किये जायें।
- ग्रीष्मकालीन मक्का में Grain filling नहीं होने एव Sterility की समस्या का समाधान होना चाहिये।
- Rapeseed, Mustard एवं Linseed की HYV को विकसित किया जाना आवश्यक है।
- Blue bull, Deer, Monkeys इत्यादि की डुमरांव क्षेत्र में बड़ी समस्या है। इससे निजात पाने के बेहतर उपाय विकसित किये जायें।

3.3. Mandan Bharti Agricultural College, Agwanpur

क्षेत्रीय अुनसंधान एवं प्रसार सलाहकार समिति जोन –II रबि (2020) की बैठक का आयोजन दिनांक 24.09.2020 को मंडन भारती कृषि महाविद्यालय के सभा कक्ष में की गई। इस बैठक में सह निदेषक अनुसंधान, डा० उमेष सिंह के अतिरिक्त मंडन भारती कृषि महाविद्यालय एवं क्षेत्रीय अनुसंधान संस्थानों के वैज्ञानिक एवं क्षेत्राधिकार में आने वाले कृषि विज्ञान केन्द्र के वरीय वैज्ञानिक एवं प्रधान के साथ–साथ विषय वस्तु विशेषज्ञ एवं जिला कृषि पदाधिकारी, सहरसा के प्रतिनिधि के रूप में श्री राहुल कुमार, सहायक निदेशक, पौधा सरक्षण एवं परियोजना निदेशक, आत्मा, सहरसा के अतिरिक्त इस जाने के अन्तर्गत आने वाले आठ विभिन्न जिलों, अररिया, पूर्णिया, सुपौल, खगडिया, सहरसा, मधेपुरा, किशनगंज, एवं कटिहार के कृषि विभाग के अधिकारियों के अतिरिक्त सम्मानित कृषका ने भाग लिया। सह–निदशक, अनुसंधान, डॉ. उमेश सिंह ने अतिथियों का स्वागत करते हुए विगत वर्ष के क्षेत्रीय अुनसंधान एवं प्रसार सलाहकार समिति की कार्यवाही प्रस्तुत किया एवं इसके उद्देश्यों पर विस्तृत चर्चा की।

जिला कृषि पदाधिकारी के प्रतिनिधि श्री राहुल कुमार ने सरकार की ओर से चल रही विभिन्न योजनाओं को कृषकों के समक्ष प्रस्तुत किया ।

तकनीकी सत्र के आरम्भ में विभिन्न जिलों से आये हुए कृषि विभाग के पदाधिकारियों ने प्रक्षेत्र की जल जमाव क्षेत्र में मखाना एवं मछली उत्पादन के संभावनओं की चर्चा की। डॉ0 अनिल कुमार, मुख्य अनुवेशक (मखाना), भोला पासवान शास्त्री कृषि महाविद्यालय, पूर्णियां ने किसानों को जल जमाव के क्षेत्र में मखाना की खेती के साथ–साथ मछली उत्पादन के वैज्ञानिक विधि की विस्तृत जानकारी दी।

तकनीकी सत्र में विभिन कृषकों ने अपने क्षेत्र की समस्याओं को रखा जिसका समाधान वैज्ञानिको द्वारा किया गया, जो निम्नलिखित है –

श्री चन्द्रशेखर ठाकुर, बरहशेर, सत्तर कटैया, सहरसा ने कृषि कार्य में लागत खर्च कम करने तथा उचित विपणन के लिए सरकारी सहयोग की अपेक्षा के साथ ही साथ खेसारी की उन्नत प्रभेद की उपलब्धता की जानकारी चाही। श्री ठाकुर ने गहरी जमीन, मध्यम पानी वाली जमीन एवं ऊंची जमीन में धान के साथ–साथ गेहूँ या अन्य फसल के अच्छे उत्पादन हेतु जानकारी प्राप्त करना चाहा । उन्होंने बिहार सरकार के कृषि पदाधिकारियों से लेजर लेबलर द्वारा किसानों की जमीन को समतल कराने हेतु अनुरोध किया, जिससे कि अच्छा उत्पादन प्राप्त किया जा सके। श्री ठाकुर ने कोशी बांध के भीतर वाले जमीन में जो पूर्णतः बलुआही है उसमें सिर्फ कास (खर) होता है, वैसे जमीन में खस लगाने हेतु जानकारी प्राप्त करना चाहा।

कार्यान्वयन, निदेशक, अनुसंधान, बि.कृ.वि.वि., सबौर, भागलपुर श्री जवाहर ठाकुर महिषी, सहरसा ने मक्का में नये कीट के लगने से फसल में काफी हानि होने की चर्चा की एवं उसके बारे में जानकारी चाही। डॉ0 श्याम बाबू साह, कीट वैज्ञानिक ने नये कीट फॉल आर्मी वर्म के बारे में कृषक भाईयों को

विस्तृत जानकारी दी। श्री ठाकुर ने कृषि विभाग द्वारा प्रत्यक्षण में दी गई प्रजाति 6444 के समय से पूर्व फूटने की चर्चा की ।

कार्यान्वयन, पौधा प्रजनन, शस्य विज्ञान एवं पौधा संरक्षण के वैज्ञानिक, मं.भा.कृ.महा., अगवानपुर,

श्री हरिमोहन झा, अररिया ने कोशी जोन में लेमन ग्रास, मेंथा, तुलसी आदि सगंध एवं औषधीय पौधों की खेती एवं उसे नगदी फसल के रूप में उत्पादन करने हेतु वैज्ञानिक तकनीकी विकसित करने हेतु अनुरोध किया ।

कार्यान्वयन, निदेशक अनुसंधान, बि.कृ.विश्व., सबौर श्री अरूण कुमार मंडल, कटिहार ने सोयाबीन से दूध एवं पनीर इत्यादि बनाने की चर्चा करते हुए ये जानना चाहा कि दूध के अंदर गंध बनी रहती है। इस समस्या के समाधान के लिए सह–निदेशक, अनुसंधान ने भारतीय कृषि अनुसंधान परिषद् के संस्थान, भोपाल में प्रशिक्षण प्राप्त करने हेतु सलाह दी। श्री मंडल ने जूट में 90 से 110 दिन के अन्दर तना सूखने की समस्या का समाधान जानना चाहा, जिसका समाधान वैज्ञानिकों द्वारा करते हुए इस स्टेम रॉट नामक बीमारी के नियंत्रण हेतु सीस्टेमीक एवं कॉन्टैक्ट फफूंद नाशक दवा का प्रयोग करने की सलाह दी गई, साथ ही साथ यदि जूट की बुआई समय से की जाए तो इस समस्या से पूर्णतः बचा जा सकता है। इस बिमारी से बचने के लिए जूट की प्रजाति एस–19 में रोग–प्रतिरोधक क्षमता होने के कारण इसे लगाने की सलाह दी गई।

श्री राहुल कुमार, सहायक निदेशक, पौधा संरक्षण ने कोशी प्रमण्डल में आम के पौधों की टहनियों के सूखने की समस्या तथा आम के तना में तना छेदक नामक कीट के प्रकोप की चर्चा की, जिसका समाधान वैज्ञानिकों द्वारा किया गया।

अनुसंधान योग्य :–

- कोशी बांध के भीतर वाले जमीन में जो पूर्णतः बलुआही है उसमें सिर्फ कास (खर) होता है, वैसे जमीन में खस लगाने की वैज्ञानिक तकनीक विकसित करने की आवश्यकता है ।
- विश्वविद्यालय को कोशी जोन में लेमन ग्रास, मेंथा, तुलसी आदि सगंध एवं औषधीय पौधों की खेती हेतु वैज्ञानिक तकनीक विकसित करने की आवश्यकता है ।

मंच का संचालन डॉ0 देवन कुमार चौधारी, कनीय वैज्ञानिक–सह–सहायक प्राध्यापक (शस्य) तथा धन्यवाद ज्ञापन डॉ० उमा कान्त सिंह, कनीय वैज्ञानिक–सह–सहायक प्राध्यापक (उद्यान) ने किया।

4. Research Higlights

4.1. Crop Improvement

4.1.1. Wheat Breeding

4.1.1.1. Trials Conducted

1. Trials (Coordinated) : 06
2. Nurseries (Coordinated): 06
3. CIMMYT Nurseries: 02
4. Barley Trial (Coordinated): 02
5. Station Trials: 03
6. State Varietal Trials: 02
7. Private Wheat Testing: 01
8. Evaluation of advance lines under timely and late sown condition
9. Fresh Crosses made 397 Combinations
10. Handling of Segregating Generations F_2 - F_6

4.1.1.2. AICRP Nominations:

Genotypes entered in NIVTs: BRW 3895, BRW 3897, BRW 3901 & BRW 3902

4.1.1.3. Results of Trials and Nurseries:

- A total of 744 entries from national and international sources in various nurseries were evaluated. Out of which 126desirable fixed lines and 817 segregating single plants were selected for further evaluation and utilization in future breeding programme. Under hybridization programme, 397 fresh cross combinations were made with parents having desired agronomic characteristics and resistant to major diseases. Various segregating generations were also grown and 96 desirable single plants and 742 desirable progeny rows were selected for further evaluation and selection.
- Under timely sown irrigated condition five trials *viz.*, NIVT-1A, NIVT-1B, AVT, **Station Trial and State Varietal Trial** were conducted. In NIVT- 1A (TS-IR) with 36 entries including 4 checks *viz*; HD2967, DBW 187, HD 3086 and K 1006 were evaluated in simple lattice with two replications. The varietal differences among the entries were highly significant. The genotype HD 3349 gave the highest yield (56.3 q/ha) followed by PBW 827 (55.4 q/ha) and both were significantly superior to the best check DBW 187 (49.7 q/ha).

- In **NIVT-1B** (TS-IR) with 36 entries including 4 checks viz; HD 2967, HD 3086, K 1006 and DBW 187 were tested in simple lattice with two replications. The various entries showed significant differences with respect to grain yield. Highest grain yield was recorded with the check variety DBW 187 (51.5 q/ha) followed by WH 1283 (48.4 q/ha) & WH 1274 (46.8 q/ha) and these three entries were at par with each other.
- **AVT** was conducted with 6 entries along with five checks namely K 1006, DBW 187, HD 2733, PBW 804, DBW 39 & HD 3249 in RBD with four replications. The varieties differ significantly with respect to grain yield. Highest grain yield (49.3 q/ha) was observed with the check variety DBW 187 followed by HD 3249 (47.4 q/ha) and the test entry PBW 804 (46.6 q/ha). These entries were at par with each other.
- **Station Trial** (TS-IR) was conducted with 27 entries including two checks viz., HD 2967 and Sabour Samriddhi (BRW 3708) in RBD with three replications. Yield differences among the genotypes were found to be significant. The genotype BRW 3902 recorded the highest yield (51.17 q/ha) followed by BRW 3895 (50.49 q/ha) and check variety HD 2967 (48.63 q/ha). Numerically both these test entries had higher grain yield but statistically at par with the check. Based on the performance of yield & disease reaction both these genotypes i.e. BRW 3895 and BRW 3902 have been entered in NIVT (TS-IR).
- **State Varietal Trial** (TS-IR) was conducted with 14 genotypes in RBD with three replications at seven locations viz., Sabour, Tiloundha, Purnea, Madhepura, Mokama, Islampur and Dhangain. At all locations yield differences among the genotypes were significant. At Sabour, the genotype SVT-TS-21 recorded the highest yield (46.86q/ha) followed by SVT-TS-22 (44.17q/ha) and SVT-TS-24 (43.58q/ha).These three entries were at par with each other. At Purnea center the genotype SVT-TS-15 gave the highest yield (32.66 q/ha) followed by SVT-TS-20 (33.53q/ha) and SVT-TS-17 (29.55q/ha). At Madhepura SVT-TS-17 was the top yielder (63.67q/ha) followed by SVT-TS-14 (61.83q/ha), SVT-TS-24 (61.33 q/ha) and SVT-TS-18 (59.17q/ha). At Islampur highest grain yield was recorded with the genotype SVT-TS-16 (36.83 q/ha) followed by SVT-TS-24 (35.83q/ha) and SVT-TS-11 (34.67q/ha). At Mokama SVT-TS-24 gave the highest yield (44.77 q/ha) followed by SVT-TS-17 (43.33q/ha) and SVT-TS-13 (42.83q/ha). At Dhangain highest grain yield was recorded with the genotype SVT-TS-23 (32.36 q/ha) followed by SVT-TS-20 (30.33q/ha) and SVT-TS-13 (29.08 q/ha). Genotype SVT-TS-18 was top yielder (41.65 q/ha) across locations.

- **Under late sown irrigated condition** three trials viz., NIVT-3A, Station Trial, and State Varietal Trial were conducted. In NIVT-3A, 36 entries including four checks i.e. DBW 107, HI 1563, HD 3059 and DBW 173 were evaluated in simple lattice with two replications. Yield differences among the genotypes were significant. Highest grain yield was recorded with the genotype DBW 317 (48.0 q/ha) followed by DBW 319(46.4 q/ha) and PBW 833 (43.6 q/ha) and these entries were at par with the best check DBW 107 (43.7 q/ha).
- **Station Trial under late sown irrigated condition** was conducted with 27 entries including two checks viz., BRW 934 and HI 1563 in RBD with three replications. Significant yield differences were observed among the genotypes. Highest grain yield was recorded with the genotype BRW 3897 (42.57 q/ha) followed by BRW 3887 (41.10 q/ha) and the check variety HI 1563 (38.15 q/ha). BRW 3897 was significantly superior to the check varieties HI 1563 and BRW 934. Based on the yield performance and disease reaction BRW 3897 has been entered in NIVT (LS-IR).
- **State Varietal Trial** (LS-IR) was conducted with 9 genotypes in RBD with three replications at seven locations viz., Sabour, Tiloundha, Purnea, Madhepura, Mokama, Islampur and Dhangain. At all locations yield differences among the genotypes were significant. At Sabour, the genotype SVT-LS-9 recorded the highest yield (38.24q/ha) followed by SVT-LS-2 (37.68 q/ha) and SVT-LS-1 (36.45q/ha). Three entries were at par with each other. At Purnea center the genotype SVT-LS-1 gave the highest yield (26.72 q/ha) followed by SVT-LS-7 (25.44q/ha) and both were at par with each other. At Madhepura SVT-LS-9 was the top yielder (50.92 q/ha) followed by SVT-LS-6 (46.85q/ha) and both were at par with each other. At Islampurhighest grain yield was recorded with the genotype SVT-LS-2 (42.96 q/ha) followed by SVT-LS-9 (41.29 q/ha) and SVT-LS-5 (41.11q/ha). At Mokama SVT-LS-3 gave the highest yield (43.08 q/ha) followed by SVT-LS-9 (41.48 q/ha) and SVT-LS-5 (41.42 q/ha). At Dhangainhighest grain yield was recorded with the genotype SVT-LS-9 (42.72 q/ha) followed by SVT-LS-3 (40.27q/ha) and SVT-LS-6 (38.73 q/ha). Genotype SVT-LS-9 recorded highest yield (39.82 q/ha) across locations.
- **Under timely sown restricted irrigated condition** three trials viz., NIVT-5A, AVT (RI) and Station Trial were conducted.In NIVT 5A (TS-RI), 25 entries including four checks viz; , HD 3171, WH 1142, PBW 644 and K 1317 were tested in simple lattice with two replications. Yield differences among the genotypes were observed to be significant. The test entry DBW 322 recorded the highest yield (42.0 q/ha) followed

by HD 3369 (39.2 q/ha), DBW 321 (37.6 q/ha) and the check variety PBW 644 (36.8 q/ha). All these test entries were at par with the check variety PBW 644.

- In **AVT** (TS-RI), one test entry along with 5 checks viz; HI 1612, HD 3171, DBW 252, K 1317 and HD 2888 were evaluated in RBD with four replications. Highly significant yield differences among the treatments were observed. Highest grain yield was recorded with the test entry HD 3293 (37.8 q/ha) and it was significantly superior to best check HD 3171 (30.7 q/ha).
- **Station Trial under timely sown restricted irrigated condition** was conducted with 27 genotypes including two checks HI 1612 and BRW 3723 in RBD with three replications. Significant yield differences were observed among the genotypes. Highest grain yield (38.67 q/ha) was recorded with the genotype BRW 3901and it was significantly superior to better check HI 1612 (33.94 q/ha). BRW 3901 has been entered in NIVT-5A.
- **Two Barley experiments** *viz.*; IVT-RF and IVT-IR were conducted.
- **IVT-RF** was conducted with 15 entries including two checks viz., K 603 and Lakhan in RBD with four replications under rainfed condition. Yield differences among the genotypes were significant. Highest grain yield was recorded with the check variety Lakhan (31.6 q/ha). All the test entries were significantly inferior to check Lakhan except DWRB 213 (31.1 q/ha) which was at par with the checks.
- **IVT-IR** was conducted with 25 entries including five checks viz., BH 946, DWRB 137, BH 902, RD 2552 and RD 2899 in RBD with four replications under irrigated condition. Yield differences among the genotypes were significant. Highest grain yield of 46.7q/ha was recorded with the check variety BH 902 followed by HUB 272 (46.6 q/ha), KB 1822 (45.7 q/ha) and PL 911 (44.0 q/ha). All these four entries were at par with each other.
- **Testing of private wheat varieties**

  One trial was conducted for testing of three private wheat varieties (Coded) viz., PVT-19-150, PVT-19-151 and PVT-19-152 supplied by Shriram Fertilizers and Chemicals were evaluated along with three recommended wheat varieties i.e. HD 2967, K 0307 and Sabour Samriddhi (BRW 3708) during *rabi* 2019-20 under timely sown irrigated condition in RBD with four replications. Grain yield differences among the genotypes were significant. The highest grain yield was recorded with the genotype PVT-19-150 (47.97 q/ha) followed by K 0307 (44.74q/ha) and BRW 3708

(44.35 q/ha). These three genotypes were statistically at par with each other. Remaining three genotypes were significantly inferior to PVT-19-150.

4.1.1.4. Technical programme of work for 2020-21:

- Maintenance of germplasm
- Hybridization programme for development of varieties under different situations
- Advancement of F1 generation
- Handling of segregating generations
- Station trials under different situations
- State varietal trials under different situations
- AICRP trials under different situations
- National and International nurseries
- Seed multiplication of promising lines
- Nucleus seed production of released varieties

4.1.1.5. Genetic characterization of wheat genotypes to initiate wheat precise breeding database

- Total 32 new wheat genotypes have been incorporated in the study. So, now the total number of target genotypes =128 (4 times of the proposed 32 genotypes).Plant height, days to maturity, grain colour and kernel polyphenol oxidase activity data for 96 wheat genotypes have been recorded and analyzed. A protocol for co-dominant screening of the PPOD1 loci has been optimized.
- Screening for PPO, yellow pigment, *Lr34* and phytase activity has been completed with 6 molecular markers. As reproducibility of wheat markers is challenging, novel primers for agronomically important traits have been designed and their validation work is initiated.

4.1.1.6. Development and identification of suitable doubled haploid wheat genotypes for spot blotch resistance

- F_1 from nine parental combinations were raised and seeds from each combination (110-650) have been obtained. Spikes in the colchicines treated haploid were obtained. Most of the spikes were empty but few had week seeds. The spikes of the same have been stored for germination on artificial media. Attempts were made for diploidization of genome prior to incubation of embryos on nutrient media.

4.1.2. Maize Breeding

4.1.2.1. Evaluation of inbreds

- **Normal inbreds:-** A total of 254 inbreds were evaluated for maturity and its suitability for male, female or both parents on basis of yield and yield attributing traits. 39 inbred were found suitable for late maturing group and 31 inbreds were found suitable for medium duration. 19 parents were categorized as male parents, 39 as female parents and 21 inbreds as both male and female parents.
- **QPM inbreds:-**A total of 93 QPM inbreds were evaluated for maturity and its suitability for male, female or both parents on basis of yield and yield attributing traits. 9 inbred were found suitable for late maturing group and 11 inbreds were found suitable for medium duration. 9 parents were categorized as male parents, 19 as female parents and 12 inbreds as both male and female parents.
- **Procurement of QPM inbreds and population:-**89 inbreds of QPM and 4 population of QPM were procured from CIIMYT-Hyderabad.
- **Nucleus seed production :-** 2.5kg nucleus seed of SML-1, 2.0 kg nucleus seed of CLO2450 and 1.0 kg nucleus seed of CML 451 were produced.
- **Breeder seed production:-** 50 kg breeder seed of SML-1 was produced.
- **Hybrid seed production:-**450 kg of certified seed of SHM-1 was produced.

4.1.2.2. Inbred development:

4.1.2.2.1. Development of pool

- Flint type pool:-29 flint type commercial hybrids were utilized for development of flint pool.
- Dent type pool:-8 dent type commercial hybrids were utilized for development of flint pool.

4.1.2.2.2. Selfing generation

- S_1 generation:-236 flint, 45 dent and 49 QPM S_1 were produced.
- S_2 generation:-234 S_2 generation were produced.
- S_3 generation:-102 S_3 generation were produced
- S_4 generation:-67 S_4 generation were produced
- S_5 generation:-52 S_5 generation were produced
- S_6 generation:-38 S_6 generation were produced
- Development of F_1:-53 F_1 were produced from 53 local hybrids.

4.1.2.3. Making of crosses:- A total of 609 single cross hybrids were made. .

- Making crosses for submission in AICRP on Maize trials:- A total of 8 crosses were made namely BRM17-1 (normal yellow) early, BRM17-2 (normal yellow) medium, BRM17-3 (normal yellow) medium,BRM17-4 (normal yellow) medium,BRM17-5 (QPM yellow) early,BRM17-6 (normal yellow) medium, BRM17- 7 (normal yellow) medium, BRM17-8 (normal yellow) medium were produced.

4.1.2.4. Evaluation of station Trials:-

- Station Trial 301:-A total of 50 entries with 2 checks were evaluated. Entries no. 18 (110.2 q ha^{-1}) produced 16.6% higher yield than the best check DKC9081 (94.5 qha^{-1}).
- Station Trial 302:-A total of 50 entries with 2 checks were evaluated. Entries no. 5 (107.9 q ha^{-1}), 9 (112.3 q ha^{-1}) ,14 (109.3 q ha^{-1}) 15 (111.7 q ha^{-1}) and 18 (113.2 q ha^{-1}) produced 13.1%, 17.7 %, 14.6 %, 17.1% and 18.7% higher yield than the best check DKC9081 (95.4 q ha^{-1}) respectively.
- Station Trial 303:-A total of 50 entries with 2 checks were evaluated. Entries no. 4 (112.3 q ha^{-1}), and 10 (106.3 q ha^{-1}) produced 19.1%, and 12.7 % higher yield than the best check DKC9081 (94.3 q ha^{-1}) respectively.
- Station Trial 304:-A total of 50 entries with 2 checks were evaluated. Entries no. 2 (108.4 q ha^{-1}), 12 (112.3 q ha^{-1}) , and 16 (114.6 q ha^{-1}) produced 15.6%, 19.7 %, and 22.2% higher yield than the best check DHM 117 (93.8 q ha^{-1}) respectively.
- Station Trial 305:-A total of 50 entries with 2 checks were evaluated. None of the entry exhibited 10% superiority over the best check P 3355 (110.3 q ha^{-1}).
- Station Trial 306:-A total of 50 entries with 2 checks were evaluated. Entries no. 9 (115.6 q ha^{-1}), produced 10.5%, higher yield than the best check P 3355 (104.6 q ha^{-1}).
- Station Trial 301:-A total of 50 entries with 2 checks were evaluated. None of the entry exhibited 10% superiority over the best check P 3355 (107.6 q ha^{-1}).
- Station Trial 308:-A total of 50 entries with 2 checks were evaluated. Entries no. 4 (119.2 q ha^{-1}) produced 10.8%, higher yield than the best check P3355 (107.6 q ha^{-1}).
- State Maize Varietal Trials:-A total of 9 entries with 2 checks were evaluated. Entries no. SMVT/19R-3 (105.2 q ha^{-1}) produced highest yield and entry SMYT/19R-8 (79.4 q ha^{-1}) produced lowest yield.

4.1.2.5. AICRP on maize trials

- Popcorn trial:-A total of 8 entries were evaluated with 3 replications in 9.6 m^2 plot. Crop was sown on the 23rd Nov., 2019. Yield and yield contributing trait's data were recorded and send to IIMR, Ludhiana.
- QPM trial:-A total of 8 entries were evaluated with 3 replications in 9.6 m^2 plot. Crop was sown on the 23rd Nov., 2019. Yield and yield contributing trait's data were recorded and send to IIMR, Ludhiana.
- AVT I Late:-A total of 11 entries were evaluated with 3 replications in 9.6 m^2 plot. Crop was sown on the 23rd Nov., 2019. Yield and yield contributing trait's data were recorded and send to IIMR, Ludhiana.
- AVT I-II Medium:-A total of 15 entries were evaluated with 3 replications in14.4 m^2 plot. Crop was sown on the 23rd Nov., 2019. Yield and yield contributing trait's data were recorded and send to IIMR, Ludhiana.
- AVT II Late:-A total of 9 entries were evaluated with 3 replications in 14.4 m^2plot. Crop was sown on the 27th Nov., 2019. Yield and yield contributing trait's data were recorded and send to IIMR, Ludhiana.
- NIVT Late:-A total of 33 entries were evaluated with 3 replications in 4.8 m^2 plot. Crop was sown on the 27th Nov., 2019. Yield and yield contributing trait's data were recorded and send to IIMR, Ludhiana.
- NIVT Medium:-A total of 48 entries were evaluated with 3 replications in 4.8m^2 plot. Crop was sown on the 27th Nov., 2019. Yield and yield contributing trait's data were recorded and send to IIMR, Ludhiana.
- Multi Location Trial:-A total of 15 entries with 2 checks were evaluated at Araria, Islampur and Sabour. Entries no. 8 (101.9 q ha^{-1}) and 11 (105.6 q ha^{-1}) produced 11.3% and 14% higher yield than the best check P3355 (91.6 q ha^{-1}) respectively.

4.1.2.6. Evaluation of hybrids of multinational seed companies for its suitability in Bihar

Experiments were conducted during Rabi Season of 2019-20. Total fifty one maize hybrids of multinational Seed companies along with two checks were evaluated for their suitability in Bihar at the Research Farm of Bihar Agriculture College, Sabour, Bhagalpur (Zone IIIA), Botanical Research Center, Islampur (Zone IIIB) and Irrigation Research Station Araria (Zone II) under the Bihar Agricultural University, Sabour, Bhagalpur, Bihar in randomized Block Design with three replications. All recommended good agricultural practices were followed to raise good crop at all

locations. Hybrids P3396 and P3522 were used as checks. At Sabour, the grain yield varied from 83.4 q ha^{-1} (Yugandhar-3538)) to 156.5 q ha^{-1} (X 35 N 557). The check P3522 (125.5 q ha^{-1}) was found high yielder than the check P3396 (120.8 q ha^{-1}). Eleven test hybrids viz. DKC 8220 (143.6 q ha^{-1}), X 35 N 293 (145.7 q ha^{-1}), X 35 M 278 (P3526) (149.8 q ha^{-1}), X 35 N 557 (156.5 q ha^{-1}) and NMH 3377 (139.6 q ha^{-1}) showed significantly higher grain yield with superiority of 14 per cent, 16 per cent, 19 per cent, 25 per cent and 11 per cent, respectively over the best check P3522 (125.5 q ha^{-1}), whereas, rest test hybrids showed significantly at par with the best check P 3522 (125.5 q ha^{-1}) for the character grain yield. At Islampur, the check P3396 (86.6 q ha^{-1}) was found high yielder than the check P3522 (80.7 q ha^{-1}). The grain yield ranged from 61.8 q h^{-1} (Bisco Bio Science (LG 36803) to 93.8 q ha -1 (KMH 3981). Out fifty one test hybrids only one test hybrids namely KMH 3981 (93.8 q ha^{-1}) showed significantly higher grain yield with the superiority of 8 per cent over the best check P3396 (86.6 q ha^{-1}). However, rest test hybrids observed significantly at par or low yielder with compare to the best check P3396 (86.6 q ha^{-1}) for the character grain yield. At Araria, the check P3396 (109.4 q ha^{-1}) was found high grain yielder than the check P3522 (109.0 q ha^{-1}). The grain yield ranged from 83.3 q ha^{-1} (P 3504) to 132.6 q ha^{-1} (X 35 N 543). Out of fifty one test hybrids only eleven test hybrids namely DKC 8220 (117.6 q ha^{-1}), P 3355 (120.5 q ha^{-1}), DKC 8228 (129.3 q ha^{-1}), Bisco Bio Science (LG 36803) (117.7.3q ha^{-1}), 5202 (120.6 q ha^{-1}) ADV 759 (118.9 q ha^{-1}) , ADV 757 (122.4 q ha^{-1}), PRMH 592 (119.1 q ha^{-1}) , P3388 (128.4 q ha^{-1}) , X 35 N 543 (132.6 q ha^{-1}) and NMH 3377 (129.6 q ha^{-1}) showed significantly higher grain yield with the superior P3396 (109.4 q ha^{-1}) with superiority of 17 per cent, 10 per cent, 18 per cent, 8 per cent, 10 per cent, 9 per cent, 12 per cent, 9 per cent, 17 per cent, 21 per cent, 18 per cent, respectively. However, rest test hybrids observed significantly at par or low yielder compare to the best check P3396 for the character grain yield. In pooled mean, the grain yield varied from 82.9 q ha^{-1} (Yugandhar -3538) to 116.2 q ha^{-1} (DKC 8220). The check P3396 (109.5 q ha^{-1}) was found low yielder than the check P3522 (105.1 q ha^{-1}). Overall none of the test hybrids showed significantly higher grain yield over the best check P3396 (109.5 q ha^{-1}).

4.1.3. Chickpea Breeding

Name of the Project	**:**	**AICRP on Chickpea**
No. of Experiment Conducted	:	11
Proposed no. of experiments	:	10
No. of F.L.D. Conducted	:	10
Proposed no. of F. L. D.	:	15
Distinguished Visitors	**:**	**University Monitoring Team, BAU, Sabour**

4.1.3.1. Salient achievements:

- During the season *rabi,* 2019-20, total eleven no. of experiments (AICRP-05, ICRISAT-02 & station trials-01, Germplasm maintenance -01 and Breeding material maintance-01) were conducted viz; collection, maintenance and utilization of germplasm, IVT (Desi), AVT-1(Desi), IVT (Desi) M.H., IVT (Late sown), AVT-1 (Late sown), ICVT (Desi), ICVT (M.H.), Station Trial, National crossing programme and germplasm maintenance & evaluation. F.L.D. were conducted in 10 ha, area.
- **Promoted Entry:**

Trial	Entry	Parentage
AVT-1 (Desi) Late Sown	BRC-9-14	SAKI 9516 x GNG 1958

4.1.3.2. AICRP Trials:

- **Collection, Maintenance and utilization of Germplasm:** 140 germplasm were evaluated and categorized on the basis of maturity, plant height, 100-seed weight and grain yield.
- **I.V.T. (Desi):** 42 entries were tested for different traits in alpha lattice design with three replications. Varietal differences for seed yield were found to be significant. Three entries namely, IPCD 2016-44 (2319 kg/ha), BRC 9-14 (1944 kg/ha) and GJG 1707 (1932 kg/ha) were found to be significantly superior over the best check BG 3043 (1608 kg/ha).
- A**VT-1 (Desi):** 05 entries were evaluated for different traits in RBD under four replications and found that varietal differences for seed yield to be significant. But none of the entrywas recorded significantly superior to the best check BG 3043 (1942 kg/ha).
- **IVT (Desi) M.H.:** 28 entries were evaluated for different traits in RBD with three replications and varietal differences for seed yield were found to be significant. Three entries namely, RG 2016-84 (2068 kg/ha), H 12-63 (2065 kg/ha) and RVSSG-86

(1984 kg/ha) were observed significantly superior over the best check HC 5 (1676 kg/ha).

- **I.V.T. (Late sown):** 37 entries were tested for different traits in RBD with three replications. Varietal differences for seed yield were found to be significant. None of the entries was found to be significantly superior over the best check GNG 2299 (1474 kg/ha). However, two entries namely, BRC 9-14 (1657 kg/ha) and RG 2016-31 (1585 kg/ha) were recorded significantly at par to the best check GNG 2299 (1474 kg/ha). One entry, **BRC 9-14** has been promoted for AVT-1(Desi) Late Sown, *rabi* 2020-21 to NEPZ.
- A**VT-1 (Late sown):** 05 entries were evaluated for different traits in RBD with four replications and found that varietal differences for seed yield to be significant. None of the entrywas found to be significantly superior to the best check BG372 (1391 kg/ha)

4.1.3.3. ICRISAT:

- **ICVT (Desi):** 20 entries were evaluated for different traits in which varietal differences for seed yield were found to be significant. None of the entries was observed significantly superior to the best check JG16 (1936 Kg/ha). But only one entry ICCV19115 (1947 kg/ha) showed numerically at par with the best check JG16 (1936 Kg/ha).
- **ICVT (MH):** 20 entries were tested for mechanical harvesting traits with high yield in RBD design with three replications. Varietal differences were found to be significant and only one entry namely, ICCV191602 (2030 kg/ha) was found to be significantly superior over the best check Sabour chana-1 (1705 kg/ha).

4.1.3.4. State Trial:

- **Station Trial (Desi):** 15entries were evaluated in RBD design with three replications for yield and yield attributing traits. The varietal differences for seed yield were found to be significant. Four entries, namely, BRC-2 (1859 kg/ha), BRC-08-2016 (1755 kg/ha), BRC-5-2016 (1732 kg/ha) and BRC-3 (1709 kg/ha) were recorded significantly higher yield over the best check GCP-105 (1650 kg/ha).
- **FLD–**Ten (10) nos. of F.L.D. on chickpea with variety GCP 105 was conducted in the farmer field of Bhagalpur and Banka district with full package technology. The highest seed yield was recorded 1610 kg/ha. The range of increase of improved variety over local variety varied from 23% to 36% and average % increase grain yield was 39%.

4.1.3.5. National crossing programme and evaluation of crossed breeding material (F_1, F_2, F_3, F_4& F_5 generation).

- **Crossing Programme**

Twenty fresh crosses were attempted under national crossing programme. The details of the crosses attempted are given below:

National Crosses:

Sl. No.	Crosses	Sl. No.	Crosses
1.	GCP105 x BRC-3	6.	GCP105 x GNG2264
2.	GNG2264 x GNG2304	7.	BRC-1 x ICCV 19117
3.	GNG2207 x BRC-1	8.	GNG2207 x GCP105
4.	GCP105 x BRC-1	9.	RSGD-1017 x RSGD 1080
5.	PG186 x GCP105	10.	GL16063 x RSGD 1071

- **Station Crosses:**

Sl. No.	Crosses	Sl. No.	Crosses
1.	BRC-1 x GCP105	6.	GNG2264 x GNG2207
2.	DCP92-3 x GNG2207	7.	BG372 x DCP92-3
3.	BG372 x DCP92-3	8.	IPC2010-134 x BRC-1
4.	GNG2207 x DCP92-3	9.	RSGD1080 x BRC-1
5.	KPG59 x GNG2207	10.	RSGD-1071 x GL16063

- **Status of breeding material:**

Generation	No. of crosses	SPS	Progenies
Fresh cross attempted	20	-	-
F_1	06	-	-
F_2	18	211	-
F_3	16	110	-
F_4	09	-	-
F_4 Bulk-IIPR	08	-	95
F_5 Bulk-ICRISAT	21	-	126

4.1.3.6. Development of short and medium duration varieties resistant to Prevailing diseases and insect-pest:

Shuttle Breeding programme, National crossing programme and evaluation of crossed breeding material (F_1, F_2, F_3, F_4& F_5 generation).

Seed Multiplication, Rabi 2019-20

S. No.	Varieties	Quantity(Kg)
1..	Sabour chana-1 (B/S)	215
2.	Sabour chana-1 (N/S)	80

4.1.3.7. Technical Programme of Chickpea for Rabi 2020-21:

- **AICRP Trials:**

  (i) IVT (Desi) (ii) AVT-1(Desi) (iii) IVT (Desi) M.H. (iv) IVT (L. S.) (v) AVT-1(L.S.) and (vi) National Crossing Programme for high yielding, medium maturity and resistant to wilt, DRR & Stunt Diseases.

S. No.	Parentage	Traits
1.	BG3043 x PG211	Fusarium wilt resistant
2.	GNG2207 x H12-63	Fusarium wilt resistant
3.	IPC2011-112 x IPC2005-62	High Protein content
4.	IPC2004-98 x DCP92-3	Pod Borer tolerant

- **ICRISAT Trials:**

  (i)ICVT –Desi (Extra-Early) (ii) ICVT -Desi (M.H.) and (iii) F_5 Population

- **State Trials:**

  (i) Station Trial (Desi) (ii) Germplasm maintenance

- FLD on Chickpea = 15 Nos.

- **Seed production programme**

4.1.3.8. State Co-ordinated Varietal Trial of Desi chickpea (Rabi 2019-20)

State Coordinated Varietal Trials of Desi chickpea was conducted in two different environments *viz*., normal sown and late sown at eight different locations under different Agro-climatic zones of Bihar during Rabi 2019-20. The experiment was carried out at six locations viz. Saharsa (Zone-II), BAC, Sabour and Tiloundha (Zone-III A), PRC Mokama & BRC Islampur and VKSCOA, Dumraon (Zone III B) under the jurisdiction of Bihar Agricultural University, Sabour(Bhagalpur) while two locations viz. TCA, Dholi and Gopalganj (Zone-I) were under the jurisdiction of RPCAU, Pusa (Samastipur). Normal sown trial comprised of 09 genotypes and significant differences were observed among the genotypes. The experiment was conducted in randomized block design with three replications with a plot size of 4.8 m 2. On the basis of pooled mean data of grain yield, the top three promising entries identified were SVTCH19-5 (1649.14kg/ha), SVTCH19-9 (1619.52 kg/ha) and SVTCH19-8(1533.64 kg/ha). Late sown experimental material comprised of seven genotypes of Desi chickpea. The experiment was conducted in randomized block design with three replications with a plot size of 4.8 m 2. Significant differences observed among the genotypes. On the basis of pooled mean data of grain yield, the top three promising entries identified were SVTCH19-27 (1725.38 kg/ha), SVTCH19-24(1551.36 kg/ha) and SVTCH19-22 (1549.77 kg/ha).

4.1.3.9. Identification and utilization of terminal heat tolerant chickpea genotypes for rice-fallow area in the state of Bihar (Funded by CGIAR Research Program on Grain Legumes)

Sixty chickpea genotypes including two checks (PG 186, JG14-1,) checks were evaluated in Alfa lattice design (Normal; 24. 11. 2019 as well as late 17.12.2019) with two replications the spacing of plant to plant 10 cm and row to row 30 cm with a row length of 4 meter. Varietal difference with respect to grain yield was found significantly superior which ranged from 432 kg/h to 2171 kg/ha under normal sown condition and 371 to 1966 kg/ha under late sown condition of Sabour Chana-2. Highest grain yield was recorded by Sabour chana 2and is released for Bihar Satate (suitable for late sown condition /rice fallow) followed by BRC 304, SAKI 9516, and ICCV 07118 under late sown conditions. Relative expression profiling of candidate genes was done in seven (selected) genotypes. Based on their expression pattern HSP-Ca-25602 and HSF-B2a gene has been identified as potential heat responsive candidate gene. it has been found that expression of two genes responsible for heat tolerance were up regulated in case of BRC Sabour Chana 2. Hence based on the results of field performance and expression profile, BRC 304 is nominated to IVT for late sown condition during 2019.

4.1.3.10. Early stage evaluation of segregating generation (F5) for yield and earliness and Heat avoidance

120 (single cross and RIL progenies) evaluated for yield and yield attributing traits in Augmented design with four checks. Date of sowing was 29.11. 2019, at Modal Bhitti farm, Sabour. Average yield recorded from 19.3 /ha to 23.6 /ha. However, flowering initiated60 days after sowing and maximum genotypes attended 50% flowering in 68 days and attended maturity within 119 days.

4.1.3.11. To develop taller varieties with upright growth habit which can be directly harvested by combine harvesters

Eighteen advanced developing high yielding chickpea lines, which are suitable for mechanical harvesting.BRC 505 and 502 gave yield superior to best check BRC 423 and was amenable to machine harvesting. Total of 4 lines performed better or at par than check NBEG47. Seeds multiplied and fresh cross combinations made and generation advanced.

4.1.3.12. Identification of collor rot resistant lines in chickpea through mutation breeding

Raising M_1 generation Uniform, dry and healthy seeds of two varieties of chickpea *viz.*, GCP 105 and PG 186 were irradiated with 10, 20, 30, 40, 50 and 60 kR doses of gamma-rays (Source- 60 C) at BARC, Trombay. Effects of mutation were observed for germination percentage, radical and plumule length (cm), number of pods per plant and grain yield per plant. The root length was measured since it is a very rapid method of assessing the mutagenic influence in addition to shoot length. Germination percentage, radical and plumule length decreased with the increase in the doses of gamma rays. Maximum germination %, seedling root and shoot length were observed in 10 and20 kR doses of gamma rays while, minimum in 60 kR. Effects of mutations on yield components showed that number of pods per plant and grain yield per plant was reduced in the higher doses of gamma-rays. LD_{50} of gamma rays is 40 KR.

4.1.3.13. Molecular Breeding for Fusarium Wilt and DRR resistance in chickpea

Donors for Fusarium wilt (JG 315) and DRR (JG 24) tolerance was procured from ICAR Agricultural research centre, Sriganganagar, Rajasthan. Recipient parents (PG 186 and GCP 105) and Donors (JG315, Vijay, JG 24 and BRC-1) plants were raised and crosses were made using donors as male parent. F_1 seeds were harvested. Hybridity testing of F_1s (F_1s: Pusa256xVijayraised previous year 2018-19) done through molecular marker, BC_1F_1 raised and F_1s were also crossed with BRC-1.

- **Pre-breeding for the improvement of chickpea** (BAU/SNP/CI/Rabi/2019-9)

  Germplasm has been collected from IIPR, Kanpur and NBPGR, New Delhi as well. Screening trials for high yield and donor for wilt resistant parents havealso been conducted.

4.1.4. Pigeonpea Breeding

- **Breeding Pigeonpea Genotypes Resistant to Major Diseases**

  Two Crosses made (MAL 13 x BSMR 846 and MAL 13 x BSMR 736) to transfer sterility mosaic resistant gene in high yielding cultivar (MAL 13). Eight progenies (F6) evaluated for disease and yield, and it's been found that three out of total showed 100% field resistance with average yield 18 q/ha. Genotyping carried out paper entitled "A diagnostic marker kit for fusarium wilt and sterility mosaic diseases resistance in pigeonpea", has been accepted for publication in Theoretical and Applied Genetics" got accepted for its publication in *Theoretical and Applied Genetics* by Rachit Saxena et al., 2020.

- **Breeding Pigeonpea Genotypes Resistance to Fusarium Wilt (*Fusarium udum*)**

  Generation advanced (MAL 13 x BDN 2029) and 9 progenies made, however two backcross generations were advanced to F_4 and F_5 and their seeds bulked as follows:

  MAL 13 x BDN 2029…F_5….9 progenies

  2. MA 6 x BDN 2029……BC_4….Bulk

  3. Bahar x BDN 2029…….BC_1F_5….Bulk

- **To Identify waterlogging tolerant genotypes of pigeonpea (*Cajanus cajan* L. MillsP.) and assessing genetic diversity using RAPD marker**

  Six pigeonpea genotypes (3 tolerant and 3 susceptible) were run with 24 primers (RAPD) for amplification, out of that 9 showed polymorphic reaction. However out of nine two markers (OPC-01 and OPA-13) showed unique band. Crosses between susceptible and tolerant made to generate mapping population, and 3 crosses advanced.

- **Evaluation of long duration pigeonpea**

  Eight entries including checks (Bahar) were tested. Varietal difference with respect to grain yield was found significant which ranged from 1119 to 2352 Kg/ha. Highest grain yield(2352 Kg/ha) was recorded by BRA 303 followed by BRA 301 (2212 Kg/ha), which were found statistically superior than the local check Bahar (1953.6 Kg/ha).

4.1.4.1. Identification of water logging stress responsive microRNAs in pigeonpea (*Cajanus cajan* L.)

Pigeonpea genotype ICPL 20092 was identified as tolerant and ICPL 87 as susceptible genotype through pot based water logging stress tolerance study. Small RNA reads of 24 hr treated and control leaf and root samples of tolerant and susceptible genotypes were generated on Illum in a platform. Raw reads were filtered and analyzed for identification of water logging stress responsive micro RNAs and their target genes. Potent water logging stress responsive micro RNAs were identified as miR171c-3p, gma-miR398c, gma-miR408a-5p, gma-miR408a-5p, novel_148, gma-miR166u and gma-miR156d novel_143. Candidate target genes of these micro RNAs were identified to code for ARATH Probable sphingolipid transporter spinster homolog; ARATHABC transporter G family, ARATH Copper chaperone for superoxide dismutase, chloroplastic/ cytosolic, ARATH Probable plastid-lipid-associated protein 14, chloroplastic; ARATH ATPase family AAA domain-containing

protein; ARATH NADPH-dependent thioredoxin reductase); Probable glucan endo-1,3-beta-glucosidase; ARATH Guanylate kinase 3,chloroplastic; ARATH Phosphatidyl serine decarboxylase proenzyme, ORYSJ Vacuolarcation/proton exchanger and ORYSJ Squamosa promoter-binding-like protein 3. Candidate target genes identified in this study plays important role in water logging stress tolerance.

4.1.5. Lentil Breeding

- **Identification of heat tolerant and early maturing lines of lentil (*Lens culinaris* Medik L.) for late sown condition**
- No. of experiment conducted: 09
- **State Varietal Trial (Govt.of Bihar) Rabi, 2019-20**

  A trial consisting eighteen genotypes including two checks (with coding) was conducted at 11 locations (all zones of Bihar) to test the performance for its adaptability in different ecological regions of Bihar. Experiment was conducted in Randomized Complete Block Design (RCBD) with three replications with 6-meter row length with 5 lines along with spacing of 30×10 cm (R×P).Data has been analyzed from all zone except Zone-I as no data was provided by the Zone-I for inclusion in RCM. Data from Madhepura was not included to calculate the pooled mean as the average yield was found below state average yield.On the basis pooled mean data SVTLR(19)-13 was found highest yielder (1389 Kg/ha) followed by SVTLR(19)-1 (1319 Kg/ha), SVTLR(19)-16 (1287 Kg/ha),SVTLR(19)-18 (1255 Kg/ha), SVTLR(19)-3 (1173Kg/ha) and SVTLR(19)-12 (1148 Kg/ha).
- **Station trial timely & late (non-plan) Rabi, 2019-20**

  Station trial consisting 10 entries including 3 checks was conducted in Randomized Complete Block Design (RCBD) with three replication with 4 meter row length with 4 lines along with spacing of 30×10 cm(R×P).Data has been recorded on various traits and analyzed.HUL 57 (1213 Kg/ha) was found best check and Pusa Ageti has yielded out highest (1589 Kg/ha), followed by BRL-3 (1556 Kg/ha), in normal sown condition, while HUL-57 (813Kg/ha) was found best check BRL-1 has yielded out highest (1190 Kg/ha).
- **Screening & validation trial (non-plan) Rabi, 2019-20**

  Germplasm screening trial of lentil consisting 232 lines excluding 4 checks was conducted in Augmented Block Design with 1 meter row length with two rows along with spacing of 30×10 cm(R×P) to validate the results of previous year trials.Data has been recorded on various traits and analyzed and Out of 232 germplasm, lines with

higher yield PL6 (1811 Kg/ha) fallowed by P.Vaibhav (1762 Kg/ha),BRL-2 (1743 Kg/ha),W717 (1722 Kg/ha) and 20013-L (1698) were observed to be superior for seed yield. The yield of the best check was KLS 218 (1285 Kg/ha).

4.1.5.1. ICARDA International nurseries

From ICARDA nurseries small seed & early lines were evaluated and SPS were selected from different nurseries

Sl. No	Trial (International nurseries) ICARDA	No. of cross combinations	Promising entries
I	SINGLE PLANT SELECTION F3 -(LIEN-MN) F4-(LIPBN) F4 (LIDTN) F5(LIENE) SPS	15 17 13 21 12	Lines were bulked from Single plant progeny showing extra early maturity and early maturity (90-108 days) with a yield range of 1252-1692 Kg/ha
II	SINGLE PLANT SELECTION F6 (LIENE) F7(LIENE) F5(LIENE)	44 35 45	Lines were bulked from Single plant progeny showing extra early maturity and early maturity (90-105 days) with a yield range of 1333-1637Kg/ha
III	SINGLE PLANT SELECTION F8 F9 Bulked F8-F9	55 45 45	Lines were bulked from showing extra early maturity and early maturity (91-109 days) with a yield range of 1350-1730 Kg/ha and will be evaluated in station trial I Rabi 2020-21

- **Breeding material generated**

Sl. No	Crossing programme	No. of cross combinations	Remarks
I	F1	17	Fresh cross combinations made, High yield × Earliness, Heat tolerant ×High yield and high yield ×wilt resistant
II	F1	33	Random cross combination
III	F2	08	
IV	Back crosses	05	F1 raised and backcrosses made

4.1.5.2. Biofortification of lentil –Harvest Plus, BAU, Sabour

Twenty entries of lentil were evaluated in Randomized Complete Block Design (RCBD) with two replication with 3 metre row length with 4 lines along with spacing of 30×10 cm(R×P).Data has been recorded on various traits and analyzed. Yield range was found from 1328Kg/ha -1806Kg/ha. Samples are sent for Zn analysis. Result is awaited.HUL 57 was found best check (1328 Kg/ha). Two entries were found significantly superior namely IC55965 (1806) fallowed by GP2585 (1785).

4.1.5.3. Biofortification of lentil –NBPGR, New Delhi

Ten entries of lentil were evaluated in Randomized Complete Block Design (RCBD) with two replication with 1 metre row length with 2 lines along with spacing of 30×10 cm(R×P).Data has been recorded on various traits and analyzed. Yield range was found from 1310Kg/ha -1999Kg/ha. Samples are sent for Zn analysis. Two entries were found high yielder namely L4727(1999 Kg/ha)fallowed by IPL81(1955 Kg/ha),DPL 81(1570 Kg/ha),KLS 218(1570 Kg/ha),DPL 15(1547 Kg/ha) and IPL 406 (1496 Kg/ha).

4.1.5.4. Improvement of popular lentil (*Lens culinaris* L.) cultivars of Zone III (B) of Bihar for high yield and pod borer tolerant through induced mutagenesis"

The M 2 generation mutant plants of physical and chemical mutagen were selected and harvested, separately based on various doses of mutagens (γ-rays: 05kR, 10 kR,20kR, 30 kR and 40kR; EMS: 0.05%, 0.10%, 0.15%, 0.20%, 0.25%, 0.30%, 0.35% and 0.4%). The LD_{50} of both mutagens were analysed again during December, 2019 by seed shocking method of mutagen treated seed in petri-plates. For EMS and Gamma-rays mutagen, the LD_{50} was 0.35% and 40kR, respectively. Based on mutagenic observations, lower doses of EMS (0.05% to 0.10%) showed higher seed germination and plant survival with less root and shoot reduction than the higher doses of EMS in 09^{th} and 16^{th}days after treatment and higher dose of EMS (0.3 % to 0.35%) showed contrary effect on seed germination and plant survival with higher root and shoot reduction. Similarly, in gamma-radiation (physical) treatments, lower doses (up-to 20kR) were exhibited higher seed germination and plant survival with less root and shoot

reduction in 09th and 16thdays after treatment as compared to control and higher doses of γ-rays (30 kR and 40 kR). However, in combination treatments (Gamma rays and EMS), doses 05kR+0.10%, 05kR+0.20% and 10kR+0.10% showed better seed germination and plant survival with lower root and shoot reduction than the other combinations in 09th and 16thdays after treatment as compared to control and other combinations. For other traits, higher doses of both mutagens were exhibited the earliness with dwarf plant type and also reduce the plant yield as compared with control during 2019-20. However, the higher yield per yield and medium plant type were observed in lower dose of both mutagenic treatments. Aphids infestations have also been observed in the month of January to February, 2020 in lentil crop. However, in lentil crop, wilt, rust, *Aschochyta blight* are the major diseases, and pod borer and Aphids are the harmful insects as reported by many workers/ farmers during ZREAC meetings and damaged the crop up to 11 to 19 % by insect infestation and 18 to 37 % by diseases in epidemic condition during last five years.

4.1.5.5. AICRP on MULLaRP on Lentil and Lathyrus 2019-20

- 23 coded entries of lentil were evaluated in IVT in Randomized Complete Block Design (RCBD) with three replication with 3 meter row length with 4 lines along with spacing of 30×10 cm(R×P).Data has been recorded on various traits and analyzed. Yield range was found from 704 Kg/ha -1434 Kg/ha. While 07 coded entries of Lathyrus were evaluated in IVTin Randomized Complete Block Design (RCBD) with three replications with 3-meter row length with 4 lines along with spacing of 30×10 cm(R×P).Data has been recorded on various traits and analyzed. Yield range was found from 553 Kg/ha to 1012Kg/ha.
- **Development of low ODAP lathyrus varieties (BAU/SNP/CI/Rabi/2019-8)**
  Different germplasms of lathyrus has been collected from IIPR, Kanpur and NBPGR, New Delhi and their phenotypic evaluation has been performed. Screening trials for low ODAP genotype have also been conducted.

4.1.5.6. Seed Quality Enhancement using Botanicals

After finalization, a comparison of the best concentrations of each botanicals primed chickpea and lentil seed were done. In case of chickpea turmeric primed seeds were showed maximum significant increase in germination percentage, seedling length, seedling dry weight, vigour index I and II followed by neem, garlic bulb and papaya.

In case of lentil, all botanicals were able to enhance germination percentage significantly over control and the highest increased was observed in turmeric primed seed, which was as par with papaya, neem, and ginger. Papaya primed seed showed the maximum significant increases in seedling length, seedling dry weight, vigour index I and II followed by turmeric and neem.The biochemical activities of hydrolytic and antioxidant enzymes (Catalase, Peroxidase and Superoxide dismutase) were observed in the present investigation in non-primed and botanicals primed seeds. The results of the effect of botanical priming on the activity of antioxidant enzymes were increased as compared to non-primed seed. The selected concentration of best performing botanicals were used to prime the medium vigour seeds of both crops and has been kept for storage (12 months) under ambient condition in sealed Aluminium laminated packets. The observations have been recorded at 3 months intervals. After 3 months of storage, the germination percentage of non-primed seeds were reduced in comparison to botanical primed seed whereas seedling length, seedling dry weight, vigour index I and II have minor reduction in both chickpea and lentil seeds. With the increasing storage period (9 months of storage), the biochemical activities of antioxidant enzymes (Catalase, Peroxidase and Superoxide dismutase) and hydrolytic enzyme (amylase) have been found reduced and the slight changes were observed in the protease and lipid peroxidation in both primed and non-primed seeds. During the 9 months of storage, it was observed that the non-primed seeds were deteriorated more rapidly than primed seeds in all physiological parameters as well as biochemical assessment.

4.1.5.7. Seed Treatment with Carbon Nanoparticles for Seed Enhancement in Pulse

The seed lot of chickpea (var. PG186) and lentil (var. HUL 57) was soaked in sufficient amount of dispersion with carbon-based nanoparticles at different concentration (50, 100,125, 150 mg/l) then seed became dried under shade at room temperature to the initial seed weight to maintain original or near to safe moisture content. Both the crops were treated with different carbon-based nanoparticles viz., graphene (G) and graphene oxide (GO) single walled carbon nano tube (SWCNT) and multi walled carbon nanotube (MWCNT) with different concentrations (dispersant) as mentioned above. It was found that in both the crop all seed quality parameters are significantly improved up to the concentration of 125 mg/l but after that there was a reduction in germination, vigour, relative storability of seed lot. Carbon nanoparticles

improved the seed germination, vigour, root and shoot length, seedling dry weight and membrane permeability and dehydrogenase activity.

4.1.5.8. Prediction of Seed Viability through Developing Seed Longevity Chart

After facing problems in purchase of key equipment i.e. accelerated ageing chamber, it was decided to avail the facility of ICAR-Indian institute of Seed Science, Mau (UP) and then run the project in collaborative way by assigning Co-PI from this institute also, but they have inform us to also sign an MOU between both institute. Accordingly, approval from competent authority has been taken, and MOU has been drafted by concerned PI and submitted through proper channel to IISS for signing it. Few more procedural steps required and it will come in action very soon.

4.1.6. Mungbean Breeding

4.1.6.1. Development of short duration, high yield & Synchronous maturity Mungbean (*Vigna radiata*) genotypes for Bihar

- No. of experiment conducted: 05
- **Screening trial (non-plan) Summer, 2020**

  Germplasm screening trial of Mungbean consisting 134 lines including 4 checks was conducted in Augmented Block Design with 2 meter row length of two rows along with spacing of 30×10 cm (R×P) to screen and evaluate against Yellow Mosaic Virus, earliness, higher yield and and synchronous maturity in Augmented Block Design. Samrat was found best check (1022 Kg/ha). Genotype namely; IPM-2-3 (1490 Kg/ha) fallowed by IC369233 (1372 Kg/ha), MH 52L (1295 Kg/ha), IPM4103 (1190 Kg/ha) and MH1464 (1168) moderately resistant with high yield
- **Station trial (non-plan) Summer, 2020**

  Station trial consisting 17 fixed lines including 1 checks was conducted in Randomized Complete Block Design (RCBD) with three replication with 4 meter row length with 4 lines along with spacing of 30×10 cm(R×P).Data has been recorded on various traits and analyzed.PDM-139 (1307 Kg/ha) was found best check and BRM14 (1658 Kg/ha) fallowed BRM13 (1648 Kg/ha), BRM12 (1667 Kg/ha), BRM10 (1533 Kg/ha) and BRM06 (1444 Kg/ha)
- **Crossing programme-Breeding material generated and evaluated**

Sl.No.	Breeding material	No. of cross combinations	Remarks
I	F_1	05	Fresh cross combinations made,F_1 raised and backcrosses made

II	F_2	19	
III	Back crosses	-	02
IV	Bulked (F6)	-	66
V	SPS (F7)	-	26
VI	Bulked (F7)	-	32

4.1.7. Linseed Breeding

4.1.7.1. Significant Achievements

- Two varieties of linseed, namely, Sabour Tisi-1 and Sabour Tisi-2 have released.
- Three entries, namely, BRLS 104 (for rainfed), BRLS 119 (for irrigated) and BRLS 107(for utera) promoted from AVT first year to AVT 2nd year in the AICRP trials
- Three entries, namely, BRLS 109-2, BRLS 112-2 and BRLS 111-2 promoted from special AICRP Utera trial 2nd year to 3rd year.
- Two entries, namely, BRLS 121 and BRLS 110-4 promoted from IVT irrigated to AVT 1st Year irrigated in the AICRP trials
- The entries, BRLS 110-6 and BRLS110-7 have nominated in IVT rainfed in AICRP trial.
- The entries, BRLS 103-1 and BRLS120have nominated in IVT irrigated in AICRP trial.
- The entries, BRLS 105 and BRLS112-3have nominated in IVT utera in AICRP trial.

4.1.7.2. Genetic enhancement

- 159 linseed germplasm were collected and being maintained.
- Nine double crosses were made using single crosses of the following parents BRLS 111-1,TL 145, BRLS 110-1, PKDL 167, Priyam, SLS 118, Dibya, KL 134, LMS 2015-27,RL15561, BRLS 106, T 397, BRLS 107-1, PKDL 165, PKDL 167, RLC 167, BRLS109-2 with objective of Development of varieties for seed type for irrigated, rainfed and utera condition with resistant to bud fly, leaf blight, rust, wilt, Powdery mildew
- Forty single crosses were advanced in F_1 generation.
- 167 SPS from F2, 356 SPS from F3, 293 SPS from F4,97 SPS from F5,27 SPS from F6 were selected and also03 progenies row were bulked from F7generation59 promising lines were developed for further testing in station and AICRP trials.

4.1.7.3. Trials conducted

- The following trials were successfully conducted which are given below:
- Seven AICRP trials, namely, Initial Varietal Trial (Rainfed), Advanced Varietal Trial (Rainfed), Initial Varietal Trial (Irrigated), Advanced Varietal Trial (Irrigated), Initial Varietal Trial (Utera), Advanced Varietal Trial (utera) and Evaluation of linseed germplasm under utera condition were successfully conducted.
- Three station trials, namely, evaluation of genotypes under utera condition, Evaluation of genotypes under irrigated condition and Evaluation of genotypes under rainfed condition were conducted.
- State Varietal Trial of linseed were conducted

4.1.7.4. Seed Production

- AS per DAC Indent of Sabour Tisi-1 (2.0 q) breeder seed was produced.
- Seeds of 59 promising lines of linseed were produced

4.1.7.5. Front line Demonstration

- Twenty FLD were conducted as programme of AICRP on linseed

4.1.7.6. Development of Budfly resistant linseed lines using mutation breeding

The genotype, BRLS 102 was treated with gamma rays with ten doses. Out of them 350 Gywas identified as LD 50. In M 3 generation under 3000 Gy ,05 genotypes, namely, 3001-1,3006-1, 3006-2, 3007-2, 3008-2 were identified as resistant genotypes for bud fly infestation. Under 350Gy,07 genotypes, namely,3505-1, 3507-1, 3512-1,3516-1, 3522-1, 3522-2, 3523-1were identified as resistant genotypes for bud fly infestation. Similarly, under 400Gy, 04genotypes, namely, 4001-3,4002-1,4002-2,4006-1 were identified as resistant genotypes for bud fly infestation.

4.1.8. Sesame Breeding

4.1.8.1. Development of High Yield and Short duration varieties of Sesame for Bihar

Thirty- three crosses were successfully made during 2020 with various combinations involving twenty different parents. Twelve crosses have been advanced to F_1 namelyBRT10 × Kalika,BRT-08 × Kalika, BRT-10×BRT08,BRT-09× Kalika, BRT09×BRT10, BRT09× BRT08, AT336× AT 255, JLS-120× AT255,AT336×BRT06,JLS120× TKG523, TKG22× TKG523 and AT-255× TKG523. Three F_3crosses (BRT06×AT201, BRT01×BRT06 and AT255×BRT06) were advanced to F_4generation. F_4 crosses were advanced to F_5 generations which are VS10-57×OSM170, AT234×BRT04, BRT04×VS10-57, VS10-57× OSM22, OSM22×OSM170 andBRT04×NIC8253. Twenty-seven different germplasms and

local collections of white and black sesame were evaluated at BAC, Sabour. Germplasm were morphologically characterized as per DUS. Multiplications and maintenance of seed of BRT-04, BRT-08, BRT-09, BRT-10, TKG-22, JTS-08, GT-10 was going on.

4.1.8.2. Morphological and Molecular Characterization of *Sesamum indicum* L. of Bihar

28 promising entries have been morphologically characterized for their quantitative and qualitative characters in summer 2020. Molecular characterization of sesame germplasm with twenty-four (24) primers were tested on thirty-three genotypes and six were found to be polymorphic. Based on polymorphism three clusters are found. Ranges of similarities among 33 genotypes varies from 0.34 – 1.

4.1.8.3. AICRP Trials:

AVT and IVT were conducted and the data was sent to PC unit, Jabalpur. Twelve genotypes including two local checks were evaluated for AVT while nineteen entries which consisted of two checks were evaluated for IVT. Among IV highest yielder (1926 kg/ha) was Suprava with 88 days' maturity and IVTs-19-7 was found earliest among all entries having 72 days' maturity with 1516Kg/ha productivity. In AVT, no any entries were superior yielder than Suprava with 1136 kg/ha yield and LC 1 lowest days to maturity.

4.1.9. Rapeseed and Mustard Breeding

4.1.9.1. Station Trialfor Indian Mustard (Irrigated)

- Total fourteen entries comprised of 09 promising lines and 05 checks were evaluated for yield in RBD design replicated thrice with gross plot size 09 m^2 and net plot size 5.76 m^2 under timely and late sown conditions for two consecutive years 2018-19 and 2019-20.
- Under timely sown conditions entry no. BRRM 6-3 (2646 kg/ha) and BRRM 22-1(2647kg/ha) significantly out yielded the best check Rajendra Suflam (2209 kg/ha) during2018-19. The range of yield varied from 1767 kg/ha to 2647 kg/ha.
- During 2019-20 the entries BRRM 6-3 (2519 kg/ha), BRRM 44-1 (2525 kg/ha) and BRRM22-1 (2888kg/ha) performed superior for yield but the entry no. BRRM 22-1 (2888kg/ha) significantly out yielded the best check Varuna (2549kg/ha).
- Pooled average of two consecutive years revealed that entry BRRM 6-3 (2582 kg/ha) and BRRM 22-1 (2767 kg/ha) was highest yielder whereas entry BRRM 22-1 (2767 kg/ha)significantly out yielded the best check Varuna (2325kg/ha).
- The pedigree of BRRM 6-3 and BRRM 22-1 is RAURD 10-1 X Rajendra Anukul.

4.1.9.2. Multi-location Testing: (Co-Ordinated State Varietal trials 2019-20)

4.1.9.2.1. TORIA

- Nine entries were evaluated for yield at five locations viz. Madhepura, Purnea, Sabour, Mokama and Islampur centre of agro-climatic Zones II, III A and III B of Bihar respectively. The trials were conducted in RBD design with three replications having gross plot size 9 m^2 and net plot size 5.4 m^2.
- On the basis of mean over- five locations entry no. TCSN-19-3 reflected highest yield i.e.1614 kg/ha followed by TCSN-19-5 (1608 kg/ha). The range of mean yield over-five locations was 1105 kg/ha to 1614 kg/ha.

4.1.9.2.2. Crop: Yellow sarson

- Nine entries were evaluated for yield at five locations viz. Madhepura, Purnea, Sabour, Mokama and Islampur centre of agro-climatic Zones II, III A and III B of Bihar respectively. The trials were conducted in RBD design with three replications having gross plot size 9 m^2 and net plot size 5.4 m^2.
- On the basis of mean over- five locations entry no. YSCSN-19-1 reflected highest yield i.e. 1792 kg/ha followed by YSCSN-19-6 (1618 kg/ha). The range of mean yield over-five locations was 1416 kg/ha to 1792 kg/ha

4.1.9.2.3. Crop: Indian Mustard

- Nine entries were evaluated for yield at five locations viz. Madhepura, Purnea, Sabour Mokama and Islampur centre of agro-climatic Zones II, III A and III B of Bihar respectively. The trials were conducted in RBD design with three replications having gross plot size 9 m^2 and net plot size 5.4 m^2.
- On the basis of mean over-five locations entry no. MSCSN-19-7 reflected highest yield i.e. 1911 kg/ha followed by MSCSN-19-2 (1829 kg/ha). The range of mean yield over-five locations was 1600 kg/ha to 1911 kg/ha

4.1.9.3. Multi-location Testing 1st year: Indian Mustard (Private sector-2019-20)

- One mustard hybrid of multinational seed company along with six checks was evaluated in randomized Block Design with three replications during Rabi Season of 2019-20 for its suitability in Bihar. The site of evaluation were Research Farm of Bihar Agriculture College, Sabour, Bhagalpur (Zone IIIA), Betel-vine Research Centre, Islampur (Zone IIIB) and Regional research Station, Agwanpur (Zone II) under the Bihar Agricultural University, Sabour, Bhagalpur, Bihar. The varieties viz. Varuna, Pusa Bold, Kranti (NC), RGN 73, Rajendra Suflam (LC) and PM-25 were used as checks.

- At Sabour location, the grain yield varied from 1622 kg ha^{-1}(Rajendra Suflam) to 2187 kg ha^{-1}(RGN-73). The check RGN 73 (2187 kg ha^{-1}) was found highest yielder than the other five checks. The test hybrid 19-154 (1967 kg ha^{-1}) did not showed significantly higher grain yield over best check RGN 73 (2187 kg ha^{-1}) however; it showed at par grain yield with the best check RGN 73.
- At Islampur, range of grain yield varied from 919 kg ha^{-1} (Pusa bold) to 1234 kg ha^{-1} (PM-25).The check PM-25 (1234 kg ha^{-1}) was found highest yielder than the other five checks. The test hybrid 19-154 (1061 kg ha^{-1}) was numerically or significantly low grain yielder over best check PM-25 (1234 kg ha^{-1}).
- At Agwanpur centre range of grain yield varied from 631 kg ha^{-1} (RGN 73) to 1168 kg ha^{-1}(19-154). The check Rajendra Suflam (1146 kg ha^{-1}) was found highest yielder than the other five checks. The test hybrid 19-154 (1168 kg ha^{-1}) was significantly low grain yielder over best check PM-25 (1234 kg ha^{-1}) however significantly /numerically at par with the best check.
- In pooled mean, the grain yield varied from 1117 kg ha^{-1} (Varuna) to 1399 kg ha^{-1} (19-154). The check PM 25 (1385 kg ha^{-1}) was found best check than the others. Overall the test hybrids did not showed significantly higher grain yield over the best check PM 25 (1385 kg ha^{-1}) however it showed significantly at par performance to the best check.

4.1.9.4. PYT late sown irrigated: Indian mustard (BAARC-2019-20): D/S: 09.12.2019

- Twenty Trombay mustard (TM- series) strains along with four checks were evaluated during *rabi* Season of 2019-20 at Sabour location for its suitability in Bihar. The trial was conducted in Randomized Block Design with three replications. The gross plot size 09 m^2 and net plot size 5.4 m^2 during sowed. The genotypes Rajendra suflam (LC), Kranti (NC), CS-56(LR) and NRCHB-101 (ZC) were used as checks.
- None of the test entries significantly out yielded the best check NRCB-101 (1626 Kg/ha).While the entry TM-130 was good yielder (1516 Kg/ha) having bold seed (Test weight; 5.10).

4.1.9.5. AICRP on Rapeseed and mustard: Late sown irrigated: Indian mustard

- Twenty strains under AICRP were evaluated along with two checks were evaluated duringRabi Season of 2019-20 at Sabour location (Zone III). The trial was conducted inRandomized Block Design with three replications. The gross plot size 09 m 2 and net plot size 5.4 m^2 during sowed. The genotypes CS-56 (LR) and NRCHB-101 (ZC) were used as checks.

- None of the test entries was better yielder than the overall mean of the zonal check NRCB-101 (1905 Kg/ha). While six entries were better performer for yield as compared to the overall mean of the latest release check NRCB-101 (1685 Kg/ha).

4.1.9.6. Crosses:

4.1.9.6.1. F_1 and Segregating generations: Indian mustard (Rai)

- 106 F_1 were advanced to F_2
- F_2 Generation: 120 single plants were selected from 28 cross combinations grown F_3 Generation: 757 single plants were selected from 447 progeny rows of 60 cross combinations grown. One yellow seeded plant was identified in F 3 of cross combination Pusa Jaikisan× Pusa Bold.
- F_4 Generation:801 single plants were selected from 16 cross combinations out of 129 cross combinations grown (674 progeny rows)
- F_6 Generation: 26 single plants and 03 bulk populations were selected from 15 cross combinations grown. One short statured with small pod uniform progeny row identified having good yield.
- F_7 Generation: 11 bulk populations were identified from 39 progeny rows of cross six cross combinations. 16 single plants were identified having basal branch. 43 SPS were selected for hairy leaves whereas 26 SPS were selected for non-hairy leaves.

4.1.9.6.2. Yellow Sarson/ Toria:

- 50 F_1 were advanced to F_2
- Inbred line development: 07 S_1 generations were raised and selfed again for further S_2generation
- Population Improvement: 7 inter-crossed parents (36 crosses) were raised in 2019-20 and superior selected plants were inter-crossed again

4.1.9.7. Fresh cross combinations:

4.1.9.7.1. Indian Mustard: for high yield, earliness, bold seeded for timely/late sown

- No. of cross combinations: 58 (diallele) (Rai X Rai)
- Wide cross: 05 (Rai × Cauliflower, Rai ×X Chinese cabbage)
- Hybrid development: 07 cross combination (Restorer-line X selected parents) 05 (A × R)
- Ogura based CMS conversion of heterotic parents/ varieties: BC_1: 11, BC_2: 18

4.1.9.7.2. Yellow Sarson: for high yield, resistant to biotic and abiotic stress and earliness and high oil

- No. of cross combinations: 40 (diallele)

- Double crosses: 12
- F_1 X F_1: 38

4.1.9.7.3. Toria: for high yield and earliness

- No. of cross combinations: 47 (population improvement) + 17 fresh
- Toria X Brown Sarson: 11
- Introgression of Rfo (fertility restorer gene for ogura CMS) genes in heteroticfemale lines of *B. juncea*: 06 (BC_1) + 01 fresh cross

  Parents involved: Male parent: R-Line,Recurrent parent: Rajendra Suflam, PusaBold, Laxmi, RH-30,Rajat, RLM 1359, EC 394300
- Maintenance of male sterility (Ogura based CMS) lines: 08 (A-B pairs: M-4 (NA) X M-4 (F_5), M-6 (NA) X M-6 (F_5), M-9 (NA) X M-9 (F_5), M-16 (NA) X M-16 (F_5), M-29 (NA)X M-29 (F_5), M-33 (NA) X M-33 (F_5), M-70 (NA) X M-70 (F_5), IM-49 (NA) X IM-49 (F_5)

4.1.9.7.4. Germplasm maintenance:

- 134 (109- *B. juncea*, 03- *B. carinata*, 01-*B. fruticulosa*, YS: 14, *toria*: 07)

4.1.9.8. Introgression of Aphid resistant gene (s) in *Brassica juncea* through embryo rescue

- As per the objective "Development of Fruticulosa-rapa hybrid through embryo rescue technique" a total of 3419 buds were used for hybridization involving *Brassica fruiticulosa* as seed parent and *Brassica rapa* as pollen parent. 2-4 D treatment was allowed one day after pollination.
- Finally 2104 successfully hybridized (treated as well as untreated), buds were obtained and were cultured on 16 Medias (M1 to M16) having different concentrations of plant growth regulators with different days of intervals viz. two to eight days.
- Direct shoot regeneration without intervening callus was obtained in M1, M2 and M7media having 7.2 %, 2.3 % and 6.09 % of shoot regeneration.
- In vitro flowering was also observed in M8 (74.4 % callus induction & 72.83 % shoot regeneration) and M9 (84.9 % callus induction & 31.11 % shoot regeneration) media
- The highest no. Of callus induction was obtained in M9 (84.9 %) whereas lowest was observed in M3 (2.2%).
- Highest shoot regeneration was obtained in M8 media (72.83 %) and lowest in M16 (2.3 %)

- Media M4, M6 and M14 did not responded neither for callus induction nor for shoot regeneration
- The hybridity of the regenerated plantlets was confirmed by the two different gene specific primers of *Brassica rapa* (male parent): The DNA band of male parent and the hybrids reflected on the same position (Kb) whereas the female parent *Brassica fruiticulosa* did not showed any amplification which confirmed the hybridity of a total 52 embryo rescued plantlets.
- The confirmed hybrids are being under acclimatization

4.1.10. Vegetable and Floriculture

4.1.10.1. Evaluation of tomato lines carrying different combinations of *Ty* genes forresistance against begomovirus infection

A set of 105 tomato genotypes has been evaluated for tomato leaf curl virus disease infield condition during Rabi 2019-20. The tomato genotypes with *Ty3* gene performedwell.Fifty samples of tomato genotype showing symptoms of virus infection (very mild tosevere) from trial were collected from field. Total genomic DNA was extracted and each sample was tested by Polymerase chain reaction (PCR) with universal begomovirus primers to test for the presence of leaf curl (begomovirus) infection. Out of 50 samples, 38 revealed presence of begomovirus infection. A set of selected 20 tomato genotypes from Rabi 2019-20 trial were also evaluated for tomato leaf curl virus disease in field and protected condition during summer 2020 as the peak season for whiteflies and leaf curl disease pressure locally. The disease incidence was found low compared to summer 2019 as whitefly pressure was low. There were symptoms of tomato leaf curl virus disease only on susceptible varieties (Pusa Ruby and AVTO-01) both in field and protected condition. However, the experiment was affected by COVID-19 pandemic.

4.1.10.2. Potato Leaf Roll Virus infecting potato crops (project completed)

During Rabi 2017-18 and 2018-19, a total number of 486 infected leaf samples were collected from different agroclimatic zones of Bihar to test of PLRV infection. The analysis of the samples was carried out through DAS-ELISA method. Total 80samples were found positive for the PLRV infection. Further the confirmation of PLRV were also carried out using RT-PCR and confirmed through sequencing. The sequences were submitted to NCBI-Gen Bank with accessions number from MH974473-MH974473.The whole genome sequencing of eight (08) PLRV isolates of different agroclimatic zones of Bihar was completed. The phylogenetic analysis of

these isolates revealed that there was more than 95% genetic similarity among the isolates and they were closely related to report Indian PLRV isolates. The NGS transcriptome analysis was also carried out in PLRV infected leaf samples and the genes involved during PLRV-Potato interaction were identified. 686 high quality transcriptomes were submitted to NCBI gene bank having accession no.GIOE00000000.The mRNA expression knock down study was carried out using potato as host. Potato plants agro infiltrated with MP siRNA constructs exhibited no rolling symptoms upon PLRV infection, indicating that the silencing of MP gene expression is an efficient method for generating PLRV-resistant potato plants. These findings indicated that siRNA constructs hampered or suppressed viral translocation and multiplication in the plants.

4.1.10.3. Marker assisted breeding for different disease resistance alleles in tomato

Heterozygosity of different F1 combinations was tested using molecular markers. A few (12) cross combinations were tested in field condition through un-replicated trial for preliminary identification of better combinations. MAS in different F_2 populations was carried out to genotype promising lines.A Double-cross F_1 population was screened for the presence of disease resistance alleles. Preparation of a 4 parental RIL population was initiated. Large number of F_2 seeds has been prepared for subsequent MAS and field evaluation for different combinations. Through MAS, a potential repulsion phase linkage between Ty3 and Mi1.2 genes has been detected. A simultaneous detection method for Mi1.2 and Ph3 resistance genes in tomato has been optimized and published.

4.1.10.4. Identification and Molecular Characterization of Major Viruses infecting Tomato and chilli from Koshi region of Bihar

Virus infected samples of chilli and tomato were collected from Kishanganj, Bahadurganj, Thakurganj and Purnearegion. Further, these samples were serologically analyzed for the CMV and TSV and found to be positive.

4.1.10.5. Development of tomato genotypes suitable for processing purpose

MTA has been sent to IIVR, NBPGR, IIHR, IARI, BCKV for collection of genotypes. However, 20 genotypes from BCKV, Mohanpur, WB and 11 from Dr. YSPUHF, Nauni, Solan, HP could be collected. Morphological characterization of these genotypes and other genotypes available from BAU, Sabour has been done as well as quality traits like TSS and lycopene of the genotypes has been carried out. Few crosses to develop F_1 hybrids has been attempted using promising lines.

Morphological characterization of hybrids available from BAU as well as study of TSS of these lines has been carried out. The genotypes IIHR-2614, Pusa Rohini, Kashi Chayan, SolanVajr and BRDT-2 have been found promising in terms of TSS and pericarp thickness which are important traits for processing tomatoes.

4.1.10.6. Identification and Characterization of Pathogenesis related (PR) gene (s) against Phomopsis blight in Brinjal

Plantation of phomopsis blight sensitive and resistant variety of brinjal for artificial induction of phomopsis blight disease was done. Isolation, culture and storage of *phomopsis vexans*, the causative agent of phomopsis blight disease in brinjal from Phomopsis blight infected plant will be used in pathogenicity.

4.1.10.7. Varietal Improvement in Garlic for Yield and Storability

Two promising garlic genotypes have been identified viz., BRG-13 (Sabour Garlic White) and BRG-14 (Sabour Garlic Pink). These genotypes are in pipeline of release and these are promising with respect to yield, quality and storability. Multiplication of genotypes under pipeline, BRG-13 (White garlic line) and BRG-14(Pink garlic line) has been done. Maintenance of 21 genotypes of garlic for future research purposes has been done. Multi location testing at KVKs, Lakhisarai and Sheikhpura in zone III A, Nalanda and Rohtas in III B, Madhepura, Saharsa, Araria and Jalalgarh in zone II and also at farmers' field in these locations and also in Zone I have been done. Pipeline varieties along with checks have been sent to the Directorate of Onion and Garlic Research (DOGR), Rajgurunagar, Pune, have been multiplied at Ludhiana and now included in IET trial and being evaluated at different network centres.

4.1.10.8. Improvement of local onion variety for shape and size through mass selection

Exploration and collection of local germplasms, Jirat and Beloria, Patna Red, Nasiklocal onion collections have been done. Postharvest study and morphological characterization and selection of the collected entries has been conducted.MTA was also signed with DOGR, Pune and seeds 40 entries of onion were procured for research purposes. Selfing and massing and crossing in all possible combinations was done among the local collections and seeds were collected for further research work which aims at development of onion variety having high yield, desirable quality and longer storage life.

4.1.10.9. Identification of high yielding early genotypes in vegetable pea (*Pisum Sativum* L.)

The selected materials have been planted in three different dates 15thOctober 2015, 27th October 2019 and 7th November 2019 and genotypes were characterized at the different dates. Crossing programme in Line x Tester fashion with 10 lines and five testers were attempted but satisfactory result with 6 lines and 4 testers was obtained. Approximately all quantitative as well as qualitative characters slightly resulted in maximum performance during first date of sowing D 1 (15thOctober) than other sowing dates. It may be due to relatively favourable temperature and longer time availability for the growth and development of earlier sowing plants. Days to 50 % flowering and days to first green pod picking was observed minimum for seven genotypes (IC-342046, IC-291544, IC-291553, EC-269301, P-2110, IC-427130, IC-382756) than all the four checks while IC-415499 show earliness over three checks except Arkel.5438/P-2110 contained high TSS percent, total sugar, reducing sugar percent, high protein and ascorbic acid followed by IC-415499, P-2999 etc. while lowest amount of above qualitative characters were observed for IC-342046.

4.1.10.10. Collection, conservation, Characterization and Evaluation of Bakala (*Viciafaba*) germplasm for green pod, seed yield and development of varieties

Altogether 20 Bakala germplasm were collected from different parts of Bihar. All these germplasm were characterized with help of Bakala descriptor for 21 traits. Wide range of variability were found for traits *viz*; branching from basal nodes, plant height, pod length and no. of seeds per pod. Total of 170 crosses were attempted in L x T matting design out of that only 68 crosses were found successful. Maximum no. of pods were obtained by crossing between Bak-15/Bak-20 (7) followed byBak2/Bak-5 (6).

4.1.10.11. Screening and Identification of high yielding early genotypes in French bean(*Phaseolus vulgaris* L.)

Six genotypes were found earlier than all the three check varieties, i.e., Arka Komal, Swarn Priya and Swarn Lata.Four genotypes (RCFB-1, RCFB-4, MCFB-3 and NCFB-1) were observed higher yielder than all three checks. Two genotypes (HS-6 and HS-10) were observed earlier but low yielder than checks.RCFB-5 contained high folic acid, HS-10 contained high iron and NCFB-1 contained high zinc percentage. Approximately, performance of all F 1 was observed slightly higher than the superior parent for some characters but none of the genotypes were found significant over

check and selected elite genotypes. F 1 s developed earlier has been planted to produce advance lines (F_2) for selection in them for getting new varieties.

4.1.11. Fruit and Fruit Technology:

4.1.11.1. Understanding the bearing habit in Mango using Next Generation sequencing

Total RNA were extracted from the bud of mango samples namely Amrapali, Barahmasi and Langra (Vegetative and Flowering buds).Next Generation sequencing was performed for four samples. In total 28,325 transcripts were obtained.293 SSR markers were observed in all the four samples. Several SNPs has been identified in this study. KEGG pathway analysis showed phenyl propanoid pathway and trehalose biosynthetic pathways are significantly up regulated in analyzed sample.

4.1.11.2. Survey, collection and evaluation of Pummelo in Bihar

This is the first year of trial and have collected more than 100 (One hundred) germplasmsfrom Muzzaffarpur, Samastipur districts and BAU campus. Among them 25 germplasms were found promising in respect of sweetness. After evaluation it has been found that fruit weight varies from 0.5 to 1.1 kg, no. of seeds per fruit varies from 36 to 212 and no. of flecks 11 to 19.In biochemical parameters TSS varies from 8.3 to16^{o} Brix, acidity 0.48 to 3.2 % and ascorbic acid from 21 to 70 mg/100g pulp.

4.1.11.3. Survey, collection and characterization of available minor fruits of Bihar

In order to study the genetic variability of minor fruits crops grown in Bihar, the matured fruits of custard apple and bael were collected and characterized from different districts of Bihar. Survey of family yards and orchards was performed and a total of eighteen distinct bael genotypes and fifteen custard apple genotypes were collected and analyzed. Eighteen bael genotypes were characterized for nine fruit traits viz. fruit weight, fruit length, fruit width, no. of seed, seed weight, pulp weight, skin thickness, TSS, acidity and total sugars content during 2019-2020. The collected accessions showed rich genetic variations regarding their fruit characteristics. The fruit characteristics, viz., fruit weight ranged from (330.20–1506.65 g), fruit length (78.40–162.43 mm), fruit width(87.66–125.34 mm), number of seed (40.55–176.40), seed weight 8.38–55.33 g), pulp weight (201.17–1243.87 g), TSS (26.30–37.6 o Brix), acidity (0.20–0.30%), and total sugars(7.14–18.83 mg/100 g) among the different genotypes. On the basis of overall assessment, two genotypes, were found to be most promising. Fifteen custard apple genotypes were characterized during 2019-2020. The fruit characteristics, viz., fruit weight ranged from (86-267.73g), fruit length (4.64-9.91cm),fruit width (3.43-9.09cm), number of seed (12-41), seed weight

17.25g-33.93g), pulp weight (47.59-181.11g), TSS (20.10-25.30 o Brix),acidity(0.35-0.45%), Ascorbic acid content (23.45mg/100g- 38.54mg)and total sugars (13.53-18.20mg/100g) among the different genotypes. The collected accessions showed rich genetic variations regarding their fruit characteristics. On the basis of overall assessment, one genotype, were found to be the most promising.

4.1.11.4. Suitability of different germplasm of pineapple (*Ananas comosus* M.) in new edaphic condition

Planted some local and exotic varieties of pineapple such as MD2, Amrutha, M5 and Kew and all from Kerala along with Queen local and Kew local available in DKAC campus. Morphological data has been collected for the first year after establishment of plants.

4.1.11.5. Phytoremediation of heavy metals from contaminated water by exploiting the potential of duckweeds (*Lemna minor*) and its molecular characterization

Chemical analysis of Duck weed *viz.*, protein, carbohydrate, ash content, dry matter, crude fibre, calcium and phosphorus were performed so far. Physico-chemical characteristics (TDS, pH, EC, chloride, fluoride, nitrate, sulphate, As, Cr, Zn, Pb and iron) of water from different source were also performed.

4.1.12. Tissue Culture and Others:

4.1.12.1. Development of an efficient pineapple (*Ananas comosus*) micropropagation protocol for commercial production

An efficient protocol for micropropagation of pineapple has been optimized through somatic embryogenesis. Field trials for tissue culture raised plantlets are underway at DKAC, and KVK, Kishanganj and data has been recorded.

4.1.12.2. *In vitro* propagation of popular cultivars of banana in Bihar for large scale production of disease free planting material

Establishment of banana cv. Chinia cultivars for initiating shoot proliferation by using various sterilants. Shoot proliferation and multiplication has been achieved by using different combinations of plant growth regulators.

4.1.12.3. Insights into the mechanism of plant virus assembly

Knockdown of viral capsid protein leads to the generation of virus free (low titre) crops, suggesting their role during virus assembly process. A protocol of gene knockdown has been optimized by considering capsid protein of PLRV as a prototype.

4.1.12.4. Development of a microcontroller based smart sensor platform for monitoring environmental parameters related to tissue culture rooms, green houses and plant science laboratories

A microcontroller based smart sensor platform for monitoring environmental parameters was designed and developed using an arduino based microcontroller with sensors for temperature, humidity and light. To log these sensor's data to a database, MySQL based database was developed. A web based interface was also developed for easy visualization and retrieval of the logged data. The developed platform was further improved by incorporation of a real-time clock for time keeping and a user login and admin system. Validation of data recorded through developed platform was also carried out.

4.2. Natural Resource Management

4.2.1. Agronomy

4.2.1.1. AICRP on weed management

Experiment No. 1: **Efficacy of different post-emergence herbicides in chickpea (*Cicer arietinum*)**

- The results revealed that the lowest weed density (2.72/m^2) and weed dry weight (1.54 g/m^2) were recorded under Clodinafop-propargyl+Na-aciflurofen 220 g/ha (Readymix) which were at par with topramezone (6.10/m^2) & (3.68 g/m^2).
- The highest weed control efficiency at 60 DAS (95.16%) was recorded with Clodinafop-propargyl+Na-aciflurofen 220g/ha (Readymix) but it caused phytotoxicity upto 06 level followed by two hand weddings at 30 and 50 DAS (91.73%), topramezone (88.43%).
- The weed Index % was recorded lowest in treatments topramezone (3.32%). Maximum grain yield (1.69, 1.63 and 1.32 t/ha) recorded under treatments two hand weeding, topramezone and imazethapyr respectively.
- The highest gross return (Rs. 82,290/ha) and net return (Rs. 48,824/ha) were recorded by two hand weeding which was statistically at par with topramezone (Rs.79,560) & (Rs.47,404) and followed by imazethapyr (Rs.64,496) & (Rs.37,7790). The highest B: C ratio (Rs.1.47) was recorded by topramezone followed by two hand weeding (Rs.1.46), imazethapyr (Rs.1.42) and lowest net return (Rs.16,705/ha) and B:C ratio (0.65) was recorded under weedy check.

Experiment No. 2: **Herbicides combinations for control of complex weed flora in wheat (*Triticum aestivum*)**

- The results revealed that the lowest weed density (5.36/m^2) and weed dry weight (2.12 g/m^2) were recorded by two hand weeding which were significantly superior over rest of the treatments.
- Among different herbicides, the lowest weed density (16.13/m^2) and weed dry weight (10.55 g/m^2) were recorded by Pendimethalin 1.0 kg/ha (PE) fb sulfosulfuron 0.018 kg/ha (30-35 DAS).
- The highest grain yield of Wheat (4.49 t/ha) was recorded by the treatment two hand weeding which was statistically at par with Pendimethalin 1.0 kg/ha (PE) fb sulfosulfuron 0.018 kg/ha (POE) (4.26 t/ha) followed by Mesosulfuron+Iodosulfuron-

methyl (RM) (12 g+ 2.4g) POE (4.17 t/ha) and Clodinafop 0.06 kg/ha + metsulfuron 0.004 kg/ha at 30-35DAS (3.93 t/ha).

- The highest weed control efficiency was recorded in two hand weeding (96.22 %) which was closely followed by Pendimethalin 1.0 kg/ha (PE) fb sulfosulfuron 0.018 kg/ha (POE) (81.21%).
- The highest gross return (Rs.81,426/ha) and net return (Rs.39,526 /ha) were recorded by two hand weeding which was statistically at par with Pendimethalin 1.0 kg/ha (PE) fb sulfosulfuron 0.018 kg/ha (POE). The highest B:C ratio (Rs.2.01) was recorded by Pendimethalin 1.0 kg/ha (PE) fb sulfosulfuron 0.018 kg/ha (30-35 DAS) and Mesosulfuron+Iodosulfuron-methyl (RM) (12 g+ 2.4g) POE (Rs.1.96) and lowest economics were observed in un-weeded control.

4.2.1.2. AICRP Wheat

Experiment No. 1: **Performance of new wheat genotypes under restricted irrigation conditions**

- Six wheat genotypes K1317 (C), HD3171 (C), DBW252 (C), HD3293, HI1612 (C) and HD2888 (C) were evaluated under restricted irrigation i.e. without irrigation, one irrigation at CRI stage and two irrigation at CRI and Boot leaf stage and it was observed that mean grain of all the six genotypes were significantly higher at two irrigation levels (42.88 q/ha) being statistically at par with one irrigation (40.63 qt./ha)and significantly higher than without irrigation.
- Among different wheat genotypes maximum grain yield (43.83 q/ha) was obtained by HD3171 followed by DBW 252 (41.13 q/ha).Genotypes K1317 was found to performed not so good under restricted irrigation as compared to rest of the genotypes.

Experiment No. 2: **Exploring timely sowing of wheat in NEPZ through surface seeding, seed priming and seed rate under rice-wheat system**

- Under this trial different materials of seed priming like KNO3 and $CaCl_2$ were used along with three rates of seed i.e. 100kg, 125 kg and 150 kg seed /ha for which variety HD 2967 was used. From one year of experimentation it was observed that all the seed priming materials were found to have non-significant effect on grain yield of wheat. Although maximum grain yield was observed when seed was used @ 100 kg/ha and seed priming with 1% $CaCl_2$ which was statistically at par with remaining treatments.

Experiment No. 3: **Optimisation of nitrogen doses for high yield potential under different zones**

- This trial was conducted to maximize the wheat productivity by optimizing the doses of nitrogen fertilizer only. Variety DBW 187 was used under this experiment. From the experimental data it was observed that maximum grain yield was produced when crop was fertilized with 150 % of NPK (51.71 qt. /ha) which was at par with the 100 % of NPK (49.23 qt. /ha) only. Regarding the lodging, maximum lodging by crop was reported when 150 % RDF of N only was applied. Lodging was reduced when plant growth regulators (Chloromequat chloride and Tebuconazole) were applied at first node and boot leaf stage.

Experiment No. 4: **Maximizing the wheat productivity by fine tuning of sowing time and fertilizer rates**

- In this trial 4 fixed dates were selected/given for sowing i.e. 25 Oct 2019, 5 Nov 2019, 15 Nov and 25 Nov 2019. But this was not possible to conduct on given date as there was heavy rainfall during the last month of Oct 2019. The same has been reported to PI of AICRP, Karnal also.

Technology validation: **Performance of normal maturing wheat varieties (NMWV) & early maturing wheat varieties (EMWV) under late sown condition in Bihar**

- This experiment was conducted under restricted irrigation with six wheat varieties namely HD 2967 (125 days), HD 2733 (130 days), Sabour Samriddhi (125 days), PBW 373 (125 days), HI 1563 (110 days), HD 2985 (115 days) at Sabour, Dhangain and Agwanpur to observe the performance of these varieties under late sown condition. It was found that at all the centres early maturing varieties performed better (HI 1563, 34.02 qt/ha and HD 2985, 34.28 qt./ha) than those normal maturing varieties.
- The effect of restricted irrigation was found to have non-significant effect on yield at all the centre. Among varieties also non-significant difference was observed except at Dhangain centre. Pooled data of yield also found non-significant although higher yield was found of early maturing varieties.

4.2.1.3. Evaluation of different super absorbent polymers as moisture controlled release agents in agriculture under dry land regions of Bihar

- Application of solid rain hydrogel @ 15.0 kg ha^{-1} with increasing number of irrigation levels recorded significantly highest economic yield of crops which was found at par with nano hydrogel @ 20.0 kg ha^{-1} with increasing number of irrigation levels.

4.2.1.4. Nutrient and weed management in mustard under rice-mustard cropping system

- Application of pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} as pre emergence followed by quizalofop 5 EC @ 60 g a.i. ha^{-1} as post emergence with 125% of recommended dose of fertilizers in mustard recorded significantly highest seed yield, net returns, and weed control efficiency as compared to rest other treatments.

4.2.1.5. Exploring the suitable sowing windows of *rabi* maize crop and crop modeling in changing climate scenario of Bihar

- Long duration maize variety sown in fourth week of October to second week of November recorded the highest seed yield.

4.2.1.6. Product CFG and Oorja tesing in Rabi maize

- It was concluded that highest grain yield and Net return was noticed with application of 180:112:75:5:30 kg N:P:K:Zn:S ha^{-1} + 375 kg CFG+50 kg Oorja ha^{-1} + 5 Boond+258 Urea which was at pat to treatments T1, T3 T4 and T6 at both location BAC Sabour and JRS Katihar

4.2.1.7. Response of potassium on growth and productivity of wheat in zone –III B of Bihar

- Leaf Area Index at 80 DAS significantly higher in 75 % RD of K +1/3rd paddy crop residues incorporation (T5) followed by 75% RD of K + 25% K through FYM (T6).
- Number of tillers at maturity significantly higher T5-75% RD of K + 1/3rd paddy residue incorporation followed by T3-125 % RD of K as basal.
- Significantly higher grain yield was found in 75 % RD of K +1/3rd paddy crop residues incorporation (T5) followed by 125 % RD of K as basal (T3).
- Highest K-use efficiency found in 75% RD of K + 1/3rd paddy residue incorporation followed by 75% RD of K + 25% K through FYM(T6) and T7-75 % RDK as basal + 25 % RDK at 45 DAS.
- Highest potassium and nitrogen uptake in wheat grain were found highest in T4-150 % RD of K as basal followed by T5-75% RD of K + 1/3rd paddy residue incorporation.

4.2.1.8. Effect of micronutrient and sulphur application on productivity of maize in kosi region

- The results indicated that the growth parameters and yield attributes increased with subsequent increase in sulphur, zinc and boron with causes beneficial effect on grain yield. Application of sulphur @ 20kg/ha, zinc @ 30 kg/ha and boron @ 1kg/ha

individually increases 10.5, 7.6 and 6.1 percent, respectively in grain yield of maize over without its application.

- The maximum grain yield (90.5 q/ha) was observed in S30Zn30B2 But it was statistically at par with all combination of treatment dose of zinc and born with sulphur at 30 kg/ha.

4.2.1.9. Production potential of early, mid and late sown potato under different potassium levels

- Results of the second year study revealed that late variety of potato *viz*., Kufri Sindhuri proved significantly better in terms of growth, yield and economics over early and mid-varieties.
- Among potassium treatments most of the growth parameters, yield attributes, yield and economics of potato have increased significantly with increasing levels of potassium up to 187.5 kg K_2O/ha.
- Further increase in potassium level up to 225 kg K_2O/ha also increase these parameters but the magnitude of increase was not up to level of significant. Application of potassium to potato also brought significant impact on quality and various losses incurred during storage.

4.2.1.10. Yield maximization and lodging management in wheat under different tillage options

- Results of the first year study revealed that application of RDF + One spray of NPK (19:19:19) @ 1.0% + Two spray of chlormequat chloride @ 0.2% proved the significantly superior treatment in terms of growth parameters, yield attributes, yield, economics and quality of wheat along with negligible lodging of crop as compared to control and sole RDF treatment.
- Among different tillage options Zero-tillage with residue retention proved the significantly better with respect to net returns from wheat over conventional method of sowing.

4.2.1.11. Effect of irrigation method and fertilizer dose on yield of boro rice

- The experimental results of the first year study revealed that grain yield of boro rice was found to be significantly superior in irrigation based IW/CPE ratio (52.9 q/ha) over the conventional method of irrigation (44.0 q/ha) and this increment was observed to be 18.2 %.
- However, variation in grain yield due to irrigation based on 20% depletion of available soil moisture (DSM) and IW/CPE ration were observed non-significant. The variation in grain yield was also found significant due to fertilizer doses.

- The fertilizer application based on nutrient expert based fertilizer recommendation and 120:60:60:20 kg N P_2O_5 K_2O and Zn ha^{-1} produced statistically similar grain yield and significantly superior over 80:40:20:20 kg NPK& Zn/ha

4.2.1.12. Effect of crop establishment and potassium management in boro rice

In crop establishment method, transplanted rice was produce significantly higher yield as compared to direct seeded rice and among the potassium management 45 kg K_2O from Potassium sulphate + 45 kg K_2O from FYM, produced significantly higher yield over control and 60 K_2O kg/ha from Potassium sulphate but it was at par with 90 K_2O kg/ha from Potassium sulphate and 60 K_2O kg^{-1} from 50 % Potassium sulphate +50 K% from FYM.

4.2.1.13. Effect of pre and post emergence herbicides for control of Smell melon (Ghurmi) {*Cucumis melo* var. dudaim (Naud.)} in summer green gram for Koshi region of Bihar

- Treatment **(T_3)** Pendimethalin (PE) 1 litre a.i. /ha *fb* Imazethapyr (POE) 40g a.i./ha recorded higher weed control efficiency (in all growth stages). Whereas higher Yield and B:C ratio (2.29) was recorded in (T_4) at Supaul location**.**
- Weed index was found higher in Treatment **(T_4)** i.e. Pendimethalin (PE) 1 litre a.i. /ha *fb* Imazethapyr (POE) 60g a.i. /ha at Saharsa location only.

2.1.14. Effect of different doses of Sulphur on Growth, Yield, S-Uptake and Oil Content in Mustard- Soybean cropping system in Koshi region

- The higher seed yield (q/ha) was obtained under the treatment combination of S3T2 (12.35) which was statistically superior over rest of the treatment S2T2 (12.01) and S1T2 (11.96). While seed yield was minimum in S0T1 (9.15). As the dose of suslphur was increased, the yield gradually increases significantly.
- The oil content (%) and S uptake by plant gradually increased as the dose of S increased and it was recorded maximum in S3T2 (42.10 %) and 21.10 Kg /ha respectively which was significantly superior over rest of the treatment combination.
- The net return and B: C ratio was also maximum in S3T2 (32648.00) Rs/ha 2.42 respectively which was significantly superior over rest of the treatment combination.

2.1.15. Effect of feed block feeding on milk yield and milk composition of cross bred cow

- A total of 35 lactating cows selected and divided into 7 groups (1C+6T). As per this observation the average milk production for the group T4 & T5 was highest with 8.8

ltr/ day & 9.7 l/ day while it was 4.6 for T0. Milk will be recorded for next 1-2 month period for one lactation period.

4.2.2. Soil Science and Agricultural Chemistry

4.2.2.1. Heterotrophic Metabolism of sulphur

- Forty samples of rhizospheric soil of various crops were collected from different locations of Bhagalpur, Lakhisarai, Patna and Noorsarai districts have been collected.
- The chemical analysis of soil samples has been completed.
- The enumerations of microbial population of from the collected soil have been completed.
- Ten isolates of bacteria have been isolated and morphologically characterized.
- Out of ten isolates of bacteria most potent five isolates have been sent for DNA sequencing.

4.2.2.2. Evaluation of N containing superabsorbent hydrogel in Wheat, Chickpea, Lentil and Mustard

- N Containing superabsorbent hydrogel improved Available water content, soil aggregation and dehydrogenase activity.
- $KMnO_4$-N Content was also higher as compared to other under superabsorbent polymer.
- Benefit: cost ratio was highest under T3 (Hydrogel 10 kg ha^{-1} with 1 irrigation at CRI stage).
- Superabsorbent polymer (@ 10 kg ha^{-1}) was economically viable option for chickpea, lentil and mustard.

4.2.2.3. Alternative management based approaches for enhancing Zn and Fe bioavailability in a Rice-Lentil system- A comprehensive comparative study on potential, prospects and economics

- Isolation and morphological characterization of Zinc solubilizing bacteria have been done.
- Seed nutri-priming at different doses of Fe and Zn for time duration of 12 h and 24 h has been done. This is necessary to standardize the nutrient concentrations through germination tests before the proposed pot experimentation.

4.2.2.4. Potential Uses of Parthenium, Bhang and Water hyacinth in Agriculture

- Leaves of Parthenium had higher contents of nutrients esp. K and S; while that of water hyacinth had lower nutrient content.

- The nutritional composition of vermin-compost prepared from Parthenium was higher in comparison to that prepared from Water hyacinth.
- To produce vermin-compost from Parthenium, minimum 15% cow-dung is required to get maximum recovery percentage.
- To produce vermin-compost from Water hyacinth, minimum 10% cow-dung is required to get maximum recovery percentage.
- Recovery percentage of vermin-compost increased with increasing amount of cow dung used.
- Germination % of good quality seeds increased at lower concentrations of Parthenium leaf extract; while for poor quality seeds, better germination % was recorded at higher concentrations

4.2.2.5. National Project on Management of Soil health and Fertility (NPMSHF)

- Grid base map of Bhagalpur has been prepared.
- Soil fertility status of Bhagalpur:- pH -6.00 – 8.90, EC (dS m^{-1})-0.01 – 1.07, Organic Carbon (%)-0.14 – 1.10, Avail. N (Kg ha^{-1})-62.72 – 288.50, Avail. P2O5 (Kg ha^{-1})-4.10 – 82.08, Avail. K2O (Kg ha^{-1})- 69.19 – 467.10, Avail. S (mg kg^{-1}) 5.15 – 92.97, DTPA-Zn (mg kg^{-1})- 0.38 – 4.38, DTPA-Cu (mg kg^{-1})-0.21 – 2.74, DTPA-Fe (mg kg^{-1})-14.00 – 42.50, DTPA-Mn (mg kg^{-1})-8.52 – 33.18, Avail. Boron (mg kg^{-1})-0.20 – 4.00
- Soil fertility map of Bhagalpur has been prepared.
- Other centres soil fertility status has also been worked out.

4.2.2.6. Mapping the spatial variability of soil physical conditions under various land use situations of BAC farm, Sabour

- Soil samples have been collected from the different land uses covering under different perennial orchards like Mango (3 sites), Guava (2 sites), Litchi (2 sites), Kinnow (1 site).
- Geo referenced soil sampling has been done from different depths (0-15 cm, 15-30 cm, 30-45 cm and 45-60 cm).
- Bulk density (BD) and mechanical analysis is under process.

4.2.2.7. Sustainability of various land use systems of Bihar as influenced by soil nitrogen and carbon content.

- Geo-tagged soil samples from 0-20 cm, 20-40 cm and 40-60 cm depth were collected from the following land use system from Bhagalpur (Inceptisols): Fallow/Native

vegetation (Reference), Mango orchard, Guava orchard, Banana orchard, Rice-wheat system, Rice-Maize system, Vegetable system.

- Soil physical and chemical analysis has been done.

4.2.2.8. Identification of promising material for controlling algal growth in Makhana field

- Identified rice straw @ 250 kg ha^{-1} as the most promising way which was found ecologically as well as economically most effective against algal growth in comparison to all other treatments.

4.2.2.9. Iron and zinc bio-fortification of popularly grown rice and wheat cultivars intensively cultivated in Bihar

- Delineation of available Zn and Fe in soils of Kishanganj, Purnea and Araria district is accomplished.
- A field trial comprising 23 rice varieties is conducted at DKAC, Kishanganj centre in previous Kharif-2019 season for screening of high Zn and Fe containing cultivars. Results revealed that the cultivar Sahbhagi Dhan, Swarna and SBRZ5 cultivars are high Zn efficient.
- The field trials at multi-locations conducted on ZN and Fe agronomic bio-fortification in rice and wheat. Results revealed that different modes of application of Zn significantly increased the wheat grain Zn concentration up to 1.5 to 2-fold through soil plus foliar application of Zn.
- Results also revealed that different wheat cultivars respond differently as per their Zn acquisition in grains through different modes of application of Zn. It was found that the soil plus foliar application of $ZnSO_4$.7H2O is highest efficient in enriching Zn concentration grains of both rice and wheat followed by the application of Zincated nano-clay polymer composites.

4.2.2.10. Effect of sample storage duration on aggregate stability, soil carbon and nitrogen fractions

- Soil samples were collected from the BAC farm, Sabour.
- Soil samples have been stored using different storage methods and materials
- Soil pH and electrical conductivity have no effect of storage method till 3 months of study.
- Trend of changes in Available P, Available K and forms of carbon in increasing order: Storage duration-within week>1 month> 2 month>3 monthStorage method-Room temperature>Refrigerator>Deep freezing

- Decrease in soil organic carbon is 2.3-11.6% depending on the storage method used during study.

4.2.2.11. Integrated Nutrient Management in Makhana (*Euryale ferox* Salisb.) under field condition

- Maximum growth and yield of Makhana under field condition observed in combined application of organic manure (vermicompost (25% N of RDN) +75% N through chemical fertilizer + rest phosphate and potassic fertilizer produced yield at par than sole application of RDF (75:45:30 N-P_2O_5-K_2O).

4.2.3. Vegetable and Floriculture

4.2.3.1. Standardization of planting dates of exotic vegetables for zone III B of Bihar

- The trial was conducted in the month of September 2019 and continued up to April, 2020.
- Five different types of exotic vegetables such as broccoli, brussels sprouts, red cabbage, Chinese cabbage and lettuce were transplanted on three different dates i.e. 15thOctober, 1stNovember and 15thNovember.
- Days taken for curd initiation in broccoli, brussels sprouts, red cabbage, Chinese cabbage and lettuce was respectively 65, 90, 46 and 38 and 35 days after transplanting.
- Similarly, days to harvest was 85, 120, 88,60 and 57 days in broccoli, brussels sprouts, red cabbage, Chinese cabbage and lettuce.
- Among these five exotic vegetables brussels sprouts took the longest duration to mature (110 days) and the sprouts continued up till the month of April.
- The yield of all these exotic vegetables was up to the mark
- All these five vegetables can be successfully cultivated in this zone and the suitable time of their transplanting is 15 Nov.

4.2.3.2. Effect of potassium and boron levels on yield and quality of potato

- Result revealed that application of K at 150 % of RDF along with boron 2kg/ha gives the best higher yield. However, it was at par with K at 150 % of RDF along with boron 3kg or 1 kg or 0 kg/ha.
- TSS, Vit-C content, specific gravity, ash content, reducing sugar in potato tubers increase with potassium and boron application to certain level.
- Lower dose of K converts starch into sugar and vice versa at higher dose.
- Vit-C content also increases with increasing potassium fertilizer dose and boron.
- Dry matter and specific gravity is more affected with potassium fertilizer.

- Potassium have helped to slow down senescence and reducing the physiological disorders in storage and decreasing % total weight loss.

4.2.3.3. Response of varieties to fertility level and plant spacing on garden pea (*Pisum sativum* L.) in Koshi area of Bihar

- The experiment was conducted with two varieties, Azad Pea-3 and Punjab-89, three different spacing, S_1 30 cm x 10 cm, S_2 30 cm x 15 cm, S_3 30 cm x 20 cm, and three levels of fertilizer, F_1 60:60:60 NPK (kg/ha), F_2 60:80:80 NPK (kg/ha) and F_3 60:100:100 NPK (kg/ha); the design was factorial RBD with 3 replications.
- $V_1S_1F_1$ (Azad Pea-3 planted at 30cm x 10cm and applied with 60:60:60 NPK) was the earliest for flowering.
- $V_2S_3F_1$ (Punjab-89 planted at 30cm x 20cm and applied with 60:60:60 NPK) at par with $V_2S_1F_3$ (Punjab-89 planted at 30cm x 10cm and applied with 60:100:100 NPK) produced the highest yield.

4.2.3.4. Standardization of cultivation techniques for summer marigold (*Tagetes erecta* Linn)

- An experiment was conducted at the experimental farm of the DKAC Campus during 2019-20 in split plot design with four main plot treatments as planting dates and four sub-plot treatments as fertilizer dose with three replications.
- The main plot treatments included four planting dates, viz., 1st February (D_1), 10^{th}February (D_2), 21^{st}February (D_3), 3^{rd}March (D_4), whereas, sub plot treatments included four fertilizer dose as 80:60:60 (F_1), 100:70:70 (F_2), 120:80:80 (F_3), 140:90:90 (F_4).
- Treatment D_1F_4 was found best (1^{st} February transplanting along with F_4 dose of fertilizers 140: 90: 90) in different growth and flowering related traits.
- Flower yield per plant (g) was found maximum (482.5g) with D_1F_4 which is at par with F_1D_3 i.e. 466.5 (g).

4.2.3.5. Effect of different planting time and varieties on Growth, flowering behaviour and corm production of Gladiolus (*Gladiolus grandiflorus* L.) in Bihar

- The experiment was performed with four varieties of gladiolus, Red Beauty, Candyman, White Prosperity and Intrepid, planted at four dates, 25^{th} September, 10^{th} October, 25^{th} October and 10^{th} November.
- On the basis of growth parameters, variety Red Beauty showed best performance for minimum days taken to sprouting (15 days) and plant height (142.73 cm), whereas,

the variety Candyman exhibited highest number of leaves (12) and length of leaves (84.33cm) planted on 10thOctober.

- In flowering parameters, Red Beauty showed good performance in minimum days taken to spike initiation (79 days), minimum days taken for first floret (93 days) and length of spike (122.73 cm), whereas, White Prosperity showed better results in number of florets/ spike (21.07), fresh weight of flower spike (146.97g) and vase life of spike (15.53days), which were planted on 10thOctober.
- For corm production, Red Beauty showed better performance in number of corms/plant (2.27), whereas, White prosperity showed better performance for number of cormels (107.33), diameter of corms (7.88cm) and average weight of corms/ plant (129.17g) on 25thSeptember of planting.

4.2.4. Fruit and Fruit Technology

4.2.4.1. Compatibility and adaptability study of different rootstocks in Kinnow mandarin and Sweet orange (Mosambi) under Zone III A region of Bihar

- Seeds of different rootstocks have been collected from PAU, Ludhiana and IARI, New Delhi and planted in the nursery.
- Potting of rootstocks sapling has been completed in polybag.
- During first year propagation of Kinnow and Mosambi were done through T- Budding on two available rootstocks i.e. Jatti Khatti and Carrizo on different dates. Upto 50 % survival was noticed after sprouting of new shoots but no longer survival was found and all budded plants were dead during 2-3 months.

4.2.4.2. Standardization of efficient propagation methods of some minor fruit crops.

- Studies on propagation methods of Jamun, Jackfruit, Custard apple and Bael have been undertaken. Three propagation methods have been employed during different months of the year.
- **Jamun:** Fifty per cent graft success was obtained with softwood grafting Jamun in the month of June -July. Softwood grafting was the best method of propagation in respect of shoot length, number of leaves, and success and survival percentage of graft.
- **Jackfruit:** Forty six per cent success was observed with wedge and side grafting in the month of November -December. Wedge grafting was the best method of propagation in respect of shoot length, number of leaves, and success and survival percentage of graft.

- **Custard apple:** Fifty five per cent success was registered with wedge grafting done during the month of August-September. Wedge grafting was the best method of propagation in respect of shoot length, number of leaves, success and survival percentage of graft.
- **Bael:** Wedge grafting and budding are employed in Bael during April-May,2020. Encouraging results were found with wedge grafting in Bael.

4.2.4.3. Performance of different grape cultivars for their yield and quality parameters under the agro-climatic condition of III A zone of Bihar

- A total of thirty seven (37) grape plants of seven different genotypes were transferred from the nursery to the main field of BAC, Sabour while cultivars collected from NRC on Grape, Pune are yet to transfer in coming December.
- Vegetative growth viz. shoot length (53.34 cm), total number of leaves per metre length of shoot (12.5) and leaf area (88.32 cm2) was recorded maximum in the cultivar Pusa Navrang with least vigour was recorded in Black Musket and Flame Seedless.
- Cultivar Pusa Navrang, Bharat Early and Flame Seedless has already came in bearing stage with maximum fruit retention capacity at harvest and highest bunch weight (126.25 gm) in cv. Pusa Navrang followed by Flame Seedless.
- However, fruit quality parameters viz. individual berry weight, TSS and TSS:Acid ratio was recorded maximum in cv. Bharat Early (2.75 gm, 16.08 °B and 25.13).

4.3. Crop Protection

4.3.1. Plant Pathology

4.3.1.1. Survey for emerging insect pests and diseases of maize, pulses, mango and banana in context of climate change

Total of seven districts namely Bhagalpur, Munger, Banka, Katihar, Purnea, Khagari and Patna were surveyed for emerging insect pests and disease of maize, mango, banana and pulses. Major growing areas of maize up to block areas of Bhagalpur, Katihar, Purnea and Khagaria were surveyed for emerging insect pests and diseases. In all surveyed areas late wilt of maize in rabi season (2019-20) with 3-11% incidence was found as an emerging disease. Maximum incidence with 7-11% of late wilt was found in Brari block of Katihar. In some fields 100% late wilt was observed. In Dhamdhaha block of Saharsa and Falka block of Katihar late wilt incidence was found up to 9% followed by Bihpur with 5-8% incidence and Beldaur (Khagaria) with 4-6%. Medium incidence of late wilt with 3-5% was observed in Banmankhi (Purnea), Kursela (Katihar) and Naugachia (Bhagalpur). Late wilt with low incidence of 2-4% was found in Nathnagar and Kharik (Bhagalpur), Kora and Manihari (Katihar), Kirtianandnagar and Barkarakothi (Purnea), and Maheshkunth (Khagaria). It was observed that the cause of Late wilt in above said areas is not only pathogen (*Harpophora maydis*) but high plant density or poor nutritional management or late sowing (around 15 Dec.) or combination of all or few.

Recommendations for farmers against Late wilt of maize

On the basis of survey following recommendation may be done:

1. Avoid susceptible varieties
2. Avoid high plant density and poor nutritional management or late sowing (around 15 Dec.)

Fall armyworm (*Spodoptera frugiperda*) as an emerging insect pest was observed at Kursaila and Fulka block of Katihar district with 45-100% incidence whereas at Sabour, Bhagalpur some incidence of the insect was found.

Recommendation for farmers against Fall armyworm of maize

1. Use of pheromone trap @ 10/hectare
2. Application of Emamectin benzoate 5% SG@ 0.4 g/l water
3. Spray Thiamethoxam 12.5% + lambda cyhalothrin 9.5% @ 0.5 ml/l water

As far as major diseases are concerned, Turcicum leaf blight (TLB) with 5-12% incidence with 2-5 severity (on 0-9 scale), Banded leaf and sheath blight (BLSB) 3-12% incidence with 1-2 severity (on 0-5 scale), cut worm with 4-8% and stem borer with 6-20% incidence was observed in rabi 2019-20 in maize.

Effects of climatic factors on the disease severity of Turcicum Leaf Blight of maize

Matrix combination of all linear correlation coefficient (r) of important climatic factors in relation of TLB severity was calculated and it was found that all the factors are interdependent, so to find the principal component group, Eigen value was calculated, and found that T_max, T_min, RH_max and Sunshine had the major significant impact on the development and severity of the disease.

Recommendation for farmers against TLB of maize

On the basis of last five years survey following recommendation may be done:

1. Avoid susceptible varieties
2. Avoid late sowing (around 15th Dec. enhanced the TLB severity).

Survey for Banana Crop

Major growing areas of banana crop up to block areas of three districts (Bhagalpur, Katihar and Purnea) were surveyed for emerging insect pests and diseases. In all surveyed areas Fusarium wilt (Panama wilt) of banana in 2019-20 with 8-25% incidence was found as a major disease. Maximum incidence of Panama wilt 8-25% was found in Falka followed by Kursela (9-20%) blocks of Katihar, Bihpur (9-18%), Naugachia (8-15%) blocks of Bhagalpur, and Sarsi (2-6%) block of Purnea. Different isolates of the pathogen, *Fusarium oxysporum* f.sp *cubense (foc)* from different growing areas were isolated and molecular characterization was done. No TR4 race was found whereas, *Foc* race-1/race-2 were present. Other major diseases and insect pests were found Sigatoka (5-25% severity) and scaring beetle with 5-35% incidence, respectively.

Survey for Mango Crop

Major growing areas of mango crop up to block areas of three districts (Bhagalpur, Munger and Banka) were surveyed for emerging insect pests and diseases. In all surveyed areas, Red banded mango caterpillar (*Deanolis sublimbalis*) was found as an emerging pest with 5-10% incidence.

Survey for Pulses

Major pulses growing areas of five districts (Patna, Lakhisari, Bhagalpur and Munger and Banka) were surveyed for emerging insect pests and diseases. In all surveyed areas no emerging insect pests or disease was observed. Whereas, less than 5%disease incidence of wilt, collar rot and dry root rot were observed in all lentil growing areas especially *Taal* areas (Mokama, Maranchi, Badhayya, Barh and Ount areas). In some fields Dry root rot incidence was found between 50-60%.

4.3.1.2. An Investigation of Soil Microflora with reference to Plant Pathogens and Bio-control Agents in Conservation Agriculture Ecology

Soil is the inhabitant of many microbes. The microbes in soil are known as micro flora. Soil micro flora includes various fungi, bacteria and other microscopic organisms. It plays a pivotal role in evaluation of soil conditions and in stimulating plant growth. Microorganisms are beneficial in increasing the soil fertility and plant growth as they are involved in several biochemical transformation and mineralisation activities in soils. Continuous use of chemical fertilizers over a long period may cause imbalance in soil microflora and thereby indirectly affect biological properties of soil leading to soil degradation. Thus the present study was conducted in the Department of Plant pathology, BAC, Sabour with the aim to study the demography of soil microflora with reference to Plant Pathogens and Bio-control agents in Conservation Agriculture Ecology.

Soil samples were taken from cropping system of subplot (soybean + maize – wheat, maize – wheat, maize, maize-mustard, chickpea and soyabean – maize) and isolated major soil borne fungi, bacteria and antagonist. Fungal populations included dominant genera of *Aspergillus*, *Curbularia*, *Fusarium*, *Penicillium*, *Trichoderma* and *Rhizopus* whereas Bacterial communities presented *Pseudomonas* and *Bacillus* as dominant species. It was revealed that maximum No. of colonies (32) were found in maize + wheat cropping system which was followed by soyabean + maize (29) and soyabean + maize + wheat (24). Highest average percent contribution (11.30%) was recorded with *Aspergillus* species which was followed by Trichoderma (7.70%) and *Penicillium* (7.30%). In present study, antagonistic efficacy of bio-agents (antagonists) viz, *Trichoderma viride* (Tv), *Trichoderma harzianum* (Th), *Trichoderma viride* (Tv) +*Trichoderma harzianum* (Th), *Pseudomonas fluorescens* (Pf) and *Bacillus subtilis* were tested through dual culture techniques. Data revealed that all the bio-agents were superior in inhibiting the mycelial growth of tested fungus. Among five different antagonists, Highest percent inhibition (79.23%) was recorded in *Fusarium* with *Trichoderma harzianum* (Th) which was followed (77.43%) with *Trichoderma viride* (Tv) and (75.27%) with the combination of *Trichoderma viride* (Tv) +*Trichoderma harzianum* (Th). Among fungal and bacterial antagonist, least inhibition was recorded with bacterial antagonist i.e *Bacillus subtilis.* Among five antagonist minimum mycelial growth (15.20 mm) was observed with *Trichoderma harzianum* (Th) which was at par with *Trichoderma viride* (Tv) with mycelial growth 16.52 mm in case of *Fusarium.*

4.3.1.3. Prevention of Charcoal Rot through Mushroom Waste Amendment in Chickpea

The mean values of disease incidence in different treatments ranged from 1.3 to 4.7 % during 2017-18, from 2.2 to 15.1% during 2018-19, and from 2.6 to 12.5% during 2019-20. Indication of temperature, particularly minimum temperature, in charcoal rot disease development is recognised. The plots received treatments of MW6+T and MW8+T rendered 35.6% and 38.8% greater yield, respectively compared to the control plot. Application of carbendazim rendered 56.5% greater yield than control. Overall, the experiment indicates for a suppression of chickpea charcoal rot with mushroom waste amendment. This is possibly due to enhancing rhizospheric activity of beneficial microorganism. The results indicate for its usefulness for fields of upland condition and moisture stress condition. The output of this work also suggests that it is also useful in the late sowing cultivation system. In view of changing climate, this could be adopted as the provided agri-waste ensures water holding for a longer period. Also, this can be practiced where organic production system is targeted.

4.3.1.4. Nanoparticles Mediated Altered Melanin Biosynthesis in Fungal Pathosystem

Nearly 50% or more than 50% inhibition of spore germination was detected at 100 ppm concentration of ZnNP for both the isolates. However, the results varied between isolates when the examination was made with TiNP. The lowest radial growth was observed in 50 ppm for both nanoparticles in all three isolates. Zinc and titanium nanoparticle reduced the sporulation intensity by 25%. There is a continuous decline in dry weight of mycelium with increase in concentration of both the nanoparticle. The relative melanisation decreases at 150 ppm concentration of titanium nanoparticle and 100 or 200 ppm of zinc nanoparticle. There is regular decrease in relative melanin content with the increase in nanoparticle concentration in broth.

4.3.1.5. Advancing Soil-borne Research at BAU Sabour Development of Sick Plot of *Macrophomina phaseolina*- PHASE-1

Isolates were tested for phenotypic variability. Fluffy, sparse and compact colonies showing white, grey and dark grey colour were collected. Isolates were mass-multiplied on sorghum grain and inoculated in the field. Screening of different genotypes was done in the inoculated field. Charcoal rot disease incidence ranged between 2.5 and 4.2%. Overall, mean disease incidence across entries was 3.0% in the *Macrophomina phaseolina* inoculated field. Further, repeated inoculation is being practiced for maintenance of inoculum in the field.

4.3.1.6. Study on Prevalence of Foliar Blight Diseases of Wheat in Eastern Bihar

A total of 38 wheat varieties were screened against foliar blight disease at Dr. Kalam Agricultural College, Kishanganj. Out of the 38 wheat varieties 6 varieties (Raj 4120,

DBW 14, BRW 3775, BRW 3723, HI 1563 and SW 129) have shown resistant disease reaction and 1 variety (Chirya 7) has shown highly resistant reaction. The severity of foliar blight varied from 02-68 score. Leaf rust reaction of 40S (40% leaf area covered with large susceptible pustule) was observed in Sonalika and Agralocal while HUW 234 shown 20S reaction.

4.3.1.7. Analyzing *Alternaria brassisicola-Brassica* interactions at an elevated temperatures

Later dates of sowing promoted the development of Alternaria blight in mustard. Test weight was also found lower at the later date of sowing. Test weight was found maximum at second and third dates of sowing. There were significant differences between primary and tertiary branching of mustard under different dates of sowing. However secondary branching shows non-significant differences.

4.3.1.8. Exploration of viral complexity in papaya plantation

Under the project "Exploration of viral complexity in papaya plantation" monitoring of aphid population was done in both papaya and cucurbit hosts. The maximum population was recorded between February and March months. Papaya ring spot virus and whitefly-transmitted geminiviruses were detected in both hosts. The progression has been made towards whole genome sequencing of leaf curl associated viruses and subsequently IR-region will be analyzed.

4.3.1.9. Monitoring of mosaic complexity in onion and garlic and their management

A field trial was conducted and mosaic incidence was recorded different lines of garlic Mosaic incidence was recorded different lines of garlic entries 493,499 and 516 were free from disease and mosaic incidence was recorded different lines of garlic G- 282 (20.7%) BRG-13(3.3%) BRG-14(3.4%) and local cultivar 15.8% incidence. In molecular detection studies of viruses using RT-PCR in different genotypes, each sample was tested against Potyvirus. The molecular detection of virus was done through the isolation of RNA from the infected leaves and by using Potyvirus specific primer in RT-PCR assay. In the collected samples five genotypes namely G-1, G-189, G-282, G-323 and G-50 as compared to other genotypes were found positive. Among all the treatments thiamethaxam @2g / 5 lit of water was found to be the most efficient chemical reducing 56.3 % disease incidence of garlic mosaic disease over control whereas neem based neem oil decreased 53.2 % incidence over control. All the chemicals were found superior over neem based formulation in controlling disease. As far as yield is concerned maximum yield was found with foliar application of

Thiamethaxam with 57.3 q/ha. Yield in all chemical treatments were found significantly higher than neem oil treated (49.2 q/ha) over control (34.5 q/h).

4.3.1.10. Influence of climatic factors against web blight disease of black gram in Kosi Zone of Bihar

Web blight disease prevalence in all black gram growing areas of Purnea, Katihar, Araria and Kishangunj districts of Kosi Zone Bihar during Rabi 2019-2020 cropping seasons. The disease incidence was found range from 13.62 to 33.80 percent. Maximum disease incidence 33.80 percent was observed in Kursela followed by BPSAC, Farm Purnea (29.53%), Baisa (19.27%) and Kajha (18.68%) and other areas. Minimum disease incidence was recorded in parora with 13.62% and in Kasba with 16.36 % during 2019-2020 cropping seasons. 15th February sown crop were found to be most effective in increasing yield (6.33 q/h) and reducing the disease incidence (14.61%) followed by 22th February (15.08%, yield 6.04 q/h) and 1st March (15.56%, 5.44 q/h). The positive and highly significant correlation showed between the average minimum temperature and morning Relative humidity of disease incidence. Two foliar spray of Hexaconazole 5EC@ 0.1% was found to be most efficacious in reducing disease incidence (11.02%) and increase yield (6.33 q/h) followed Difenoconazole 25 EC @ 0.05% (12.30%) and Carbendazim 50WP @0.1% (13.41%).

4.3.1.11. Major diseases in Boro rice and their management in Koshi region of Bihar

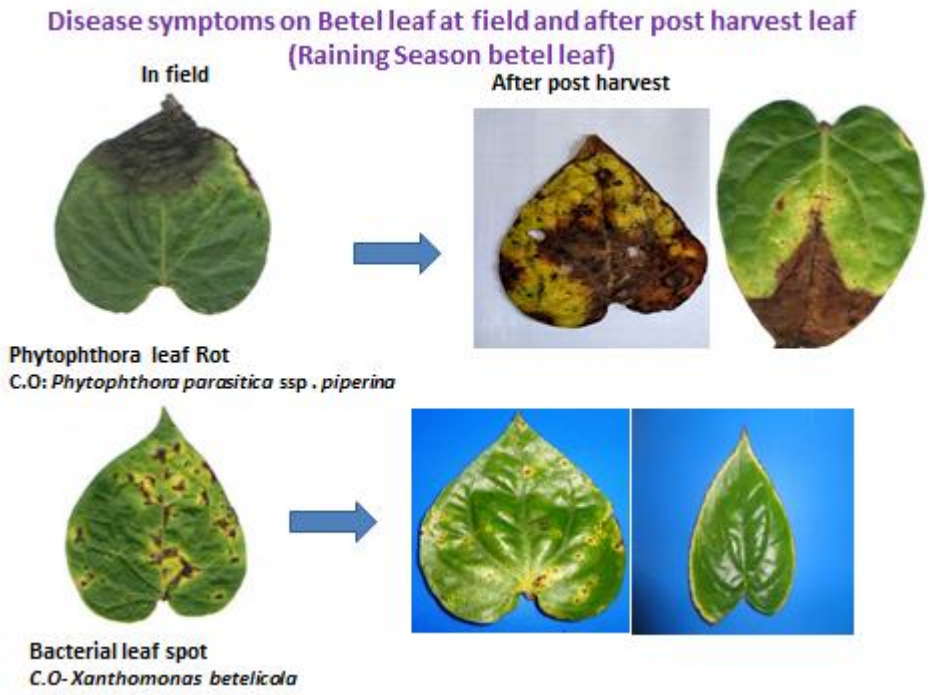
The observation recorded on the basis of survey and experiment conducted at BPSAC farm and found that per cent disease incidence of Sheath blight is highest (i.e. ranges from 22-to-32 %) as compared to Brown leaf spot and Blast disease of Boro rice. Among the treatments with bio control agents (against Sheath blight,) seed treatment + 3 spraying with *Trichoderma harzianum* performed best result with minimum Percent Disease Index (PDI) followed by seed treatment + 3 spraying with *Pseudomonas fluorescens.* During the Comparative study of efficacy against Sheath blight, with botanicals and chemicals, minimum Percent Disease Index was recorded with treatment Azoxystrobin 11% + Tebuconazole 18.3% SC @0.2% followed by Carbendazim 50WP @ 0.1%

4.3.1.12. Management of post-harvest diseases of betel leaf and enhancing the shelf-life of leaf

Survey for betel leaf infection after post-harvest was done in Islampur Market (at Paan Shops-Retailers) and Gaya Paan Mandi (Traders) during the July and August 2020. Spoilage of leaf studies during investigation and infected leaf sample collected for laboratory study. Five, each traders and retails included for loss estimation by post-harvest leaf infection (raining season post-harvest betel leaf). The betel leaf losses noticed higher (30.0%) in paan

mandi (Traders) and lower losses was observed (19.0%) in Paan Parlor (Retail shops). Shelf life of betel leaf was found 9.3 days in betel leaf market based on survey data among traders and retailers.

Post-harvest spoilage of betel leaf (Raining season's leaf) was studied at normal room temperature (25±2°C). At every four days interval spoilage percentage of betel leaf observed up to complete spoilage in present experiment. No any betel leaves were spoilage up to 8 days of post-harvest. It means shelf life of betel leaf was found 8 days. Spoilage of leaf started onward 10 days of post-harvest and on 12 days 4.8% leaf spoilage was noticed. Complete leaf spoilage was noticed on 52 days. Spoilage of betel leaves were found due to infection Phytophthora leaf rot and Bacterial leaf rot caused by *Phytophthota parasitica* Ssp. *Piperina* and *Xanthomonas betelicola* respectively. Shelf life of betel leaves were studied also after post-harvest dip the leaf into 5 different solution including control (water) for 10 minutes. All treatment showed significant difference (at P-0.05) for shelf life under laboratory condition. Shelf life of betel leaf in lemon grass oil @ 0.2% was found superior 20.2 days as compared to control (water) 10.6 days and other treatments applied. Due to antimicrobial action of lemongrass oil @ 0.2% enhanced the shelf life of betel leaf to 1.9 times as compare to control. Significant reduction (at P-0.05) in both diseases of post-harvest (in raining season leaf), Phytophthora leaf rot and bacterial leaf rot was found superior in Lemongrass oil @ 0.2% over control (water) and reduced the diseases by 81.1 and 70.6 % respectively.



4.3.1.13. Development of sustainable seed treatment models for lentil wilt (*Fusarium oxysporum* f.sp. *lentis*)

Collection and processing of rhizosphere soil of healthy lentil plants from different locations of Dumraon for isolation of biocontrol agent i.e., *Trichoderma* spp. and *Pseudomonas flourescens* have been done. Collection and procession of partial / complete wilted lentil plants for isolating virulent pathogen (*Fusarium oxysporum* f.sp. *lentis*) from different locations of Dumraon have been done.

4.3.1.14. Prevalence and Management of Chickpea Dry Root Rot (*Macrophomina phaseolina*) using Agri-waste Amendments

Survey work has been conducted for dry root rot disease in chickpea in different block of Dumraon and with field experiments. But, due to COVID-19 some work has been badly hampered.

4.3.1.15. AICRP (chickpea) Pathological trials

4.3.1.15.1. Evaluation of IVT, AVT1 and AVT2 (Desi, Kabuli, Rainfed and Late sown) chickpea entries against dry root rot disease

- AVT2+1 (Desi): Twenty one test entries were evaluated in which GL15017, DC-17-1115, H15-27, CSJ902 and JG2018-52 exhibited moderately resistant reaction against the disease.
- IVT (Desi): Thirty two entries were evaluated in which BG4010, PhuleG171103, ADBG487 and DC-18-1107 showed moderately resistant reaction.
- AVT (Late sown): Two test entries evaluated in which BRC421 was found moderately resistant.
- IVT (Late sown): Thirty test entries were evaluated in which H1608, IPCB2015-165, BG4017, PG246 and PhuleG1216-6 exhibited moderately resistant reaction.
- AVT1 (Rainfed): Three test entries evaluated entries in which none of them showed moderately resistant against the disease.
- IVT (Rainfed): Twenty four entries were evaluated in which IPCB2016-222, GNG1721, PhuleG11075, H16-12, RKG-19-5 and GL17004 were found moderately resistant against the disease.
- AVT 2+1 (Kabuli+ELSK): Twenty eight test entries evaluated in which PG219, GJGK1617, GLK14306 and IPC13-163 exhibited moderately resistant reaction against the disease.
- IVT (Kabuli+ELSK): Eighteen test entries evaluated in which GLK1640, NBeG789 and HK17-30were found moderately resistant against dry root rot disease.

- IVT (MH)**:** Twenty six entries evaluated in which PG239, RLBGMH-1, BRC423, PG2015-17, JG2019-7444958-2 and IPC2014-10 were found moderately resistant against the disease.
- AVT2+1 (DTIL): Eleven entries evaluated in which JAKI9218 and IPC (L22-33-2) were found moderately resistant against dry root rot disease.
- AVT1 (WRIL): Nine entries evaluated, in which Vijay and BG20211 were found moderately resistant against the disease.
- Check lines: Thirty seven test entries evaluated in which GNG2299, DCP92-3, HC-5, GNG2171, GAKI9218 and JG315 were found moderately resistant against the disease.

4.3.1.15.2. Evaluation of IVT, AVT1 and AVT 2 (Desi, Kabuli, Rainfed and Late sown) chickpea entries against stunt disease

- AVT2+1 (Desi): Twenty one test entries were evaluated in which PhuleG1609, H15-27, JG2018-52, DC17-1115, CSJ902 and CSJ1065 exhibited moderately resistant reaction against the disease.
- IVT (Desi): Thirty two entries were evaluated in which BG4010, Dc18-1104 and ADBG487showed moderately resistant reaction.
- AVT (Late sown): Two test entries evaluated in which none of them showed moderately resistant reaction against the disease.
- IVT (Late sown): Thirty test entries were evaluated in which H16-08, RSGD-984, PG248 and GL1608 exhibited moderately resistant reaction.
- AVT1 (Rainfed): Three test entries evaluated entries in which IPC15-116showed moderately resistant against the disease.
- IVT (Rainfed): Twenty four entries evaluated in which IPC2016-69, IPCB2016-222, GNG2461, PhuleG1107-5, RKG19-5 and RKG19-6 were found moderately resistant against the disease.
- AVT 2+1 (Kabuli+ELSK): Twenty eight test entries evaluated in which GNG2453 and RVSIG633 exhibited moderately resistant reaction against the disease.
- IVT (Kabuli+ELSK): Eighteen test entries evaluated in which BG4019, BG4018 and RSJK-179 were found moderately resistant against stunt disease.
- IVT (MH)**:** Twenty six entries evaluated in which PG239, DMHC18-1664, BRC423, PC2015-17, JG2019-744958-2, RKG19-12, RSGD-966 and IPC2014-10 were found moderately resistant against the disease.
- AVT2+1 (DTIL): Eleven entries evaluated in which IPC (L4-25), NC2, BGM10220 and IPC (L22-33-2)were found moderately resistant against the disease.

- AVT1 (WRIL): Nine entries evaluated in which IPCMB19-2, IPCMB19-3 and IPCMB19-1 were found moderately resistant against the disease.
- Check lines: Thirty seven test entries evaluated in which GNG2299, JG16, GNG2171,JAKI9218, KPG59 and Pant Gram5 were found moderately resistant against stunt disease.

4.3.2. Entomology

4.3.2.1. Molecular characterization of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee)

After the sequencing of Primer I and II, a phylogenetic tree was prepared. After preparation of the phylogenetic tree it revealed that three clusters were formed. Under cluster 1, Araria, Purnia, Banka and Bhagalpur isolates are fallen, in cluster 2, Katihar and Munger isolates are fallen and in cluster 3, Munger, Katihar and Banka isolates are fallen. Maximum genetic similarity was 100 % and minimum genetic similarity was 89.91 %. It shows that the diversity is very less. Phylogenetic relationship between collected samples and reported isolates revealed that the isolates from Bihar were not very diverse and it seems to be originated from a common ancestor. Single management strategy can be adopted against *L. orbonalis* for the entire state of Bihar.

4.3.2.2. Seasonal Incidence and Management of Mango Leaf Webber

The maximum population (4.2-4.9) of leaf webber was recorded in the standard week 33rd-37th. The most preferred variety of mango leaf webber namely, Amrapali, Barmasia, Bombai Calcattia, Maldah, Neelam, Safed Bathua and Tommy Atkins.

4.3.2.3. Bio-ecology and management of red banded mango caterpillar on mango

The Red Banded Mango Caterpillar, *Deanolis albizonalis* have been confirmed to be present at Sabour and the adjoining areas. In the laboratory, a comprehensive study on the bio-ecology of the borer has been done which suggested the different behaviours of the borer. The *Deanolis albizonalis* preferred to lay eggs on the base of the fruits. The bore hole of *Deanolis* (Red banded mango caterpillar) was found at the tip of the fruit without excreta coming out of it. The preference-non preference test done in the laboratory indicated that the *Deanolis* only preferred the bark as the site of pupation. The reasons behind the susceptibility of the cultivars like Langara have been worked out successfully. According to us, the site of pupation is the most exciting and encouraging indication from the point of view of managing the pest. In the year 2020, a large scale experiment on the management of RBMC suggested that spraying of Chloropyriphos 50% + Cypermethrin 5% EC @1.5 ml/lit on the tree trunk

only & Inoculative release of *Trichogramma chilonis* at peak flowering stage could suppress the pest.

4.3.2.4. Network Project on Fall Armyworm in Bihar

4.3.2.4.1. Survey and surveillance on fall armyworm

The average Per cent damage to the crop was in the range of (22 to 38 %) at farmer field in Purnea and adjoining districts. Data showed that the larval population and per cent damage has slowed down in the month of 15 Dec to 15 Jan because of low temperature and or otherwise the temperature, humidity may not be within the range of suitability for their life cycle. In survey, farmer responded that all these four insecticides are quite effective for controlling FAW. Among all these insecticdes Thiomethaxam+Lambda cyhalothrin (12.6 % +9.5 %) is easily and cheaply available in the market compared to other insecticides However farmer also reported that Thiomethaxam+Lambda cyhalothrin and Emamectin Benzoate 5SG are very effective at early stages of FAW larvae while spinotoram and chlorontroliliprole were effective even against late instar larvae. During first week of June 2020, infestation of fall army worm on Kharif Maize was observed at Chakani village, Simari Block, Buxar district. However, incidence was restricted to areas near to south bank of river Ganges in Buxar district. During survey conducted on fall army worm in Sahpur under Sonbarsa Block , Bhelwa, Telwa, Birgawn, Baghwa,Manovar under Mahisi block, Chakbhro in Simri block of Saharsa district fall armyworm was found causing damage to maize crops. It was also reported from Maharas, Sarbela, Sahuriya, Itahari panchayat of Banma Itahari Block. FAW infestation was found raning 1-2 % in Bara Khurd, Narai, Purandarpur, Muzaffarpur, Chandasi and Noorsarai block.

4.3.2.4. 2. To screen the tolerant varieties/hybrids against fall armyworm on maize

Maximum FAW infestation was found 18.22 with the hybrid 5x11 and least infestation was 7.40 % with the variety SHM-1 at BAC, Sabour, FAW infestation was found least with the hybrid 9135 (9.63%) and maximum with 13x7 (22.45%) at BPSAC, Purnea while FAW infestation was found least with the hybrid 3392 (6.17%) and maximum with 4249 (25.25%) at MBAC, Agwanpur, Saharsa. The infestation was found about 1% in Rabi maize at COH, Noorsarai.

4.3.2.4. 3. Evaluation of some insecticides against fall armyworm

Module IV comprising collection and destruction of egg masses and larvae feeding in groups at initial stage (15-25 DAS), Application of sand + fly ash in 1:1 ratio (After whorl formation), Ist spray with Indoxacarb 14.5 SC@1ml/l after 5 days of application of sand + fly ash, Spraying of Thiamethoxam 12.6% + Lambdacyhalothrin 9.5% @ 0.5ml/l at 15 days after

Ist spray was found most effective in reducing number of damaged leaves/ 10 plants (2.65),number of larva/10 plants (2.04) and number of holes/windows/10 plants (2.88) with highest yield 78.12 q/ha

4.3.2.5. Insect fauna of maize with special reference to management of maize stem borer

Soil Insect fauna *viz*.; Cricket, Spodoptera larvae, black ants, Beetles, cutworm, earwig, ant, *Gonocephalum* spp. were found during the year 2018-19 and 2019-20. A new invasive pest, Fall Armyworm was also found during the year 2019-20. Maximum population of stem borer of 2.75/10 plants was found at 37th standard week, 15.57 pentatomid bugs/10plants at 45th standard week, 2.25 ichneumonid wasps/128m^2 at 44th standard week and 1.02 cobworm larvae/10plants at 45th standard week during Kharif 2018. Maximum population of pink stem borer of 2.45/10 plants was found at 7th standard week, 16.75cutworm/50 m^2 at 6th standard week, 2.40 shoot fly/50m^2 at 5th standard week and 8.45 cobworm larvae/10plants at 17th standard week were found during Rabi, 2018-19. Maximum population of stem borer of 3.44/10 plants was found at 39th standard week, 8.23 pentatomid bugs/10plants at 45th standard week, 3.10 ichneumonid wasps/128m^2 at 44th standard week and 4.78 cobworm larvae/10plants at 46th standard week during Kharif, 2019. Maximum population of pink stem borer of 3.76/10 plants was found at 7th standard week, 3.26 cutworm/50 m^2 at 5th standard week, 2.08 shoot fly/50m^2 at 3rd standard week and 7.74 cobworm larvae/10plants at 15th standard week were found during Rabi, 2019-20. Pooled data of the two years showed that the treatment, spraying of Emamectin Benzoate 5 SG @250 g/ ha was found effective in reducing leaf damage 3.98, and 1.77 per cent cob damage while Fipronil 5 SC @125 ml/ ha was found reducing the dead heart (1.83%). Yield was highest 54.72 q/ha in this treatment. Population of natural enemies was found higher in the treatment.

4.3.2.6. Population Dynamics of Insect Pest and their management in Boro paddy

Among all the treatments, Module-IV (it consist of Pheromone trap with 5mg lure @ 20 trap/ha + release of % trichocard/ha of *Trichogramma japonicum* for mass trapping from 20 date at 15 days interval + NSKE @ 5%) was highly effective in the management of yellow stem borer in Boro rice with least dead hearts (6.08% at 30 DAT and 6.28% at 50 DAT and also white earhead (6.18 % at 90 DAT) was found significant compared to the control.

4.3.2.7. Biotic stress management through organic amendment and bio-pesticide in Makhana (Euryale *ferox*)

Soil Amendment with 100 % vermicompost and application of bio-pesticide gave highest yield (35.45), B: C ratio (5.65:1) and lowest population of insect pest in Makhana.

The lowest insect pests were observed in the treatment having different doses of vermicompost compared to plot receiving chemical fertilizer. Application of vermicompost increases secondary metabolites such as total phenol, SOD, which reduces the pest population, but peroxidase enzyme showed almost similar in all the treatments. The experiment was further taken to the farmers' field with the treatment which was given the best result in our experiment i.e., Soil amendment with 100 % vermicompost and application of bio-pesticide.

4.3.2.8. Fumigant toxicity of essential oil against three stored product beetles

The Essential oil of *Chenopodium botrys, Citrus reticulata, Lantana camara and Pinus roxburghii* either alone or in combination at 0.4 per cent found highly effective *against Sitophilus oryzae, Rhyzopertha dominica* and *Tribolium castaneum* in stored wheat. These essential oils are highly effective against *S. oryzae, R. dominica* and *T. castaneum* at 0.4 per cent as they can check the feeding and breeding of test insects in stored wheat in metal bins and super bags as compare to untreated control. These essential oils either alone or in combination at 0.4 percent does not affect the germination quality of stored wheat and organoleptic properties of chapatti in either washed or unwashed condition.

4.3.2.9. Bio-efficacy of Diatoceous Earth against insect pest of stored grain

The diatomaceous earth was found effective against *Sitophilus oryzae* and *Rhyzopertha dominica,* at 1.25 and 1.5 per cent concentration as they inhibits the 100 per cent population as compare to untreated control, whereas, it showed highly effective against *Tribolium castaneum* at 0.75, 1.00 1.25 and 1.5 percent concentration as they inhibits the 100 percent population as compare to untreated control. The diatomaceous earth was also found effective against *Collasobruchus Chinensis* at 1.00 1.25 and 1.5 percent concentration as they inhibit the 100 per cent population as compare to untreated control.

4.3.2.10. Survey and management of Mango bark eating caterpillar in Koshi region of Bihar

The poorly managed orchards of mango were more prone to attack with an incidence of 88 and 92 per cent in comparison to 20 and 24 per cent in well managed orchards, respectively. Young orchards were less prone to attack of bark eating caterpillar infestation with an incidence of 16 and 20 per cent in comparison to 88 and 80 per cent in old orchards of mango respectively. Neglected and shady orchards are more prone to attack by this pest. Thrusting of wire + pouring of carbon bisulphide+ plugging holes with mud showed maximum mortality (93.19%) due to holes plugged with mud. Clean the infected hole + hole

fill with micronutrients such as zinc, iron etc+ *Lantana camera* leaf extracts causes , 90.19% mortality, it is Eco Friendly and also help in packing and healing of bark.

4.3.2.11. Population dynamics, loss assessment and bio-efficacy of various insecticides against pest complex of cabbage

Maximum infestation of Diamond back Moth was observed in the first week of April and Tobacco leaf eating caterpillar was recorded in the third week of February. Infestation of Cabbage head borer was highest in the first week of April. Among the treatments, Spinosad (0.3ml/lit.) was the most superior treatment against DBM and recorded highest yield followed by Indoxacarb (0.5 ml/lit.) The treatments Novaleuron, Flubendiamide, Enamectin Benzoate and Profenophos were at par with each other. The bio-pesticide, NSKE 5% showed poor result as compared to the chemical pesticides in controlling cabbage pest complex.

4.4. Product Development and Marketing

4.4.1. Food Science and Post Harvest Technology

4.4.1.1. Development of Real Time On-package Freshness Indicator for Fruit Packaging

In this project, the best formulation for sensors has been identified to have a smart packaging system. Sensors were successfully validated with climacteric fruits such as banana, guava, and tomato facilitating non-destructive quality assessment of during packaging, suitability for transporting the fruit lot, and suitability for fresh consumption. The rejection point could be identified through changes in color of sensors. Moreover, a sensor to assess the ripeness of sapota was developed.

4.4.1.2. Coupling Ultrasound with Eco-safe Compounds for Delaying Pericarp Browning in Litchi

In this project, the effect of ultrasound treatment for different durations (5 to 20 min) at 40 and 60 C was assessed. Treatment at 60 C for all duration resulted in the blackening of litchi fruits so the treatment at 40 C was further used for assessing different parameters. Different quality parameters linked to pericarp browning and senescence of litchi fruits were verified. The ultrasound treatments for 5 or 10 min at 40 C were found to have better effects on quality preservation.

4.4.1.3. Fabrication of Ohmic heating unit for Liquid Foods

Design for fabrication of ohmic heating unit has been completed as per the review collected. Ohmic heating unit set up of size 1250 × 75 × 50 mm of teflon sheet is under process for heating and concentration of milk, watermelon juice and sugarcane juice etc.

4.4.2. Agricultural Engineering

4.4.2.1. Design and development of self propelled light weight boom sprayer

Design of machine has been completed and as per design, Frame of machine has been fabricated and equipped with 5 HP diesel engine as well a high pressure pump is fixed on the machine for spraying. Fabrication and fixing of boom and nozzles are under process.

4.4.2.2. Design, Fabrication and Testing of a Battery operated Rotary Tiller

Design of the machine has been completed and purchase process for the assembly of machine, items like battery, controller etc. has already been initiated. Alternating current based rotary tiller has been developed, and it requires to be operated by battery.

4.4.3. Olericulture & Floriculture

4.4.3.1. Shelf Life Studies in Dry Flower Products

On the basis of the shelf life, 115 dry flowers and planting material [identified in earlier research work (SP/PDM/Kh/2015-02) in between 2015-2018] have been cateogarised. Eight dry flower products (photo frames, greeting card, pen stand, coaster, table mat, scenery, bookmark and table top) made with identical designs and flowers, were studied under eight different conditions viz., T0 (uncovered condition), T1 (display board), T2 (thin polythene lining), T4 (thick transparency sheet), T5 (laminated condition), T5 (framing or glass cover), T6 (acrylic plastic cover) and T7 (cello tape covering). Since last 20 months, it was observed that poor quality and minimum shelf life was observed in uncovered condition followed by display board condition. In treatments T3, to T7, the products are found in good condition with no insect and fungus infestation except for the trait colour deterioration. aIn natural flower colour retention studies, sixteen flowers and leaves (with good to higher shelf life) were studied via utilization in product preparation and kept under above mentioned coverings and it was concluded that in most of the flowers, maximum colour retention was under lamination condition, plastic cover and cellotape covering.Under moisture loss and flower shrinkage study, thirteen flowers viz., Ixora, rose, chrysanthemum, cassia, annual chrysanthemum, pansy ice plant, brachychome, phlox, dianthus, carnation, gerbera and perennial chrysanthemum were studied. In this study it was found that optimum moisture content in flowers directly control the quality and shelf life of the product. Usually it should be in between 10-12% but it varies from flower to flower, depending on its texture, size and utility. In some flowers like dahlia and gladiolus it was found towards higher side (up to 23%) in order to manage flower appearance and in some flowers like ixora and helichrsum, it was towards lower side (around 5%) due to its drier texture.

4.5. Social Science

4.5.1. Agricultural Extension Education

4.5.1.1. Designing and development of Branding strategies for selected released technologies of BAU, Sabour

In this study we observed that there is a mixed attitude of the farming community towards advertising. Majority of them considered that advertising increases the prices of the product as well as they are sceptical about credibility. At the same time, they feel that advertisements create competition among different firm which will ultimately help in getting quality products. As far as the different medium is concerned News and Magazine are the most credible source of advertisement followed by television. Internet is having least credibility as far as advertisement is concerned. In the context of brand value, the majority of the respondents are having favorable attitude towards functional value followed by the conditional value. They reported that branded products are costly but having quality assurance. Majority of them also reported that they use to prefer different brands for different products. The quality of advertisement depends on For branding strategies, we have to follow the same colour, same music, name, and design for different products. Assured quality and continuous supply are two important parameters which need to take care during the brand strategies. In the coming future, online marketing could be a potential way to sell university products. Further, micro-entrepreneurs could act as a market channel at the grassroots level for the university products.

4.5.1.2. Understanding Farm-Household Management Decision making for Increased Productivity in the Eastern Gangetic Plains

Farmers are not 'Homo-economicus' their decision-making process is also driven by social norms, heuristics, cognitive biases, loss aversion and other factors. We have conducted focus group discussions and 80 key informant interviews at five nodes of Purnea district. Most of the times farmers don't want to break their status quo situation. By proper tailoring of messages the adoption process could be accelerated. Majority of farmers are in small and marginal category, micro-incentives are also helpful in the adoption process. Continuous reminder and push also affect the adoption process up-to a great extent. Based on KIIs and FGDs potential choice experiments will be designed and executed in the coming days.

4.5.1.3. Reasons and Effect of Migration on Farm Household Level in Seemanchal Area of Bihar

The rising levels of stress on agriculture-based incomes and livelihoods and the urban centric nature of economic growth happens to influence pattern of migration, in rural to urban

migration rising in significance. In this backdrop, the project was designed to find out the reasons, pattern and effects of migration as well as livelihood vulnerability of farm household in Seemanchal area which is happened to less developed area of Bihar. The locales of study are Kishanganj, Purnea, Araria, Katihar district of Seemanchal area of Bihar. Results showed migration has major contribution in farm household's income and members mostly migrated to outside state for earning income.

4.5.1.4. Assessing the Impact of BSDM Training Imparted by BAU Sabour on Practicing Trainees in their Activities

Under the Bihar Skill Development Mission (BSDM), Bihar Agricultural University, Sabour is imparting training under Bihar Skill Development Mission (BSDM) for the last three years. So it becomes imperative to know the impact of this training to the trainees in their enterprise activities accomplishment. Three trades viz. Beekeeping, Mushroom and Gardener were selected for this purpose. Sixty successful trainees were interviewed and it is noted that important characteristics of successful trainees are passion for success, determination for success, confidence in target achievement, stability in business output, optimism in business and risk bearing ability. However, the major constraints faced by the trainees were lack of fund, lack of land for the centre establishment, complicated and difficult institutional loaning procedure and unawareness on institutional credit facilities in some cases.

4.5.1.5. Impact Assessment of Innovative Extension Approaches Adopted by Bihar Agricultural University, Sabour

The innovative approaches like Videoconferencing, Kisan Helpline, YouTube, Micro-SD card-based Transfer of technologies were studied. It was found that in case of Videoconferencing, the extent of interactivity (77.00%) and ease of usage were very high (80.00%) whereas ease of accessibility (12%) and extent of learning (33.00%) were very low. It was also observed that in case of YouTube, the extent of learning retention (87%) however cost of accessing services were perceived to be moderate (80%) by majority of respondents. It was also found that ICT interventions have reduced cost of reaching farmers by around 80%. This is further expected to reduce as the subscriber base increases.

4.5.1.6. Assessment of Production System Constraints and Development of Research and Recommendation Domain Priorities for the Major Farming Systems of Agro-Climatic Zones II and IIIA of the Bihar

The cropping systems *viz*. Makhana cropping system in the flood prone areas, Maize cropping system in Diara region and Katarni rice production system in the Bhagalpur region

have been delineated. The production constraints and to study their intensity, distribution pattern and their interaction pattern with natural and socio-economic factors have been carried out in case of Katarni rice and Makhana based cropping system.The major research and extension domain recommendations have been developed for Katarni Rice, Diara Maize and Makhana based production systems. Locations specific technology needs profiles and to priorities the research and extension activities have been developed for all the three production systems.

4.5.1.7. Intervention opportunities in Agriculture and allied areas for the livelihood security of tribal farmers of Bhagalpur district of Bihar

The project is implementing in two Tribal villages, namely Sheetalpur and Bermasia of Pirpaintee block in Bhagalpur districts. Group approach is adopted for the sustainability of interventions *viz.* farming, poultry, and backyard kitchen gardening for tribal farmers' livelihood security rather individual approach. With the several meetings; as well as telephonic talk due to COVID-19 Pandemic the tribal women farmers have been motivated to develop SHG, having twelve (12) women in this group is being strengthen. Simultaneously, rural youths are also being motivated for developing FPO of the 25-40 age group ; having 10 tribal farmers in this group.

4.5.1.8. Study on Adoption Behavior of Organic Growers and their Market Linkage in Koshi Region of Bihar

Project is implementing in Saharsa, Supaul and Madhepura districts of Bihar with the objectives of to study knowledge and adoption behavior, constraints faced, Participatory Guarantee System (PGS) in organic farming and market linkage of organic vegetable farmers. From the study it is noted that farmers grow Cauliflower, Tomato, Onion and Brinjal under organic farming programme. They are using Vermicompost, *Trichoderma*, neem oil, PSB and Azotobacter as inputs for organic farming. It is noted that most of the farmers are small and marginal and middle age group. Farmer wants more training on organic farming and more field visit by experts for advisory on organic farming. Farmers find it difficult to get remunerative price of organic vegetables from the market.

4.4.4. Agricultural Economics

4.5.2.1. Computation of vulnerability indices in the context of climate change in Zone II of Bihar

The present study on Computation of vulnerability indices in the context of climate change in Zone II of Bihar has been planned to find out contributory factors of vulnerability and its sources in second zone of Bihar. The study was conducted in eight district of Bihar.

Secondary data on identified factors like population density, literacy rate, infant mortality rate under demographic factors and other determinants were variance in annual rainfall as well as minimum and maximum temperature variance under the climatic factors, however production, productivity and cropping intensity were most important determinants of vulnerability were collected from Directorate of Economics and Statistics ,Government of Bihar for the period from 1975-2015 thereafter index for selected districts were calculated by using Patnaik and Narayanan's method of the equal weight and simple average score. It revealed that, the population density of the district was hypothesized to be positively related to the vulnerability i.e., with the increase in the number of persons per sq. km., the vulnerability to climate change would increase due to its direct impact on global warming. However the literacy rate was hypothesized to have a negative relationship with demographic vulnerability. Other determinants were variance in annual rainfall as well as minimum and maximum temperature variance, indicated that increase in the variability of these climatic indicators would increase the vulnerability of the districts to climate change. District- wise analysis indicated that, as per ranking Kishanganj district placed at the first position followed by Khagaria, Saharsha and Purnia. It is important to focus on the impacts of climate change on level of income / productivity of crop, level of education, cropping intensity, and re-establish the links with poverty, livelihood and environment. It could also be seen that higher yields of crops led to higher incomes of the farmers and thereby increasing their risk bearing ability to various shocks.

4.5.3. Statistics, Mathematics and Computer Application

4.5.2.1. Development of Weather based forecasting models for food grain production in Zone III of Bihar

Crop production data for Rice, Wheat, Maize, Pigeon Pea, Chick Pea has been collected from Directorate of Economics & Statistics. Fifty years daily weather data (Temperature, RF, RH, Wind speed and Sunshine hour) purchased from Indian Meteorological Department, Pune. Compilation of all types of data collected is finished. Programming of codes for ARIMA, ARIMAX and ANN procedure is in progress using R software.

5. Variety and technology release proposal

Sl. No.	Variety/ Technology	Group	Proposed by
1	Mango Hybrid-140	Crop Improvement	Dr. Sanjay Sahai, BAC, Sabour
2	BRG-13 (White garlic line)	Crop Improvement	Dr. Sangeeta Shree, BAC, Sabour
3	BRG-14 (Pink garlic line)	Crop Improvement	Dr. Sangeeta Shree, BAC, Sabour
4	Management of Armyworm (*Mythina separata*) in rice	Crop Protection	Dr. S.B.Sah, MBAC, Agwanpur
5	Management of Red banded mango caterpillar	Crop Protection	Dr. T.N. Goswami, BAC, Sabour

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   b) Dr. Tushar Ranjan (MBGE.)
   c) Dr. Satyendra (PBG.)

2. **Crop Improvement**
   a) Dr. T. Chattopadhay (PBG.)
   b) Dr. Dhrmasheela Thakur (MBGE.)
   c) Dr. Shrin Akhtar (Veg.)
   d) Dr. K. Karuna (Fruit)

3. **Natural Resource Management**
   a) Dr. Sangeeta Shree (Veg.)
   b) Dr. Amit. Pradhan (SSAC.)
   c) Dr. Mainak Ghosh (Agro.)
   d) Dr. Manoj Kumdu (Fruit.)

4. **Crop Protection**
   a) Dr. Arshad Anwer (P.P.)
   b) Dr. T.N. Goswami (Ento.)
   c) Dr. Abhijeet Ghatak (P.P.)

5. **Product Development & Marketing**
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   b) Dr. Wasim Siddique (FST.)
   c) Mr. Perm Prakash (FST.)

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   b) Dr. Chandan Kr. Panda (Extn.Edn.)
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   b) Dr. Ajay Bhardwaj (Veg.)
   c) Dr. Samik Sengupta (SSAC)

8. **Valedictory Function**
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   b) Dr. Deepti Singh (Veg.)
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