Annual Report 2017-18

DIRECTORATE OF RESEARCH UTTAR BANGA KRISHI VISWAVIDYALAYA PUNDIBARI, COOCH BEHAR, WEST BENGAL, PIN-736165

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#### Preface

With an objective of catering the location specific research need of Hill Zone and sub Himalayan plains of the State, the Government of West Bengal up-graded the North Bengal Campus into a full-fledged Agricultural University by the name of Uttar Banga Krishi Viswavidyalaya 21<sup>st</sup> February in 2001 by the West Bengal Act XX of 2000 with the jurisdiction area of six Northern districts viz., Darjeeling, Cooch Behar, Jalpaiguri, Dakshin Dinajpur, Uttar Dinajpur and Malda comprising one college, three Regional Research Stations and their three sub-stations and two Krishi Vigyan Kendras(KVKs) as on 22 August 2000. The goal setting was done on the basis of identified rationales and the task was accomplished by dedicated participation of multidisciplinary group of scientists each committed to his/her own field. In 2001, the three Regional Research Stations extended adequate support in formulation of new Directorate of Research of Uttar Banga Krishi Viswavidyalaya (UBKV) born out of bifurcation of BCKV and since then it became a constituent of the same. This also incurred some static change in scientists group through optional discontinuity of few seniors and subsequent refilling by fresher. Under the present era of UBKV, the stations observes due responsibility to keep parity with the predecessors vis-a-vis setting new goals pertaining with existing agro ecological dynamics of the zone. Based upon the research need of this area under consideration programmes are adopted and carried out accordingly on seasonal basis twice in a year i.e. Rabi and Kharif. Apart from half yearly project formulation session, Scientists meet regularly for technical discussion on progress of running programmes once in every month and all issues related with same are covered duly. The present Report comprises of results obtained out of programmes under taken at the three research station for three consecutive crop seasons i.e. Pre Kharif , Kharif 2017and Rabi 2017-18. Critical observations, suggestions on this report will be cordially accepted for further improvement of the same.

Prof. Ashok Choudhury (Director of Research, UBKV)

# **Region specific broad areas of research and priority areas**

## Vision:

To become a Centre of Research Excellence on Farm Science for the three agro ecological zones of the North Bengal

## Mission:

To achieve commendable leadership in addressing Regional Research issues for the interest of farming community of Northern part of West Bengal in particular and Eastern India in general.

# Perspective:

- Productivity to Profitability with long term sustainability.
- Subsistence agriculture to Commercial agriculture.
- Food security to Nutritional security.
- Commodity oriented economy to Farming system economy.
- Local market orientation to Export market orientation without disturbing food security.
- Chemical technology to Biological technology.
- Supply driven production decision to Demand driven production decision.
- Raw farm produce to Value added output.
- Public sector extension to Private sector service provisioning.

# Strategy:

- > Identification of thrust area on the basis of perspective parameters.
- Prioritisation of research questions on time frame and thereby to decide on interventional mode.
- Generation of location specific new technology and refinement of existing one.
- Organisational collaboration with reputed host institutes both public and private that ensures mutual interest.

## **Issues:**

 Development of high quality improved cultivars to meet domestic and export demand and resistance or tolerance to abiotic and biotic stresses.

- Refinement of crop models encompassing with dynamics of climate change and augmentation with new research results.
- ✤ Generation of cost effective site specific technologies within the affordable range.
- Collection, characterisation, screening and conservation of plant genetic resources for futuristic use.
- Screening, characterization and multiplication of native flora and fauna towards the formulation of bio inputs.
- Development, validation and promotion of plant health management protocols including INM and IPM modules keeping parity with crop diversification, availability of local inputs and affordability of practicing farmer.
- Exploration of remunerative area from agribusiness point of view and devising functional linkages along the value chain.
- In-situ evaluation, monitoring and impact assessment of existing technology to ascertain economic and ecological performance.
- Efficient utilisation of biomass obtained from various crop wastes.
- Development of post-harvest protocol for fruits, vegetables, spices, etc. by adopting suitable physical and chemical pack house treatments and packing systems.
- Simulation and forecasting on uncertain variables like rain fall, temperature, incidence of major pests on major crops, crop acreage, marketable surplus and harvest price, etc. those directly influence farm income.
- Up scaling of production and productivity of allied farm income avenues like fisheries and animal husbandry through research intervention.
- Proposition for organised marketing.
- Assessment of Plant diversity, Regeneration dynamics, Carbon pools and Climate change mitigation strategy.
- Establishment of research platforms on cropping system including crop production and crop protection with emphasis on productivity, quality, soil health, production constraints and economics.
- Preparation of exhaustive soil resource maps to ensure site specific nutrient recommendations.
- Application of Geo spatial tools (Remote sensing and GIS) for crop area assessment, yield prediction, soil water monitoring and management, digital soil mapping and pest and disease monitoring.

# Mandated crop:

Crops	RRS TZ	RRS HZ	RRS OAZ
Cereals	Rice, Wheat, Maize	Rice, Maize	Rice, Wheat, Maize
Pulses	Lentil, Green gram,	Green gram	Lentil, Black gram, Green
	black gram	Soybean	Gram
		Rice bean	
Oil seed	Mustard	Mustard	Mustard, groundnut
Spices	Turmeric, Black pepper,	Turmeric, large	Turmeric, Seed spices
	Bay leaf, ginger etc.	cardamom,	
		Zinger,	
Vegetables	Brinjal, Tomato,	Chow-chow,	Brinjal, Tomato, Chilli and
	Cucurbits, Potato and	chilli, cole	Cucurbits etc.
	othertuber Crops, Ridge	vegetables,	
	gourd, Pointed gourd,	potato, radish,	
		carrot, beans Bell	
		pepper (Dalley	
		Khorsani) and	
		yacon etc.	
Fruits	Banana, Pineapple,	Mandarin,	Mango, Litchi
	Jackfruits and Citrus	Strawberry	
Plantation	Areca nut, Rubber and	Теа	Coconut
	Coconut etc.		
Flower	Gladiolus, Orchid,	Orchid, Gladiolus,	Marigold, Gerbera
	Gerbera	Anthurium,	
		Alstromeria,	
		Gerbera, Azaleae	
Fishery	Indian Major Carp (IMC)		Indian Major Carp (IMC)
	and Jeol fish		
Animal	Black Bengal Goat, Dairy	Poultry, Piggery,	Dairy, Poultry, Apiary
Science		Gotary	

Having considerable market share from commercial point of view.

# Zone specific research issue needs immediate attention:

# Hill Zone:

✓ Integrated Management strategies for Rhizome rot and wilt complex of ginger

- ✓ Integrated Management strategies for Declining of Darjeeling Mandarin.
- $\checkmark$  Integrated Management strategies for large cardamom diseases.
- $\checkmark~$  Refinement of Water harvesting technology.
- $\checkmark~$  Management of sewage water for irrigation.
- ✓ Collection, characterisation, screening and exploitation of bio-agent suitable for hill and mountainous ecosystem.
- ✓ Packaging of floricultural product.
- ✓ Multiplication of good planting material.
- ✓ In-situ small scale processing unit.
- $\checkmark\,$  Production protocol for medicinal plants and broom stick.
- ✓ IFS in Hill standardisation of optimum scale

# **Old Alluvial Zone:**

- ✓ Conservation Agriculture
- ✓ Water saving technology
- $\checkmark~$  Small scale processing and storage unit.
- ✓ Low cost fish feed.
- ✓ Soil water testing kit for fishery pond.
- ✓ Wheat variety tolerant to terminal heat
- ✓ Management of Mango orchard.
- ✓ Restoration of genetic diversity of pulses and crop improvement programme.
- ✓ Nodule formation problem of pulse in acid soil.

# Terai Zone:

- ✓ Wheat varieties tolerance to spot blotch, terminal heat, etc.
- ✓ Contingent technology for erratic rains during rabi season
- ✓ Refinement of crop production system of pulse in problem soil with proper bioinoculation protocol.
- $\checkmark$  Introduction of mechanized farming for various crops of the region.
- ✓ Acid soil management for augmenting crop productivity and soil health.
- ✓ Failure of obtaining quality fibre from Jute by terai farmers.
- ✓ Protected cultivation technology for vegetables and high value commercial crops.
- ✓ Up gradation of native breeds of Black Bengal goat and Pig along with rearing protocol.
- ✓ Animal disease mapping.
- ✓ Documentation of NTFP (non- timber forest product) of North Bengal and their industrial linkage.
- ✓ Standardisation of Breeding protocol for Joel fish.

# ONGOING MAJOR RESEAR CH PROGRAMME

# A. University funded Project

Sl.	Project Code	Title of the Programme
No.		
1	RRSTZ/Kharif	Studies on the prevalence of the major vector borne diseases
	/17-18/04	affecting cross breed cattle in Cooch Behar district, West Bengal
2	RRSTZ/2017-	Improved induced breeding program on Asian magur through
	2018/Kharif/0	administration inducing hormone and different synthetic
	5	analogues.
3	RRSTZ/2017-	Performance trial of different crops with fish under Integrated
	2018/Kharif/0	Farming System Research in the fish farm of RRS, Terai Zone
	6	
4	RRSTZ/2017-	Selection of mungbean genotypes for tolerance to water-logging
	2018/Kharif/0	under field condition
	3	
5	RRSTZ/Kharif	Project Title: Improved package of practices for major
	/1/-18/02	Agricultural and Horticultural crops in Terai Zone of West
		Bengal.
6		Derived Tide A Deriver of the Original of Deriver at Discourse
0	$\frac{\text{RKSIZ}}{17.18/01}$	of major arong and Their Management in Targi Degion of West
	/1/-18/01	Dengel
7	DDST7/Dabi/	Deligat
/	17 18/06	percent of Khaki Campbell ducks under somi intensive rearing
	1/-10/00	system at low ambient Temperature in Terai Zone of West
		Bengal
8	RRSTZ/Rabi/1	Performance trial of different crops with fish under Integrated
Ŭ	7-18/09	Farming System Research in the fish farm of RRS. Terai Zone
9	RRSTZ/Rabi/1	Performance of grafted tomato (Stock: UBB-8Scion: Meghali)
	7-18/08	for enhancing the resistance against biotic stress
10	RRSTZ/Rabi/1	Selection of mungbean genotypes for tolerance to water-logging
	7-18/05	under field condition
11	RRSTZ/Rabi/1	Effect of seed priming on the performances of wheat cultivars
	7-18/01	under zero tillage
12	RRSTZ/Rabi/	Effect of different dates of planting (DOP) on a heavy panicle
	17-18/12	rice variety 'Maudamani' in Terai zone of West Bengal
13	RRSTZ/Rabi/1	Occurrence and Management of Major Fungal Diseases of
	7-18/03	Tomato under Terai Zone of West Bengal
8	RRTZ/Rabi/17	Evaluation of different management strategies on the insect-pest
	-18/04-01	complex of cabbage
14	RRTZ/Rabi/17	Evaluation of conservation agricultural strategies on wheat,
	-18/04-02	maize and lentil agro-ecosystem
15	RRSTZ/Rabi/1	Evaluation of different pest management modules for the insect
	7-18/02	pest complex of brinjal
16	RRSTZ/Rabi/	Title of the programme: Effect of sowing time and variety on the
	2017-18/07	Growth, yield and quality of bush type vegetable French bean

# **B.** External funded project

Sl.			Budgted Pro	oject Cost		
No.	Title of the project and sponsoring Agency	Year In which Started	Capital (in Lakhs)	Recurring (in Lakhs)	Total (in Lakhs)	Remarks *(status: Completed/ Ongoing)
1.	<ul> <li>Technology standardization for Lab to land of</li> <li>Asiatic Lily for development of tribal community in Terai-Dooars region of North Bengal under Phase-1</li> <li>Funded by WBSCST</li> </ul>	2014	0.0	14.21175	14.21175	Ongoing
2	Quality Parameter Testing of the Acclimatized Valerianajatamansi in Terai Zone West Bengal and muss propagation of Valerianajatamansi, Begenia ciliate, Piper longum for distribution with awareness programme. Ministry of Ayurveda Govt. of India	2016	6.850	16.525	23.375	Ongoing
3	Dissecting the ingteractome development at sieve element due to Aphid infestation for better understanding of enhanced	2016	5.99	16.285	22.275	Ongoing

	insecticidal effect in					
	resistant host plant.					
	Science and					
	Technology					
	Research Board					
	underGovt of India.					
4	Intro du sti su	2017	4.00	21.760	25.760	0
4	introduction,	2017	4.00	21.709	25.709	Ungoing
	standardization of					
	nursery technology					
	of living fossil					
	Ginkgo Biloba					
	(Ginkgoaceae) in					
	Hill and Terai Agro-					
	climatic zone of					
	West Bengal					
	Funded by NMPB					
	AIUSH					
5		2017	2.00	30.289	32.289	Ongoing
5		2017	2.00	30.289	32.289	Ongoing
5		2017	2.00	30.289	32.289	Ongoing
5	Collection	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation,	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and Standardization of	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass Regeneration of	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass Regeneration of Selected Endangered	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass Regeneration of Selected Endangered Rare and Vulnerable	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass Regeneration of Selected Endangered Rare and Vulnerable Medicinal Plants of	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass Regeneration of Selected Endangered Rare and Vulnerable Medicinal Plants of Darjeeling Hills	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass Regeneration of Selected Endangered Rare and Vulnerable Medicinal Plants of Darjeeling Hills <b>Funded by NMPB</b>	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass Regeneration of Selected Endangered Rare and Vulnerable Medicinal Plants of Darjeeling Hills <b>Funded by NMPB</b> <b>Ministry of</b>	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass Regeneration of Selected Endangered Rare and Vulnerable Medicinal Plants of Darjeeling Hills <b>Funded by NMPB</b> Ministry of AYUSH	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass Regeneration of Selected Endangered Rare and Vulnerable Medicinal Plants of Darjeeling Hills <b>Funded by NMPB</b> <b>Ministry of</b> <b>AYUSH</b>	2017	2.00	30.289	32.289	Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass Regeneration of Selected Endangered Rare and Vulnerable Medicinal Plants of Darjeeling Hills <b>Funded by NMPB</b> <b>Ministry of</b> <b>AYUSH</b> Standardization of Agro technology and	2017 2016	2.00	30.289 22.985	32.289 23.985	Ongoing Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass Regeneration of Selected Endangered Rare and Vulnerable Medicinal Plants of Darjeeling Hills <b>Funded by NMPB</b> Ministry of AYUSH Standardization of Agro technology and Mass Multiplication	2017 2016	2.00	30.289 22.985	32.289 23.985	Ongoing Ongoing
5	Collection Conservation, Digitization and Standardization of Protocal for Mass Regeneration of Selected Endangered Rare and Vulnerable Medicinal Plants of Darjeeling Hills <b>Funded by NMPB</b> Ministry of AYUSH Standardization of Agro technology and Mass Multiplication for production of	2017 2016	2.00	30.289 22.985	32.289 23.985	Ongoing Ongoing

	Quality Seedlings of Woodfordiafruticosa , Sidacordifolia and Desmodiumgangetic um Funded by NMPB Ministry of AYUSH					
7	Image based Identification of Individuals Breeds and diseases of Pigs and Goats. Funded by Media Lab Asia; Information Technology Research Academy (ITRA)	2016	8.75	16.72	25.47	Ongoing
8	In vitro mass Multiplication and conservation of some endanger Citrus species of NEH Region of India Funded by DBT, Ministry of Science and Technology.	2017	6.30	17.79	24.09	Ongoing
9	Generation of elite, disease free planting materials of turmeric through micro- propagation and its distribution among tribal farmers of terrain of West Bengal Funded By <b>DST</b> ,	2017	598440	1674660	2273100	Ongoing

	Ministry of Science and Technology, Govt. of India.					
10	Assessment of Ecosystem service in Home garden agro forestry systems in Sikkim and sub– Himalayan region of West Bengal Funded By Science and Engineering Research Board (SERB)	2017	474787.00	100000.00	574787.00	Ongoing
11	Production of quality Planting Materials of some important medicinal Plants through Identification, Multiplication, Supply of Health Elite Genotypes and capacity building programme for improving rural livelihood in Northern part of west Bengal. Funded by NMPB Ministry of AYUSH	2016	525000	3509360	4034360	Ongoing
12	Retrievel of biophysical parameter in Buxa tiger reserve using GISAT Funded by Space Applications Centre, ISRO, Ahmedabad	2017	7.75	7.20	14.95	Ongoing

13	Survey of pests and diseases of Medicinal Plants in West Bengal Funded by: National Medicinal Plant Board (NMPB)	2017	7.00	27.01	34.01	Ongoing
14	Promotion of Oilseed Crops in Northern Districts of West Bengal for Livelihood Security of small and Marginal Farmers"	2017			20910000. 00	
15	Scientific evaluation and cost-benefit analysis of Duck rearing system special emphasis to socio-economic up- liftment through women empowerment (NABARD)	2017	32000	413000	445000	Ongoing
16	"Enhancing Pulses Production For Food And Nutritional Security, Improved Livelihoods And Sustainable Agriculture In West Bengal" (ICARDA) Funded by Dept. of Agriculture Government of West Bengal	2017			19694000 0.00	Ongoing

17	Medicinal orchids:	2018	6.00	34.958	40.958	Ongoing
	A step towards					
	commercial					
	cultivation through					
	collection,					
	Conservation and					
	multiplication in					
	Himalayan Region					
	of Darjeeling					
	Funded by:					
	National Medicinal					
	Plant Board (NMPB)					
18	"Survey and	2017	440000	2038800	2478800.0	Ongoing
	surveillance for				0	
	wheat blast caused					
	by					
	Magnaportheoryzae					
	Pathotype1 riticum					
	research to manage					
	it."					
	Funded By: NESM					
	Ministry of					
	Agriculture and					
	Farmers Welfare,					
	Department of					
	Agriculture,					
	Cooperation and					
	Farmers Welfare,					
19	To evaluate the bio-	2016			234000.00	Ongoing
	efficacy of					
	Monocrotophos 36%					
	pests of Tea					
	P0000 01 100.					
	Funded by UPL					

20	To evaluate the bio- efficacy of Monocrotophos 36% SL against insects pests of Chili. Funded by UPL	2016			234000.00	Ongoing
21.	Study on Bio – Efficacy, Pytotoxicity and residue analysis of Tolfenpyrad 15% EC in vegetable crops. Funded by Coromondal International Pvt.Ltd.					Ongoing
22.	To evaluate the bio efficacy and Phytotoxicity of new fungicide "juniper" against disease on Chilli. Funded By Swal Corporation Ltd. Mumbai	2016			234000.00	Ongoing
23.	Bio-efficacy data generation of clethodin 25% EC on Soybean crop. Funded by M/S- Krishi Rasayan Exports Pvt.Ltd.	2016	120000.00	180000.00	390000.00	Ongoing
24.	Bioefficacy phytotoxicity and residue study of copper Oxychloride 47% <sub>+ Metalaxy 8% Wpin</sub> Potato.					Ongoing

25.	Study on Efficacy of some Herbicides in Wheat Funded by Dow Agro Sciences India Pvt. Ltd.	2013			832000.00	Ongoing
26.	Bio-efficacy and Residue Studies of some new Generation Molecules of different Crops Okra, Rice, Chilli, Tomato, Mango And Tea. Funded by: Willow Wood Chemicals Pvt. Ltd.	2013			1196000.0 0	Ongoing
27.	Evaluation of Bio- efficacy and phytotoxicity of monocrotophos 36% SL against Mosquito bug Thrips and Jassids on Tea Funded by (UPL)	2016			250000.00	Ongoing
28.	Evaluation of Bio- efficacy and phytotoxicity of Flubendiamide 480 SC against Looper in Tea Funded by	2017	64500	166000	300000.00	Ongoing
	Bayer Crop Science Ltd.					

29.	To evaluate the bio- efficacy and phytotoxicity of UPF 115 against disease complex in Chilli. Funded by (UPL)	2016			312000.00	Ongoing
30.	To evaluate the bio- efficacy and phytotoxicity of UPF 115 against disease complex in paddy. Funded by (UPL)	2016	140000	100000	312000	Ongoing
31.	Residue Analysis of Buprofezin 20% + Acetamiprid 2% WP on Rice Funded by M/S- Krishi Rasayan Exports Pvt.Ltd.	2016			748800.00	Ongoing
32.	Residue Analysis of Cyhalofopbuty 10% EC in direct seeded Rice Funded By M/S- Krishi Rasayan Exports Pvt.Ltd.	2016			374400.00	Ongoing
33.	To evaluate the effect of Triacontanol 0.1% EW on Yield and its phytotoxic effect in relation to health on tea bushes.Funded by: M/S Godrej Agrovet. Mumbai	2016	120000	335000	455000	Ongoing

34.	Bio –Efficacy, phototoxicity and residue studies of some fungicides on different crops.	2014				Ongoing
35.	Bioefficacy, Phytotoxcity and residue study of Copper Oxychloride 47% + Metalaxyl 8% WP in Potato. Funded by: Agro Lifescience Corporation	2016			234000.00	Ongoing
36.	Evaluation of Bio- efficacy, Phyto- toxicity and residue of Cyazafamid 34.5% SC on Potato and tomato Crops. Funded by: M/S- Krishi Rasayan Exports Pvt.Ltd	2016			390000.00	Ongoing
37.	Bio-efficacy phyto- toxcity of Dichlorvos 76% EC on Paddy & Wheat. Funded by Agro Life Science Corporation	2016	103500	46500.00	195000.00	Ongoing
38.	To evaluate the bio- efficacy and phytotoxicity of Butachlor 50% EC against weed flora in	2016			97500.00	Ongoing

	transplanted rice Funded by: M/S Krishi Rasayan Export Pvt. Ltd.				
39.	To evaluate the bio- efficacy and phytotoxicity of Pyrazosulfuran Ethyl 70% WDG against weed flora in transplanted rice Funded by: M/S Krishi Rasayan Export Pvt. Ltd.	2016		195000.00	Ongoing
40.	To evaluate the Bio- efficacy and phytotoxicity and Residue analysis of Tricyclazole 75% WP on paddy Funded by: M/S Agro Life Science Corporation.	2017		97500.00	Ongoing
41.	Bio-efficacy and phytotoxicity study of WCPL 6060 against Blast ( <i>PyriculariaoryzaeC</i> <i>avara</i> ) and Blight disease in Paddy crop. Funded by WillowoodChamicas Pvt. Ltd.	2017		247000.00	Ongoing

42.	Evaluation of bio- efficacy and phytotoxicity of CCP-4620 against mites of Tea.	2018	75000.00	245000.00	416000.00	Ongoing
43.	Evaluation of new fungicides offering better chemicals management of plant Disease Funding Agency: Syngenta India Limited	2017			644800.00	Ongoing
44.	Evaluation of new fungicides offering better chemicals management of plant Disease Funding Agency: Syngenta India Limited	2017			1440000.0 0	Ongoing
45.	Evaluation of bio- efficacy of abamectin 1.9% ECagainst red mite, tetranychusspp and serpentine leaf miner, liriomyzatrifolli of tomato.	2017			299000.00	Ongoing
46.	Bioefficacyevaluatio n ofCarbofuran 3% CG against root knot and reniform nematode in Brinjal- Funded by FMC, Pvt. Ltd.	2017			399000.00	Ongoing

47.	Evaluation of the effect of ASL- Seaweed + Humic GR. On the Growth and yield of paddy. Funded by M/s- AcadianSeaplantsHe alth	2017	25000	75000	150000	Ongoing
48.	Bio-efficacy and phytotoxicity evaluation of pyriproxyfen 10% EC in Chilli. Funded by Sumitomo Chemicals India Pvt. Ltd	2017			260000.00	Ongoing
49.	Bio-efficacy and phytotoxicity evaluation of pyriproxyfen 10% EW in transplantedRice. Funded by Sumitomo Chemicals India Pvt. Ltd	2017			260000.00	Ongoing
50.	Main Head:Evaluation of new fungicides offering better chemical management Plant Disease Sub Head: Bio- Efficacy, phytotoxicity and residue study of some					Ongoing

	fungicideseffective against disease in different crops				
51.	Bio Efficacy, Phytotoxicity and effect on natural enemies of some new generation insecticide molecules on different crops Funded by: Willow Wood Chemicals Pvt. Ltd.	2017		855000.00	Ongoing
52.	Study on Bio- Efficacy, Phytotoxicity and Residue analysis of some Herbicides and Chemical in tea and non-cropped area Funded by: Willow Wood Chemicals Pvt. Ltd.	2017		1163000.0 0	Ongoing
53.	To evaluate the bio efficacy and phytotoxicity of Carfentrazone ethyl 40% DF against weed flora in wheat" Funded by: M/S Krishi Rasayan Export Pvt. Ltd.	2017		560000.00	Ongoing

54.	To evaluate the bio efficacy and phytotoxicity of GPH-315 against weed flora in Tea. Funded by United Phosphorus Limited	2018		336000.00	Ongoing
55.	To evaluate the bio efficacy and phytotoxicity ofIprodione 50% WP against Sheet blight disease in Rice Funded byM/S Krishi Rasayan Export Pvt. Ltd.	2018		336000.00	Ongoing
56.	Testing of Improved Wheat Varieties Funded by Shriram Fertilizer and Chemical Pvt. Ltd.	2017		172500.00	Ongoing
57.	Investigation on Bio- efficacy and phytoticity of Apex 50(R) Helicoverpa Spodoptera and Semilooper in Soybean. Funding Agency: Crystal Crop	2018		399980.00	Ongoing
58.	Optimising Nutrient use efficiency under zero tillage operations in Rice –	2015			Ongoing

-		T		1
	Maize cropping			
	system in Cooch			
	Behar and Malda			
	District of West			
	Bengal. (South Asia,			
	East India and			
	Bangladesh)			
	International Plant			
	nutrition Institute –			
	South Asia			
	Programme East India			
	And Bangladesh.			
50				<u> </u>
59.	Improving water use			Ungoing
	for dry season			
	Agriculture by			
	marginal and tenant			
	farmers in the			
	Estern Gangetic			
	Plains Australian			
	Centre for			
	International			
	Agricultural			
	Research (ACIAR-			
	LWR)			
	(Austrolion)			
	(Australian)			
	Govt. of Australia			
60	Spot Blotch of			Ongoing
00.	Wheat: Delivering			ongoing
	Resistant Wheat			
	Lines and Diagnostic			
	and Molecular			
	Markara for			
	Registents			
	Resistents.			
	CIMMYT			
	(International Maize			

	and Wheat Improvement Centre)					
61.	Transnational And Unified Crop Monitoring System (Tu-Crop) in Wheat BBSRC (Biotechnology and Biological Science Research Council)					Ongoing
	U.K., CIMMYT	2015			10000000	
62.	Development of innovative agri- entrepreneurship roles for young agri- professionals in West Bengal	2017			1000000.0 0	Ongoing
	Funded by Australia- India Council					
63.	Up –gradation of market linkage Network for promotion of Bengal Aromatic Rice Under RKVY	2018	36.10	71.00	107.10	Ongoing

# Annual Report 2017-18

# Regional Research Station (Terai Zone), Uttar Banga Krishi Viswavidyalaya

List of Kharif-2017-18 P	rogramme under RRSTZ

Sl.	Project Code	Title of the Programme	Associate Scientists				
110.	Animal Science & Fishery						
1	RRSTZ/Kharif/17- 18/04	Studies on the prevalence of the major vector borne diseases affecting cross breed cattle in Cooch Behar district, West Bengal	Dr. Nonigopal Shit Dr. Dilip Kumar Hajra				
2	RRSTZ/2017- 2018/Kharif/05	Improved induced breeding program on Asian magur through administration inducing hormone and different synthetic analogues.	Prof. Debapriya Sarkar and Dr. Nilanjana Chaudhuri				
3	RRSTZ/2017- 2018/Kharif/06	Performance trial of different crops with fish under Integrated Farming System Research in the fish farm of RRS, Terai Zone	Prof. Debapriya Sarkar and Dr. Nilanjana Chaudhuri				
		Crop Improvement					
4	RRSTZ/2017- 2018/Kharif/03	Selection of mungbean genotypes for tolerance to water-logging under field condition	Dr. Rupsanatan Mandal				
		Crop Production					
5	RRSTZ/Kharif/17- 18/02	Project Title: Improved package of practices for major Agricultural and Horticultural crops in Terai Zone of West Bengal.	Dr. Parthendu Poddar, Dr. Suchand Datta, Dr. Partha Sarathi Patra				
		Crop Protection					
6	RRSTZ/Kharif/17- 18/01	Project Title: A Review on the Occurrence of Pests and Diseases of major crops and Their Management in Terai Region of West Bengal	Dr. Suprakash Pal, Dr. Nilanjana Choudhuri, Dr. Satyajit Hembram				

**Title of the Programme:** Studies on the prevalence of the major vector borne diseases affecting cross breed cattle in Cooch Behar district, West Bengal

Project code: RRSTZ/Kharif/17-18/04

Associate Scientist/s: Dr. Nonigopal Shit & Dr. Dilip Kumar Hajra

#### **Objectives:**

✓ The investigation of the prevalence of vector borne haemoprotozoan diseases in cross breed cattle population in Cooch Behar district



Figure 1: Blood collection at the peripheral circulation and thin smear preparation from the different areas of Cooch Behar district

#### Methodology of the programme:

- ✓ *Sample collection:*
- Blood collection (at least 5ml) was aseptically made from the jugular vein or peripheral circulation (ear vein) of the target animals in an anti-coagulant coated sterile sample collection vial labelled previously as required. Immediately after collection, sample was temporarily kept in the ice-pack insulated box and brought cautiously to the laboratory without hemolysis.



Figure 3: Microscopic examination (100X) of *haemoprotozoan* parasites of cross bred cattle in Cooch Behar district

- ✓ *Smear preparation and centrifugation:*
- A small drop of fresh blood was mounted over a dry and grease free slide and using another slide of smooth edge, a thin blood smear was made in triplicate. The rest blood was centrifuged following standard protocol (3000 rpm for 10min) for the serum extraction. The serum was emptied to the serum collection cryo-vials suitably labelled and stored at -18°C for further biochemical study.
- ✓ *Staining and Microscopic examination:*
- Glass slides with thin blood smear were air dried and fixed with methanol (75%). Consequent to that glass slides were kept on the staining rack and the smear was stained with diluted Giemsa's stain (Himedia Pvt. Ltd) following to manufacture's instruction. The stain was allowed for 15min and finally washed under slow tap water till the stain is removed. The smear was air dried completely and each slide was examined under oil emersion microscope (100 x illuminations) and counted the total number of parasites from at least fifty fields of each slide.



Staining of dry blood smear

Figure 2: Giemsa's staining of dry blood smear at the laboratory, animal science unit for the prevalence study of *haemoprotozoan* parasites

#### **Results:**

✓ The study was focused to examine the occurrence of the *haemo-protozoan* parasites in the cross bred cattle under Cooch Behar district. Among the total 200 samples, only 28, 5, 13 and 2 samples were recorded positive for the Theileriosis, Babesiosis, Anaplasmosis and Trypanosomiasis respectively. On the percent prevalence basis, Theileriosis (*T. annulata*) revealed highest degree of prevalence (14%) and the least infection was counted for Trypanosomiasis (*T. evansi*).



Figure 4: Prevalent percent of the *haemo-protozoan* parasites recorded in the cross bred cattle in Cooch Behar district



Figure 5: Positive samples of different *haemo-protozoan* parasites in the randomly collected blood of cross bred cattle in Cooch Behar district



Figure 6: Identification of the intra-cellular *haemoprotozoan* parasites under oil emersion microscopic examination

✓ The questionnaire survey prior to this study demonstrated in spite of the proper management animals suffers from the chronic problems of anorexia, laboured breathing, gradual loss of production and susceptibility to diseases even in minor changes of climatic condition. The present findings could be invariably correlated with these facts and facets which are prevailed over the field condition. Biochemical analysis may correlate more precisely to reach at pin point diagnosis. Further study including DNA based molecular diagnosis of the antigen for those parasites will be more valuable for concrete year round recommendations

Title of the Programme: Improved induced breeding program on Asian magur through administration inducing hormone and different synthetic analogues.

Project code: RRSTZ/2017-2018/Kharif/05

Associate Scientist/s: Prof. Debapriya Sarkar and Dr. Nilanjana Chaudhuri

**Objectives:** 

- ✓ Assessment on comparative efficacy of ALFA-FH (synthetic hormone) and pituitary extract (natural hormone) on stripping method of induced breeding in Asian magur.
- ✓ Comparison betweennumber of hatchlings produced from stripping (sacrifice) and non-sacrifice method of induced breeding.
- $\checkmark$  Interpretation on cost analysis for both ways.

#### **EXPERIMENTAL DESIGN**

#### **Experiment No. 1.**

**Title :** Comparative efficacy of ALFA-FH and pituitary extract on stripping method of induced breeding in *Clarius batrachus*.

#### **Methodology** :

- Five sets (males : females = 2:1) of brood Asian magur each weighing 200-250g were separately injected with ALFA-FH and pituitary hormone @ 0.4 ml/100 g and 4mg/100g body wt of female respectively.
- Stripping method were followed for egg collection from females after 16 hrs
- Sperm fluid were collected through sacrificing the males
- Two males were used to fertilize eggs collected from one female
- Sticky fertilized eggs were kept in aluminium tray with medium water flow to get hatchlings within 24 hours (Fig.1)
- Hatchlings were fed after 72 hrs with artemia as recommended for 15 days and later on with egg custard or boiled rice and eggs to attain a length of 2 inches.

#### **Observations :**

# Table 1. Summary table of Asian magur breeding with ALFA-FH and Pituitary extract

	ALFA-FH	PITUITARY EXTRACT
Av.wt of female (g)	200 g	200 g
Av.wt of male (g)	250 g	250 g
Dose in female	0.4 ml/100gbw	4 mg/ 100 g bw
Dose in male	0.2 ml/fish	2 mg / fish
Av. no of eggs released	2650 nos/100g	4500 nos/100g
No of hatchlings	1000 nos/100g	2500 nos/100g

#### **Interpretation :**

Table 1 clearly indicated a better performance by pituitary extract as compared with ALFA-FH as inducing agent in stripping method. There was a better maturation and free flowing status of females injected with pituitary leading to more number of hatchling production from stripping method. Actually pituitary gland contains natural gonadotropic hormones (GTH) like FSH and LH which induces ovarian and testicular follicles to develop and to secrete steroids like oestrogen and progesterone from the gonads to initiate reproductive process. It is easily acceptable and adjustable by any fish being natural inducing agent whereas ALFA – FH being a synthetic analogue of Salmon GnRH is comparatively less acceptable and thereby elicit less reproductive response. Still the synthetic agents are used widely as it is ready to use and its quality is assured whereas availability and quality of pituitary gland is doubtful and complicated to prepare in suspension.

#### **Experiment No.2.**

**Title:** Production of hatchlings bynatural (non-sacrifice) induced breeding without sacrifice of maleusing ALFA-FH and pituitary extract as inducing agents.

#### **Methodology :**

Eleven experimental trials were set for induced breeding experiments by ALFA-FH and pituitary extract. For each experiment male and female ratio were 3:3 and the dose of administration of both inducing agents as well procedure followed were mentioned in the **Table 2** 

Trial No	Illustration of breeding method followed
T1	ALFA-FH - Dose of injection @0.4ml/100g female and 0.15ml/100g
	male. Injected fish released into the 'glass aquaria (4'x1.5'x1.5') in the
	evening with constant aeration.
T2	ALFA-FH -Dose same as above. Fish released into large cement vat
	(5'x3'x3') bearing soil bed and rooted grass to reflect an apparent natural
	pond situation and with aeration.
T3	ALFA-FH – Dose same as above. Released into large cement tanks
	(5mx2.5mx1.5m) bearing soil bed and rooted grass and water hyacinth to
	reflect an apparent derelict pond situation and with no water flow.
T4	ALFA-FH – Dose lowered @ 0.2ml /female and 0.1ml /male as initial
	installment for preparing and after 7 days again the same dose for
	breeding. Released into large cement tanks (5mx2.5mx1.5m) bearing soil
	bed and rooted grass only.
T5	ALFA-FH – Dose lowered @ 0.2ml /female and 0.1ml /male Released in
	morning into the large cement tanks (5mx2.5mx1.5m) bearing soil bed
	and rooted grass to reflect an apparent natural derelict pond situation and
	with continuous moderate water flow.
T6	ALFA-FH – Dose of injection @0.3ml/100g female and 0.15ml/100g
	male. Released into the small experimental pond with no artificial aeration.
T7	PITUITARY-Dose of injection @15mg/250g female and 5mg/250g male.
	Released into large cement tanks (5mx2.5mx1.5m) bearing soil bed and

	rooted grass and water hyacinth to reflect an apparent derelict pond situation and with no water flow.
Т8	PITUITARY-Dose of injection @15mg/250g female and 5mg/250g male. Released into large cement tanks (5mx2.5mx1.5m) bearing soil bed and rooted grass and water hyacinth to reflect an apparent derelict pond situation and with continuous moderate water flow
T9	PITUITARY- Three different dose to three set of breeding pair @15mg, 10mg and 5mg /250g female and 5mg/250g male. Released into a deep earthen channel connected with another narrow channel located upward so as to provide scope for their upward migration for breeding.
T10	PITUITARY-Dose of injection @15mg/250g female and 5mg/250g male. Released into the small experimental pond with no artificial aeration.
T11	PITUITARY-Dose of injection @10mg/250g female and 5mg/250g male. Released into the channel excavated throughout the length of the rice field during the end of july,2017(during monsoon).

#### **Interpretation** :

- ✓ Both ALFA-FH (synthetic analogues of gonadotropin) and pituitary extract (containing natural gonadotropin hormone) can induce spawning of asianmagur in cement tanks as well as earthen ponds provided there is sufficient water flow, either natural (as rain) or artificial, in the spawning ground.
- ✓ Dose of inducing hormone is a prime determining factor for fish breeding. Even dose of hormone used for stripping method had been proved to be very high and detrimental to those fish lying under non-stripping natural induced breeding as observed in case of T1 and T7. Therefore a low dose of hormone for natural induced breeding is alwayspreferred.
- ✓ Success of non-stripping induced breeding technique was found to be dependent on continuous water flow in the breeding ground as observed in T5 and T8. However ALFA-FH injected fish in pond during monsoon resulted in successful breeding (T6) though hatchling collection as well as harvest is very difficult in monsoon from the natural ground and it lead to a high rate of predatory attack on hatchlings by so many natural predators existing in the ponds.
- ✓ Injected fish released into the stagnant earthen ponds merely promote any induced spawning. Therefore, in stead of earthen ponds, creation of an apparent weed infested breeding ground with inundation is desirable.
- ✓ The non-sacrifice method of induced breeding (without stripping) is a very significant achievement from the standpoint of animal ethics . It is also very easy to perform and therefore easily adoptable by the stakeholders. However, the number of hatchling production is less in this method .
- ✓ Interpretation on production of hatchlings and sale price between sacrifice and non-sacrifice method clearly indicate more profit in case stripping method as the number of hatchling production is more and they can be sold in the early stage of their life as they remain indoor whereas it is very hard to collect the hatchlings produced from

natural induction occurred in the natural water bodies and they are prone to predatory attack as they stay there for a long time.

	Fingerling produced / 400g female	Hatchling produced / 400 g female	Sale price
Sacrifice method	-	10000	40,000
Non-sacrifice method	400	-	4,000

1. From the standpoint of economic return as well as farmers profit, the stripping method is more recommendable and from the conservation point of view non-stripping method is more preferred. It is therefore recommendable to adopt both the techniques in a rational way by the fish breeders.



Fig1. Stages of stripping method in Asian magur induced breeding



Fig2. Release of injected fish in cement vat for induced breeding.

# Title of the Programme: Performance trial of different crops with fish under Integrated Farming System Research in the fish farm of RRS, Terai Zone

#### Project code: RRSTZ/2017-2018/Kharif/06

Associate Scientist/s: Prof. Debapriya Sarkar and Dr. Nilanjana Chaudhuri

#### **Objectives:**

- ✓ To study the performance of Turmeric grown organically fish pond adjoining area
- $\checkmark$  To study the performance of Ginger grown in pond dyke and fish pond adjoining area
- $\checkmark$  To study the performance of Elephant foot yam in pond dyke
- $\checkmark$  To study the performance of plantation crops in pond dyke
- ✓ To study the performance of paddy-cum-fish culture in low lying pond adjoining areas
- ✓ To study the performance of water tolerant paddy variety in low lying pond adjoining areas with organic package of practice
- ✓ To study the performance of muga silkworm host plant (som) in medium land and the effect of nutrient supplementation and intercropping to make them grow fast in terai agro-climatic situation.
- $\checkmark$  To study the performance of fish in fish farm pond

#### Materials:

#### Objective 1

- ✓ Turmeric variety TCP 2 (Suranjana)
- ✓ Solid and liquid indigenous microbial culture,
- ✓ Handmade botanical insecticide (Agniastra)

#### **Objective** 2

- ✓ Ginger variety Local
- ✓ NPK at recommended dose and liquid indigenous microbial culture,
- ✓ Handmade botanical insecticide (Agniastra)

#### Objective 3

- ✓ Elephant foot yam variety Kavur
- ✓ NPK at recommended dose

#### Objective 4

- ✓ Areca nut and Coconut
- ✓ NPK at recommended dose

#### Objective 5

- ✓ The total area 225 m<sup>2</sup>(paddy variety RajendraMashuri in 180 m<sup>2</sup> area, water channel 20 m<sup>2</sup> area (excluding 1m depth) for fish and dyke 25 m 2area.
- ✓ Solid and liquid indigenous microbial culture,
- ✓ Handmade botanical insecticide (Agniastra)

#### Objective 6
- ✓ Paddy variety RajendraMasuri, Nilanjana, MTU 1075 and Sabita
- ✓ Solid and liquid indigenous microbial culture,
- ✓ Han made botanical insecticide (Agniastra)

## Objective 7

- ✓ Muga host plant Som (Machilusbombycina) as main crop.
- ✓ Turmeric, vegetable, spices, legume and oil seed crops as intercrops.
- ✓ Solid and liquid indigenous microbial culture.
- ✓ Hand made botanical insecticide (Agniastra)

## **Objective** 8

- ✓ Lentil variety Moitree
- ✓ Solid and liquid indigenous microbial culture,
- ✓ Hand made botanical insecticide (Agniastra)
- ✓ NPK

## Methodology:

## Objective 1

- ✓ Turmericrhizome was planted during 1stweek of May in the  $125m^2$  plot.
- ✓ Solid indigenous microbial culture applied during field preparation.
- ✓ After that liquid indigenous microbial culture, was applied at fortnightly interval.
- $\checkmark$  Agniastra was applied as need based.
- ✓ The crop was harvested in February, 2018
- ✓ The observations of plant and yield parameters for conventional farming were taken from the field maintained under University farm.

## Objective 2

- ✓ In the fish pond adjoining area (100 m2) Gingerrhizome was planted1st week of May, 2017 and in the same plot lentil was sown during 1st week of December, 2017.
- ✓ In the pond dyke only ginger was raised in 150 m2area.
- $\checkmark$  NPK at recommended dose applied during field preparation for ginger.
- ✓ After that liquid indigenous microbial culture, was applied at fortnightly interval.
- ✓ Agniastra was applied as need based.
- ✓ All the crop were harvested in March,2018

## Objective 3

- ✓ Tuber of Elephant foot yam was sown during 1stweek of May in the 200 m2 area.
- $\checkmark$  Recommended agronomic practices were followed
- ✓ The crop was harvested in January,2018
- ✓ The average weight of each rhizome was 700 gm
- ✓ The yield was 7t/ha.

## Objective 4

- ✓ 50 number of areca nut and 20 number of coconut seedlings were transplanted on and around the pond dyke during May, 2017.
- ✓ Recommended agronomic practices were followed

## Objective 5

- ✓ The 21 days old seedling was transplanted during2nd fortnight of July, 2017
- ✓ Solid indigenous microbial culture during land preparation and after that liquid at fortnight interval
- ✓ The botanical insecticide (Agniastra) was applied as per need.
- ✓ Fish were released into the paddy field after 15 days of rice transplantation. Asian magur hatchlings (50 numbers and 20 days old) and freshwater prawn juveniles (100 numbers and 45 days old) were released in first phase. IMC fries name namely Rohu and Mrigel (1 kg and 30 days old) were released in the second phase.
- $\checkmark$  Growth of fish was checked monthly by netting.
- ✓ The crop was harvested in November, 2017

## Objective 6

- ✓ Paddy variety namely RajendraMashuri, MTU 1075, Sabita and Nilanjana were raised in the plot size of 180 sq.m, 70 sq.m., 250 sq.m. and 110 sq.m. respectively
- ✓ 21 days old seedlings were transplanted by 1st fortnight of August
- ✓ Solid indigenous microbial culture applied during field preparation.
- ✓ After that liquid indigenous microbial culture, was applied at fortnightly interval.
- ✓ Agniastra was applied as need based.
- ✓ The crop was harvested in November-December,2017
- ✓ The observations of plant and yield parameters for conventional farming were taken from the field maintained under University farm.

## Objective 7

- ✓ Muga host plant (100 numbers) was planted in 3mx3m in the medium land during 3rd week of September, 2017.
- ✓ The plants were transplanted in two parts, in one part of 250 m2 area the turmeric germplasm TCP 70 was planted during 1st week of May
- ✓ In the other part of 470 m2 area different vegetable, legume and oil seed crops was sown/transplanted during 2ndweek of December, 2017.
- ✓ Solid indigenous microbial culture applied during field preparation.
- ✓ After that liquid indigenous microbial culture, was applied at fortnightly interval.
- ✓ Agniastra was applied as need based.
- ✓ The turmeric was harvested in February,2018, vegetable, spices, legumes and oilseed crops were harvested in 1st week of April
- ✓ The observations of plant and yield parameters of turmeric for conventional farming were taken from the field maintained under University farm.

## Objective 8

✓ Lentil and maize were sown duringlast week of December, 2017

- ✓ Both the crops were raised organically in 130 m2 plot and by conventional farming in 100 m2 area.
- ✓ Solid indigenous microbial culture applied during field preparation.
- ✓ After that liquid indigenous microbial culture, was applied at fortnightly interval.
- ✓ Agniastra was applied as need based.
- ✓ In conventional farming normal agronomic practices were followed
- ✓ The crop was harvested in March and May,2018

## **Results:**

**Objective** 1



Figure 1: Plant parameters of turmeric (variety Suranjana) raised in two different farming system



Figure2: Yield attributing parameters of turmeric (variety Suranjana) raised in two different farming system

#### **Objective 2**

#### Table 1: Plant and yield attributing parameters of ginger (variety local)

Plant height	Shootnumber	Lamina	Lamina	Single rhizome
(cm)		length (cm)	width (cm)	fresh weight (gm)
61.23	23.25	19.45	1.98	500

#### Table 2: Comparative account of yield in two types of land situation

Area	Crop	Yield t/ha
Pond dyke	Ginger	2.235
Madium land adjacent to fish nond	Ginger	2.558
Medium fand adjacent to fish pond	Lentil	1.50

#### *Objective* 5



Figure 3: Pest population infesting paddy in Kharif 2017



Figure 4: Influence of cultivation practices on plant parameters of paddy at maturity

Parameters *	Fish Species				
	Rohu	Mrigel	Asian Magur	Prawn	
Av Initial length (cm) in Aug	2.5	2.2	2.0	1.5	
Av Initial weight (g) in Aug	1.8	1.9	1.3	0.15	
Av length (cm) in Sep	8.4	8.7	-	1.8	
Av weight(g) in Sep	8.0	8.9	-	0.6	
Av length (cm) in Oct	10.2	12.2	-	2.8	
Av weight(g) in Oct	37	49	-	4	
Av final length (cm) in Nov	11	14	14	6	
Av final weight(g) in Nov	55	65	20	10	
Fish released	0.5 kg	0.5 kg	50 nos	100 nos	
Fish production	2.0 kg	3.0 kg	10 nos	22 nos	
Control weight (individual)(g)	35	40	35	30	

#### Table 3: Growth performance of fish in paddy field

\*No of sample taken to calculate average data is 4



## Figure 5: Growth performance of fish

**Objective** 6

Table 3:	Pest po	pulation	infesting	paddy	varieties	raise	organically	v in	Kharif	2017
I upic of	I COU PO	Pulution	meseing	pauay	val ieueo	I unoc	or Sumcan	,	I SHULLI	

Insect-pest populations	RajendraMashuri MTU		MTU 1	1075 Nilanjar		ana	na Sabita	
	FP	OC	FP	OC	FP	OC	FP	OC
Leaf folder/5hill	1.12	1.03	1.02	1.01	1.56	1.00	1.38	1.02
Dead Heart/5hill	1.06	0.95	1.00	0.85	1.23	1.11	1.14	1.02
White ear head/5hill	0.87	0.58	0.21	0.11	1.02	0.97	1.05	1.02
Gundhibug/5hill	0.27	0.25	0.21	0.14	0.32	0.21	0.37	0.30

FP= Farmers Practice; OC= Organic Cultivation

 Table 4: Influence of cultivation practices on plant parameters of paddy varieties at maturity

Plant	Rajendra	aMashuri	MTU 1075 Nilanjana S		Nilanjana		Sabita	
Parameters	FP	OC	FP	OC	FP	OC	FP	OC
Plant	125 65	122.20	125 99	122 75	145 60	142.65	172 74	171.60
height (cm)	155.05	155.20	123.00	123.75	145.09	142.03	1/3./4	1/1.09
Tillers/hill	13.12	11.32	14.10	13.05	13.24	12.15	14.33	12.85
Panicles/hill	12.89	11.04	13.85	12.50	13.00	12.02	14.00	12.35
Panicle	27 45	28.04	72 77	24.05	21.21	22.00	22.57	24.19
length (cm)	27.45	20.04	23.11	24.03	21.21	22.00	23.37	24.10
Grains/panicle	158.65	159.33	273.67	277.69	158.26	161.00	157.24	163.02
Filled grains	141.80	144.81	240.67	249.02	138.25	144.33	137.12	141.67
Chaffy grains	16.85	14.52	33.00	28.67	20.01	16.67	20.12	21.35
Yield (kg m <sup>-2</sup> )	507.2	459.7	502.5	282.3	463.4	457.5	412.6	410.2

## **Objective** 7

## Table 5: Plant parameters of turmeric (germplasm TCP 70) raised in som plantation

Farming practice	Plant height (cm)	Leaf number	Shoot number	Lamina length (cm)	Lamina width (cm)
Organic	119.23	8.4	2.8	57.5	14.95
Conventional	124.32	9.2	3.2	61.8	16.25

## Table 6: Yield and yield attributing parameters of turmeric (germplasm TCP 70) raised in som plantation

Farming	Primary	Mother	Single rhizome	Fresh
practice	Rhizome	rhizome	fresh weight	rhizome
-	Length (cm)	length (cm)	(gm)	Yield (t/ha)
Organic	7.56	7.78	385.23	19.86
Conventional	8.00	7.89	388.25	20.56

#### Table 7: Yield Performance of different crops in som plantation

Crop		Yield (t/ha)		
Cabbage		11.82		
Tomato		30.15		
Carrot		12.35		
Chilli		16.56		
Pea		9.32		
Lentil		1.54		
Garlic		1.85		
1	1.9		1.47	Plant heigh
0		1		i
	Part 1 Turmer	ic	Part 2 Other	crops



#### **Objective** 8

#### Table 8: Performance of Lentil variety Moitree WBL77in two different farming system

Farming practice	Aphids /leaf	Yield gm plant <sup>-1</sup>	Yield t ha <sup>-1</sup>
Organic	0.47	82.29	1.626
Conventional	0.68	78.83	1.616

## Table 8: Performance of Maize variety: DKC9081in two different farming system

Farming practice	Aphids Leaf <sup>-1</sup>	Leaf roller (folded leaves) Plant <sup>-1</sup>	Single Cob weight (gm)	Yield t ha <sup>-</sup> <sup>1</sup> (fresh weight)
Organic	0.50	0.047	248.35	4.09
Conventional	0.98	0.090	483.40	14.01

## **Findings:**

#### **Objective** 1

- ✓ Plant and yield attributing parameters of Suranjanawere higher in conventional farming than the organic one but the difference was non-significant.
- ✓ Yield of TCP 70 was less than Suranjana. It was fade in colour and fresh weight of single rhizome was also lesser (388 g).

#### **Objective 2**

- $\checkmark$  Plant growth as well as rhizome growth is moderate.
- $\checkmark$  Ginger intercropped with lentil provided higher return as compared to sole crop.

#### Objective 3

- $\checkmark$  The average weight of each rhizome was 700 gm
- ✓ The yield was 7t/ha.

#### *Objective* 4

✓ Crops are growing satisfactorily in the loam soil whereas those in the sandy soil are a bit slow in their growth.

## Objective 5

- ✓ The insect pest populations (leaf folder, yellow stem borer and gundhi bug) were observed more in the farmers practice than organically managed experimental plot.
- ✓ Plant height was comparatively higher in farmers' practice.

- ✓ Number of tillers/hill, panicles/hill, panicle length and grains/panicle were relatively more in organic farming over conventional farming.
- ✓ The yield was slightly lower in organic farming than conventional one.
- ✓ Growth of rohu and mrigel in the paddy field as well as water channel is optimum. However it is expected to enhance several manifolds with the increase in area under paddy-cum-fish cultivation and increase in water area and depth holding the fish throughout the culture period.
- ✓ Though the growth record of asianmagur is satisfactory but number harvested is really frustrating which is because of their escaping nature and its needs further protection across the dyke area of the land using strong and high nets so as to control escaping of fish.
- ✓ Performance of freshwater prawn juvenile in paddy field is not so satisfactory as in pond they grow much bigger where a separate care for their feeding is adopted. In the paddy field cannibalistic behaviour of prawn resulted in reduction in their number. At the same time, lack of sufficient food could not result in the optimum yield.

## *Objective* 6

- ✓ The important insect-pests infesting paddy were stem borer, leaf folder and gundhi bug. The population was maximum in the field in conventional than organic farming.
- ✓ Plant and yield attributing parameters were comparatively higher in farmers' practice than organic cultivation.
- ✓ Yield performance followed an order of RajendraMashuri>Nilanjana>Sabita>MTU 1075

## *Objective* 7

- ✓ The som plantintercropped with turmeric as well as different vegetables, legumes and oil seed crop attained the height of 1.90ft and 1.47ft respectively at 7 months after transplanting.
- ✓ Plant and yield attributing parameters of turmeric were slightly higher in conventional farming than the organic one but the difference was non-significant.

## *Objective* 8

- ✓ Pest population of lentil and maize was observed lower in organically managed plots.
- $\checkmark$  The yield attributing parameters of lentil were higher in organic farming than the conventional one.
- $\checkmark$  The yield attributing parameters of maize were higher in conventional farming than the organic one.

## **Future Scope:**

## Objective 1

✓ There lies a huge scope to explore optimum growth and yield of this crop through continuous organic soil management applications

## Objective 2

✓ There lies a huge scope to explore optimum growth and yield of this crop through organic soil management applications

## Objective 3

- ✓ The average weight of each rhizome was 700 gm
- ✓ The yield was 7t/ha.

## **Objective** 4

✓ There is ample scope of production as well income from this crop cultivated in pond dyke with improvement of soil quality in coming 2-3 years through optimum organic management practice.

## *Objective* 5

✓ This technology can be adopted in thelow lying areas of teraizone having sandy loam soil and also in some other localities having less frequent ponds to obtain high paddy as well as fish yield from the paddy-cum-fish culture plots.

## Objective 6

✓ Identification of more number of water tolerant variety of paddy for execution of paddy-cum-fish culture with organic culture practice in the low lying areas for better profit and sustainability.

## *Objective* 7

✓ Improved growth will lead the plants to reach an optimum height required for muga silkworm rearing within shortest possible time and the lean period can be exploited by the farmer through income from the intercropped vegetables and spices.

## Recommendation

#### Objective 1

- ✓ The yield of turmeric is almost same in both the farming system which suggests bright prospects of adoption of organic farming system for turmeric cultivation in this region.
- ✓ Turmeric has been proved to be one of the most optimally growing horticultural crops in the fish pond adjoining areas of terai zone bearing sandy soil with the help of minimum input and labour cost.

Objective 2

- $\checkmark$  The potential scope of ginger recommends its incorporation in the IFS system as a valuable spice crop.
- ✓ The quality improvement of sandy soil of pond dyke is essential to make the farming system more remunerative.

## Objective 3

✓ The yield is not satisfactory this year as the crop was grown in the dyke containing highly sandy soil and it needs more attention for soil texture improvement in terms of nutrient supplement to the crop bearing plots.

## *Objective 4*

✓ Proper growth of the plants in coming 5-6 years will make the IFS unit economically strong.

## *Objective* 5

 Recommendation can be done after continuous conduction of the same experiment for 2 years in at least 1 acre plot.

## *Objective* 6

✓ The result suggests bright prospects of adoption of sustainable organic farming system for paddy-cum –fish cultivation in terai region. Components of solid indigenous microbial culture and agniastra are mostly domestic and easily available and cheaper in price that will augment the technology adoption by the stakeholders.

## Objective 7

✓ The gestation period of muga host plant is 4-5 years and to minimize the period, the option of intercropping in the inter spaces of som plants can be a better option.

Project Title: Selection of mungbean genotypes for tolerance to water-logging under field condition

Project code: RRSTZ/2017-2018/Kharif/03

Associate Scientist/s: Dr. Rupsanatan Mandal

## **Objectives:**

✓ Identification of flood tolerance genotypes suitable for Terai Zone, West Bengal Materials:

✓ . Ten mungbean genotypes viz. Samrat, Sonali, Sukumar, Panna, Birerswar, Selection
 -1, Selection-2, TC-39487, TC-39499, and TC-39544 were tested under this study.

## Methodology:

- ✓ The experiment was conducted in the field of the Regional Research Station, Terai Zone, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar during June, 2017 to August, 2017.
- ✓ The genotypes were flooded with 3-5 cm of standing water for 7 days (96 hours) at 25 days after emergence (DAE), 35 days after emergence and 45 days after emergence.
- $\checkmark$  The experiment was laid out in a split-plot design with three replications.
- ✓ Flooding treatments were placed in the main-plots and mungbean genotypes were in the subplots.
- ✓ The size of each main plot was 8m x 2m =16 m2 and the size of each subplot was (2m x 1.5m).
- ✓ Drain in between two main plots was 1.5 m so that flooded water cannot soak to the neighboring experimental plots.
- ✓ Each sub-plot had 5 rows of mungbean genotype with a spacing of 30 cm x 10 cm.
- ✓ At the border of each plot respective mungbean genotype was grown to avoid border effect.

#### **Results** :

Genotypes	% 25DAE	%35DAE	%45DAE
Samrat	56.45	40.12	20.75
Sonali	52.78	39.48	15.68
Sukumar	52.18	38.46	16.45
Panna	60.12	40.78	21.36
Birerswar	61.78	38.45	20.13
Selection -1	98.78	95.46	84.53

# Table 1: List of mungbean genotypes and percentage of plant survived at 25, 35 and 45days after emergence of seedlings

Selection-2	97.89	96.78	83.12	
TC-39487	70.12	42.12	12.45	
TC-39499	68.12	40.75	12.46	
TC-39544	67.23	41.45	15.45	

## Table 2: Rescaling value of survival % with grain yield of mungbean genotypes

Genotypes				Tatal
	25DAE	35DAE	45DAE	Score
Samrat	0.09	0.03	0.12	0.24
Sonali	0.01	0.02	0.04	0.08
Sukumar	0.00	0.00	0.06	0.06
Panna	0.17	0.04	0.12	0.33
Birerswar	0.21	0.00	0.11	0.31
Selection -1	1.00	0.98	1.00	2.98
Selection-2	0.98	1.00	0.98	2.96
TC-39487	0.38	0.06	0.00	0.45
TC-39499	0.34	0.04	0.00	0.38
TC-39544	0.32	0.05	0.04	0.42

## **Major Findings:**

The genotype Selection-1 and Selection -2 were showed the maximum value of survival in flooding situation.

#### Project Title: Genetic improvement of local germplasm used for puffed rice

#### Project code: RRSTZ/Kharif/17-18/08

#### Associate Scientist/s: Hossain Ali Mondal

#### **Objectives**

✓ Crossing program of the local germplasm, Mala (popular rice variety in Terai zone for puffing purpose) with high yielding variety for creating variability, increasing the yield of grain, developing early maturity variety, developing disease resistant variety, developing insect and pest resistant variety.

#### Materials:

✓ Rectified Spirit, Needle, Scissor, Forceps, James Clips, Tags, Polythene Bags, Bamboo Sticks, Conical Flask, Threads, Tob filled with soil etc.

#### Methodology:

- ✓ Selection of female plants- selected Insect and disease free healthy plant
- ✓ Selection of flowers expected to open by next morning
- ✓ Removal of immature and open flowers
- ✓ EMASCULATION Purpose of emasculation is to prevent pollination. Selection of panicles based on expectation to open in the morning. Lemma and palea cut at a place 25% bellow from the tip. Stamens need to remove one by one with sterilized needle or forceps done at evening. Bagging of emasculated flowers with polythene.
- ✓ EMASCULATION PROCESS- Manual emasculation.

Gotra

- ✓ POLLINATION- Collection of yellow and turgid anthers from desired male plant and putting them in bright sunlight for 15 minutes. Temporary removal of bag from female plants and pollination is done by dusting pollens over stigma surface of emasculated buds.
- ✓ BAGGING -Fixation of bamboo stick and keep the pollinated flower inside the bag. Two james clip through holes.
- ✓ TAGGING- After bagging tag bear following information. Cross combination (Mala x Gotra) with date of emasculation and date of pollination.

#### Female Male No of cross Mala Gotra 3 ChakhaoSamparark Mala 16 Mala Harpidhan 6 PB-1 15 Mala Mala Moudamini 1 PB-1 Mala 10

#### **Results:**

Findings:

Mala

4

✓ The shape of crossed seeds reflects the crossing successful. It needs to be tested in the coming season (2018).

#### Future Scope

 $\checkmark$  Next season, 2018, the crossed seeds will be germinated for F1 generation plants.



Picture 1-3: Pollination was completed, and bagging is followed for getting crossed seeds. Picture 4: Process for maximizing the probability of pollens keeping in sunlight at morning.

Project Title: Improved package of practices for major Agricultural and Horticultural crops in Terai Zone of West Bengal. Project code: RRSTZ/Kharif/17-18/02 Associate Scientist/s: Dr. Parthendu Poddar, Dr. Suchand Datta, Dr. Partha Sarathi Patra

#### Package of practices of Green gram (Vigna radiata L.) R. Wilczek

Green gram is a short duration pulse crop and its contents high amount of protein nearly about 25 percent. The sprouted seed contain ascorbic acid (vitamin, C), these are easily digestible and suitable for patient. The green gram plants may also be used as a green manures, fodder and control of soil erosion.

**Climate:** - Green gram is best suited to areas having annual rainfall of 60 to 70 cm. The crops need hot climate. Mainly green gram is cultivated in kharif and summer season. Ideal temperature is about 25 to  $35^{0}$  C.

**Soil:** - A well - drained loamy to sandy loam soil is best suited for green gram cultivation. Saline and alkaline soils are not suitable for green gram cultivation.

**Field preparation**: - Field is prepared by tractor and then followed by planking. The field should be well leveled and free from weeds. Pre- sowing irrigation should be provided for better germination of seed if there is deficit of soil moisture.

**Seed treatment:** - Seeds are treated with Thiram 75 % or Carbendazim 50 % (Bavistin) or Captan 50% at the rate of 3 gm/kg seeds and it should be done mainly for controlling of seed born disease. If the crop is being taken in the field for the first time or after a long period, it is desirable to treat the seed with suitable Rhizobium culture as well. The use of CRM-6 at the rate of 200 gm per Bigha results more yield.

**Time of sowing: -** Crop is grown during kharif season where sowing is done in last fortnight of June to first week of July. Optimum time of sowing for summer season is last week of February to first week of April.

Seed rate: - 4 kg/Bigha

**Method of seed sowing**: - The crop should be sown in line to get higher yield. Line to line distance about 30 cm and plant to plant 10 to 15 cm should be maintained.

**Fertilizer application:** - Various type of organic manures like Vermicompost, FYM and seed cake etc, are applied at the rate of 200 to 500 kg per bigha during land preparation. Soils

of North Bengal are mostly acidic in nature, so application of 100 kg lime or 150 – 200 kg Dolomite per bigha is recommended, one month before land preparation when soil contains sufficient moisture. Application of 5kg urea, 30 kg SSP and 9 kg potash at the time of land preparation is recommended for achieving higher yield. Foliar spray of urea at the rate of 20 gm mixed with one liter water, 30 to 40 days after sowing (DAS), gives higher yield. Spraying of Zink 12% (Chelamin/Chelazink/Trasko) at the rate of 0.5 gm/ L of water 21 days after sowing (DAS) and 20% Borax (Albore/Agribore/Total B-20) at the rate of 1gm/ L of water 28 days after sowing (DAS) helps in improving yield.

**Irrigation:** - Generally green gram does not require irrigation however; under deficit soil moisture condition one pre-sowing irrigation should be given. The first irrigation should be given before flowering stage and second irrigation should be given at the time of pod formation stage.

**Weed management: -** Green gram usually suffers from a severe weed competition up to 35 days after sowing (DAS). Weed do not pose a serious problem during summer, however one weeding should be done at the time of 25 days after sowing (DAS)

Varity:- Sonali, Panna, Samrat and Bireswar

Yield: - 100-120 kg /Bigha

#### Package of practices of Wheat (Triticum aestivum L)

Wheat is the second most important cereals crop after rice in west Bengal. Presently wheat area and production is in decreasing trend in our state probably due to dependency of long duration wheat variety and non availability of high quality seed, balance fertilization and irrigation facility

**Climate:** - Wheat prefers cool and moist climate during vegetative growth followed by dry, warm weather to enable the grain to ripen properly. The optimum temperature for wheat growth is between  $20-24^{\circ}$ C, temperature  $16^{\circ}$ C to  $18^{\circ}$ C produced more number of tiller. Excessively high and low temperature and drought are harmful to wheat, cloudy weather with high relative humidity, rainfall and low temperature is conductive for disease attacked like, rust disease.

**Soil:** Wheat is grown in a variety of soil in west Bengal. Loam, sandy loam and silty loam with good drainage facility is ideal for wheat cultivation.

**Land preparation:** Depending on the nature of the soil land should be ploughed 3 to 4 times with tractors followed leveling of land level with the help of ladder or rotovator. Land must be leveled and subdivided in to different plots to facilitate irrigation. One Pre sowing irrigation should be given 6 to 7 days before the final land preparation in area where soil moisture is lacking. Field should be fee from weeds.

**Time of sowing:** Optimum sowing time is 15<sup>th</sup> of October to last fort night of November; though sowing time can be extended upto first week of December under late sown condition.

**Suitable variety for Terai Zone:** PPW-343, Deva (K-9107), NW-1012, Rajlaxmi(H.P.-1713), P.P.W-443, H.U.W-468, Satabdi (K-0307)and Purba (H.D-2824)

**Seed treatment:-** Seeds should be treated with carbendazim 2gm or thiram 3gm/kg of seed to control of seed borne disease.

**Seed rate:**-Seed rate are mainly depends on time of sowing and grain weight. Seed rate for timely sown irrigated condition is 13 kg per Bigha. For irrigated late sown condition seed rate is16 kg/Bigha. About 17 kg seed/Bigha is sufficient for surface seeding or broadcasting.

**Manures and fertilizer**: - Application of 700 kg well decomposed FYM or compost, 2 kg Azotobactor and PSB/bigha at the time land preparation. As soil of terai region is acidic, so 150 to 200 kg dolomite/bigha should be applied 3 weeks before land preparation. Under irrigated condition 8 kg nitrogen (17.50 kg urea), 8 kg phosphorus (50 kg single super phosphate) and 8 kg potassium (13.28 kg muriate of potash) per bigha should be applied as basal and 4 kg nitrogen (8.8 kg urea) at 21 DAS and 4 kg nitrogen (8.8 kg urea) 45 DAS respectively should be applied as top dressing.

Fertilizer for late sown condition is 6 kg nitrogen (13.2 kg urea), 7 kg phosphorus (43.75 kg single super phosphate) and 7 kg potassium (11.62 kg muriate of potash). Potassium should be applied in split doses in light texture soil.

In deficient soil application of 2.5 kg sulfur 3.3 kg zinc and 1.3 kg borax/ bigha along with 7 kg organic manure (cowdung or vermicompost) is recommended. In terai region foliar application of 0.5 g ammonium molybdate/L of water is found effective.

**Weed management:-S**everal types of grasses, sedges and broad leaf weeds are found in the wheat field. If weeds are not controlled timely almost 40 % of yield is reduced. Critical stage of crop weed competition is upto 40 to 45 days after sowing (DAS). Therefore 1<sup>st</sup> weeding

should be done 21 DAS at the time of first irrigation and second weeding should be done at before second irrigation *ie* 42 DAS.

Application of 4 gm Sulfosulfuron 75 WG (Leader)/bigha in 30 litre of water 30 days after sowing, Pendimethalin 30 EC (stomp) @ 3ml/ litre of water 2 days after sowing is beneficial for controlling *Phalaris minor*. Care should be taken so that field should have sufficient moisture at the time of herbicide application. For controlling *Chenopodium album* 2, 4-D sodium salt 80% WP (Cut off 80/weedclean) @1.5ml/L of water 35-40 days after sowing is found effective. Application of Isoproturon 75 WP (Arelon, Delron or tritilon) 3 ml/L of water 30 to 35 days sowing is found beneficial for controlling grasses.

**Water management:-** Irrigation is plays an important role for wheat production, though plant cannot with stand water logged condition. Under water logged condition plants become yellow and finally die. Depending on the availability of water, irrigation should be given in the following critical stages.

- 1. Crown root initiation (CRI) stage (21 DAS)
- 2. Tillaring stage (45 DAS)
- 3. Booting stage (50-55 DAS)
- 4. Heading stage (65-70)
- 5. Flowering stage (90-95)
- 6. Milking stage (110-115)

Four irrigations at CRI, tillering, flowering and milking stage is found sufficient for getting profitable yield. CRI is very important stage so if one irrigation is available, that should be given at this stage.

Harvesting: Harvesting time of wheat depends upon the variety and type of cultivation i.e. whether rainfed or irrigated. Rainfed crop reaches the harvest stage much earlier than the irrigated crop. It is harvested when the grains harden and the straw becomes dry. Harvesting is done by cutting crop close ground to level with sickle. The plants are tied in small bundles and kept to dry under sun for few days. Threshing is done by trampling under bullocks feeds or by a stone-roller or by thresher. In recent year harvesting id done by reapers in bigger wheat plots in which operations like harvesting threshing, cleaning and bagging are done at same time.

Yield: 450 to 600kg/Bigha

## Jute (Corchorus sp.)

*Introduction*: Jute being the second most important commercial fibre yielding cash crop next to Cotton is termed as 'Golden Fibre'. In the present era of hue and cry about the environmental hazards created by the use of synthetics and also to provide employment to the burgeoning population in country like India due patronage should be given to the natural fibers like jute and allied ones which play a very significant role in Indian economy. Area under cultivation of jute is 8.35 lakh ha in the country, which is spread over seven states like West Bengal, Bihar, Assam, Orissa, Meghalaya, Tripura and parts of Uttar Pradesh. About 04 million of farm families are involved in jute farming and an employment to the tune of 10 million paid man-days is generated in this sector.

## **Ecological requirement:**

<u>Soil</u>: Deep alluvial soil with occasional deposition of silt is ideal for quality fibres of jute. River basin of Jamuna (Brahamaputra at lower stage) and Meghna produces the best quality jute fibre in the world. Gangetic soils in Nadia and adjoining stretches in the Burdwan districts produce better quality jute fibre, In North Bengal, alluvial soils of Teesta, Torsa, Jaldhaka river are suitable for production of fairly good quality fibre.

<u>**Climate</u>**: Well distributed annual precipitation of 1500-2000 mm during the growth stages is ideal / warm humid climate favours high quality of jute fibre. Rains during night and bright sunny weather with mild wind at day time are congenial for jute production. Alternate rain and sun is ideal temperature range for jute cultivation is  $24-37^{0}$ </u>

## Package of practices:

Land Preparation: Land preparation should have the following objectives-

- 1. Jute seed is very fine. Hence fine tilth is necessary.
- 2. Jute seed is highly sensitive regarding soil moisture ----- so correct soil moisture regime should be maintained.

Land preparation is initiated with first north-western shower. After  $1^{st}$  ploughing and laddering land is left for 1 week. Weeds come and with  $2^{nd}$  ploughing these weeds are removed. The land is ploughed and cross ploughed 4-5 times with necessary leveling. If irrigation is available, one pre-sowing irrigation at final stage of

land preparation is given. Otherwise sowing is done with the receipt of the premonsoon showers.

#### Varieties:

Olitorius:: JRO-632, JRO-878, JRO-7835, JRO -524, JRO-3690, JRO-66, JRO-8432, JRO-128

Capsularis: JRC -321, JRC-212, JRC-7447, Padma, JRC-698

#### **Sowing parameters:**

Seed treatment: Seed must be treated with or immersed in the solution of fungicides like Captan, Dithane M-45@ 5 gm/ kg of seed / lit. of water for 10 minutes. Then the seeds are shade dried.

• Seed Rate :

Species	Line sowing (kg/ ha)	Broadcasting (Kg/ ha)
Capsularis	6-8	10
Olitorius	4-6	7

#### • Methods of sowing:

- 1. Broadcasting
- 2. Line sowing
- 3. Drill sowing

Line sowing is advocated for higher yield and economic benefit.

#### • Time of sowing:

 Early sowing: In low lying areas where there is a chance of flood sowing may be done on 1<sup>st</sup> week of March with residual soil moisture.

2. Normal sowing: Capsularis: 15<sup>th</sup> March to 15<sup>th</sup> April

Olitorius: 15<sup>th</sup> April to 15<sup>th</sup> May

Normal sowing with Olitorius Jute starts from middle of April. In case of Chaitali Tossa, it is claimed that sowing is possible from the middle of March, but in areas where there is a possibility of drop in minimum temperature below  $20^{\circ}$ C there may be pre-maturing flowering. The problem is more common in North

Bengal areas. Hence for this region sowing of Olitorius Jute should be delayed up to first week of April.

- **Depth of sowing**: 2 cm
- Spacing: Capsularis-: 30 X 10 cm
  - Olitorius -: 20 X 10 cm

#### Weeding:

It is the most important inter- culture operation of jute because -

- 1. Weed control consumes a lot of Mondays
- 2. Weed musty be controlled d at early stages of the plant.

Some points in favour of high rate of weed growth of jute:

- i) Jute is grown in warm humid season.
- ii) Jute is grown in medium high to high land situation.
- iii) The soil is light in texture in many areas.

#### • Name of the weeds associated with jute:

Cyprus rotundus	Phyllanthus niruri
Eleusine indica	Cynodon dactylon
Euphorbia hirta	Scoparia dulcis

#### Methods of weed control

- i) <u>Cultural method</u>: Before final land preparation, land is left for one week to control weeds.
- ii) <u>Mechanical method</u>:
  - a. Sowing the crop in the row.
  - b. Operating wheel-hoe in the rows during early growth stages 3 times at
     4-5 days Interval during bright weather condition.
  - c. Two hand weeding first at 15-20 DAS, second at 30-40 DAS.
- iii) <u>Chemical method</u>: Application of fluochloralin (Basaline) @ 1.5 kg *a.i.*/ha in 500 to 600 liter of water as pre plant incorporation. After spraying soil should be raked lightly to prevent volatilization.

#### Thinning:

Thinning of Jute is also very important inter- culture operation. First thinning with  $1^{st}$  weeding and  $2^{nd}$  thinning with  $2^{nd}$  weeding is to be done.

At 50-60 days of crop age, some plants may be found lacking in growth. These plants are thinned, retted and fibre is extracted for family use or sale.

An optimum plant population of five lakh plants/ ha is considered ideal for better yield and quality.

**Irrigation**: Usually jute is grown `as rain-fed crop, sometimes one pre-sowing irrigation is given. If dry spell continues for long time, irrigation may be given during early stages of growth.

<u>Manuring</u>: Before fixing the manuring schedule for jute, the following points should be taken into consideration.

## Initial soil fertility status

<u>Cropping intensity</u>- in case more than 200 cropping intensity every crop should be manured moderately

<u>Nature of preceding crops</u>:- when jute is grown after potato, very little amount of fertilizer is to be applied for jute. Only moderate quantity of N may be enough for a good crop as potato is manured heavily and residual fertilizer may be enough for jute crop. But when jute is grown after wheat, high amount of fertilizer is to be given as wheat is fairly exhaustive crop.

## Physiological growth stages of the crop

Dose	Ν	Р	K
Capsularis	60 kg/ha	30 kg/ha	30 kg/ha
Olitorius	50 kg/ha	30 kg/ha	30 kg/ha

Sometimes 5-10 tons of FYM / green manuring with Dhaincha or Sunhemp @ 5- 10 t/ha is applied/ ha. For better fibre quality, potash may be given in slightly higher doses.

## Time and method of application:

1/3 N + full P and K is to be applied as basal. For areas with high rainfall, the 1 <sup>st</sup> application of nitrogen should be skipped over in order to avoid the encouraging growth of weeds. In

such cases, the  $1^{st}$  application of N is done after  $1^{st}$  weeding. The remaining 2/3 of N fertilizer is applied in two splits at 30 and 45 DAS.

**Foliar application of N:** Foliar feeding of N in case of jute is advised instead of applying 2/3 <sup>rd</sup> N fertilizer as top- dressing. The following schedule of foliar feeding may be undertaken to save 1/5 of total N fertilizer.

Age of the Crop	Concentration	Requirement of water/ha	Requirement urea/ha
3 weeks	1%	300 litre	3 kg
4 weeks	2%	500 litre	10 kg
6 weeks	3%	500 litre	15 kg
7-8 weeks	3%	500 litre	15 kg

**Liming**: In acid soils of Tripura, Assam and N. Bengal, dolomite containing both Ca and Mg being available in plenty in N. Bengal and Bhutan border area is being considered as superior amendment to neutralize soil acidity. Liming @ 2.5 t/ha (once in a 3 years) or dolomite @ 10-15 q/ ha is recommended when pH is below 5.5. Liming also reduces the root rot and stem rot.

**Micronutrient**: Light soil in N. Bengal deficient in micronutrient particularly Boron needs application of Borax 2 10 kg/ ha. However, its application depends on the cropping pattern also. For example, if mustard or wheat is grown before jute, B application may not be required because B is normally used in mustard or wheat. Olitorius jute has been found to be more sensitive to Boron deficiency than Capsularis, Soil application of Mo @ 400 g/ha or seed soaking with ammonium molybdate @ 90- 180 g/ amount seed required for one hectare or foliar application of sodium molybdate @ 0.5-1.0 g/lit water is advocated. In case of zinc deficiency, ZnSo<sub>4</sub> @ 5-10 kg/ha is applied.

**Jute based crop rotations:** Growing of different crops on the same piece of land in a preplanned succession within a year is crop rotation.

Low land situation:- Jute (capsularis)-rice-wheat

Medium land situation:- Jute (olitorius) - rice--- oilseed / pulses/ potato/ wheat

Under West Bengal condition jute is always followed by transplanted rice in *kharif* and if irrigation is available, a third *rabi* crop such as wheat, potato, mustard and other oilseeds or any *rabi* vegetables is grown.

Solanaceous crops should not be taken after jute because main disease of jute is stem rot of jute caused by *Macrophomina phaseolina*. The sclerotia of the fungus can survive free in soil or dead tissues. If we grow Solanaceous crop after jute, the sclerotia of the fungus may infect the Solanaceous crops.

#### Harvesting:

Depending on the requirement and situation, jute crop may be harvested any time between 100-150 days of crop age. When harvested early, the quality of the fibre is good but yield suffers. If harvested at flowering and early pod formation stage, both quality and yield are optimum. If harvesting is over delayed up to the fruit maturity stage, both quality and yield are drastically reduced.

Capsularis jute is harvested at 120-130 DAS and Olitorius jute at 130-140 DAS.

In low lying areas, Capsularis jute often gets partially submerged after heavy rains in catchment areas. Pre- mature harvesting has to be done in such cases.

High yielding *kharif* transplanted rice is often taken after jute and any one of many *rabi* crops is taken after rice. Hence, a tight schedule is to be followed in such cases. Even Olitorius jute is harvested at 120 days of crop age under such situations.

#### Seed production of jute

Jute being a bast fibre crop, both fibre and seed of the good quality can't be obtained from the same crop (plant) and the quality of the fibre deteriorates if the crop is left standing till the seed maturity. Some farmers keep a small portion of the crop at the corner of the field to produce seed and the rest is harvested for fibre. It has been estimated that the average area retained for jute seed production is about 9.1 % the total area under jute cultivation. The seed produced in West Bengal isn't sufficient to meet the demands of jute growers of the state. As a result the major part of the jute seed is supplied from Maharashtra, Gujrat and as joining

areas of Bihar and Orissa. If effort is made, good quality seeds can also be produce in West Bengal in the drier districts of Purulia, Bankura and Midnapur.

#### Package of practice:

- Seed: Seed must be procured from National Seed Corporation, WB State Seed Corporation, CRIZAF, Universities or State Seed Multiplication Farms etc. Standard varieties suitable for different agro- climatic regions should be used to raise a seed crop. A good seed sample should have 98% germination at 33<sup>0</sup> C temperatures.
- Selection of land: Same as fibre crop
- Isolation distance: Though jute is a self pollinated crop, cross pollination does occur to some extent. It has been estimated that natural cross pollination in the Capsular range from 2-5 % and in case of Olitorius it may as high as 12%. For foundation seed production the seed field should be isolated by 50m whereas in case of certified seed production it is 30m. Isolation distance of only 3 m should be provided between two species of jute.
- Land preparation: Same as other fibre crops. The beds should be raised 4-5 cm high with shallow drainage at all the sides to prevent water stagnation. Soil moisture ranging from 21-45% is considered ideal for jute seed germination.
- **Seed treatment**: Same as fibre crop
- ✤ Seed rate: Same as fibre crop
- **\*** Time of sowing: July- August
- Method of sowing: Line sowing
- Spacing and plant population: For a seed crop, profuse branching is encouraged as the no. of flowers, fruits and quantity of seeds would be much more. This is quite in contrast with the fire crop where branching is considered to be a bad trait.
- Manuring: The recommended dose for N, P, & K is 15:15:15 (kg/ha) ½ + total P & K is applied as basal. The rest ½ N to be top dressed 1 month after sowing under adequate soil moisture condition.
- **♦ Irrigation**: 1 pre- sowing irrigation + 2-3 subsequent irrigation.
- ✤ Inter culture operation: Same as fibre crops
- Roughing: Roughing of off-type, diseased and infected plant should be carried out at 30-50 days age of the crop, flowering and capsule forming stage.
- Pruning: Pruning apical bud 6 week after sowing induces growth of lateral axillary buds leading to profuse branching. It should be done at a place of the stem 5-7 cm from the top.

- Cutting: Stem cutting of the jute easily strike rots when planted in well prepared nurseries. Sometimes farmers harvests a part of jute crop well ahead of the flowering at 90-100 days when the crop has attained 75-80 % of the growth. After harvest of Jute, the apical portion is cut – off and they are planted in well prepared nurseries first and replanted in the main field to get good quality seed and the remaining portion of the stem will portion of the stem will produce good quality fibre.
- Harvesting: In case of Capsularis harvesting is to be done when stems and pod are not dead ripe but in case of Olitorius, harvesting should be done when the pods are fully ripe. The procedure is same as in case of fibre crops.
- Storage: Seeds should be properly dried till the moisture content of seed reduces to 9
   % and the seeds are to be stored in optimum storage condition.
- ✤ Yield : Capsularis-----3-4 q/ha

Olitorius----- 1.5 q/ha.

## Turmeric (Curcuma longa L.)

## **INTRODUCTION :**

Turmeric (*Curcuma longa* L.)is an important rhizomatous spice in India and World too belongs to the family zingiberaceae. Dried rhizome is used as spice. It is basically herbaceous perennial tropical plant however for commercial cultivation itis grown as annual crop. It is used as a condiment, dye, drug and cosmetic in addition to its use in religious ceremonies. India is the largest producer (more than 75% world production), consumer and exporter of turmeric across the world. India has an jealous monopoly over world turmeric trade. Apart from India, it is also cultivated in China, Myanmar, Nigeria and Bangladesh, Pakisthan, Sri Lanka, Indonesia, Mozambique, Jamaica, Haiti, costarica, peru, Brazil, Malaysia, Vietnam, Thailand, etc. During the year 2016-17, India exported about 116500 MT of turmeric and earned a tune of 1241.89 cores of foreign money. The curcuminoids, which include curcumin (diferuloylmethane), demethoxycurcumin, and bis-demethoxy curcumin, are most important chemical components of turmeric. However, the major compound is curcumin, which generally varies from 3-9%, For export purpose, turmeric more than 5% curcumin content is desirable for foreign trade.

## SOIL AND CLIMATIC REQUIREMENTS:

Turmeric can be grown in diverse tropical conditions from sea level to 1500 m above MSL. It requires temperature ranging from  $20 - 30^{\circ}$ C with annual rainfall of 1500 mm or more. In the Sothern parts of the country it is grown as irrigated crop. However, in the Northern Eastern parts and Northern parts of the country it is grown as rainfed crop. It can be grown on various types of soils from light black, ashy loam, clayey loam and red soils. However, it grows well in a well-drained sandy or clay loam soils. Sandy clay loam soil of terai zone is highly suitable for growing turmeric.

#### **IMPROVED VARIETIES**

A good number of varieties (CO.1, BSR.1, BSR.2, Krishna, Sugandham, Roma, Suroma, Ranga, Rasmi, Rajendra Sonia, Megha turmeric 1, Suranjana, Suvarna, Suguna, IISR Prabha, IISR Prathibha, IISR Alleppey Supreme). have developed from the different research institutes and Agricultural Universities. In Northern parts of West Bengal including terai zone turmeric variety Suranajana is most popular ones.

#### LAND PREPARATION AND PLANTING

The land is prepared with the onset of pre - monsoon in the month of April and its onward upto end of May. The soil is brought to fine tilth by giving about four deep ploughings and weeds, stubbles, roots etc. are removed. Beds of size 1-1.5 m width, 15 cm height and of convenient length are prepared with spacing of 50 cm between beds. Small pits are made with hand hoe in the beds in rows with spacing of 15-25 x 30 cm and covered with soil or dry powdered cattle manure. Generally ridges and furrows method is used for planting by keeping optimum spacing of 45-60 cm between rows and 25cm between plants. Whole or split mother rhizomes are used for planting. A seed rate of 2000 kg of rhizomes is required for planting in one hectare. Datta et al. (2016) reported that fresh yield of seed turmeric rhizome increased with increasing seed rhizome weight under terai zone of West Bengal. However, the fresh yield of turmeric seed rhizome of 32.00 t/ha was produced with the 50 g  $(W_3)$  seed rhizome that was statistically *at par* with 35 g  $(W_2)$  seed rhizome. Significantly the highest fresh rhizome yield was recorded in 20 cm X 15 cm spacing. Considering the interaction effect, the highest quantative and qualitative fresh turmeric seed rhizome yield of 35.43 t/ha was recorded in treatment combination of 35 g seed rhizome planted at a spacing of 20 cm X 15 cm ( $W_2S_2$ ) and that may be recommended for both seed and crop production of turmeric.

Before planting of turmeric rhizome in the main field, it should be treated with suitable fungicides (copper oxy chloride fungicides @ 4g/litre of water, mancozeb @ 3g/litre of water or carbendazim @ 1g/litre of water or bio control agent (*Trichoderma viride*) for a period 30 minutes and thereafter treated rhizome should be dried in shade.

#### NUTRIENT MANAGEMENT

Being an exhaustive crop, turmeric requires heavy manuring for higher yield. Cattle manure or compost at the rate of 40 tonnes per hectare is applied by broadcasting and ploughing at the time of preparation of land or as basal dressing by spreading over the beds to cover the seed pits after planting. Recommended fertilizers dose for irrigated crop is 125 kg N, 80 kg P2O5 and 120 kg K2O per hectare. The beds are earthed up after each top dressing with fertilizers.

Jana *et al.* (2017) conducted an experiment to study the efficacy of *Azospirillum* in organic and ntegrated nutrient management with farmyard manure (FYM) and graded levels of nitrogenous fertilizer on turmeric, at Uttar Banga Krishi Viswavidyalaya. The results revealed that application of 75% recommended inorganic nitrogen with *Azospirillum* at 5kg/ha and FYM at 15 t/ha gave the highest yield of 26.29 t/ha as against 22.96 t/ha in the control of recommended dose of fertilizers at the rate of 80:80:120 kg N, P2O5 and K2O per hectare. It was followed by the combined application of 50% recommended inorganic nitrogen with *Azospirillum* at 5 kg/ha and FYM at 15 t/ha with a yield of 25.8 t/ha and then 100% recommended in organic nitrogen with *Azospirillum* at 5 kg/ha and FYM at 30 t/ha.

Datta *et al.* (2017) studied the effect of different micronutrients on turmeric variety Suranjana in terai region of West Bengal. The results revealed that soil application of boron (as borax) @ 25Kg ha-1) gave the highest yield (11.13 kg/3 m2 and 22.45 t/ha) which was also statistically *at par* with foliar spray of boron as borax @ 0.5% at 60 and 90 days after planting (10.59 kg/3 m2 and 21.36 t/ha). The lowest yield (7.17 kg/3m<sup>2</sup> and 14.45 t/ha).was recorded in the control treatment (i.e. without micronutrient application). The highest cost benefit ratio (1: 2.04) was recorded with soil application of boron (as borax) @ 25Kg ha<sup>-1</sup> followed by foliar spray of boron (1: 1.95).s

Application of all the organic inputs (viz., FYM - 10 kg, Pongamia cake 250 gm, Sterameal 250 gm, Rock phosphate 500 gm, Wood ash 250 gm per 3m<sup>2</sup>) except neem cake

resulted maximum fresh rhizome yield, although statistically lower from the treatment with recommend dose of fertilizer (AICRP Report).

Datta et al. (2017) conducted an experiment to study the effect of organic source of nutrients and biofertilizers on growth, yield and quality of Turmeric (*Curcuma longa* L.). The results revealed that application of green leaf manure (from *Glyricidia maculata*) @ 12tonnes/ha along with rock phosphate @ 0.2 tonnes/ha, wood ash @ 1 tonnes/ha, *Azospirillum* @ 5kg/ha + PSB @ 5kg/ha (T<sub>5</sub>) gave the significantly highest fresh (29.27 tonnes/ha) and dry yield (7.81 tonnes/ha) followed by vermicompost 5 tonnes/ha along with *Azospirillum* @ 5kg/ha + PSB @ 5kg/ha (T<sub>4</sub>) (26.30 tonnes/ha and 6.99 tonnes/ha, respectively) which was statistically *at par* with sole application of 30 tonnes/ha farm yard manure (T<sub>2</sub>) ( 26.00 tonnes/ha and 6.77 tonnes/ha, respectively). Maximum dry recovery (27.22%) and curcumin content (5.24%) was recorded in the treatment of sole application of FYM @ 15 tonnes/ha (T<sub>1</sub>).

#### **INTERCULTURAL OPERATIONS**

The crop is to be mulched with green leaves at the rate of 12-15 tonnes per hectare immediately after planting. It may be repeated again after 50 days with the same quantity of green leaves after weeding and application of fertilizers. Weeding may be done thrice at 60, 120 and 150 days after planting depending upon weed intensity. It could be grown as mixed crop with chillies, colocasia, onion, brinjal and cereals like maize, ragi etc. Irrigation should be depends on the weather and the soil conditions. Under terai zone of west Bengal application surface irrigation, 5cm, and 0.90 IW/CPE ratios gave the highest yield of 20.91 t/ha followed by drip once in 2 days at 40% PE (18.59 t/ha) which was also statistically *at par* with drip once in a day at 40% PE (17.36 t/ha), drip once in 2 days at 60% PE (17.26 t/ha) and drip once in a day at 60% (17.24 t/ha). The highest benefit: cost ratio (2.58) was recorded in application surface irrigation, 5cm, and 0.90 IW/CPE ratios (Report of AICRP on Spices).

#### HARVEST AND YIELD:

The crops become ready for harvest in seven to nine months depending upon the variety. It may extend from January – March. The land is ploughed and the rhizomes are judiciously picked up with a spade. Harvested rhizomes are cleaned of mud and other extraneous matter adhering to them. The average yield comes to 25-30 tonnes of green turmeric per hectare.

After harvesting, turmeric should be processed to improve the quality and storage life of rhizomes.

## **Plant Protection**

Yield losses of turmeric mainly affected due to pests like shoot borer, rhizome scales and diseases like leaf blotch, leaf spot and rhizome rot etc.

Rhizone rot :

Seed treatment as well as soil application of *Trichoderma viride* and *Pseudomonas fluorescens* @ 12.5 kg /ha and 25.0 kg /ha as basal and top dressing respectively with application of recommended NPK and FYM was proved to be the best treatment for management of rhizome rot of turmeric (AICRP on Spices report).

Leaf blotch

In leaf blotch experiment, seed treatment as well as spraying with Mancozeb + Carbendazim (0.2% + 0.2%) showed lowest disease incidence and highest yield too. Seed treatment as well as spraying with Carbendazim (0.2%) showed lowest disease incidence and good yield.

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## **Ginger** (*Gingiberofficinale* L.)

#### **INTRODUCTION**

Ginger is a slender herbaceous perennial grown as annual crop belonging to Zingiberaceae family. Ginger of commerce founds the dried rhizome of the plant which is used as a spice. It is used in different forms such as raw ginger, dry ginger, bleached dry ginger, ginger powder, sliced ginger, ginger oil, ginger oleoresin, ginger in brine etc. It has usage in foods, beverages, preservatives, medicines and perfumery industries also.

Ginger contains 4.2 to 10.9% oleoresin, 1.6 to 4.4% crude fibre 1.7 to 6% essential oil. The major functional constituent of ginger is zingibarin which can aid immunity and is associated with anti-inflammatory activity. This is due in part to the fact that ginger acts as an antioxidant with more than twelve constituents superior to vitamin E.

#### SOIL AND CLIMATIC REQUIREMENTS:

Ginger requires in warm and humid climate. It is mainly cultivated in the tropics from sea level to an altitude of above 1500 MSL. It thrives best in well drained soils like sandy or clay loam, red loam or lateritic loam. Friable loamy soil rich in humus is ideal for ginger cultivation.

#### **Improved Varieties of Ginger :**

Suprabha, Suruchi, Suravi, Himgiri, IISR Varada, IISR Mahima, IISR Rejatha.In the northern parts of West Bengal, Gorubathan is the dominant cultivar followed by Bhaise. Very recently, variety release committee of the XXVII annual Workshop of AICRP on Spices recommended the Ginger Germplasm GCP-49 for national level release as a variety of ginger in the name of UBKV Aada-1 (with popular Name : Mohini). For National release the proposal has been already send to the Central variety Release Committee, Govt. of India, New Delhi.

#### **Propagation and planting**

The land is ploughed 4-5 times to bring the soil to fine tilth and weeds, stubbles, roots etc. are removed. Beds are prepared with a dimension of about one metre width, 15 cm height and of convenient length and distance between beds should be of 50 cm. In case of irrigated crop, the ridges are formed 40 cm apart. Northern parts of West Bengal , it can be planted well in advance during the middle March and may continuedupto Middle of May.

Ginger is propagated by portions of rhizomes known as seed rhizomes. Seed rhizomes weighing 20-25 gm, length of 2.5-5 cm and each having one or two good buds are used for

planting. For planting one hectare area 1500-1800 kg rhizomes are enough and at high altitudes the seed rate varies from 2000-2500 kg per hectare. The seed rhizome bits are place in shallow planting pits prepared with a hand hoe and covered with well rotten farm yard manure and a thin layer of soil and levelled it.

#### NUTRIENT MANAGEMENT:

At the time of planting, 25-30 tonnes well decomposed and dried cattle manure or compost per hectare is applied. The recommended dosage of fertilizer to ginger is 75 kg N, 50 kg  $P_2O5$  and 50 kg  $K_2O$ . N is applied in two split doses, first dose during 40 days after planting and second dose during 90 days after planting while, whole quantity of  $P_2O5$  and  $K_2O$  are applied as basal dose. Application of neem cake @ 2 tonnes per hectare at the time of planting helps in reducing the incidence of rhizome rot of ginger and increase the yield.

Application of inorganic N 100% + *Azospirillum* 50g + FYM 5 kg per 3 sq.m. plot produced highest yield compared to controls (recommended dose of fertilizer @ 80:80:120 NPK per hectare) in ginger (Annual report of the AICRP on spices).

To evaluate the effect of organic source of nutrients and biofertilizers on growth, yield and quality of ginger (*Zingiberofficinale*Rosc.) datta et al (2017) conducted an experiment at the terai zone of West Bengal. The results revealed that application of green leaf manure (from *Glyricidiamaculata*) @ 12t/ha along with rock phosphate @ 0.2 t/ha, wood ash @ 1 t/ha, *Azospirillum* @ 5kg/ha + PSB @ 5kg/ha (T<sub>5</sub>) gave the significantly highest fresh (20.68 t/ha) and dry yield (4.52 t/ha) followed by vermicompost 5 t/ha along with *Azospirillum* @ 5kg/ha + PSB @ 5kg/ha (T<sub>4</sub>) (18.59 t/ha and 4.06 t/ha, respectively). Somewhat higher dry recovery percentage was recorded in case of all the organic treatments compared to control treatment (T<sub>6</sub>). Maximum dry recovery (22.43%) and oleoresin content (4.37%) was recorded in the treatment of sole application of FYM @ 15 t/ha (T<sub>1</sub>).

#### **INTERCULTURAL OPERATION**

Beds are mulched with green leaves to enhance germination as well as to prevent of washing off soil due to soil conservation. The first mulching is done at the time of planting and repeated at 40th day and 90th day after planting with 10-12 tonnes and 5 tonnes of green leaves per hectare respectively. Weeding is done just before fertilizer application and mulching. Two to three weeding are required depending upon the intensity of weed growth. Proper drainage channels are to be provided to drain off stagnant water. Ginger is grown in rotation with other crops such as tapioca, chillies, paddy, gingelly, ragi, ground nut, maize,

vegetables, red gram, castor, etc. It is also grown as an intercrop with coconut, arecanut, coffee and orange plantations.

## HARVESTING AND YIELD :

The crop becomes mature harvest within eight months and ready for harvesting when the leaves turn yellow and start drying up gradually. The clumps are picking up carefully with a spade or digging fork and the rhizomes are detached from the dried up leaves, roots and adhering soil. The average yield of fresh ginger varies from 15-25 tonnes per hectare depending upon the varieties.

For vegetable ginger, harvesting is done from 6th month onwards. The rhizomes are thoroughly washed in water twice or thrice and sun dried for a day. For dry ginger, the produce is soaked in water overnight and then rubbed well to clean them

## **PLANT PROTECTION:**

Shoot borer, leaf roller and rhizome scale are major pests infesting ginger as well as diseases like soft rot, bacterial wilt and leaf spot infecting ginger in the field which affects the quality and yield of the crop.

## Rhizome Rot :

Rhizonme rot is the devastrating disease of the ginger. It is the major hindrance for expansion of the ginger area in the terai zone of the West Bengal. In case of rhizome rot, biocontrol agent, *Trichodermaharzianum* proved to be the best treatment when applied in soil with neem cake after hot water treatment at 51°C for 10 minutes. The treatment reduced the disease up to 36% in comparison to control. *Trichodermaharzianum*should be applied @ 20 kg / ha mixed with 1 Kg neem cake per 3 m  $\times$  1 m bed (Annual report of the AICRP on Spices).

## Leaf spot

Leaf spot of ginger caused by *Phyllostictazingiberi*has become a serious phytopathological constraint now in cultivation in the ginger growing areas of India. Among the different fungicides and fungicides combination tested including control for management of *Phyllosticta*leaf spot disease of ginger, Hexaconazole (0.1%) first at disease appearance and then 2 times at 20 days interval produced the lowest leaf spot disease severity (PDI 12.12) followed by spray with 0.1% Propiconazole (PDI 12.95) and spray with mixture of Carbendazim and Mancozeb@ 0.1% first at disease appearance and then 2 times at 20 days interval (PDI 16.83). The highest yield of 6.42 kg/plot (12.94 t/ha) was obtained by 0.1% Propiconazole spray which was very closely followed by spraying with Hexaconazole @

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0.1% with a yield of 6.40 Kg/plot (12.90 t/ha). So, it can be concluded that spraying with Hexaconazole or Propiconzole @ 0.1% for 3 times is highly effective against leaf spot disease of ginger.

## INTEGRATED MANAGEMENT OF *PYTHIUM*, *FUSARIUM* AND *RALSTONIA* ASSOCIATED DISEASES OF GINGER:

Against *Pythium*, *Fusarium* and *Ralstonia* of ginger, it was found that seed treatment with *Trichodermaharzianum* was the best treatment in reducing the disease over control. This treatment reduced 68.49 % disease over control. However, seed treatment with RidomilMancozeb [100 ppm Metalaxyl] and seed treatment with hot water at  $51^{0}$ C for 30 minutes were also very effective against *Pythium*, *Fusarium* and *Ralstonia* of ginger (Annual report of the AICRP on Spices).

It was observed that Bio-fumigation with cabbage recorded the lowest disease of 7.03% - 9.97% soft rot and 5.92 - 10.4% bacterial wilt incidence. This treatment produced the highest yield of 7.02 - 7.52 kg per plot (14.15-15.16 t/ha). Procedure for Biofumigation with cabbage refuse: Since cabbage is cultivated during winter (October–November) in the place where ginger is proposed to be planted in the next season, cabbage may be cultivated and after harvest the leaves and roots are to be incorporated into soil by ploughing. After this the beds are prepared and solarized by polythene mulching for about 15-30 days. Planting with rhizome has to be done after solarization) (Annual report of the AICRP on Spices).

Similarly, Bio-fumigation with mustard also recorded the lowest soft rot (7.16 - 9.44%) and bacterial wilt (6.74 - 10.45%) disease of ginger. This treatment produced the highest yield of 7.18 - 7.53 kg per plot (14.47 - 15.18 t/ha). Procedure for Bio-fumigation with mustard: Beds are to be sown with mustard (during march-April) cultivated for about 30-45 days and the leaves are to be incorporated into soil by ploughing. After this the beds are to be solarized by polythene mulching for about 15-30 days followed by planting with rhizome. (Annual report of the AICRP on Spices).

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## Chilli (*Capsicum sp* L.)

Chilli (*Capsicum* spp.) is one of the most important vegetable cum spice crops in India and world too. The *Capsicum* genus represents a diverse group of plants, from the well known sweet bell capsicum to the fiery hot chilli. There is tremendous variation in fruit shape, size, colour and as well as in plant habit among capsicum cultivars and species. The name *Capsicum* derives from the Greek word *Kapto*means 'to bite' referring to the pungency or heat of the fruit. *Capsicum* species are the member of the *Solanaceae* family that includes potato, tomato, tobacco, etc. The genus capsicum contains more than 25 wild species and 5 domesticated species among them *Capsicum annuum* and *Capsicum frutescens* are being most commonly grown as cultivated species.

The chief use of chillies throughout the world is as a vegetable cum spice on account of its pungency, colour, pleasant flavour, oleoresin and vitamin content. The alkaloid compounds called capsaicinoids, produced in the fruit, are the main source of pungency in peppers. Capsaicin ( $C_{18}H_{27}NO_3$ , trans-8-methyl-N-vanillyl-6-nonenamide) is the most abundant one, followed by dihydrocapsaicin,Chilli is widely used in the preparation of various food items. When chillies are taken with food stimulate our taste buds and thereby increasing the flow of saliva which has a great role in digestion of foods. It is rich in vitamin C and vitamin A. The dry red chilli powder or paste which is mainly used everyday in Indian kitchen for preparation of curries, sambar, dalna and many other fish or meat dishes to impart pungency and colour. It is also an important ingredient of curry powder, curry paste and all kinds of pickles, sauces, soups, salads, sausages etc. In food and beverage industries, chilli is being used in the form of oleoresin which permits better distribution of colour and flavour in foods.

The most important chilli growing countries are India, China, Egypt, Ghana, Nigeria, Tunisia, Itali, Mexico, USA, Argentina, Indonesia, Bangladesh, Pakistan, Sri Lanka, Turkey, Hungary, Romania, Spain and Bulgaria. In India, it is cultivated in an area of about 7.92 lakh hand with a production of 13.75 lakh MT. In West Bengal it is cultivated in 63000 ha and witha production of 1.00 lakh MT (Geetha and Selvarani, 2017). During 2016-17, India earns about a tune of 3997.43 crores by exporting chilli and chilli products (Anonymous, 2017).

#### Soil and climatic requirements:

Chilli can be grown in wide range of soil starting from lateritic loam to black soil. However, it can be grown best in sandy loam soil with moderate pH. Friable and loose soil

with good drainage is ideal as oxygen demand in root is more. Water stagnation for short duration also results in yellowing and shedding of leaves. Blossom end rot is a common phenomenon in heavy soil.

It is basically warm loving plant, although it is grown in wide range of climates.. Warm areas experiencing well distributed 60 to 150 cm rainfall is suitable for chilli cultivation. Erratic and heavy rainfall is very detrimental for its growth and fruiting. Plant can withstand high temperature during growing period but fruit setting is hampered due to high temperature and heat wave. 21°C temperature is ideal for vegetative growth of the plant and 26.7°C is best for good fruiting. Desication of flower and fruit drop is common during heat wave.The climatic condition of terai zone is sub-tropical humid in nature characterized by high rainfall, high relative humidity, moderate temperature, prolonged winter with high residual soil moisture is highly suitable for growing chilli.

#### **Nursery operations:**

Fungicide treated (Carbendazim @ 1g per kg of seeds) seed should be sown in the well prepared nursery beds. In case of rabi season crop seed should be sown form last week of September to Middle of October and for Kharif season crop seed should be sown end of February to last week of March. Nursery raising of seedlings is done in raised beds situated in high land with light sandy loam soil. The area is ploughed for 3-4 times to get fine tilth and leveled after removal of weeds and clods. Beds of 1.2 m width and convenient length raised to 15 cm are prepared for sowing seeds. Seeds are generally sown in lines at a distance of 10 cm and at a depth of 1.5-2.0 cm. Seeds are treated with fungicides (Agrason-GN or Copper oxychloride solution) before sowing. Watering is done just after sowing of seeds and seed beds are often covered with rice straw or other mulches for better and quick germination which is also removed just after completion of germination. After sowing, seeds should be covered with fine layer of farm yard manure. Light irrigation can be given, when bed showed insufficient moisture. Timely application of insecticides and fungicides should be arried out depending upon the incidence of pests and diseases. Seed rate is 1.0 to 1.5 kg/ha that should sown in a nursery bed of 200-250 square meter.

Transplanting of seedlings is the better method for chilli production. Seedlings become ready within 30 to 40 days after sowing of seeds to transplant in the main field. Chilli can also be grown by direct seeding method. For better establishment of seedlings in the main field irrigation in nursery bed should be stopped 7-10 days before transplanting and only stought, straight seedlings should be transplanted during the cloudy evening. A light
irrigation is necessary after transplanting. Seedlings are normally planting at a spacing of 45 to 60 cm between lines and 30 to 45 cm within lines depending upon the variety, water and nutrient management practices.

# Variety:

A large number of variety including F1 hybrids have been developed form the different Research Stations, Agricultural Universities and from Private Sector. PusaJwala, PusaSadabahar, Bhagyalakshmi (G-4), Andhra Jyoti (G-5), Sindhur (CA-960), Pant C-1, Punjab Lal, KashiAnmol, ArkaMeghana (F1 Hybrid), ArkaHarita (F1 hybrid), Pragati, NS 1701, NS 7510, Indam-5, Indam-6, Tejaswan, SARPAN F1. hyb. Chilli SH-26, SARPAN F1.hyb. Chilli SH-48, SARPAN F1.hyb. Chilli SH-60 is some of the important varieties of the chilli. Bowa, Akashi and Suryamukhi are also very popular cultivar in the terai zone of West Bengal. Different research programme was undertaken for selection of suitable varieties of chilli under treai zone of West Bengal.

Datta and Jana (2009) reported that in *rabi*season, the highest number of fruits and fruit yield was observed in 'Ulka686F1 ' (232.24 and 21.00 tonnes/ha, respectively) as compared to 'Jwalan' (206.53 and 16.23 tonnes/ha, respectively) and 'CA 29' (174.63 and 15.50 tonnes/ha, respectively). Similarly, in *kharif*season, the highest fruit yield was recorded in 'Jwalan' (12.08 tonnes/ha) followed by 'Ulka 686 F1 (11.27 tonnes/ha) and 'PusaSadabahar' (9.53 tonnes/ha).

Datta and Jana (2012) reported that during *rabi* season the highest fresh green fruit yield was recorded in Ulka 686 (15.98 t/ha) and was specifically adopted under favourable condition (higher fertility level). Higher yield was also recorded by Jwalan (15.68 t/ha ), CA-29 (14.76 t/ha) and CA-48 (13.92 t/ha) but these genotypes were not stable under changing environment as their s d value was significant. Among the high yielding genotypes CA-47 (14.81 t/ha), NS-1701 (13.06 t/ha) performed better under favourable condition and the genotypes Tejaswini (10.65 t/ha), DKC-8 (10.10 t/ha) and CA-30 (10.01 t/ha) performed better under adverse (lower fertility level) condition.

# **Nutrient Management**

Chilli requires a high amount of manures and fertilizers since it is long growing season (more than 6 months) crop. Among the different major nutrient, it responds well to nitrogen and potash rather than phosphorus. But respond depends upon the inherent fertility status of the soil. Apply higher amount of nutrient under irrigated condition than the

rainfedcondition. Response of chilli crop to fertilizers depends upon the variety (local types or named variety or  $F_1$  hybrids), type of soil, fertility status of the soil and soil moisture. Normally 15-20 tonnes of well decomposed farm yard manure or compost applied at the time of final land preparation. For .irrigated transplanted crop apply 100 kg N, 50kg P & 50 kg K should be applied per hectare. Half of the nitrogenous fertilizers are applied as basal during land preparation along with full phosphatic and potasic fertilizers. Remaining nitrogenous fertilizers are applied in two equal splits at 45 days and 90 days after transplanting.

Talukder and Jana (2009) reported that the growth, yield and quality characters of green chilli crop increased with the inoculation of biological nitrogen fixers using *Azotobacter* and *Azospirillum*. Performance of *Azospirillum* was better as compared to Azotobacter. Dual inoculation gave a synergistic effect in increasing crop growth and yield. Dual inoculation with the biological nitrogen fixers, 100% recommended dose of N-fertilizer @ 80 kg N/ha and farmyard manure @ 15tonnes/ha recorded maximum growth, yield (7.43tonnes/ ha) and quality parameters, and cost : benefit ratio of 1.55 and no significant difference was observed when N-fertilizer level was reduced to 75%. Thus associative nature of the above biofertilizers helped to save 25% nitrogenous fertilizer in chilli crop. There was increased content of residual available soil nitrogen (202.90 kg/ha), phosphate (67.10 kg/ha) and potash (70.50 kg/ha) with dual inoculation with the biological nitrogen fixers along with full dose of N-fertilizer.

Datta and Jana (2009) conducted an experiment on the effect of seasons and fertility levels on yield and quality of chilli (*Capsicum annuum*L) genotypes in teraiagroclimatic region. According to them performance of genotypes Ulka 686  $F_1$  (24.85 t/ha), Jwalan (19.96 t/ha)and CA-29 (19.28 t/ha)were selected for growing at 150% Recommended Dose of Fertilizer(RDF) (RDF is 100 : 50 : 50 Kg N , P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O kg/ha, respectively). Similarly for kharif season genotypes Jwalan (12.20 t/ha), Ulka 686  $F_1$  (11.25 t/ha) at 100% RDF and PusaSadabahar at 150% RDF (10.43 t/ha) were selected.

Datta and jana (2014) found that there was a significant variation in nitrogen (N), phosphorus (P) and potassium (K) content and their uptake by different plant parts with respect to growing seasons, fertility levels and genotypes. Similarly, N, P and K content and uptake (except fruit N and fruit P uptake) increased with increase in the levels of soil fertility from 0 to 200% of recommended dose of fertilizers (RDF). Considering yield performance of different genotypes, 'Ulka 686 F1' (24.9 t/ha), 'Jwalan' (20.0 t/ha) and 'CA-29' (19.3 t/ha),

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were selected for growing at 150% RDF in the winter season (low temperature and low rainfall regime). Similarly for rainy season (high temperature and high rainfall regime), 'Jwalan' (12.2 t/ha), 'Ulka 686 F1' (11.3 t/ha) at 100% RDF and 'PusaSadabahar' at 150% RDF (10.4 t/ha) were selected. Highest amount of total N, P and K uptake of 158.55, 68.51 and 195.35 kg/ha, respectively was recorded by Ulka 686 F1 at 200% RDF. Partioning of nutrient revealed that fruit N, P and K content increased with increasing fertility level upto 150% RDF in winter season and 100% RDF in rainy season thereafter decreased subsequently. Stem N, P and K percent increased with increasing fertility level whereas reverse case was noticed in the case of root N, P and K content irrespective of season.

# **Intercultural operation**

After transplantingone light irrigation was given for quick establishment of seedlings and there after irrigation was given as and when required. Weeding, hoeing, staking and other intercultural operations were also done as and when required. Chilli can not tolerate moisture stress as well as excess moisture in the soil. Thus judicious irrigation is necessary depending upon the condition of soil. Ten leaf stage, flowering and after each periodical harvest are crici stage of irrigation for chilli crop. Irrigation should be given in these stages if soil moisture is deficit. Generally fortnight irrigation during winter and weekly irrigation during summer is generally recommended. Additionally to keep the crop free from weed, 2 hand weeding and 3 hoeing is necessary for keep the field free from weed and loosening of the soil, respectively.

Sarkar*et al.* (2007) carried out an experiment on pinching on chilli. According to them pinching at 30 days after transplanting increased number of branches led to production of more number of flowers which ultimately produced more number of fruits as a result yield of the pinched treatment increased about 17 per cent fruit yield.

# Harvest ing:

Harvesting of chilli was done at the mature green stage when a few number of fruits change colour from green to red considering consumer preference. Harvesting of the mature fruit was done at 15 days interval. But in case of dry chilli production, fruits are harvested when they are partially dry on the plant.

# PLANT PROTECTION PEST

**Whitefly** (Bemisiatabasi Gen) :Both adults and nymphs suck the sap from the lower surface of the leaf. Due to sucking chlorotic spots develops, leaves become brittle and drop prematurely. Honey dew secretion results in sooty mould development in the leaf.

Using a diluted soap mixture and manually removing infected leaves is the best method, although it can take many weeks to eradicate the infestation. It can be managed by spraying neem oil or by spraying systemic insecticides

**Thrips**(*Scirtothripsdorsalis* Hood) :It is an important pest of chilli. Both adults and nymphs of these insects suck sap from tender leaves growing shoots and young fruits. As a result of thrips infestation, leaves become smaller, thickened, curled upward and brittle.

Avoid chilli and onion mixed cropping. Seed treatment with withimidacloprid 70% WS @ 8 g /kg of seed. Apply carbofuran 3% G @ 33 kg /ha or phorate 10 % G @ 10 kg/ha or spray systematic insecticides like Imidacloprid 17.8 % SL @ 3.0 ml/10 litre of water or Dimethoate 30 % EC @1.0 ml/litre of water.

**Mites** (*Polyphagotarsonemuslatus* Banks) :Both nymphs and adults suck the sap from young foliage and growing tips. Due to the sucking downward curling of leaves giving an inverted boat shaped appearance, stunted growth, elongation of Petiole is very common with reduced fruit size.In severe infestation, scarring of the stem and fruit skin is noticed.

The peast can be managed by growing resistant/tolerant varieties S-7, Pant C1 and Pant C2, Dh-7-6-6, Jwala, 21-8, IIHR-243-1-1-5 and Musalwady selection has been found resistant for mites. Frequent overhead watering of plants during the dry weather helps to reduce the pest population. Spraying with miticides such as Dicofol @5 ml per litre or wettable sulphur 3 grams per liter or Pegasis @ 1 gm per liter or Vertemic @ 0.5 ml per litre is very effective for management of the pest. Apart from sulphur containing compounds some other insecticides like monocrotophos and phosalone having the acaricidal properties.

# DISEASES

**Cercospora leaf spot** (*Cercosporacapsici*): Both in nursery and main field may be affected by this foliar disease. Leaf lesions typically are brown and circular with small to large light grey centres and dark brown margins. The lesions may enlarge up to 1.0 cm or more in diameter and sometimes coalesce to each other. Stem, petiole and pod lesions also have light grey centres with dark borders, but they are typically elliptical. Severely infected leaves drop off prematurely resulting in reduced yield.

Spray twice at 10-15 days interval with 2.5g Mancozeb or 1g Carbendazim/litre of water to effective management of the disease.

**Bacterial Leaf Spot**(*Xanthomonasvesicatoria*) : This disease is mostly prevalent during the post rainy season. Leaves, stems and fruits are affected by this disease. On young leaves the

spots are yellowish green but on older leaves they are dark and water soaked. Narrow, elongated lesions or streaks may sometimes develop on stems Water soaked spots appear on green fruits and sometimes small blister like spots appears on the fruit and ultimately becoming warty in appearance later.

Seed treatment with corrosive sublimate and crop rotation may reduce the incidence of the disease. The nurseries and plants in the mainfield may be sprayed with a copper fungicide such as Bordeaux mixture. Spraying Agrimycin - 100 k at 200 ppm plus Copper Oxychloride 0.3 percent in the main field may manage the disease effectively.

**Damping off** (*Pythiumaphanidermatum*) :This is very common and serious disease in chilli seedlings and mostly occurs in nursery bed. This disease is commonly noticed in n moist soils with poor drainage. Due to the incidence of the disease seed may rot or the seedlings may be killed before they emerge from the soil. The seedlings affected with this disease rot at ground level and then the plants fall over ground. In nursery bed the disease may appear in patches in 2-4 days, the entire lot of seedling may be destroyed.

Partial sterilization of soil by burning trash in the surface or by formalin treatment before sowing is effective for management of this disease. Soil drenching with 1% Bordeaux mixture or CopperOxychloride @3 g/litre of water at 12 and 20 days after sowing is also useful. Seed treatment with 3g Captan or Thiram/kg seed or by 4g *Trichodermaviride* formulation combined with 6g Metalaxyl is highly effective.

# Anthracnose / Die back and Fruit rot (Colletotrichumcapsici) :

It is most common fungal disease of chilli. . It is mostly appeared on ripened fruits and hence the disease is also called as ripe fruit rot. The spots are usually circular, watersoaked and sunken with black margins. When these spots occur, the fruits rot and drop off prematurely resulting in heavy loss of yield. Moist weather, shade and heavy dew favours the occurring and spreading of this disease. The fungus may attack on twig portion of the plant and cause "Die back" symptom. Dieback symptom also spread gradually from the top to downward portion of the branches and ultimately branches dry up.

Use disease free seed and seed treatment with 3g captan or mancozeb/kg of seed reduce the incidence of this disease. Removing and burning of attacked plants or branches and spraying the disease affected crops with mancozeb @ 2.5 g or copper oxychloride @ 2.5g and carbendazim at 1 g litre of water are the control measures for this disease

**Leaf Curl :** It is a viral disease and mainly transmitted by chilli thrips and aphids. Affected leaves become small in size and the leaves turn downward and become curly. The leaves may fall off in case of severe attack. The disease usually spreads through insect vectors such as thrips and etc.

The infected plants should be uprooted and burnt or buried into soil to avoid further infection. Avoid monoculture of chilli crop. Nursery beds should be covered with nylon net to protect the seedlings from vector of this disease. Selection of healthy and disease free seed. Suitable insecticidal (Dimethoate or Monocrotophos @ 1 ml/ litre of water or Imidacloprid @ 1ml /3 litre of water) sprays reduce the neidence of viral diseases, since majority of viral diseases are transmitted by insect vectors.

**Fusarium wilt** (*Fusariumoxysporum*f.sp. *capsici*) : This fungal disease is characterized by wilting of the plant and upward and inward rolling of the leaves. The leaves turn yellow and die. High temperatures and wet soil conditions favour disease development. It is mostly occurred in poorly drained soils.

Water stagnation should be avoided by creation provision of drainage to control this disease to some extent. Drenching with 1% Bordeaux mixture or copper oxychloride may also helpful. To manage this disease seed treatment with *Trichodermaviride* formulation @ 4g/kg of seed or carbendazim @ 2 g /kg seed is effective.

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#### **BLACK PEPPER**

Black pepper (*Piper nigramL*.) is one of the oldest and world most important spices and is called King of spices. The word "Peperi" in Greek, Pepper in English and Greek and Piper in Latin were derived from the Sanskrit word "Pippali" which was the name of Long Pepper. It is indigenous to the tropical forest of the Malabar Coast from where it is spread throughout the tropics. India has the largest area under this crop (2.17 lakh ha) and it is the largest producer (65000 MT). Northern parts of the west Bengal, particularly terai zone is suitable for cultivation of the black pepper. The alkaloid principle piperine is considered to be the major constituents responsible for the pungent and bitter principle of black pepper. It is absent in the leaves and stems of pepper plant. The curse piperne varied from 4-10%. The essential oil content varied from 2.5 to 4.5%. Black pepper constitutes an important component of culinary preparation and seasoning and as an essential ingredient of numerous commercial food stuffs. It acts as an preservative for meat and other perishable food preservation. It is an important constituent of whole, pickling spice, curry powder and spice formulae for seasoning sausages, poultry dressing, hamburger etc. Pepper oil is used as a valuable food adjunct for flavouring agent in different food stuff, beverages, liquors. It is also used in perfumery and medicine industries. Piperine is used to impart pungent test to brandy. Oleoresin also used as flavouring agent.Black pepper and its oil are used to cure dyspepsia, malaria, cold cough etc. it also helps in improving the impotency and muscular pain.

## Soil :

Crop grows well on soils ranging from heavy clay to light sandy clays rich in humus and friable in nature, well drained but good water holding capacity. Soils with high organic matter and high base saturation with Ca and Mg enhances the productivity. Soil PH should be 4.5 to 6.0 and soils with PH above 7.5 inhibit growth. Loamy humus nourishes the crop well but the best crop could be obtained in virgin forest soil.

# **Climate:**

Black is a plant of humid tropics and requires a heavy and well distributed rainfall and high temperature. It grows successfully between  $20^{0}$ N and  $20^{0}$ S of equator and upto 1500 m MSL, but thrives best at 500 m or below. Being a tropical crop, pepper requires 200-300 cm rainfall and high relative humidity with a little variation in day length throughout the year. A relative humidity of 60-95 % is optimum at various stages of growth. Rainfall of 70 cm

received in 20 days during May – June proves sufficient for triggering off flushing and flowering process in the plant. But once the process is set off, there should be continuous shower until fruit ripening. Any dry spell even 4 days within this critical period of 16 weeks results in low yield. The crop may tolerate temperature between  $10-40^{\circ}$ C and ideal temperature is 23-32 °C with an average of 28°C. Optimum temperature for root growth is 26-28°C.

# **Propagation :**

Black pepper is propagated by cuttings raised mainly from the runner shoots. Recently serpentine layering is practised for getting higher number planting materials from the single plants. Datta*et al.* (2008) conducted an experiment at UBKV, pundibarito find out the best time for propagation of black Pepper through runner vine cutting. This experiment was conducted from 18<sup>th</sup> February with ten days interval and continued up to 18<sup>th</sup> of June with cuttings taken from middle portion of the runner vines. Success in rooting of cuttings found to be increased from February onwards and it was maximum (92.67%) during 3<sup>rd</sup> week of March and decreased thereafter. Low temperature during February hinders the rooting of cutting, whereas moderate temperature thereafter enhances rooting. Maximum number of roots per cutting (9.97) was recorded when cuttings are taken during end of March. The higher length of new shoot and leaf number was recorded during the second fortnight of March and it was lowest in 3<sup>rd</sup> week of June. Propagation of Black Pepper through cutting may be taken up from mid March to end of April with a success rate of 70% and above.

# Fertilizer requirement :-

The amounts of macro and micronutrients removed through harvested produce were directly proportional to the yield, indicating the need for yield based fertilizer recommendations in black pepper. The magnitude of nutrient removal by harvested produce followed the decreasing order : N>K>Ca>Mg>P>S>Fe>Mn>Zn. Apply N : P<sub>2</sub>O<sub>5</sub> : K<sub>2</sub>O @ 100:40:140 g/mature vine/year. Apply  $1/3^{rd}$  dose for one year old plant,  $2/3^{rd}$  dose for 2 year old plant. The full dose is given from the 3 years and onwads. The fertilizer may be applied in split doses first in May – June with receipt few soaking rains and second in August – September. Apart from the inorganic fertilizers apply FYM/ compost at the rate of 10 kg per vine. It is desirable to apply lime @ 500g/ vine in April – May in alternate years, fertilizer are to be applied (on northern side) at a distance of 30 – 45 cm away from the vine (in semicircular band) and cover with a thin layer of soil.

# **Irrigation :**

Sufficient soil oisture enhances the entry of water in plant system and better translocation of nutrients for the metabolic activity of the plant. Irrigation should be provided during the rainless period from November to March to getting higher yield and productivity of the crop.

## **Cultural Practices:-**

As the cutting grows, the shoots are tied to the standard as often as required. The young vine should be protected from direct hot sun during summer by providing them with artificial shade. Regulation of shade by lopping the branches of standards is necessary not only for providing optimum light to the vines but also for enabling the standards to grow straight. Adequate mulch with green leaf or organic matter should be applied towards the end of north-east monsoon. The base of the vines should not be disturbed as to avoid root damage. In the second year, practically the same cultural practices are repeated. However, lopping of standard should be done carefully from the 4<sup>th</sup> year onward, not only to regulate the standard but also to shade the pepper vines optimally. Excessive shading during flowering and fruiting encourage pest infestation. From the forth years and onwards usually two diggings are given during onset and end of South West monsoon. Growing cover crops like *Calapogoniummucunoides, Mimosa invisia* are also recommended under West Coast conditions to provide an effective cover to prevent soil erosion during rainy season. Further they dry during summer, leaving a thick organic mulch.

#### Harvesting and Yield:

Flowering in pepper starts during May – June. The crop takes about 6-8 months from flowering to harvest. The harvest season extends from November to January in plains and January to March in hills. During harvesting the whole spike is handpicked when one or two berries in the spike turn orange or purple. Harvesting in immature stage reduces bulk density. The berries are separated from spike and dried in sun for 3 to 5 days. The average yield of black pepper (dry) obtained from vines under ideal management conditions is 2 kg/year. However yield varies with age, vigour of vine, cultivars, edaphic condition and management level. The dry recovery of pepper varies from 30-35% depending upon the variety.

To improve the colour and appearance of dry berries and reduce the drying time, harvested green pepper is to be soaked in hot water and then dried in sun. it also minimizes microbial contamination and gives hygienic product which can be preserved easily.

## **Bush Pepper :**

Black pepper can be grown as bush in pots known as bush pepper. In this case fruiting branches are used as planting materials. Bush pepper produces flower and fruit in the same year. The also continue to flower around the year.

One year old healthy fruiting branches are selected with 3-5 nodes and all the leaves are removed. The cuttings are treated with 0.2% copper oxy chloride for 20-30 minutes. The lateral should be given a slanting cut 2 cm below the nodal region and dipped in 1000 ppm IBA for 45 seconds and planted in shaded area in the nursery either in trenches or in poly bags (45X30 cm) containing moist decomposed coir dust. After planting, the trenches are covered with polythene sheets and in case of poly bags, the mouth id tightly tied to avoid moisture loss.

After 30-50 days these rooted cuttings are planted in pot or in field after sufficient hardening treatment. Swaminathan and Pillai (2000) reported that pepper grown in pot has longer spike but where as pepper grown in field condition has more number of spikes per bush and yioeld of green and dry pepper is also higher. This could be grown as an inter crop in the coconut and arecanut gardens and bund crops. A quantity of 2-5 kg FYM along with 10g NPK @ 1: 1: 2 ratio may be given per bush at 3 months interval. Watering and plant protection may be adopted according to necessity.

Variety :Karimunda, Panniyur -1, Subhakara, Sreekara and Kottanadan.

Yield : On an average 500 g to 1 kg of green pepper can be harvested during  $2^{nd}$  year of planting. Yield increase with the advance of age.

## **Curing of black pepper :**

After harvesting the spikes are heaped for 1-2 days and the berries are separated from the spikes and dried in the sun for 4-5 days on mats or clean concrete floor, until the outer skin become dark brown to black and shriveled. To improve the colour and appearance of dried berries and to reduce drying time, harvested green pepper is to soaked in boiling water for one minute and then dried in shade. During drying blackening occurs due to enzymatic oxidation of phenols, which present in epicarp and mesocarp.

# **Physiological disorder**

Spike shedding

Spike shedding in pepper, has so far, been considered as a natural phenomenon. Sometimes spike shedding occurs to the extent of 14 to 65% causing considerable loss. Though it occurs through out the period from emergence of spike to harvesting of berries. But it is high in after fertilization and in advance stage of fruit development.

# Factor affecting Spike shedding :

- i) Genetic character of the plant.
- ii) Imbalance of nutrient status
- iii) Climatic factors (Prolonged dry spell or heavy rain or sharp alteration of two).
- iv) Disease and pest infestation.

# **Control** :

- Selection and multiplication of vine showing least tendency for spike shedding eg.
   Panniyur-1, Kalluvally, Cheriyakaniakadan.
- ii) Adopt suitable management, cultural and plant protection measures.
- iii) S[praying IAA 100 ppm or Planofix 50 ppm or Zinc 0.5% at the time of berry setting stage reduces spike shedding.

# **Diseases and Pests :**

# Pests

# Pollu beetle : Longitarsusnigripensis

It is the most destructive pest and more serious in black pepper plantations in the plains and lower altitude. The adult and grub feed on the growing points, tender shoots, tender and mature leaves, tender spike and berries. It can be controlled by spraying @ 0.05% quinalphos during June-July and September – October is effective in controlling the pest.

# **Top ShhotBorer** :*Cydiahemidoxa*

Cater pillar bore into the tender shoot turning them to black and dry.

Spraying 0.05% endosulphon two tomes should be done when new shoots emerge.

# Gall thrips :Liothripskarnyi

Affected leaves become thick, malformed and crinckled

## Scale insect :

Drying the the infested portion of the vine

**Control :** Can be controlled by spraying monocrotophos @ 0.05% or dimethoate @0.05% is effective against gall thrips and scale insect.

# Nematode :

Root Knot nematode :*Meloidogyne incognita* Burrowing nematode :*Radopholus similes* 

Both species infest black pepper. The aerial symptoms are foliar yellowing, defoliation and dieback. The affected vines exhibit varying degree of root degeneration and folir yellowing from October onwards coincide with depletion of soil moisture. With the onset of S-W monsoon some of the affected vines recover and put forth fresh foliage. However the symptoms reappear in subsequent season after the cessation of the monsoon.

Application of 2 kg neem cake along with Thimate 10G @ 30 g or Carbofuran 3G @ 100g per vine twice in year.ie. One in May –June and other during September - October check the nematode population.

# **Diseases** :

# Foot rot or quick wilt : Phytophthora capsaicin

Feeder root infestation results in varying degree of root rot symptom and ultimately leading to foliar yellowing. Root rot finally lead to the foot or colar region and ultimately vine dies. Foliar infection results in dark brown leaf spots with fast advancing margin and this appear during June –August. Stalk of the spike and berries also infected resulting in spike shedding. Foliar infection leads to defoliation. High soil and atmospheric humidity during monsoon favours infection and spread.

- Adopt appropriate cultural and phytosanitation measures.
- Pre and post monsoon application of *Trichodermaharzianum* @ 50g/vine and 1 kg neem cake reduce disease incidence
- Pre and post monsoon spraying of Bordeux mixture @ 1% and drenching with Cu Oxy Chloride (0.4%) or Akomin (0.2%) is the prophylactic measure to check the disease spread.

# Pollu disease or anthracnose : Colletotrichumgloeosporides

When infection occurs on berries it splits and further growth is restricted. Sometimes brownish circular spot appear. When infection occurs on spikes, spike shedding occurs, resulting in heavy crop loss.

- Pre and post monsoon spray with Bordeaux mixture (0.1%) given against foot rot infection would be enough to control this disease.

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# Project Title: A Review on the Occurrence of Pests and Diseases of major crops and Their Management in Terai Region of West Bengal

Project code: RRSTZ/Kharif/17-18/01

Associate Scientist/s: Dr. Suprakash Pal, Dr. Nilanjana Choudhuri, Dr. Satyajit Hembram

# 1. Introduction

The terai agro-ecological zone which comprises the northern part of WestBengal lies between 25 longitude E'54°E to 58'25°N latitude and 88° N to 27'57°. The terai zone is situated in Sub-Himalayan plains comprising Kurseong, Kalimpong and Bhutan Hills in the North, Bihar border in the West, Assam border in the East and Bangladesh in the South. The zone includes Siliguri and Islampur sub-divisions of Darjeeling and North Dinajpur district respectively and entire Jalpaiguri and Cooch Behar district. Out of 12,025 sq.km geographical area of the zone 8,567 sq.km is brought under cultivation. Total geographical area of terai zone is about 13.5% of the state area which support 9.7% of the state population. Rural population exceeds the average state figure which is more than 90%.

For the overall development of agriculture in the terai region the Executive Council of Bidhan Chandra KrishiViswavidyalaya approved the establishment of North Bengal Campus along with an agricultural research station and KrishiVigyanKendra in 1979. An area of 305.05 acre was acquired by the West Bengal government at Pundibari for that purpose. Along with this the block seed farm of 25 acre also came under the jurisdiction of BCKV. The campus was started at the Gram Sevak Training Centre, Cooch Behar in February, 1979 with Professor T.K. Bose as the Professor-in-charge. The B.Sc.(Ag.) course was started in 01.03.1979. The foundation stone for the construction of North Bengal Campus at Pundibari was also done in 1979. After 10 years the inauguration of North Bengal Campus at Pundibari was done on 27.12.1989. Then full-fledged Uttar BangaKrishiViswavidyalaya was established in February, 2001.

The Regional Research Station for Terai Zone was established by the state Govt. under the North Bengal Campus of BCKV in 1978 with an objective of catering the research need of agriculturally backward northern tract of the state. The RRS set up established by the State Govt. at Pundibari was subsequently strengthened by NARP back up. Adding of a few AICRPs has also become helpful to gain its further strength. Research activities in its true sense of term were started from 1990 with implementation of NARP. A good number of technologies have been generated from the research under NARP, AICRP and Ad-hoc research projects during the period. The RRS from its very beginning has its uniqueness in organizing need-based research by involving all categories of teachers in multidisciplinary

teams and by extending assistance in the field and laboratory in co-ordinated manner. This review discusses the work done on the pest infestation and their management in the major crops grown under the jurisdiction of this zone.

# Present thrust areas of research:

- 1. Characterization of plant genetic resources for breeding/selection
- 2. Strengthening of soil microbial inventory through exploration cum conservation
- 3. Crop based performance studies on productivity, stress tolerance and seasonal sequencing
- 4. Strengthening of secondary farm data base for referral use
- 5. Exploration of production impediments of livestock enterprise
- 6. Exploration/development/standardization of farm fishery technology



Figure 1: Geographical Area of Terai Agro-Climatic Zone of West Bengal

2. Review of literature on pest infestation and their management

#### **2.1 Rice**

Rice (*Oryza sativa* Linn.) is the staple food for over half of the world's population. The total cultivated area under West Bengal is 5856 thousand ha (2003-04) having the production of 14662 thousand tonnes (Source: Directorate of Agriculture, Evaluation Wing, Govt. of West Bengal). Rice is the most widely grown crop of this zone cultivated both as *Aman* and *Boro* crop. The varieties of rice which are grown in Terai region are GB-1, MTU-1010, Sahabhagi, Parijat, Annada, Lalat, Anjali, Satabdi, Mashuri, MTU-7029, Malsira, Jaldhapa, Ranjana etc.

The pest scenario in this zone is also changing very fastto be commensurate with other parts of the country. The rice leaf folder, *Cnaphalocrocismedinalis* L. which was earlier considered as a minor and sporadic pest of rice in many Asian countries, appears to have become increasingly important with the spread of high yielding rice varieties and the accompanying changes taken place in the cultural practices. Misuse of insecticides and excessive use of nitrogenous fertilizers have been cited as the cause for high leaf folder populations. Earlier Biswas (2006) reported considerable losses to paddy crop due to this pest from this region.

Ghosh*et al.* (2013) while conducting one experiment at the farm of Regional Research Station, Pundibari observed yellow stem borer (*Scirpophagaincertulas*Wlk.),leaf folder (*Cnaphalocrocismedinalis*Guenee), gall midge (*Orseoliaoryzae*Wood-Manson),green leaf hopper (*Nephotettixvirescens/Nephotettixmigropictus*) and paddy bug (*Leptocoryzaacuta*Th.) as the important insect-pests infesting paddy. It wasobserved that dead heart incidence by stemborers ranged from 3.22 to 8.41% in differentcultivars. The lower incidence was noted inlocal cultivars in comparison to check cultivar,SwarnaMasuri (8.41%). Zeerasal varietyharboured minimum incidence (3.22%), whilemaximum on Pusa basmati-1 (6.58%) amonglocal cultivars.

Similarly, leaf folder population wasfound in higher level in check cultivar(11.30%). Among the local and scentedvarieties, maximum leaf folder infestation wasfound in Pusa basmati-1 (10.26%) andminimum in Kanakchur (4.2%).Gall midge infestationranged between 0.0 to 8.2% with no infestationin case of Sitabhog, Radhunipagal,Chinnisakkar and Zeerasal. Higherinfestation was recorded in check cultivar(8.2%) but among the local cultivars, Pusabasmati registered maximum infestation(5.6%). More or less similar type of infestation pattern of stem borer, leaf folder and gall midge has been reported by Biswas (2006) from this zone.

Gandhi bugpopulation ranged from 0.83 to 2.50/5 hillswhere maximum populaton was found in bothPusa basmati-1 and Pusa sougandh-2 (5/5 hills) and minimum in Sitabhog (0.83/5 hills)though the check cultivar harboured mediumpopulation (2.33/5 hills) (Ghosh*et al*, 2013).These findings areat par with the findings of Satpathi*et al*. (2005)in West Bengal where they reported 7.2 ofGandhi bug/10 hills. Green leaf hopperspopulation ranged from 1.33 to 6.33/5 hills.Maximum population was found in checkcultivar (6.33/5 hills) followed by Pusa Basmati-1 (5.5/5 hills), while minimum population wasfound in Sitabhog (1.33/5 hills).

Studies on natural parasitization of pests in the rice based cropping system has been carried out and the primary parasitoid *Cotesiaruficrus* (Haliday) on green semilooper, *Narangaaenescens* Moore along with two hyperparasitoids*Trichomalopsisapanteloctena* (Crawford) and *Mesochorus* sp. has been recorded for the first time from this region(Pal and Gupta, 2017). Seven species of sucking bugs were recorded on the earheads of paddy during surveys conducted from 2002-04 at Uttar BangaKrishiViswavidyalaya, Pundibari, Cooch Behar. Among them the population of *Leptocorisaoratorius* (Fabr.) was high and that of *Menidahistrio* (Fabr.) and *Eusarcocorisguttifer* Th. was moderate. Other bugs were recorded in lower proportion (Pal, 2006).

## 2.2 Maize

Maize area under the terai agro-climatic zone is increasing steadily. The maize is infested by a number of pests under this zone. Amongst the insect pests, the aphid *Rhopalosiphummaidis*(Fitch.) has been recorded as a major pest of maize under terai agro climatic conditions (Pal and Bandyopadhyay, 2005b). Other insect pest invading maize included stem borer, *Chilopartellus* (Swinhoe), gram pod borer, *Heliothisarmigera*Hubnerand leaf roller, *Marasmiatrapezalis* (Guenee).

In spite of harbouring relatively higher aphid population the crop sown on 1<sup>st</sup> March produced the highest grain yield. On the other hand the crop sown on 1<sup>st</sup> April produced the lowest grain yield though it harboured relatively lower aphid population under terai region of West Bengal. Amongst the different varieties HIM-129 performed best with respect to grain yield though it harboured relatively higher population of aphid. In spite of harbouring lower aphid population VL-42 was found to produce lower grain yield (Pal and Bandyopadhyay, 2005a).

An experiment was conducted at the University Research Farm of Uttar BangaKrishiViswavidyalaya, Pundibari, Cooch Behar to study the reaction of fourteen maize germplasm against the stem borer, *Chilopartellus* (Swinhoe) and the aphid,

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*Rhopalosiphummaidis* (Fitch.). The germplasm reacted differentially against these two pests. The varieties viz., VL-88, HIM-129, JM-8, RCM-1-1 and KH-517 had no infestation of stem borer while the variety, FH-3477 showed more infestation. The varieties *viz.*, VL-Popcorn and KH-517 were categorized as resistant to the aphid. On the other hand the varieties, viz., HIM-129, RCM-1-2 were found comparatively more susceptible to the aphid (Pal and Bandyopadhyay, 2006).

# 2.3 Mustard

Mustard is the most widely used oilseed crop in the terai region of West Bengal. In this region it is cultivated during the rabi season. The mustard crop was invaded by fourteen insect pests. Among them the aphid, *Lipaphiserysimi*Kalt.,was found as the most dominant and categorized as the major pest. Six species of ladybird beetles, syrphid flies and spiders were recorded as predators of mustard aphid. The flea beetle and diamond back moth were more abundant during pod development stage. On the other hand the sawfly activity was mostly found during the seedling stage of the crop. The natural enemies of mustard aphid appeared much late. Their population increased gradually with the gradual increase in aphid population. The natural enemies exhibited their dependence on aphid population (Choudhury and Pal, 2006).

The incidence of aphid at the farm of Uttar BangaKrishiViswavidyalaya, Pundibari, Cooch Behar commenced from  $52^{nd}$  to $2^{nd}$  standard week with a very low population levels on all the cultivars. The aphid (*Lipaphiserysimi*)population attained peak level from 7<sup>th</sup> to 9<sup>th</sup> standard week.Except for a few instances the weather parameters showed low order of associations with aphid population. Thus, the ecological factors exhibited little impact on the population build up of mustard aphid. The degree of infestation the rates of population change of the aphids on different *Brassica* cultivars seem to be governed by varietal characteristics of different germplasms. *Brassica campestris*varieties as a group harboured relatively higher populations of the aphid than *Brassica juncea*varieties (Choudhury and Pal, 2009).

The flea beetle was quite active during the month of December infesting the early vegetative stage, but later decreased significantly probably due to the cooler temperature of January as well as hardening of leaf tissues. Later on with the initiation of pod formation and rising of temperature population increased gradually and reached the peak during 4<sup>th</sup> week of February (Choudhury and Pal, 2005a).

A study was undertaken to find out the suitable variety(s) against insect pests attack aswell as incidence of natural enemies and their effect on yield on three groups of *Brassica* 

varietiesin Terai agro-ecological conditions of West Bengal. Among the different insects the importantones were aphid, flea beetle, diamond back moth and saw fly. Natural enemies include lady beetle, syrphid and spider. Contrast analysis revealed that all the pest, natural enemy population and yield varied significantly among the three groups of *Brassica* under consideration. In Terai Zoneof West Bengal, Bhagirathi (Indian mustard variety) showed medium insect-pest reaction as wellas moderate natural enemy population and provided maximum yield (736 kg/ha) and considered tobe the best fitted variety. This variety can replace the Benoy (B9) variety which enjoys the largestarea in this zone, in order to make the cultivation more remunerative in this zone(Ghosh and Chaudhuri, 2015).

An insecticidal trial was conducted at Uttar BangaKrishiViswavidyalaya, Pudibari, Cooch Behar with thiamethoxam, acephate, dimethoate, endosulfan, cypermethrin and azadirachtin to find out the efficacy against mustard aphid, *Lipaphiserysimi*Kalt., which is the most important insect pest under terai zone. One day after spraying thiamethoxam 0.003% was found to be most effective with 20.33 aphids/10 cm apical twig/plant against the highest aphid incidence of 87.00 aphids/10 cm apical twig/plant in the control. The insecticides namely thiamethoxam, acephate and dimethoate showed their residual efficacy upto 10 days after spraying. All the insecticides gave higher yield compared to control. The highest yield was obtained by acephate followed by thiamethoxam, dimethoate, azadirachtin, endosulfan and cypermethrin (Choudhury and Pal, 2005b).

# 2.4 Jute

Jute is the most important cash crop of the zone grown during the pre-kharif to kharif season. The area under under jute cultivation is decreasing day by day due to uncertainty of jute prices and choice before the farmers to grow some other more remunerative crops. Survey work was conducted at research field at UBKV and other two villages viz., village - Dharmobarakutti, G.P. Dhandinguri and village - Chandanchura, G.P. Madhupur to study the pest problems of jute. The yellow mite, *Polyphagotarsonemuslatus* (Banks) and the semilooper, *Anomissabulifera*Guenee has been found as the major pest of jute in this zone. The yellow mite infestation (no. of mite/cm<sup>2</sup> area of second unfold leaf) was maximum at 55 DAS with 25.62 and 24.89, at UBKV Research plot and at village Dharmobarakutti, respectively. In case of village Chandanchura, the highest infestation of yellow mite was observed at early stage of crop growth *i.e.* 42 DAS with25.25 mites/cm<sup>2</sup> of second unfold leaf. The highest infestation at 55 DAS and minimum infestation was observed at village Dharmobarakutti, with 7.69 % at 55 DAS (Pal *et al.*, 2015).

Earlier, Senapati and Ghose (1992) studied the life history, composition and distribution of the yellow and red spider mite on jute leaves under terai ecological conditions of West Bengal. In a field experiments in 1988-89, monocrotophos, endosulfan and quinalphos at 0.05% and chlorpyrifos at 0.04% controlled *Diacrisia obliqua* [*Spilarctia obliqua*] and *Polyphagotarsonemus latus* on jute (Senapati and Ghosh, 1994).

#### **2.5 Vegetables**

The area and production scenario of different vegetables in West Bengal as per Horticulture Statistics Division,Department of Agriculture,Cooperation and Farmers Welfare, Government of India showed that in 2014-15, it was 2985.40thousand tones for brinja in 1161.9 thousand ha; 2207.20thousandtonnes of cabbage in 78.6thousand ha; 1890.0 thousandtonnes of cauliflower in 74.0 thousand ha; 882.40thousandtonnes of okra in 75.5 thousand ha and 1149.60 thousandtones of tomato in 56.90 thousand ha; in 1387.20 thousand ha area under vegetable cultivation in West Bengal with production of 26354.60 thousand tones.

One of the major constraintsidentified in vegetable production is the increasing incidence of insectpests, diseases and nematodes, sometimes resulting in substantialyield losses. Despite considerable increase in the productivity through introduction of hybrid cultivars, a wide gap exists between the potential yield and the yield realized at the farmer's field, which is largely due to a number of biotic and abiotic stresses to which cabbage crop is exposed.

# **Brinjal:**

Brinjal, eggplant, is one of the most common vegetable crops grown in India and other parts of the world. The field experiment conducted in terai region of West Bengal, India during 1996-98 (Ghosh and Senapati, 2001) showed that brinjal crop was infested by Aphid (Aphis gossypiiI), Jassid (Amrascabiguttulabiguttula), white fly (BemisiatabaciI), Thrips (ThripstabaciI), epilachna beetle (Henosepilachnavigintioctopunctata [Epilachnavigintioctopunctata]), fruit borer(Leucinodesorbonalis) and flea beetle.Ghosh (1999) and Ghosh and Senapati (2009) reported that in terai region of West Bengal, Leucinodesorbonalis is the key pest infesting eggplant and pest was found to be most active during summer and the rainy season, particularly during May-August, and caused 49.5-81.0% damage to fruits. Peak infestation (81.0% fruit damage) was noticed in the first week of June (22nd standard week), when the mean temperature, mean relative humidity and weekly rainfall were 27.8°C, 79.2% and 81.2 mm respectively. The pest became less active during winter months particularly in December–January. Epilachna beetle (HenosepilachnavigintioctopunctataFabr.) was foundactive from April to middle of October

and highest populationwas recordedduring middle of September (8.14beetle/plant) (Ghosh and Senapati, 2001). The higher level of thrips population was maintained from March to November, while for white fly it was during August and October (Ghosh, 1999). Among different cultivars, PK-123 and Pant were the least susceptible to *L. orbonalis*, the key pest of auberginein terai region of West Bengal (Ghosh and Senapati, 2001).

## **Cabbage:**

Among various vegetables, cabbageis mostcommon and extensively grown all over the country. Besides being a rich source of vitamins and minerals, it occupies an important place in the food basket of Indian consumers. In terai region of West Bengal Chaudhuriet al. (2001) observed the incidence of insect-pests of cabbage and reported that the populations of aphid (Lipaphiserysimi) was observed during 3<sup>rd</sup>week of March, flea beetle (*Phyllotretabrassicae*) in last week of March, cabbage butterfly (*Pierisbrassicae*) in 2<sup>nd</sup>week of March, cabbage leaf Webber (*Crocidolomiabinotalis*) in 1<sup>st</sup> week of March, dimond back moth (Plutellaxylostella) in last week of March reached maximum level on spring crop. They further reported that crop raised during winter needs no protection measure because of low level of pest incidence but spring crop needs protection measures during middle of March to late April for better harvest. Das and Chaudhuri (2007) reported that In Terai region of West Bengal the Diamond back moth (*Plutellaxylostella*) appeared on cabbage during February and the infestation continued up to May in an overlapping manner, within and over the generations. During February-March the prevailing climatic conditions did not only the favourmultiplication of *Plutella* population but also activated its parasitoids. Among the diseases, Alternaria leaf spot caused by Alternaria sp. (A.brassicae and A. brassicicola) has been reported from all the continents of the world and is one among the common diseases of cabbage. Alternaria blight is one of the most dominant one that causes average yield loss in the range of 32-57% (Conn and Tewari, 1990). Abhijit (2017) reported that biocontrol agents viz., Trichodermaharzianum (UBT18) and Pseudomonasfluorescence (VPF-1)enhanced the activities of defense related enzymes and protein content against Alternaria leaf spot in cabbage.

# **Cauliflower:**

Cauliflower (*Brassicaoleracea*var.*botrytis* L.) is one of the most widely cultivated colecropin India.Cauliflower varieties are highly sensitive to soil and environmental variation which significantly affect the crop growth and curd yield.

In teari region of West Bengal maximum population of aphids, *Lipaphiserysimi* (33.36 aphids/leaf), and flea beetles, *Phyllotretacruciferae* (0.78 flea beetles/plant), were found to harbour cauliflower during the last week of December (25 to 31 December) and 3rd week of December (18 to 24 December), respectively (Ghosh*et al.*, 2000).

# **Tomato:**

Tomato (*Lycopersiconesculentum*), is an important vegetable crop inIndia. In terai region of West Bengal tomato crop is attacked by aphid, whitefly, jassid, leaf miner and fruit borer (Chaudhuri*etal.*, 2003).Higher level of leaf miner (*Liriomyzatrifolii*) infestation on tomato in terai region of West Bengal was maintained from late March to late May (Chaudhuri and Senapati, 2004). The white fly population reached the highest level (1.68/plant)during middle of February and high level was maintained from mid February to mid March whentemperature, relative humidity, sunshine hr/dayand rainfall were ranged from 17.07-22.13°C,65.29-72.78%, 7.79-8.98hr/day and 5mm respectively (Chaudhuri*et al.*, 2001).Subba (2013) found higher population level of whitefly during 2<sup>nd</sup> week of March to 3<sup>rd</sup>week of March.The important pest of tomato the fruit borer damage was observed during 6-20<sup>th</sup> SW *i.e* from mid-February to mid-May (Chaudhuri*et al.*, 2000).

# Okra:

Okra (*Abelmoschusesculentus* L.) is an annual vegetable crop, grown well under agroecological conditions of terai region. Warm humid climate, high rainfall, and loam to sandy loam soil very much favour okra cultivation in a commercial scale round the year except short spell of cold winter associated with frost for about 2 months. In okra all the important and major pests are either oligophagous or polyphagous and most of the alternate hosts are vegetables grown as proceeding or succeeding crop or in vicinity to okra fields. All these favour pests carry over and pest populations increase rapidly with raising of the crop.

In terai region the major insect-pest of okra was jassid and fruit borer. The mean jassid population was highest on pre-kharifand lowest in kharif. And the mean infestation level of fruit borer was highest in kharif seasonand least in pre-kharif.Both the pest attained ETL level at 15 and 16<sup>th</sup>SW persisted at higher level till 17<sup>th</sup>-20<sup>th</sup> SW in pre-kharif; in kharif the major pest was fruit borer and the infestation remained at peak in 35-40SW. In post-kharifpeak fruit borer infestation level was maintained between 42 to 45 SW (Subba, 2017).

# **3.** Review of literature on incidence and severity of major diseases and their management

#### **3.1 Rice**

West Bengal is the richest reservoir of rice (*Oryza sativa* Linn.) bio-diversity and the rice bowl of the country. The ecotypes of rice, spontaneously evolved in the state, are so diverse and different that Scientists at one time coined them as Oryza sativa var. benghalensis (Chatterjee et al., 2008). The total cultivated area under West Bengal is 5856 thousand ha (2003-04) having the production of 14662 thousand tonnes (Source: Directorate of Agriculture, Evaluation Wing, Govt. of West Bengal). Rice is the most widely grown crop of this zone cultivated both as *Aman* and *Boro* crop. Varieties of rice crop grown in West Bengal are Sabita, Purnendu, Amulya, Bhudev, Nalini, Bhagirathi, Ambika, Mahananda, Matangini, Saraswati, Sudhir, Sunil, Hanseshwari, Shatabdi, Khitish, Gotra Bidhan 1, Lakshmi (CNM 6), PNR 546, CNM 25. Varieties which are grown in Terai region are Annanda, GB-1, MTU-1010, Parijat, Satabdi, Mashuri, MTU-7029, Malsira, Jaldhapa, Ranjana, Niranjana etc. (Das, 2016).

Rice (Oryza sativa L.) suffers from a number of fungal and bacterial diseases and many of them occur at times in fairly severe form and cause substantial loss to the crop yield. Major fungal disease are sheath blight, blast, brown spot, false smut and bacterial diseases are bacteria leaf blight and bacterial leaf streak.

Among the major fungal diseases of rice, brown spot occupies not only an important position, but also historical interest. The disease is prevalent throughout the rice growing tracts of the world. It is found to be pendemic in heavy rainfall areas viz. the Himalayas, Assam, Malabar coast and West Bengal.

Rice blast is one of the most important diseases of rice, caused by the fungus *Magnaporthe oryzae* B. C. Couch (Couch and Kohn 2002). One of the main limitations in production is rice blast disease caused by the fungus *Magnaporthe oryzae*. Annual rice losses caused by this fungus during 90's had been estimated at 35% of the worldwide production (Oerke and Dehne 2004).

Use of *Trichoderma* spp. in heavy metal contaminated ecosystem for bioremediation and the resultant effect of less uptake and consequent low residual toxicity of metals in rice plant.

#### 3.2 Wheat:

The second most importance food crop of the country is Wheat. The area under wheat production has steadily gone up. In 2013-14 India ranked second in wheat production after china in the world for the wheat production of 95.85 million tones, and wheat area has

increased from 12.8 million-ha in 1966-67 to 29.8 million-ha in 2015-16, at the same time productivity and production has been increased by 263% and 711% respectively, and India produced 2.95 ton wheat in a hectare against 5.34 ton by china in 2015-16 (Kumar, *et al.*, 2016). For feeding purpose of the increasing population of the India, country need to produce 100 million tons of wheat with in 2030, that is a major challenge under changing climatic scenario.

With the extension of wheat cultivation in the warmer and humid region of North Eastern Plain Zone after green revolution many new diseases and pest problems were also encountered that created significant yield loss. Different types of disease found in North Eastern plain zone, like foliar blight, rust, loose smut etc. Foliar blight is complex of many pathogens, among these *Bipolaris sorokiniana* is a most destructive disease, which attack wheat plant at most crucial growth stage (Chourasia *et al.* 2000).

In warm and humid regions of the world (Kumar *et al.*, 2002) *B. sorokiniana* (syn. *Helminthosporium sativum*, teleomorph *Cochliobolus sativus*), is a well-known cause of spot blotch of wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*). *Bipolaris sorokiniana* a notorious wheat fungal pathogen. Yield losses due to spot blotch disease in wheat are reported to range from 15.5% to 100% under severe conditions of infection (Mehta, 1993). . Grain yield loss due to spot blotch in South Asia ranged from 04-38 per cent and 25- 43 per cent in the year 2004 and 2005, respectively (Sharma and Duvellier, 2006).

Leaf blight affected samples collected from different parts of terai agro-climatic zones of West Bengal shows that a number of pathogens viz. *Bipolaris sorokiniana*, *Alternaria triticina*, *Curvularia lunata*, *Drechslera gigantea*, *Alternaria alternata*, *Pyrenophora triticirepentis* were associated with the foliar blight symptoms, of which *B. sorokiniana*, *A. triticina*, *D. gigantea* and *P. tritici-repentis* were pathogenic.

Relative dominance of foliar blight pathogens in different stages of wheat is measured. *A. triticina* dominated in the very early stages of crop growth and a shift was noted at stage 47 i.e. during flag leaf sheath opening when *B. sorokiniana* became the dominant pathogen. At the latter stages of crop growth, *D. gigantea* also simultaneously appears along with *B. sorokiniana*.

Chowdhury, *et al.* (2014) found that foliar blight is the major biotic constraint of wheat in rice wheat system of eastern Gangetic plains. Singh, *et al.* (2014) observed that ooptimum growth stage of wheat and triticale for evaluation of resistance against spot blotch.

The yield loss due to foliar blight in this agro-climatic zone is estimated. The extent of yield loss was ranged from 4.5 percent to 33.3 percent.

Cultural and physiological variability among the isolates of *Bipolaris sorokiniana* indicates a wide variation. Thirteen isolates of *Bipolaris sorokiniana* have been characterized. Three linkage groups (2D, 7B, 7D) in population Sonalika/BH 1146 and four linkage groups (1B, 2B, 2D, 7D) have been detected in population Kanchan/ Chirya 1

Epidemiology of spot blotch in wheat was worked out which indicated that delayed sowing changes the physiology and microclimate of the crop. A positive relationship with canopy temperature and negative relationship with stay green property is found. Linear correlation between spot blotch severity with maximum temperature, minimum temperature, sunshine hours and evapo-transpiration has established.

More than 2000 genotype collected from National and International sources have been screened against spot blotch of wheat and few genotypes show highly resistant against the disease. The biochemical parameters viz, POX, PPO, SOD, Phenols have been estimated in resistant and susceptible genotype

Singh, *et al.* (2014) reported that phenotypic and marker aided identification of donors for spot blotch resistance in wheat.

The researches on deciphering phytohormone signalling in modulation of resistance to spot blotch disease of wheat have been carried out.

Integrated disease management against foliar blight has been worked out.

Foliar spray with Hexaconazole @ 0.1% first at disease appearance and then 2 times at 20 days interval is the best treatment for the management of leaf spot disease of ginger.

Wheat Entry no. 6746 was found to be the most resistant germplasm against spot blotch disease with lowest AUDPC both in non-protected and protected conditions. UBPF 6 (*Pseudomonas fluorescence* collected from brinjal rhizosphere of UBKV farm, Pundibari) induced the highest resistance in the wheat plants. Seed treatment with talc formulation of UBPF 6 @ 5 g/kg of seeds followed by spraying with the same @ 10 g/litre of water at 55 days after sowing (DAS) and 65 DAS was found to be the best treatment as it recorded the lowest disease and highest yield of 4.69 t/ha. Kumar, *et al.* (2017) Evaluated 19,460 numbers of Wheat Accessions Conserved in the Indian National Genebank to Identify New Sources of Resistance to Rust and Spot Blotch Diseases . Sahu, Ranabir; Sharaff, Murali; Pradhan, Maitree; Sethi, Avinash; Bandopadhyay,

Mishra, *et al.* (2016) also reported that elucidation of defense-related signaling responses to spot blotch infection in bread wheat (Triticum aestivum L.). Wheat Entry no. 6746 was found

to be the most resistant germplasm against spot blotch disease with lowest AUDPC both in non-protected and protected conditions. UBPF 6 (*Pseudomonas fluorescence* collected from brinjal rhizosphere of UBKV farm, Pundibari) induced the highest resistance in the wheat plants. Seed treatment with talc formulation of UBPF 6 @ 5 g/kg of seeds followed by spraying with the same @ 10 g/litre of water at 55 days after sowing (DAS) and 65 DAS was found to be the best treatment as it recorded the lowest disease and highest yield of 4.69 t/ha (Anonymous, 2016).

# 3.3 Maize:

Maize area under the terai agro-climatic zone is increasing steadily. The maize is infested by a number of pests under this zone. Amongst the insect pests, the aphid *Rhopalosiphummaidis*(Fitch.) has been recorded as a major pest of maize under terai agro climatic conditions (Pal and Bandyopadhyay, 2005b). Other insect pest invading maize included stem borer, *Chilopartellus* (Swinhoe), gram pod borer, *Heliothisarmigera*Hubnerand leaf roller, *Marasmiatrapezalis* (Guenee).

# 3.4 Mustard

Rapeseed-mustard (Brassica sp.) is a major group of oilseed crop of the world being grown in 53 countries across the six continents, with India being the third largest producer after China and Canada (FAO 2009). It is also important rabi oilseed crop of West Bengal cultivated in about 410.793 thousand ha with total production of about 419.58 thousand tones and average productivity of 1021 kg/ha (Anon 2011).

Varieties of mustard are Pusa Agrani (SEJ-2), Pusa Karishma (LES-39), Pusa Mahak (JD-6), Pusa Mustard 21 (LES 1 27), Pusa Vijay (NPJ-93), Pusa Mustard 22 (LET -17), Pusa Mustard-24 (LET-18), Pusa Tarak (EJ-13), NPJ-112 (Pusa Mustard 25), Pusa Mustard 26(NPJ-113), Pusa Mustard 27 (EJ-17), Pusa Mustard 28 (NPJ- 124) etc. In Terai region varieties like Jhumka, Baruna, Sita, Panchali, Binoy, Bhagirathi etc are mostly grown (Das, 2016).

Among several diseases, four diseases viz; Alternaria blight (Alternaria brassicae), white rust + downy mildew complex (Albugo candida + Hyaloperonospora parasitica), Sclerotinia stem rot (Sclerotinia sclerotiorum) and powdery mildew (Erysiphe cruciferarum) are of great economic importance, whereas among several insect pests, mustard aphid (Lipaphis erysimi) is the key pest and five others viz, sawfly (Athalia lugens proxima), painted bug (Bagrada hilaris), leaf miner (Chromatomyia horticola), cabbage butterfly (Pieris

brassicae) and Bihar hairy caterpillar (Spilosoma obliqua) are assumed to be of regional and sporadic importance (Bakhetia et al., 2002).

*Alternaria* blight caused by *Alternaria brassicae* (Berk.) Sacc. has been reported as one of the most serious threat to the production of rapeseed and mustard in West Bengal situation which is reflected in various yield attributing factors eventually affecting the yield. Variety Kalyan gave maximum yield (1544.75 kg/ha) while, it was minimum in case of variety Agrani (786.65 kg/ha). The observations also show that Alternaria has a direct effect on yield of rapeseed and mustard which was revealed by the fact that moderately resistant varieties had more yield (w.r.t. yield and other yield attributing factors) as compared to highly susceptible varieties (Mamgain, 2017).

Banerjee *et al.*(2010) reported that *Alternaria* blight [*A. brassicicola* (Schw.)] and downy mildew [*Peronospora parasitica*(Pers.) Kuntze] are the major diseases in lower Gangetic plains of India. As the rate of disease increase are dependent on weather factors, weather-based forewarning system may enable to guide farmers to take protection measures timely. The paper aims at to find the effect of weather on alternaria blight and downy mildew infestations. The weather data were compared with Percent Disease Index and the prevailing weather condition during peak disease intensity has been sorted out. It was observed that an increasing trend of last seven days average minimum temperature and relative humidity indicates more Alternaria blight and downy mildew infestation.

# **3.5 Jute**

Jute is the most important cash crop of the zone grown during the pre-kharif to kharif season. The area under under jute cultivation is decreasing day by day due to uncertainty of jute prices and choice before the farmers to grow some other more remunerative crops.

The incidence of stem rot in jute sown from March to June indicates early sown crop to be most susceptible to stem rot with 29.83% disease incidence. Crops sown later to March suffered less. Jute crop sown in the first week of April had lesser stem rot incidence than earlier sown crops and maximum fibre yield. In later crops although disease incidence was less, the yield also reduced. Among the new fungicides, application of Tebuconazole 25.9 EC @ 1ml/l (0.1 % a.i.) as seed treatment and foliar spray at 45 DAS was most effective against stem rot of jute.

# **3.6 Vegetables**

Vegetables are vital sources of minerals, vitamins and dietary fibres and thus play an important role in human nutrition in supplying adequate quantity of free radicals, anti-oxidants

and micro-nutrients. The area and production scenario of different vegetables in West Bengal as per Horticulture Statistics Division,Department of Agriculture,Cooperation and Farmers Welfare, Government of India showed that in 2014-15, it was 2985.40thousand tones for brinja in 1161.9 thousand ha; 2207.20thousandtonnes of cabbage in 78.6thousand ha; 1890.0 thousandtonnes of cauliflower in 74.0 thousand ha; 882.40thousandtonnes of okra in 75.5 thousand ha and 1149.60 thousandtones of tomato in 56.90 thousand ha; in 1387.20 thousand ha area under vegetable cultivation in West Bengal with production of 26354.60 thousand tones.

One of the major constraints identified in vegetable production is the increasing incidence of insect pests, diseases and nematodes, sometimes resulting in substantial yield losses. Despite considerable increase in the productivity through introduction of hybrid cultivars, a wide gap exists between the potential yield and the yield realized at the farmer's field, which is largely due to a number of biotic and abiotic stresses to which cabbage crop is exposed.

# A. Potato:

Late blight caused by *Phytophthora infestans* (Mont.) de Bary is one of the most dreaded diseases of potato worldwide, including India and cause significant loss in production. The causal organism of this disease came to India with imported seed potatoes from Europe.It was first recorded in india for the first time between 1870-1880 in the Nilgiri hills and sread rapidly to north Indian hills. From hills the disease gradually spread to Indo-Gangetic plains. Under tropical plains, it was first observed in 1889-1900 in Hoogly district of West Bengal. Subsequently, it was reported from other parts of the country. The pathogen is highly variable and adapt to the newly bred varieties and fungicides. India is the second largest producer of potato in the world after China and both the countries put together contribute nearly one third of the global potato production (Scott and Suarez, 2012).

Some cultivated variety of potato crop are Kufri Kisan, Kufri Kuber, Kufri Kumar, Kufri Kundan, Kufri Red, Kufri Safed, Kufri Neela, Kufri Sindhuri, Kufri Alankar, Kufri Chamatkar, Kufri Chandramukhi, Kufri Jeevan, Kufri Jyoti, Kufri Khasigaro, Kufri Naveen, Kufri Neelamani, Kufri Sheetman, Kufri Muthu etc. In 4 Terai region Khufri Jyoti, Pimpernel, Detia (Red and white skin), Solanum tuberosum sub. sp. andijena, Pokhraj, Kufri Chipsona 3, Kufri Chipsona 4, Kufri Chipsona 5 etc. (Das, 2016).

The late blight attack and kills the tops of the potato plant and invades the tubers, causing either a dry or a wet rot. It is the most destructive of all the potato diseases when conditions are favorable for its rapid development. The fungus causing this disease,

Phytophthora infestans, is basically a cold climate pathogen but has tremendous capacity to adopt to environments thus becoming widespread in almost all environments (temperate as well as sub-tropical) which support potato production.

Today the disease is a recurring feature in plains of West Bengal. It occurs in mild to moderate form every year but assumes severe form and develop epidemic only in occasions. Yield losses in the plains have been estimated around 10-75% (Dutt, 1979).

Chakraborty and Banerjee (2016) reported that prophylactic spray with mancozeb @ 0.2% followed by fenamidone + manozeb @ 0.3% as 2nd spray at the onset of the disease followed by mancozeb @ 0.2% as 3rd spray seven days after application of the 2nd spray followed by one more spray with fenamidone+mancozeb @ 0.3% as 4th spray seven days after application of 3rd spray exhibited best management of late blight of potato in terms of percent reduction of disease over control which was 83.64 and 84.79% in 2012-13 and 2013-14 crop season, respectively.

Hembram (2016) found that prophylactic spray with mancozeb @ 0.25% followed by Ametoctradin + Dimethomorph @ 0.3% at the onset of the disease and 10 days after  $1^{st}$  application followed by mancozeb @ 0.25% seven days after the last application of systemic fungicide or prophylactic spray with mancozeb @ 0.25% significantly reduce the disease pressure. He also reported that spraying of Cymoxanil + mancozeb @ 0.3% at the onset of the disease and 10 days after  $1^{st}$  application followed by mancozeb @ 0.25% seven days after the last application of systemic fungicide or prophylactic spray with mancozeb @ 0.25% seven days after application of systemic fungicide or prophylactic spray with mancozeb @ 0.25% seven days after  $1^{st}$  application followed by mancozeb @ 0.25% seven days after the last application of systemic fungicide or prophylactic spray with mancozeb @ 0.25% seven days after the last application of systemic fungicide or prophylactic spray with mancozeb @ 0.25% are also very effective.

According to Bandyopadhyay (2015) the highest percent late blight disease reduction in comparison to control was observed in Chlorothalonil 75% WP @ 1750 gm/ha (68.12%) followed by Chlorothalonil 75% WP @ 2500, 1250 and 875 gm/ha in comparison to control respectively and highest number of tuber per plant (6.33 tuber/plant) was recorded by Chlorothalonil 75% WP @ 1750 gm/ha. Lowest yield of 22.67 t/ha and number of tuber plant (3.33/plant) was found in untreated control plot.

# **B.** Brinjal:

Brinjal, eggplant, is one of the most common vegetable crops grown in India and other parts of the world. Plant Growth Promoting Microbial inoculation based organic module for vegetable seedling raising approach was formulated for tomato, brinjal, chilli, cabbage, cauliflower, capsicum etc. cultivation under organic farming system in hill and terai agro-ecological region of West Bengal (Bhattacharya, 2016)

# C. Cabbage:

Among various vegetables, cabbage is most common and extensively grown all over the country. Besides being a rich source of vitamins and minerals, it occupies an important place in the food basket of Indian consumers. Among the diseases, Alternaria leaf spot caused by *Alternaria* sp. (*A.brassicae* and *A. brassicicola*) has been reported from all the continents of the world and is one among the common diseases of cabbage. Alternaria blight is one of the most dominant one that causesaverage yield loss in the range of 32-57% (Conn and Tewari, 1990). Abhijit (2017) reported that biocontrol agents *viz.*, *Trichodermaharzianum* (UBT18) and *Pseudomonasfluorescence* (VPF-1)enhanced the activities of defense related enzymes and protein content against Alternaria leaf spot in cabbage.

Sarkar, *et al.* (2016) reported that Microbial consortium helps on plant growth promotion, biochemical attributes and nutrient uptake of Cabbage (*Brassica oleracea* L. var *capitata*).

According to Bhattacharya, *et al.*(2014) in India, clubroot caused by *Plasmodiophora brassicae* Woronin has been present on cabbage and cauliflower crops (*Brassica oleracea* L. var. *capitata* and *botrytis*) for nearly 80 years in the Eastern Himalayan Darjeeling Hills of West Bengal and South Indian Nilgiri Hills in Tamil Nadu. Since the early 1980s, *P. brassicae* has spread rapidly on the most popular cultivars of cultivated yellow sarson (*Brassica rapa* L. var. *trilocularis* (Roxb.) Kitam.) and Indian mustard (*Brassica juncea* L.) grown in the red and lateritic soils (Alfisols) and the Terai regions situated in the Himalayan foothills of the northern part of West Bengal State. Soils of both regions are acidic in nature (pH 5.3–6.7).

# **D.** Cauliflower:

Cauliflower (*Brassicaoleracea*var.*botrytis* L.) is one of the most widely cultivated colecropin India.Cauliflower varieties are highly sensitive to soil and environmental variation which significantly affect the crop growth and curd yield. Lama, *et al.* (2012) reported that seed encapsulation with *Trichoderma harzianum* on growth promotion and development of induced biochemical resistance in cauliflower seedling. Roy *et al.* (2014) observed that application of pellet based formulation of *Pseudomonas fluorescens* enhance the seedling health of cauliflower.

# E. Tomato:

Tomato (*Lycopersiconesculentum*), is an important vegetable crop inIndia. India is the second largest producer of vegetables in the world and accounts for about 11.4 % of the world's production of vegetables.

In terai region of West Bengal tomato crop is attacked by aphid, whitefly, jassid, leaf miner and fruit borer (Chaudhuri*etal.*, 2003).

Among all the diseases, *Rhizoctonia solani* induced damping off is one of the most important soil borne diseases of tomato causing severe losses under favourable environmental condition at nursery bed. Since it is difficult to achieve control through host resistance or fungicides because of soil borne nature of the pathogen and wide host range, induced systemic resistance through the use of biotic elicitors may be effective alternative in minimizing the incidence of the disease.

Dutta (2005) reported that out of 204 rhizospheric isolates obtained from mungbean, from vermicompost, 9 isolates showed showed potential rice, banana, chilli and antagonistic activity against four soil borne plant pathogens (*Rhizoctonia solani*, Macrophomina phaseolina, Sclerotinia sclerotiorum and Sclerotium rolfsii). The population of fluorescent *psedomonads* was found to be maximum in vermicompost and mungbean rhizosphere supported population of rhizospheric bacteria. Seed treatment with native biocontrol consortium exhibited enhanced level of protection as compared to native individual antagonistic rhizobacteria against both preand post-emergence damping off of tomato. The population of antagonistic rhizobacteria was increased upto 14 treatment but enhanced level of population of introduced native days after seed antagonistic bacteria were observed upto 3 weeks of seed treatment. The native isolate was able to colonize on non-host crop (Dutta, 2005).

Barik (2006) reported that approximately, 10-38% of bacterial wilt of tomato incidence was recorded into different locations of Cooch Behar district under different cropping system and Higher level of *R. solanacearum* population was observed in different tomato based cropping system, but cabbage followed by tomato has somehow lower population of *Ralstonia solanacearum*. Only ginger isolate (Kamp Gin-1) of Kalimpong, belonging to biovar-III and *Ralstonia solanacearum* isolates (tomato, chilli, potato, brinjal) from Cooch Behar region were found to be biovar-III.

He also observed that Among the various soil amendments bleaching powder and lime was found to be highly effective in reduction of bacterial wilt incidence and About 9.5 fold decrease in *Ralstonia solanacearum* was observed in the treatment where seedlings were treated with bio-agents consortium (Bpf-1, *Paecilomyces*, Azo-5, AcPSM-1) and the soil were amended with lime + bleaching powder + neem cake + vermicompost.

#### F. Okra:

Okra (*Abelmoschusesculentus* L.) is an annual vegetable crop, grown well under agroecological conditions of terai region. Warm humid climate, high rainfall, and loam to sandy loam soil very much favour okra cultivation in a commercial scale round the year except short spell of cold winter associated with frost for about 2 months. In okra all the important and major pests are either oligophagous or polyphagous and most of the alternate hosts are vegetables grown as proceeding or succeeding crop or in vicinity to okra fields. All these favour pests carry over and pest populations increase rapidly with raising of the crop.

In terai region the major insect-pest of okra was jassid and fruit borer. The mean jassid population was highest on pre-kharifand lowest in kharif. And the mean infestation level of fruit borer was highest in kharif seasonand least in pre-kharif.Both the pest attained ETL level at 15 and 16<sup>th</sup>SW persisted at higher level till 17<sup>th</sup>-20<sup>th</sup> SW in pre-kharif; in kharif the major pest was fruit borer and the infestation remained at peak in 35-40SW. In post-kharifpeak fruit borer infestation level was maintained between 42 to 45 SW (Subba, 2017). Important diseases of okra are Damping off, Fusarium wilt, Cercospora Leafspot, powdery mildew, Yellow vein mosaic and Root knot nematodes. Among them, In India, two species of *Cercospora* produce leaf spots in bhendi. C. *Malayensis* causes brown, irregular spots and C. *abelmoschi* causes sooty black, angular spots. Both the leaf spots cause severe defoliation and are common during humid seasons. The fungi survive through conidia and stomata on crop residue in soil.

Fursarium wilt, a serious disease, found wherever okra is grown intensively. The okra *Fusarium* also infects cotton and certain other plants in the sp. Malvaceae family.

# G. Chili:

Chilli (*Capsicum annuum* L.) also known as red pepper is the highest consumed spice in the world, belongs to the family Solanaceae and genus Capsicum. It is an important constituent of many foods, adding flavor, colour, vitamins, pungency and therefore indispensable to the world food industries. Chilli is one of the major cash crops in India and our country is rated to be the second largest exporter in the world.

The crop is mainly grown for its pungent fruits which are used as green and ripe to impart pungency to food. India is the single largest chilli producer contributing for about 38% followed by China. In country, West Bengal stands 4th in production (100,000 MT) grown in an area of 63.6 lakh ha with productivity 1.57 MT/ha followed by Andhra Pradesh, Tamil Nadu and Karnataka (India stat, 2011-12).

Major diseases that affect capsicum and chilli crops are <u>Bacterial wilt</u>, <u>Anthracnose</u>, Choaenophora Blight, <u>Cercospora spot</u>, <u>Powdery mildew</u>, <u>Stem rot (Sclerotinium)</u>, <u>Sudden</u> <u>wilt</u>, <u>Spotted wilt and other viruses</u>, <u>Tomato yellow leaf curl virus</u> and <u>Tomato root-knot</u> <u>nematodes</u>. Among the different diseases <u>Anthracnose</u>, Choaenophora Blight and <u>Tomato</u> <u>yellow leaf curl virus</u> are most important causing havoc damage to the crops.

A Survey was conducted by Suresh, *et.al.*(2017) in major chilli growing areas of west Bengal for most prevailing diseases in chilli during the year 2015-16. As a result in chilli apart from the anthracnose, Alternaria, Choanephora blight a new disease was observed showing symptoms as dark brown spots on leaf, stem and fruit on chilli (*Capsicum annuum* L.) plants in Basantapur, West Bengal during 2015–2016.

Using microbial inoculants reduction of inorganic fertilizers to the extent of 75% is possible in chilli under terai ecological zone of West Bengal.

Out of 81 rhizospheric isolates obtained from maize, wheat and chilli, 6 numbers of isolates showed potential antagonistic activity against 4 soil-borne plant pathogens (*Rhizoctonia solani, Macrophomina phaseolina, Sclerotinia sclerotiorum* and *Sclerotium rolfsii*). Among the six effective rhizobacterial isolates MPf-1 was found to be the most effective isolate and suppressed the mycelial growth of all the four soil-borne plant pathogenic fungi (mean % growth inhibition 70.3% and mean inhibition zone 18.6 mm) followed by MPf-2 and P-2. Among the rhizobacterial isolates, MPf-1 was most effective in inhibiting sclerotia production of the sclerotia producing soil-borne pathogens (mean inhibition of sclerotia production by 93.33%) followed by P-2 and MPf-2 respectively.

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## List of Rabi-2017-18 Programme under RRSTZ

Sl.	Project Code	Title of the Programme	Associate Scientists
No.		Animal Science & Fishery	
1	RRST7/Rabi/17-	Production performance egg quality indices	Dr. Nonigonal Shit
1	18/06	and hatchability percent of Khaki Campbell	Dr. Dilip Kumar Haira
		ducks under semi-intensive rearing system at	– - · – - · · F - · · · · · · · · · · · · · · ·
		low ambient Temperature in Terai Zone of	
		West Bengal	
2	RRSTZ/Rabi/17-	Performance trial of different crops with fish	Prof. Debapriya Sarkar
	18/09	under Integrated Farming System Research in	and Dr. Nilanjana
		the fish farm of RRS, Terai Zone	Chaudhuri
2	DD0T7/D 1:/17	Crop Improvement	D II : A1
3	RRSTZ/Rabi/17-	Performance of grafted tomato (Stock: UBB-	Dr. Hossain Ali
	18/08	8Scion: Meghali) for enhancing the resistance	Mondal
1	PPST7/Pabi/17	Selection of munghean genotypes for	Dr. Runsanatan Mandal
-	18/05	tolerance to water-logging under field	D1. Rupsanatan Mandai
	10/05	condition	
		Crop Production	
5	RRSTZ/Rabi/17-	Effect of seed priming on the performances of	Dr. Partha Sarathi Patra
	18/01	wheat cultivars under zero tillage	
6	RRSTZ/Rabi/17-	Effect of different dates of planting (DOP) on	Dr. Parthendu Poddar
	18/12	a heavy panicle rice variety 'Maudamani' in	
		Terai zone of West Bengal	
_		Crop Protection	
1	RRSTZ/Rabi/17-	Occurrence and Management of Major	Dr. Satyajit Hembram
	18/03	Fungal Diseases of Tomato under Terai Zone	
0	DDT7/Dabi/17	Of West Bengal	Dr. Niloniono
0	18/04 01	evaluation of uniferent management strategies	DI. Milanjana Chaudhuri
9	$RBT7/R_{a}bi/17_{-}$	Evaluation of conservation agricultural	Dr. Nilaniana
	18/04-02	strategies on wheat maize and lentil agro-	Chaudhuri
	10/04 02	ecosystem	Chaudhun
10	RRSTZ/Rabi/17-	Evaluation of different pest management	Dr. Suprakash Pal
	18/02	modules for the insect pest complex of brinjal	
	-	Horticulture	
11	RRSTZ/Rabi/2017-	Title of the programme: Effect of sowing time	Dr. Suchand Datta
	18/07	and variety on the Growth, yield and quality	
		of bush type vegetable French bean	
		Social Science	
12	RRSTZ/Rabi/17-	Long Term time series analysis of data on	Dr.ArunavaGhosh
	18/11	area, production and productivity of oil seed	
		(Tomporeture Deinfell and Supplies hour) of	
		Terai Agro climatic zone of West Bengal	
13	RRST7/Rabi/17_	Modelling area production and productivity	Prof S Rasak
15	18/10	of rice at Cooch Behar district	1101. D. Dasak

Title of the Programme: Production performance, egg quality indices and hatchability percent of Khaki Campbell ducks under semi-intensive rearing system at low ambient Temperature in Terai Zone of West Bengal

Project code: RRSTZ/Rabi/17-18/06

Associate Scientist/s: Dr. Nonigopal Shit & Dr. Dilip Kumar Hajra

## **Objectives:**

- $\checkmark$  Evaluation of production performance at low ambient temperature
- $\checkmark$  Examination of the egg quality attributes
- $\checkmark$  Estimation of hatching percent in relation to low ambient temperature

## Materials:

## Study location and animal ethics

The proposed programme was conducted in the learning cum experimental duck shed under Integrated Farming System (IFS) model of the university following scientific procedure during the period of October, 2017 to February, 2018. The temperature and humidity recorded during this period varied between 7.5°C to 28°C and 55% to 76% respectively during the experimental period.

✓ Experimental Design and diets

•

A total thirty khaki Campbell ducks at 16 weeks of age from the same hatch were selected based on the physical conformation for this study. They were divided into three replicates i.e. 10ducks/replicate. The subjects were managed under semi-intensive system under 16h photo-schedules. Apart from the foraging, they were offered low cost feed formulated with local resources and drinking water *ad-libitum*. After complete acclimatization, the experiment was started on 5% duck house egg production.

## Methodology:

## ✓ Production performance:

a. Body weight:

Body weight of individual duck was recorded at fortnight interval in an electronic weighing balance with 0.01 precision and expressed in gm. Body weight gain (g)

b. Hen day egg production (%)

in the laboratory

#### ANIMAL SCIENCE AND FISHERIES

Hen day egg production.	No. of eggs produced				
	No. of ducks in the house on particular day				
Hen house egg production (%)					
Hen house egg production	n: No. of eggs produced No. of ducks housed initially X 100				

## ✓ Measurement of egg quality (external and internal) parameters

## a. Egg weight:

c.

Eggs were collected daily, weighed individually to the nearest mg and recorded daily for 18 weeks. Total egg number counted and recorded daily.

b. Volume of egg  $(cm^3)$ :

Egg volume was calculated based on the length and breadth (mm) following the formula;  $V = k_v LB^2$  where, kv = coefficient and the value is 0.496 (Narushin, 1997a).

c. Shape index: (Breadth / Length) x 100

d. *Surface area* (*cm*<sup>2</sup>):

According Narushin, 2004, the surface area of egg was calculated according to the following equation,  $S = k_s LB$ ; where  $k_s$  is the coefficient, (3.155-0.0136L+0.0115B, and L = length, B = Breadth of the egg).



## Figure 1: Instructional and model duck (Khaki Campbell) rearing practice and subsequent assessment of egg quality parameters in the laboratory e. Shell weight (gm):

Egg shell devoid of albumen or yolk is dried overnight at hot air oven then weighted

f.

## Haugh Unit:

HU was determined according to the following equation:  $HU = 100 \log (H+7.57-$ 

1.7 W 0.37); H = height of the thick albumen, W = weight of the egg

g. Yolk index (YI):

by an electronic balance with 0.001 precision.

YI was calculated based on the average length, width measured by vernier caliper and the yolk height by using a tripod following the underneath equation

Yolk index = (Yolk height / Yolk diameter) x 100

h.

Egg shell thickness

Eggshell thickness was measured by a means of micrometer as an average of 3 points (top, medial and base).

✓

## Determination of fertility and hatchability

The eggs were collected daily and stored at room temperature for up to 4 days before they were placed in the incubator. Eggs are incubated automatically under standard humidity and temperatures. On the 15-18<sup>th</sup> day, an accurate assessment of the developmental stage of the embryo by candling was done, numbers of eggs containing dead embryos, those containing no embryo were counted and the percent of fertility was calculated. Hatching process usually started on 25<sup>th</sup> day finished by the end of 28<sup>th</sup> day, the chicks were removed and counted. Fertility and hatchability percentages were calculated as the following:



#### **Results:**

✓ The reproductive performance of laying birds including Japanese quail deviates upon fluctuation of environmental cues. The present study revealed that laying birds subjected under low ambient temperature showed some changes in their production performance and hatchability indices.



The mean bears different superscript abc showed significant difference P<0.05

**Figure 2:** Body weight measurement on fortnight basis in Khaki Campbell duck during low ambient temperature at Terai Zone of West Bengal

**Table 1:** Measurements of external egg quality parameters in Khaki Campbell duck during low

 ambient temperature at Terai Zone of West Bengal

Parameters	22w	24w	26w	28w	30w	32w	34w
Egg weight (g)	54.55 <sup>a</sup>	56.74 <sup>ab</sup>	58.67 <sup>b</sup>	64.40 <sup>c</sup>	65.56c	61.66 <sup>bc</sup>	65.17 <sup>c</sup>
Egg Volume (cm <sup>3</sup> )	51.69 <sup>a</sup>	56.98 <sup>b</sup>	58.45 <sup>bc</sup>	56.08 <sup>b</sup>	60.14 <sup>c</sup>	62.97 <sup>d</sup>	60.50 <sup>c</sup>
Egg mass/hen/week	1527.31 <sup>a</sup>	2383.22 <sup>b</sup>	3285.33 <sup>c</sup>	4057.20 <sup>d</sup>	4589.20 <sup>e</sup>	3021.17 <sup>d</sup>	2737 <sup>cd</sup>
Shape Index (%)	69.41	63.83	70.88	69.21	75.40	74.97	68.52
Surface area (cm <sup>2</sup> )	70.23 <sup>a</sup>	73.38 <sup>b</sup>	76.10 <sup>c</sup>	77.22 <sup>cd</sup>	79.42 <sup>d</sup>	76.14 <sup>c</sup>	72.27 <sup>ab</sup>
Shell weight (gm)	5.53	5.17	5.89	6.34	6.01	5.69	5.54

Means bearing un-common superscript in row differ significantly (P<0.05)

**Table 2:** Measurements of internal egg quality parameters in Khaki Campbell duck during low

 ambient temperature at Terai Zone of West Bengal

Parameters	22w	24w	26w	28w	30w	32w	34w
Albumen index (%)	1.51	2.31	3.27	3.92	3.24	3.44	3.14
Albumen ratio	44.05	45.66	48.79	52.43	53.29	49.87	50.88
Yolk index (%)	7.36	7.83	9.57	10.45	11.16	8.63	9.21
Yolk ratio	33.58	32.84	37.15	35.75	33.59	33.54	32.25
Yolk-albumen ratio	67.11	67.32	75.90	70.96	78.67	67.82	69.01
Haugh unit (%)	68.96	81.99	82.92	90.34	95.94	91.66	79.83



**Figure 3:** Measurement of hen-day and hen-house egg production in Khaki Campbell duck during low ambient temperature at Terai Zone of West Bengal



Figure 4: Measurement of fertility and hatchability percentage in Khaki Campbell duck during low ambient temperature at Terai Zone of West Bengal

## **Findings:**

- ✓ Laying birds subjected under low ambient temperature showed an increasing trend of gaining body weight till 30<sup>th</sup> weeks of age which declined thereafter.
- ✓ The highest peak of shape index and surface area was corresponding with egg weight and recorded on 30<sup>th</sup> weeks of age.
- ✓ The average weight of egg shell in this study varied between 5.53 to 6.34gm, however, the maximum weight was observed on 28weeks of age.
- ✓ The Haugh unit and Yolk index both revealed highest magnitude on  $30^{th}$  weeks of age when albumen ratio, yolk ratio and yolk-albumen ratio were found on  $28^{th}$  weeks.
- ✓ Maximum fertility (83.91%) and hatchability (61.53) in Khaki Campbell duck were recorded by 28<sup>th</sup> week of age.

## **Future scope:**

✓ From this study, it is revealed that nutritional management in terms of ME (Kcal/Kg) and CP (%) value in the duck ration is important along with all other standard management. So, the factors such as optimum plane of nutrition to the birds, control of wind flow and duration of egg storage may be considered for further research trials to standardize as the management tool for better performance.

## Any other information (related to the programme)

✓ Because of infrastructural shortfall, the parameters i.e. fertility and hatchability percent were performed in the private organization with due permission of the University authority. These research objectives would be successfully designed in future if the facility could avail in the University corridor.

## Title of the Programme:Performance trial of different crops with fish under IntegratedFarming System Research in the fish farm of RRS, Terai Zone

## Project code: RRSTZ/2017-2018/Kharif/06

Associate Scientist/s: Prof. Debapriya Sarkar and Dr. Nilanjana Chaudhuri

## **Objectives:**

- ✓ To study the performance of Turmeric grown organically fish pond adjoining area
- $\checkmark$  To study the performance of Ginger grown in pond dyke and fish pond adjoining area
- $\checkmark$  To study the performance of Elephant foot yam in pond dyke
- $\checkmark$  To study the performance of plantation crops in pond dyke
- ✓ To study the performance of paddy-cum-fish culture in low lying pond adjoining areas
- ✓ To study the performance of water tolerant paddy variety in low lying pond adjoining areas with organic package of practice
- ✓ To study the performance of muga silkworm host plant (som) in medium land and the effect of nutrient supplementation and intercropping to make them grow fast in terai agro-climatic situation.
- ✓ To study the performance of lentil and maize in low lying pond adjoining areas area in rabi
- $\checkmark$  To study the performance of fish in fish farm pond

## Materials:

## Objective 1

- ✓ Turmeric variety TCP 2 (Suranjana)
- ✓ Solid and liquid indigenous microbial culture,
- ✓ Handmade botanical insecticide (Agniastra)

## **Objective** 2

- ✓ Ginger variety Local
- ✓ NPK at recommended dose and liquid indigenous microbial culture,
- ✓ Handmade botanical insecticide (Agniastra)

## Objective 3

- ✓ Elephant foot yam variety Kavur
- ✓ NPK at recommended dose

## **Objective** 4

- ✓ Areca nut and Coconut
- ✓ NPK at recommended dose

- ✓ The total area 225 m<sup>2</sup>(paddy variety RajendraMashuri in 180 m<sup>2</sup> area, water channel 20 m<sup>2</sup> area (excluding 1m depth) for fish and dyke 25 m 2area.
- ✓ Solid and liquid indigenous microbial culture,

✓ Handmade botanical insecticide (Agniastra)

## Objective 6

- ✓ Paddy variety RajendraMasuri, Nilanjana, MTU 1075 and Sabita
- ✓ Solid and liquid indigenous microbial culture,
- ✓ Han made botanical insecticide (Agniastra)

#### *Objective* 7

- ✓ Muga host plant Som (Machilusbombycina) as main crop.
- ✓ Turmeric, vegetable, spices, legume and oil seed crops as intercrops.
- ✓ Solid and liquid indigenous microbial culture.
- ✓ Handmade botanical insecticide (Agniastra)

#### **Objective** 8

- ✓ Lentil variety Moitree
- ✓ Solid and liquid indigenous microbial culture,
- ✓ Handmade botanical insecticide (Agniastra)
- ✓ NPK

#### **Objective** 9

- ✓ IMC like Catla, Rohu and Mrigel fries weighing 2cm and 1.5g
- ✓ Feed pellet (4 mm)

#### Methodology:

#### **Objective** 1

- $\checkmark$  Turmericrhizome was planted during 1stweek of May in the  $125m^2$  plot.
- ✓ Solid indigenous microbial culture applied during field preparation.
- ✓ After that liquid indigenous microbial culture, was applied at fortnightly interval.
- $\checkmark$  Agniastra was applied as need based.
- ✓ The crop was harvested in February, 2018
- ✓ The observations of plant and yield parameters for conventional farming were taken from the field maintained under University farm.

#### Objective 2

- ✓ In the fish pond adjoining area (100 m2) Gingerrhizome was planted1st week of May, 2017 and in the same plot lentil was sown during 1st week of December, 2017.
- $\checkmark$  In the pond dyke only ginger was raised in 150 m2area.
- ✓ NPK at recommended dose applied during field preparation for ginger.
- ✓ After that liquid indigenous microbial culture, was applied at fortnightly interval.
- ✓ Agniastra was applied as need based.
- ✓ All the crop were harvested in March,2018

- ✓ Tuber of Elephant foot yam was sown during 1stweek of May in the 200 m2 area.
- $\checkmark$  Recommended agronomic practices were followed
- ✓ The crop was harvested in January,2018
- $\checkmark$  The average weight of each rhizome was 700 gm
- ✓ The yield was 7t/ha.

## Objective 4

- ✓ 50 number of areca nut and 20 number of coconut seedlings were transplanted on and around the pond dyke during May, 2017.
- $\checkmark$  Recommended agronomic practices were followed

## Objective 5

- ✓ The 21 days old seedling was transplanted during2nd fortnight of July, 2017
- ✓ Solid indigenous microbial culture during land preparation and after that liquid at fortnight interval
- $\checkmark$  The botanical insecticide (Agniastra) was applied as per need.
- ✓ Fish were released into the paddy field after 15 days of rice transplantation. Asian magur hatchlings (50 numbers and 20 days old) and freshwater prawn juveniles (100 numbers and 45 days old) were released in first phase. IMC fries name namely Rohu and Mrigel (1 kg and 30 days old) were released in the second phase.
- $\checkmark$  Growth of fish was checked monthly by netting.
- ✓ The crop was harvested in November, 2017

## Objective 6

- ✓ Paddy variety namely RajendraMashuri, MTU 1075, Sabita and Nilanjana were raised in the plot size of 180 sq.m, 70 sq.m., 250 sq.m. and 110 sq.m. respectively
- ✓ 21 days old seedlings were transplanted by 1st fortnight of August
- ✓ Solid indigenous microbial culture applied during field preparation.
- ✓ After that liquid indigenous microbial culture, was applied at fortnightly interval.
- ✓ Agniastra was applied as need based.
- ✓ The crop was harvested in November-December,2017
- ✓ The observations of plant and yield parameters for conventional farming were taken from the field maintained under University farm.

- ✓ Muga host plant (100 numbers) was planted in 3mx3m in the medium land during 3rd week of September, 2017.
- ✓ The plants were transplanted in two parts, in one part of 250 m2 area the turmeric germplasm TCP 70 was planted during 1st week of May
- ✓ In the other part of 470 m2 area different vegetable, legume and oil seed crops was sown/transplanted during 2ndweek of December, 2017.
- ✓ Solid indigenous microbial culture applied during field preparation.
- ✓ After that liquid indigenous microbial culture, was applied at fortnightly interval.
- ✓ Agniastra was applied as need based.

- ✓ The turmeric was harvested in February,2018, vegetable, spices, legumes and oilseed crops were harvested in 1st week of April
- ✓ The observations of plant and yield parameters of turmeric for conventional farming were taken from the field maintained under University farm.

## *Objective* 8

- ✓ Lentil and maize were sown duringlast week of December, 2017
- ✓ Both the crops were raised organically in 130 m2 plot and by conventional farming in 100 m2 area.
- ✓ Solid indigenous microbial culture applied during field preparation.
- ✓ After that liquid indigenous microbial culture, was applied at fortnightly interval.
- ✓ Agniastra was applied as need based.
- $\checkmark$  In conventional farming normal agronomic practices were followed
- ✓ The crop was harvested in March and May,2018

## **Objective** 9

- ✓ Recommended package of practice for composite fish culture in rearing pond has been followed for 16 kg of fries
- $\checkmark$  The crop was released in the month of June 2017 and harvested up to May, 2018.

## **Results:**

**Objective** 1



# Figure 1: Plant parameters of turmeric (variety Suranjana) raised in two different farming system



Figure2: Yield attributing parameters of turmeric (variety Suranjana) raised in two different farming system

#### **Objective** 2

## Table 1: Plant and yield attributing parameters of ginger (variety local)

Plant height	Shootnumber	Lamina	Lamina	Single rhizome
(cm)		length (cm)	width (cm)	fresh weight (gm)
61.23	23.25	19.45	1.98	500

## Table 2: Comparative account of yield in two types of land situation

Area	Crop	Yield t/ha
Pond dyke	Ginger	2.235
Madium land adjacent to fish nond	Ginger	2.558
Medium fand adjacent to fish pond	Lentil	1.50



Figure 3: Pest population infesting paddy in Kharif 2017



Figure 4: Influence of cultivation practices on plant parameters of paddy at maturity

Parameters *	Fish Species					
	Rohu	Mrigel	Asian Magur	Prawn		
Av Initial length (cm) in Aug	2.5	2.2	2.0	1.5		
Av Initial weight (g) in Aug	1.8	1.9	1.3	0.15		
Av length (cm) in Sep	8.4	8.7	-	1.8		
Av weight(g) in Sep	8.0	8.9	-	0.6		
Av length (cm) in Oct	10.2	12.2	-	2.8		
Av weight(g) in Oct	37	49	-	4		
Av final length (cm) in Nov	11	14	14	6		
Av final weight(g) in Nov	55	65	20	10		
Fish released	0.5 kg	0.5 kg	50 nos	100 nos		
Fish production	2.0 kg	3.0 kg	10 nos	22 nos		
Control weight (individual)(g)	35	40	35	30		

Table 3: Growth performance of fish in paddy field

\*No of sample taken to calculate average data is 4



Figure 5: Growth performance of fish

#### **Objective** 6

Insect-pest populations	RajendraMashuri		MTU 1075		Nilanjana		Sabita	
	FP	OC	FP	OC	FP	OC	FP	OC
Leaf folder/5hill	1.12	1.03	1.02	1.01	1.56	1.00	1.38	1.02
Dead Heart/5hill	1.06	0.95	1.00	0.85	1.23	1.11	1.14	1.02
White ear head/5hill	0.87	0.58	0.21	0.11	1.02	0.97	1.05	1.02
Gundhibug/5hill	0.27	0.25	0.21	0.14	0.32	0.21	0.37	0.30

#### Table 3: Pest population infesting paddy varieties raise organically in Kharif 2017

FP= Farmers Practice; OC= Organic Cultivation

## Table 4: Influence of cultivation practices on plant parameters of paddy varieties at maturity

Plant	Rajendra	aMashuri	<b>MTU 10</b>	075	Nilanjar	na	Sabita	
Parameters	FP	OC	FP	OC	FP	OC	FP	OC
Plant	125 65	122 20	125 00	122 75	145 60	142 65	172 74	171.60
height (cm)	155.05	155.20	123.00	125.75	145.09	142.03	1/3./4	1/1.09
Tillers/hill	13.12	11.32	14.10	13.05	13.24	12.15	14.33	12.85
Panicles/hill	12.89	11.04	13.85	12.50	13.00	12.02	14.00	12.35
Panicle	27 45	28.04	72 77	24.05	21.21	22.00	22 57	24.19
length (cm)	27.43	20.04	23.11	24.03	21.21	22.00	25.57	24.10
Grains/panicle	158.65	159.33	273.67	277.69	158.26	161.00	157.24	163.02
Filled grains	141.80	144.81	240.67	249.02	138.25	144.33	137.12	141.67
Chaffy grains	16.85	14.52	33.00	28.67	20.01	16.67	20.12	21.35
Yield (kg $m^{-2}$ )	507.2	459.7	502.5	282.3	463.4	457.5	412.6	410.2

## **Objective** 7

#### Table 5: Plant parameters of turmeric (germplasm TCP 70) raised in som plantation

Farming practice	Plant height (cm)	Leaf number	Shoot number	Lamina length (cm)	Lamina width (cm)
Organic	119.23	8.4	2.8	57.5	14.95
Conventional	124.32	9.2	3.2	61.8	16.25

## Table 6: Yield and yield attributing parameters of turmeric (germplasm TCP 70) raised in som plantation

Farming	Primary	Mother	Single rhizome	Fresh
practice	Rhizome	rhizome	fresh weight	rhizome
-	Length (cm)	length (cm)	(gm)	Yield (t/ha)
Organic	7.56	7.78	385.23	19.86
Conventional	8.00	7.89	388.25	20.56

Сгор	Yield (t/ha)
Cabbage	11.82
Tomato	30.15
Carrot	12.35
Chilli	16.56
Pea	9.32
Lentil	1.54
Garlic	1.85

#### Table 7: Yield Performance of different crops in som plantation



## **Figure 6 : Performance of som plants**

#### **Objective** 8

#### Table 8: Performance of Lentil variety Moitree WBL77in two different farming system

Farming practice	Aphids /leaf	Yield gm plant <sup>-1</sup>	Yield t ha <sup>-1</sup>	
Organic	0.47	82.29	1.626	
Conventional	0.68	78.83	1.616	

#### Table 8: Performance of Maize variety: DKC9081in two different farming system

Farming practice	Aphids Leaf <sup>-1</sup>	Leaf roller (folded leaves) Plant <sup>-1</sup>	Single Cob weight (gm)	Yield t ha <sup>-</sup> <sup>1</sup> (fresh weight)	
Organic	0.50	0.047	248.35	4.09	
Conventional	0.98	0.090	483.40	14.01	

- ✓ Recommended package of practice for composite fish culture in rearing pond has been followed for 16 kg of fries
- $\checkmark$  The crop was released in the month of June 2017 and harvested up to May,2018

## **Findings:**

## Objective 1

- ✓ Plant and yield attributing parameters of Suranjanawere higher in conventional farming than the organic one but the difference was non-significant.
- ✓ Yield of TCP 70 was less than Suranjana. It was fade in colour and fresh weight of single rhizome was also lesser (388 g).

## Objective 2

- $\checkmark$  Plant growth as well as rhizome growth is moderate.
- ✓ Ginger intercropped with lentil provided higher return as compared to sole crop.

## Objective 3

- $\checkmark$  The average weight of each rhizome was 700 gm
- ✓ The yield was 7t/ha.

## **Objective** 4

✓ Crops are growing satisfactorily in the loam soil whereas those in the sandy soil are a bit slow in their growth.

## Objective 5

- ✓ The insect pest populations (leaf folder, yellow stem borer and gundhi bug) were observed more in the farmers practice than organically managed experimental plot.
- ✓ Plant height was comparatively higher in farmers' practice.
- ✓ Number of tillers/hill, panicles/hill, panicle length and grains/panicle were relatively more in organic farming over conventional farming.
- ✓ The yield was slightly lower in organic farming than conventional one.
- ✓ Growth of rohu and mrigel in the paddy field as well as water channel is optimum. However it is expected to enhance several manifolds with the increase in area under paddy-cum-fish cultivation and increase in water area and depth holding the fish throughout the culture period.
- ✓ Though the growth record of asianmagur is satisfactory but number harvested is really frustrating which is because of their escaping nature and its needs further protection across the dyke area of the land using strong and high nets so as to control escaping of fish.
- ✓ Performance of freshwater prawn juvenile in paddy field is not so satisfactory as in pond they grow much bigger where a separate care for their feeding is adopted. In the paddy field cannibalistic behaviour of prawn resulted in reduction in their number. At the same time, lack of sufficient food could not result in the optimum yield.

- ✓ The important insect-pests infesting paddy were stem borer, leaf folder and gundhi bug. The population was maximum in the field in conventional than organic farming.
- ✓ Plant and yield attributing parameters were comparatively higher in farmers' practice than organic cultivation.
- ✓ Yield performance followed an order of RajendraMashuri>Nilanjana>Sabita>MTU 1075

## Objective 7

- ✓ The som plantintercropped with turmeric as well as different vegetables, legumes and oil seed crop attained the height of 1.90ft and 1.47ft respectively at 7 months after transplanting.
- ✓ Plant and yield attributing parameters of turmeric were slightly higher in conventional farming than the organic one but the difference was non-significant.

## Objective 8

- ✓ Pest population of lentil and maize was observed lower in organically managed plots.
- $\checkmark$  The yield attributing parameters of lentil were higher in organic farming than the conventional one.
- $\checkmark$  The yield attributing parameters of maize were higher in conventional farming than the organic one.

## Objective 9

- $\checkmark$  Average weight and length of fish were 80g and 25 cm respectively.
- $\checkmark$  Approximately 10 % of fish population are growing upto 300g.

## **Future Scope:**

## Objective 1

✓ There lies a huge scope to explore optimum growth and yield of this crop through continuous organic soil management applications

## Objective 2

✓ There lies a huge scope to explore optimum growth and yield of this crop through organic soil management applications

## **Objective 3**

- $\checkmark$  The average weight of each rhizome was 700 gm
- ✓ The yield was 7t/ha.

✓ There is ample scope of production as well income from this crop cultivated in pond dyke with improvement of soil quality in coming 2-3 years through optimum organic management practice.

## **Objective** 5

✓ This technology can be adopted in thelow lying areas of teraizone having sandy loam soil and also in some other localities having less frequent ponds to obtain high paddy as well as fish yield from the paddy-cum-fish culture plots.

## *Objective* 6

✓ Identification of more number of water tolerant variety of paddy for execution of paddy-cum-fish culture with organic culture practice in the low lying areas for better profit and sustainability.

## **Objective** 7

✓ Improved growth will lead the plants to reach an optimum height required for muga silkworm rearing within shortest possible time and the lean period can be exploited by the farmer through income from the intercropped vegetables and spices.

## **Objective** 9

✓ Larger fish can be used after one year for induced breeding to produce quality for future use

## Recommendation

## Objective 1

- ✓ The yield of turmeric is almost same in both the farming system which suggests bright prospects of adoption of organic farming system for turmeric cultivation in this region.
- ✓ Turmeric has been proved to be one of the most optimally growing horticultural crops in the fish pond adjoining areas of terai zone bearing sandy soil with the help of minimum input and labour cost.

## Objective 2

- ✓ The potential scope of ginger recommends its incorporation in the IFS system as a valuable spice crop.
- ✓ The quality improvement of sandy soilof pond dyke is essential to make the farming system more remunerative.

✓ The yield is not satisfactory this year as the crop was grown in the dyke containing highly sandy soil and it needs more attention for soil texture improvement in terms of nutrient supplement to the crop bearing plots.

## **Objective** 4

✓ Proper growth of the plants in coming 5-6 years will make the IFS unit economically strong.

## Objective 5

✓ Recommendation can be done after continuous conduction of the same experiment for 2 years in at least 1 acre plot.

## Objective 6

✓ The result suggests bright prospects of adoption of sustainable organic farming system for paddy-cum –fish cultivation in terai region. Components of solid indigenous microbial culture and agniastra are mostly domestic and easily available and cheaper in price that will augment the technology adoption by the stakeholders.

## Objective 7

 $\checkmark$  The gestation period of muga host plant is 4-5 years and to minimize the period, the option of intercropping in the inter spaces of som plants can be a better option.





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## ANIMAL SCIENCE AND FISHERIES



Title of the Programme: Performance of grafted tomato (Stock: UBB-8Scion: Meghali) for enhancing the resistance against biotic stress

Project code: RRSTZ/Rabi/17-18/08

Associate Scientist/s: Dr. Hossain Ali Mondal

## **Objectives:**

- ✓ Low cost (Stock: UBB-8Scion: Meghali) grafted tomato seedling production technology
- ✓ Grafted tomato for enhancing the resistance against biotic stress
- ✓ Assuring farmer's enhanced income
- ✓ Use of lesser chemical dependent farming practice.

#### Materials (in details):

✓ Soil-rite, Seedling of both Tomato and Brinjal, grafting clip, Transparent plastic container, Plant Growth Room conditioned with the soil-rite as soilless growing media under 3000 lux of light intensity, 14-hour light condition per day, and 70% of Relative Humidity.

#### Methodology:

- ✓ First allow the growth of root stock [here Brinjal for 14 days (UBB-8, Signath)].
- ✓ Initiation of SCION (here Tomato variety, ArkaMeghali, a high yielding genotype developed by IIHR) germination after 14 days later. Here it is abbreviated as Stock: UBB-8.
- $\checkmark$  Cut the stock and scion with the surgical blade.
- $\checkmark$  Stabilize the stock and scion with the help of grafting clip.
- ✓ Keep for 14 days in humid condition in the transparent plastic box in the PGR (Plant Growth Room)conditioned with the soil-rite as soilless growing media under 3000 LUX of light intensity, 14-hour light condition per day, and 70% of Relative Humidity.
- $\checkmark$  30 days from grating date, the plant was considered for main field.

#### **Results** :

- ✓ The resistant Brinjal, UBB-8 (Signath) showed the wilt resistant.
- ✓ All tomato plant, Meghali showed wilt susceptible.
- ✓ All the grafted tomato (Stock: UBB-8Scion: Meghali) also showed wilt susceptible.

 Table 1: Percentage of Wilt infection in Non-grafted Meghali, Grafted Meghali and Brinjal used as root stock.



[Percentage of infection to wilt disease of UBB-8, Meghali and Grafted Meghali at 2 months in the field condition. All the un-grafted Meghali were faced to wilt susceptibility whereas the grafted tomato 88.25% infection to wilt disease. UBB-8 showed lower susceptibility rate (16.67%) as compared to both, Grafted Meghali and Un-grafted Meghali.]



Figure 1: Bacterial count in UBB-8, Grafted tomato and ungrafted tomato

[In each series, there are 6 bars. First two bars (1&2) are assigned as Ungrafted-Meghali Upper and Lower, marked as light shaded. Next two bars (3 and 4) are assigned as Grafted-Meghali Upper and Lower, marked as more dark shade. Next two bars (5&6) are assigned as UBB-8 Upper and Lower, marked as darkest shaded.

Bars No. 1&2: All the un-grafted Meghali were infected to wilt disease realized in two months. The both upper and lower parts which are recognised as Above Ground and Below ground Plant parts showed the infestation of bacterial population. In temporal scale of ooze-out data reflects the linear fashion of release of infected bacteria.

Bras No. 3&4: 88.25% grafted-Meghali were infected to wilt disease realized in two months. The both upper and lower parts which are recognised as Above Ground and Below ground Plant parts showed the infestation of bacterial population. Very interesting, the below ground plant parts, marked as below the grafting region and part of stock, UBB-8 is highly less populated significantly as compared to Above ground plant parts, belong to Meghali as Scion. In temporal scale of ooze-out data reflects the linear fashion of release of infected bacteria from both parts. The Above ground Scion part is highly populated as compared to un-grafted Meghali. How these bacteria are harboured under this region is assigned as big question.

Bars 5&6: The UBB-8 is also faced bacterial wilt up to 16.67% in the wilt sick plot. Very interesting, the upper and lower plant parts showed much significantly lower bacterial population as compared to all plant parts either lower or upper from un-grafted and grafted Meghali.]



Figure 2: The process of Ooze out protocol



# Figure 3: The potent reason of high bacterial population in the above ground plant parts in grafted Meghali.

[Figure 3.A: In the mature plant, the grafting place was arrowed. The above position of grafting place was reflected as enhanced bacterial population estimation but in the below the grafting place which is the part of UBB-8, a bacterial wilt resistant brinjal plant was reflected as reduced bacterial population. The high population in the above ground position was not due to below ground parts due to very low population of bacteria. The presence of very lower population in the UBB-8 below ground nullify the bacterial infiltration from stock root in the grafted Meghali. It may be leached from above ground position. The main issue is the enhanced bacterial population in the above ground portion in the

grafted tomato. The one potent reason may be due to presence of root development from the above ground plant parts which belongs to Meghali plant part. The tendency of development of root from Meghali stem is also realized in the development of grafted Meghali in Plant Growth Room which is shown in Figure 3.B-1 and later on reflected on mature plant shown in Figure B-2]



Supplementary Figure 1: An initiative of grafting of High Yielding Tomato Variety (ArkaMeghali) on local Brinjal root stock

## **Findings:**

- ✓ The high yielding variety, Meghali showed 100% susceptibility to filed condition.
- ✓ The grafted tomato (Stock: UBB-8Scion: Meghali) plant rescued the susceptibility in the field condition.
- ✓ The stock, UBB-8 used in grafted Meghali showed resistance to wilt disease in the field condition.
- ✓ The root development from scion may actually contribute the susceptibility of the grafted tomato.

## **Future Scope:**

✓ Need continuation of this project mainly focusing on root development from scion in grafted tomato.

#### **Recommendation :**

 ✓ Alternative idea needs to be conceptualized for inhibiting the rooting growth from Above Ground Scion in grafted tomato plant.

## Any other information (related to the programme):

✓ Rootless Graft development was initiated for avoiding the rescue of susceptibility.

Project Title: Selection of mungbean genotypes for tolerance to water-logging under field condition

Project code: RRSTZ/Rabi/17-18/05

Associate Scientist/s: Dr. Rupsanatan Mandal

## **Objectives:**

✓ Identification of flood tolerance genotypes suitable for Terai Zone, West Bengal Materials:

✓ . Ten mungbean genotypes viz. Samrat, Sonali, Sukumar, Panna, Birerswar, Selection
 -1, Selection-2, TC-39487, TC-39499, and TC-39544 were tested under this study.

## Methodology:

- ✓ The experiment was conducted in the field of the Regional Research Station, Terai Zone, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar during November, 2017 to February, 2018.
- ✓ The genotypes were flooded with 3-5 cm of standing water for 7 days (96 hours) at 25 days after emergence (DAE), 35 days after emergence and 45 days after emergence.
- $\checkmark$  The experiment was laid out in a split-plot design with three replications.
- ✓ Flooding treatments were placed in the main-plots and mungbean genotypes were in the subplots.
- ✓ The size of each main plot was 8m x 2m =16 m2 and the size of each subplot was (2m x 1.5m).
- ✓ Drain in between two main plots was 1.5 m so that flooded water cannot soak to the neighboring experimental plots.
- $\checkmark$  Each sub-plot had 5 rows of mungbean genotype with a spacing of 30 cm x 10 cm.
- ✓ At the border of each plot respective mungbean genotype was grown to avoid border effect.

## **Results** :

# Table 1: List of mungbean genotypes and percentage of plant survived at 25, 35 and 45days after emergence of seedlings

Genotypes	25%DAE	35% DAE	45% DAE	Grain Yield per Plot
Samrat	50.12	39.45	15.67	26.25
Sonali	42.1	40.162	18.56	17.50333
Sukumar	42.75	40.56	14.87	20.83
Panna	5	35.96	20.45	30.92333
Birerswar	45.45	35.78	23.87	20.37667
Selection -1	80.47	70.12	65.78	46.535
Selection-2	85.45	72.56	67.89	27.295
TC-39487	61.78	45.32	10.56	20.555

TC-39499	59.1	38.12	13.78	20.93833
TC-39544	62.45	40.23	16.78	20.03833

Construes	250/ DAE	35%	45%	CVDD	60070	Donk
Genotypes	2570DAL	DAL	DAL	GIII	score	Nalik
Samrat	0.561	0.100	0.089	0.301	1.051	4
Sonali	0.461	0.119	0.140	0.000	0.720	9
Sukumar	0.469	0.130	0.075	0.115	0.789	8
Panna	0.000	0.005	0.173	0.462	0.640	10
Birerswar	0.503	0.000	0.232	0.099	0.834	7
Selection -1	0.938	0.934	0.963	1.000	3.835	1
Selection-2	1.000	1.000	1.000	0.337	3.337	2
TC-39487	0.706	0.259	0.000	0.105	1.070	3
TC-39499	0.672	0.064	0.056	0.118	0.911	6
TC-39544	0.714	0.121	0.108	0.087	1.031	5

#### Table 2: Rescaling value of survival % with grain yield of mungbean genotypes

#### Figure 1: Diversity analysis with 11 quantitative characters of mungbean genotypes



#### **Major Findings:**

- The genotype Selection-1 and Selection -2 were showed the maximum value of survival in flooding situation with better yield performance.
- According to Dendrogram analysis Selection-1 and Selection-2 also found in same cluster

**Future scope:** This experiment will be done repeatedly for the checking stability of genotypes toward flood tolerance.

## **Recommendation:**

- ✓ Samrat cultivars may be cultivated at low land area. It has medium level of water loggind tollerence.
- $\checkmark$  The cultivar, Panna is not suitable for cultivation in terai zone.

**Title of the Programme:** *Effect of seed priming on the performances of wheat cultivars under zero tillage* 

Project code: RRSTZ/Rabi/17-18/01

Associate Scientist/s: Dr. P. S. Patra

## **Objectives:**

✓ To study the effect of seed priming on the performances of wheat cultivars under zero tillage

## Materials:

- ✓ Five wheat varieties (C-306, PBW-343, HD-2967, K-1006 and DBW 39)
- ✓ 0.1% solution of HgCl<sub>2</sub>
- ✓ 50 ppm GA<sub>3</sub> Solution

## Methodology:

- ✓ The present experiment has been conducted at the research farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal during rabi season of 2017 to find out the effect seed priming on the performances of wheat cultivars under zero tillage.
- ✓ The farm is situated at  $26^{0}19'86''$  N latitude and  $89^{0}23'53''$  E longitude at an elevation of 43 meters above mean sea level.
- ✓ The soil is sandy loam, acidic with a pH of 5.60, low in available nitrogen (151.25 kg ha<sup>-1</sup>), medium in available phosphorus (24.33 kg ha<sup>-1</sup>) and available potash (87.50 kg ha<sup>-1</sup>).
- ✓ The experiment is conducted in factorial randomized block design with three levels of seed priming (hydro-priming, GA<sub>3</sub> priming and control) and five varieties.
- ✓ All treatments were replicated three times.
- $\checkmark$  Wheat was sown on 19.12.2017 and harvested on 07.04.2018.
- $\checkmark$  At first, the wheat seed is disinfected with 0.1% solution of HgCl<sub>2</sub> for 5 minutes.
- ✓ Thereafter, seeds were pre-soaked for a period of 24 hours at  $25 \pm 1$  °C either with hydro-priming (pre-soaking with distilled water) or with phyto-hormonal treatment (pre-soaking with GA<sub>3</sub> solution made of 50 ppm).
- ✓ Pre-soaked wheat seed is sown by using zero tillage seed cum fertilizer drill.
- ✓ Data were recorded on agronomic parameters including germination%, plant height, no. of spike/sq.m, no. of grains/ spike, test weight and grain yield.

## **Results:**

## Germination %

✓ It was observed that irrespective of varieties highest seed germination was found in GA<sub>3</sub> primed seed which was followed by hydro-primed seed.

✓ Among the varieties PBW-343 recorded highest germination (92%) under GA<sub>3</sub> primed treatments followed by C-306 and HD-2967. Normally sown wheat varieties (control) showed lowest seed germination.



## Figure 1: Effect of seed priming on germination % of wheat varieties

Yield attributes and grain yield

- ✓ Yield attributes and grain yield of wheat are presented in Table 1 and 2.
- ✓ From the tables it is clear that, GA<sub>3</sub> primed seed recorded highest values of plant height, no. of spike/sq.m, spike length, no. of grains/spike, test weight and grain yield/ha irrespective of varieties used in the experiment.
- ✓ Among the varieties PBW-343 recorded highest values of plant height (112.02), number of spike/sq.m (376.48), spike length (9.29cm), no. of grain/spike (38.69), test weight (41.52g) and grain yield (3.32 t/ha) followed by C-306, HD-2967, DBW-39 and K-1006 when seed is treated with GA<sub>3</sub>, probable reason might be due to highest germination percentage and greater root growth.

	Plant height (cm)			No. of spike/sq. m			Spike length (cm)		
Treatments	Hydro	GA <sub>3</sub>		Hydro	GA <sub>3</sub>		Hydro	GA <sub>3</sub>	
	priming	priming	Control	priming	priming	Control	priming	priming	Control
C-306	108.85	112.02	106.18	343.15	350.35	319.82	9.03	9.03	8.87
PBW-343	105.18	107.76	104.36	372.22	376.48	315.33	9.25	9.29	9.07
HD-2967	106.56	109.58	103.78	330.29	338.67	313.20	8.89	8.94	8.62
K-1006	108.14	111.35	107.42	345.56	362.45	329.10	8.85	8.87	8.68
DBW 39	106.33	108.96	99.95	337.17	357.82	324.25	8.96	8.99	8.8

Table 1: Effect of seed priming on yield attributes of wheat under zero tillage

No. of grain/spike			Test weight (g)			Grain yield (t/ha)			
Treatments	Hydro	GA <sub>3</sub>		Hydro	GA <sub>3</sub>		Hydro	GA <sub>3</sub>	
	priming	priming	Control	priming	priming	Control	priming	priming	Control
C-306	34.07	34.85	31.95	40.71	40.82	38.67	2.98	3.12	2.80
PBW-343	38.17	38.69	32.07	41.4	41.52	40.33	3.10	3.32	2.89
HD-2967	32.98	33.65	29.05	40.41	40.55	39.83	2.73	3.01	2.69
K-1006	33.15	35.5	30.12	38.5	39.15	38.01	2.87	2.95	2.70
DBW 39	33.65	35.98	29.33	39.04	39.15	38.74	2.82	2.97	2.75

## Table 2: Effect of seed priming on yield attributes of wheat under zero tillage



Plate 1: Effect of seed priming on the yield attributes of wheat

## **Findings:**

- ✓ It is primarily concluded from the one-year data that under zero tillage moisture stress condition seed priming would be a good option for achieving higher seed germination and grain yield.
- $\checkmark$  Among the seed priming method hydro-priming would be an easy and cheapest method.

Title of the Programme: Effect of different dates of planting (DOP) on a heavy panicle rice variety 'Maudamani' in Terai zone of West Bengal

Project Code: Code: RRSTZ/Rabi/17-18/12

## Associate Scientist: Dr. Parthendu Poddar

## **Objectives**:

- ✓ To find out the effect of sowing dates on growth and yield parameters of "CR dhan 307" Maudamani, a heavy panicle rice variety in *Terai* zone of West Bengal
- ✓ To optimise the date of sowing of "CR dhan 307" Maudamani, a heavy panicle rice variety in *Terai* zone of West Bengal

## Materials:

- ✓ One rice variety (Maudamani)
- ✓ Fertilizers like Urea, SSP and MOP were used as sources of nitrogen, phosphorus and potassium respectively

## Methodology:

- ✓ The Place of experiment was Uttar Banga Krishi Viswavidyalaya instructional farm, Pundibari, Cooch Behar, West Bengal.
- ✓ The design of experiment was RBD with four replications and treatments were
  - $T_1$  Transplanting on 02.01.18
  - T<sub>2</sub> -- Transplanting on11.01.18
  - T<sub>3</sub> -- Transplanting on 20.01.18
  - T<sub>4</sub> -- Transplanting on 02.02.18
  - T<sub>5</sub> -- Transplanting on17.02.18
- ✓ The plot size and spacing of the experiment were 4m x 4m and 20 cm X 15 cm respectively
- ✓ Method of sowing was mainly Hand-Transplanted & line sowing
- ✓ Nitrogen, Phosphorus and Potassium were applied @ 130 kg ha<sup>-1</sup>, 60kgha<sup>-1</sup> and 70 kg ha<sup>-1</sup> respectively. Urea, SSP and MOP were used as sources of nitrogen, phosphorus and potassium respectively.
- ✓ Dates of harvesting were

 $T_1 - 11.06.2018$  $T_2 - - 11.06.2018$ 

- T<sub>3</sub>-11.06.2018
- **T**<sub>4</sub> -- 15.06.2018
- **T**<sub>5</sub>–19.06.2018
- ✓ Data on Plant height (cm), Number of tillers per m<sup>2</sup>, Number of panicles m<sup>-2</sup>, Number of filled grains per panicle, Test weight (1000 Grain weight in g), Grain yield (t/ha), Straw yield (t/ha) were taken. Data on the above-said parameters are analysed for calculation of Harvest Index.







**Fig. 2:** Number of tillers m<sup>-2</sup>



Fig. 3: Number of panicles per m<sup>2</sup>



Fig. 4: Number of grains per panicle



Fig. 5: Test weight (g)



Fig. 6: Grain yield (t/ha)
# **CROP PRODUCTION**



Fig. 7: Straw yield (t/ha)



Fig. 8: Harvest Index (%)



**Fig.9: Field performance of rice variety "Maudamani" in different dates of planting** 

# **CROP PRODUCTION**

# **Results:**

- ✓ The crop which was transplanted on first week of January experienced poor growth in the initial days due to cold temperature of the month.
- $\checkmark$  Transplanting in the second week of January exhibited the best performance.

Title of the Programme: Occurrence and Management of Major Fungal Diseases of Tomato under Terai Zone of West Bengal

Project code: RRSTZ/Rabi/17-18/03

Associate Scientist/s: Dr. Satyajit Hembram

#### **Objectives**:

 To search efficient and economically profitable new fungicide as compared to others against tomato late blight disease in field conditions in Terai region of West Bengal.

#### Materials:

✓ Date of planting: Four (15.11.17; 01.12.17; 15.12.17; 02.01.18) for disease incidence and one (15.12.18) for evaluation for new generation fungicides ;
 Variety: Local Popular varietyPusa Rabi; Treatment: Seven; Replication: Three; Design: RBD

#### Methodology:

- ✓ The treatments comprised of different management practices.T1: Cholorothelonil 40% w/w + Difenconazole 4% w/w SC; T2:Sprays of mancozeb 75WP @ 2 g/L water followed by carbendazim 50 WP @ 0.5 g/L water; T3:Sprays of Cymoxanil + mancozeb @ 0.3% at the onset of the disease; T4:Sprays of Dithiocarbamate + mancozeb @ 0.3 % at the onset of the disease; T5:Ametoctradin + Dimethomorph @ 0.3% at the onset of the disease; T6:Difenconazole 25 EC @ 0.05%; T7: Control. Twofungicidalsprays applied to the all plot after disease incidence at 15 days interval and control plot sprayed with normal water.
- ✓ The mixture sprays will be apply as soon as the late blight disease occurred in tomato and subsequent two spray apply at 10 days interval with water volume of 500 litre/ha. The tomato cultivar "Patharkuchi"or other Local popular variety will be cultivated. The disease incidence will be measured in percentages of infested plants out of total plants observe:

Percrent Disisease Incidene =  $\frac{\text{No. of plants infected}}{\text{Total number of plant}} \times 100$ 

Whereas disease severity was estimated by Percent Disease Index (PDI) value in 0 to 9 scale (Malcolmson, 1970).

 $PDI = \frac{Sum of all numerical ratings . of plants infected}{Total plants observed x Maximum ratings scaleotal number of plant} \times 100$ 

#### **Results:**



Figure 1.Weekly average weather parameters at experimentsite during November, 2017 to February, 2018



Figure 2.Relationship between times required for disease initiation and weather parameter



Figure 3. Relationship between weather parameters and days to disease initiation over combined date of sowing

	Percent incidence of late blight								
Treatment	Before application	15 days after 1 <sup>st</sup> application	15 days after 2 <sup>nd</sup> application	30 days after 2 <sup>nd</sup> application	% reduction over control				
T1	2.37 (8.96)	3.41 (10.64)	4.84 (12.71)	6.34 (14.59)	80.55				
T2	2.36 (8.75)	5.46 (13.51)	13.64 (21.67)	15.15 (22.90)	58.33				
T3	2.58 (9.12)	3.77 (11.20)	6.73 (15.04)	8.64 (17.09)	76.24				
T4	2.55 (9.30)	3.83 (11.29)	7.27 (15.64)	9.55 (18.00)	73.74				
T5	2.96 (10.04)	3.52 (10.82)	4.75 (12.59)	6.14 (14.35)	83.11				
T6	2.61 (9.15)	6.09 (14.25)	17.74 (24.91)	19.31 (26.07)	46.88				
T7	2.34 (8.90)	9.26 (17.72)	28.12 (32.02)	36.35 (37.08)					
SEM±0.1	0.091	0.069	0.062	0.044					
CD (0.05)	0.280	0.212	0.192	0.137					

 Table 1. Effect of various management practices on the major foliar disease of

 Tomato

Findings :

- ✓ Among the four dates of planting, highest time (39 days) required for initiation of the late blight disease on 15.11.17 date of planting, there after the period for disease initiation decreases and lowest time required seventeen days observed during 2nd January, 18 sowing date.
- ✓ Date of initiation of the disease positively correlated with the maximum relative humidity and negatively correlated with maximum temperature and sunshine hours.
- ✓ It was observed that number of days to initiate late blight symptom on tomato was an inverse function (Y=a+bx-1) of average maximumhumidity and temperature from sowing and R2values of the equation were statistically significant at 1% level of significance.
- ✓ The late blight severity in untreated plots was 36.35%.
- ✓ Two spraying with Ametoctradin + Dimethomorph @ 0.3% showed lowest disease severity of 6.14% and 83.11% reductionin disease severity over control at 90 days after planting which was significantly at par with the Cholorothelonil 40% w/w + Difenconazole 4% w/w SC fungicide applied with disease severity of 6.34 and 80.55% reduction in late blight severity compared to untreated check.
- ✓ The result showed significant difference in disease severity (8.64%) when the Cymoxanil + mancozeb @ 0.3% fungicide was applied. The result was significantly at par with Dithiocarbamate + mancozeb @ 0.3 % (9.55%).
- ✓ Difenconazole 25 EC @ 0.05% was not comparatively effective in reducing late blight exhibiting 19.31% disease severity and only 46.88% reduction in comparison to untreated control.

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# **CROP PROTECTION**



Plate 1. View of Experimental field



Plate 2. Symptoms of late blight of tomato

Recommendation :

✓ Two spraying with Ametoctradin + Dimethomorph @ 0.3% andCholorothelonil 40% w/w + Difenconazole 4% w/w SC fungicidescan effectively manage late blight severity.

# Title of the Programme:Evaluation of different management strategies on theinsect-pest complex of cabbage

Project code: RRTZ/Rabi/17-18/04-01

Associate Scientist/s: Dr. Nilanjana Chaudhuri

#### **Objectives:**

✓ Evaluation of different IPM strategies for cabbage

# Materials:

- ✓ Cabbage variety Green Express
- ✓ Solid and liquid indigenous microbial culture,
- ✓ Handmade botanical insecticide (Agniastra)
- ✓ NPK

#### Methodology:

- ✓ Cabbage seed was sown after treatment with indigenous microbial culture (bijamrita) in 2<sup>nd</sup> week of November and planted in the main field again upon root dipping in bijamritaduring 2<sup>nd</sup> week of December, 2017.
- ✓ The plot size was  $2x3m^2$ , spacing was 45x30cm and replication was 4.

Management	:	Details of management schedule
strategies		
Strategy I	:	Untreated check (Fertilizer NPK at recommended dose+ no
		insecticide and fungicide)
Strategy II	:	Solid indigenous microbial culture during field preparation + Liquid indigenous microbial cultureJiwamritaat an interval of 15
		days+mustard as trap crop + mulching + botanical handmade insecticide agniastra (need based)
Strategy III	:	Solid indigenous microbial culture during field preparation + Liquid indigenous microbial cultureJiwamritaat an interval of 15 days+ mulching +botanical insecticide agniastra
Strategy IV	:	Fertilizer at recommended dose+ application of neem based insecticide and fungicides
Strategy V	:	Fertilizer at recommended dose + mustard as trap crop+ need based application of insecticide and fungicide
Strategy VI	:	Fertilizer at recommended dose + need based application of insecticide and fungicide

# **Table 1: Treatment details**

#### **Results:**

Insect-Pests	Peak Period of activity	Crop stage
Flea beetle	3 <sup>rd</sup> week of December to 1 <sup>st</sup> week of	Vegetative and Head
<i>Phyllotretas</i> p	March	formation
Aphid	3 <sup>rd</sup> week of February to 4 <sup>th</sup> week of	Head formation
<i>Lipaphiserysimi</i> Kalt	March	
Diamond Back Moth	3 <sup>rd</sup> week of February to 4 <sup>th</sup> week of	Head formation
Plutellaxylostella	March	

Table 2:	Incidence of	Insect-Pest	population	in different	t crop stage	es of cabbage



Figure 1: Insect-Pest population infesting cabbage under different management strategies



# Figure 2: Yield of cabbage under different management strategies

#### Findings

- ✓ Initially the cabbage crop was infested by flea beetle. At head formation stage of the crop with the increment of temperature during 3rd week of February the population of aphid and DBM was initiated.
- ✓ The insect-pest population was higher in strategy I and the yield was lowest 26.85t/ha.

- ✓ The lowest population of the all the pests was recorded in Strategy V followed by Strategy VI.
- ✓ Next to these come the strategy II and III with organic schedule.
- ✓ The yield was higher (32.42t/ha) in strategy V and it was almost at par in strategy II (31.78t/ha), III (31.52t/ha) and VI (31.24 t/ha).

# **Future Scope:**

✓ Crop-pests module for cabbage crop may be developed based on the findings

# **Recommendation:**

✓ Though the pest population was a little bit higher in strategies with organic schedule but the yield was at par with the recommended package of practices. Hence the strategies of organic management for insect-pest population of cabbage have proved to be better and environment friendly too.

# Title of the Programme:Evaluation of conservation agriculturalstrategies on wheat, maize and lentil agro-ecosystem

Project code : RRTZ/Rabi/17-18/04-02

Associate Scientist/s : Dr. Nilanjana Chaudhuri

**Objectives** : To study the impact of conservation agricultural strategies in pest population and yield of wheat, maize and lentil

#### Materials (in details) :

- ✓ Wheat variety HD2967, Maize variety DKC 9081 and Lentil variety Moitree
- ✓ Solid and liquid indigenous microbial culture
- ✓ Handmade botanical insecticide (Agniastra)
- ✓ NPK

# Methodology:

✓ The seeds of wheat, lentil and maize were sown in last week of December in a plot size of 3 x4 m<sup>2</sup>. The spacing was 22 x 5 cm for wheat, 25 x 10 cm for lentil and 60 x 20 cm for maize.

Table1: Details	of strategies for	all the three crops
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Conservation stra	teg	ies:				
Strategy I	:	Tillage + Seed treatment with indigenous microbial culture + Application of indigenous microbial culture as soil amendment + mulching + application of handmade botanical pesticide as and when needed				
Strategy II	:	Tillage + Seed treatment with bio-fertilizer + Application of NPK (25% less than recommended dose) + Application of synthetic insecticides as and when needed				
Strategy III		Tillage + Seed treatment with bio-fertilizer + Application of indigenous microbial culture as soil amendment + mulching + Application of handmade botanical pesticide as and when needed				
Strategy IV		Zero Tillage + Seed treatment with bio-fertilizer + Application of NPK (25% less than recommended dose) + Application of synthetic insecticides as and when needed				
Strategy V		No seed treatment + Application of indigenous microbial culture as soil amendment + mulching + application of handmade botanical pesticide as and when needed				
<b>Conventional stra</b>	Conventional strategy:					
Strategy VI	:	Farmers practice without seed treatment + recommended dose of NPK + Application of synthetic insecticides as and when needed				



Figure 1: Insect-pest and natural enemy population of wheat in different management strategies

Table 3: Performance of Wheat variety HD2967in different conservation
strategies

	Plant height	Tillers hill <sup>-</sup>	Spike length	No. of grain	Spike wt
Strategies	(cm)	1	(cm)	spike <sup>-1</sup>	(g)
SI	56.00	2.12	7.00	13.80	1.00
SII	67.32	4.25	8.57	37.31	1.39
SIII	54.31	2.04	6.95	13.33	0.90
SIV	59.80	4.05	8.56	31.38	1.20
SV	52.90	2.02	6.65	13.28	0.86
SVI	70.00	4.26	8.70	37.40	1.40



Figure 2: Aphid population of lentil in different management strategies

Strategies	Plant height	Branches	Seeds	Yield	Yield
Sualegies	(cm)	plant <sup>-1</sup>	pod <sup>-1</sup>	gm plant <sup>-1</sup>	t ha <sup>-1</sup>
SI	44.12	13.42	1.54	84.65	1.652
SII	43.65	13.05	1.50	83.75	1.642
SIII	44.26	13.40	1.52	83.25	1.625
SIV	42.85	12.56	1.45	80.02	1.612
SV	43.62	13.12	1.49	78.98	1.602
SVI	43.62	12.88	1.42	72.73	1.595

Table	4:	Performance	of	Lentil	variety	Moitree	WBL77in	different
conser	vati	on strategies						



Figure 3: Insect-pest population infesting maize in different management strategies

Table 5: Performance of Maize variety: DKC9081in different conservatio	n
strategies	

Charles in the	Plant height	Cob length	Grains	Cob weight	Yield (fresh
Strategies	(cm)	(cm)	COD	(gm)	weight) t ha
SI	127.0	12.20	154.60	253.00	4.54
SII	239.6	19.47	285.75	483.20	16.77
SIII	128.8	12.80	154.00	248.80	3.93
SIV	223.4	18.20	284.00	479.40	12.70
SV	154.2	11.60	139.40	243.25	3.79
SVI	230.2	18.80	288.00	487.60	16.76

#### **Findings:**

- ✓ The major insect infesting wheat and lentil was aphid and aphid and leaf folder in maize.
- $\checkmark$  The pest population of all the crops was lower in strategy I, III and V.
- $\checkmark$  The population was highest in conventional system strategy VI.
- ✓ The plant and yield attributing parameters of wheat were higher in strategy II and VI, lentil in strategy I and maize in strategy II and VI.
- $\checkmark$  All the parameters were found lower in strategy I, II and V.

# **Future Scope:**

✓ Crop-pest module can be developed for holistic management of such high value crops.

# **Recommendation:**

- ✓ The performance of cereal crops like wheat and maize was not satisfactory where the management was done organically which needs further study.
- ✓ In respect to legume crop lentil the organic farming system proved to the best one.

Title of the Programme: Evaluation of different pest management modules for the insect pest complex of brinjal

Project code: RRSTZ/Rabi/17-18/02

Associate Scientist/s: Dr. Suprakash Pal

# **Objectives:**

✓ To find out the comparative efficacy and economies of different management module

#### Materials:

- ✓ Variety: Hybrid, SEMINIS seeds
- ✓ Design: RBD with 5 replications
- ✓ Plot size: 4 m x 3 m
- ✓ Spacing:  $60 \text{ cm} \times 50 \text{ cm}$
- $\checkmark$  Treatments: Three treatments and one control

# **Table 1: Description of all the treatments**

M1	Soil application of FYM @ 10 t/ha + Neemcake @ 500 kg/ha as basal application;
Biointensive	Weekly clipping of infested shoots from the appearance of pests; First spray of
management	Verticillium lecanii @ 4 g/l at 35 DAT for sucking pests, second spray of
	Multineem (0.03%, 300 ppm) @ 5 ml/l at 50 DAT; third application of Beauveria
	bassiana @ 4g/l at 60 DAT; fourth application of Beauveria bassiana @ 4g/l at 90
	DAT
M2	Seedling root dip in Imidacloprid @ 1 ml/lit for three hours before transplanting;
Pesticide	two rows of maize as a border crop; weekly clippings of infested shoots and fruits
based IPM	with the appearance of shoot and fruit borer; first application of ash @ 100 kg /ha
	at 35 DAT for sucking pests; second application of tobacco decoction @ 5kg/ha at
	45 DAT; third application of Multineem (0.03%, 300 ppm) @ 5 ml/l at 60 DAT;
	fourth application of cypermethrin 10% EC @ 0.5ml/l at 90 DAT
M3	Seedling root dip in Imidacloprid @ 1 ml/lit for three hours before transplanting;
Pesticide	First spray of Imidacloprid 17.8% SL @ 0.5 ml/lit at 35 DAT;Second spray of
intensive	Abamectin 1.9% EC @ 2ml/l at 60 DAT; third spray of flubendiamide 480 SC @
management	0.3 ml/l at 90 DAT
M4	Untreated check
Control	

# Methodology:

- ✓ The experiment was conducted during the rabi season of 2017-18 at the horticultural farm of UBKV.
- ✓ The transplanting was done on 14.12.17 and normal agronomical measures were followed to raise the crop.
- ✓ The observations were recorded at 15 days interval with the initiation of pest occurrence.
- ✓ The different treatments were applied as and when required based on the pest incidence.
- ✓ The observation on the sucking pests like aphid, jassid, whitefly and thrips were recorded selecting 3 leaves one each from top, middle and lower strata of the plant.
- ✓ The observation on sucking pests started at 30 days after transplanting and repeated after 15 days.
- ✓ Data on the fruit damage by brinjal shoot and fruit borer were recorded during the periodical harvesting of brinjal which started at 90 DAT and continued till 150 DAT.
- ✓ Harvesting was done 4 times at 15 days interval.
- Per cent fruit infestation was recorded by counting the number of infested fruits in comparison to the total number of fruits.
- Collected data were then subjected to analysis of variance (ANOVA) after appropriate transformations.
- Module wise fruit yield was recorded and increase in yield per cent over control was calculated using the formula:

# Table 1: Yield and economics of different pest management modules in<br/>brinjal

Treat Ment modules	Yield (q/ha)	Increase in yield over control (q/ha)	Increase in yield per cent over control (%)	Value of increased yield (Rs./ha)	Cost of treatment (Rs./ha)	Net profit (Rs./ha)	Cost benefit ratio
M1	15.60	9.39	60.19	28170.00	33900.00	-5730.00	1: -

							0.17
M2	11.32+	5.11+	45.14	10220.00+	9510.00	13380.00	1:1.41
	12.67*	12.67*		12670.00=22890.00			
M3	18.16	11.95	65.80	23900.00	9160.00	14740.00	1:1.61
M4	6.21	-	-	-			
S. Em	2.47	-	-	-			
(±)							
CD	7.71	-	-	-			
(p =							
0.05)							

\*Yield of maize as border crop (mean of 5 plots) = 12.67 q/ha

- ✓ Average cost of brinjal: Rs. 20/kg; Rs. 30/kg (organic product for biointensive management treatment); Average cost of maize: Rs. 10/kg
- ✓ Cost of FYM @ Rs. 500/ton,
- ✓ Cost of biopesticides and insecticides: Neemcake @ Rs. 5/kg, Verticillium lecanii@ Rs. 300/100g, Beauveria bassiana@ Rs. 250/100g, Multineem (0.03%, 300 ppm) @ Rs. 65/100ml, Ash @ Rs. 2/kg, Dried tobacco leaf powder @ Rs. 150/kg, Cypermethrin @ Rs. 50/100ml, Imidacloprid 17.8% SL @ Rs. 50/25ml, Abamectin 1.9% EC @ Rs. 120/100ml, Flubendiamide 480 SC @ Rs. 200/10 ml
- ✓ Spray volume: 650 lit/ha
- ✓ Labour charges for insecticidal application: Rs. 750/spray/ha

#### **Findings:**

- ✓ The yield varied significantly amongst different treatment modules. Significantly the highest fruit yield was obtained with the module M3 (18.16 q/ha) which was statistically at par with the modules M1 and M2.
- ✓ Per cent increase yield over control was the highest in M3 (65.80%) followed by M1 (60.19%) and M2 (45.14%).
- ✓ In the module M2 in addition to brinjal fruit yield, maize grain was harvested @ 12.67 q/ha.
- ✓ The net profit and cost benefit ratio varied depending on the cost of pesticidal application (Table 1). The highest cost benefit ratio was obtained with M3 (1: 1.61) followed by M2 (1: 1.41).
- ✓ The lower net profit/cost benefit ratio for biointensive management module (M1) could be attributable to higher cost of biopesticides thereby increasing the cost of pesticidal application.

#### **Future Scope**:

✓ Further, other different type of biopesticides and organic amendments may be tested for their sustainability and economic viability for the management of brinjal pest complex.

✓ In future, the experiment may be repeated for assessing its accuracy and validation of the pest management module should be done in farmers field on a large scale basis.

#### **Recommendation**:

- ✓ Instead of producing higher yield of brinjal, the biointensive pest management module resulted in lower cost benefit ratio mainly due to higher price of biopesticides and organic amendments. Therefore, the pesticide based IPM module may be recommended which resulted in comparatively lower crop yield but returned modest cost benefit ratio (1: 1.41) compared to totally pesticide based module (1: 1.61). IPM module with thoughtful integration of eco-friendly insecticides would be economically more viable as compared to biopesticide based pest management module.
- ✓ Earlier, Satpathi*et al.* (2016) also concluded that IPM modules with ecofriendly pesticides could be considered as an effective and economic approach of insect pest management in cowpea ecosystem under terai agroecological conditions of West Bengal.

Title of the programme: Effect of sowing time and variety on the Growth, yield and quality of bush type vegetable French bean

Project Code: RRSTZ/Rabi/2017-18/07

Associate Scientist/s : Dr. Suchand Datta

#### **Objective:**

✓ To study the performances of bush type French bean (*Phaseolus vulgaris* L.) varieties

under different dates of sowing with respect to growth, fresh pod yield and quality

#### Materials:

✓ Three numbers of French bean varieties.

#### **Table 1: Details of French bean genotypes**

Serial	Name of the	Type of the	Source
Number	Variety	Variety	
1	Falguni	Bush type	Monsanto Holdings Pvt. Ltd.
2	Arka Komal	Bush type,	National Seeds Corporation, Pusa complex, New Delhi-
			110012.
3	Nandini	Bush type	Kulak, New Delhi.

#### Methodology:

- ✓ Design of the Experiments: Factorial Randomized Block design
- ✓ Replications: 3
- ✓ Factor A: 5 Sowing time (S)
  - i)  $1^{st}$  November (S<sub>1</sub>)
  - ii)  $16^{\text{th}}$  November (S<sub>2</sub>)
  - iii)  $1^{st}$  December (S<sub>3</sub>)
  - iv)  $16^{\text{th}}$  December (S<sub>4</sub>)
  - v)  $31^{st}$  December (S<sub>5</sub>)
- ✓ Factor B : Variety : 3 umbers of variety (V)
  - i) Falguni (V<sub>1</sub>)
  - ii) Arka Komal (V<sub>2</sub>)
  - iii) Nandini (V<sub>3</sub>)
- ✓ Spacing: 45 cm X 15 cm.
- ✓ Common fertilizer dose: 80:40:40 @ N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg/ha.
- ✓ Farm Yard Manure (FYM): 15 tonnes/ha.
- $\checkmark$  Time of sowing: Middle of November of each year.
- ✓ Plot Size: 1.8m x 1.5m.
- ✓ Year of Study: *Rabi* season of 2017-18.

#### **Results:**

		Plant height (cm)				Primary branches/plant			
	V <sub>1</sub>	$V_2$	V <sub>3</sub>	Mean	V <sub>1</sub>	<b>V</b> <sub>2</sub>	$V_3$	Mean	
S <sub>1</sub>	42.06	40.93	41.33	41.44	5.40	5.13	6.80	5.78	
S <sub>2</sub>	37.19	37.71	36.28	37.06	6.42	5.35	7.43	6.40	
S <sub>3</sub>	37.14	36.50	32.59	35.41	5.17	6.80	7.27	6.41	
S <sub>4</sub>	32.92	31.73	31.60	32.08	7.07	5.80	6.63	6.50	
<b>S</b> <sub>5</sub>	28.92	27.53	25.99	27.48	5.35	5.58	5.62	5.52	
Mean	35.65	34.88	33.56		5.88	5.73	6.75		
	S	V	VXS		S	V	VXS		
SEm±	0.92	0.71	1.59		0.33	0.26	0.57		
CD (P=0.05)	2.67	N.S.	N.S.		N.S.	0.74	N.S.		

#### Table 1: Effect of sowing time and variety on growth parameter of French bean

 $S_1 = 1^{st}$  November sowing,  $S_2 = 16^{th}$  November,  $S_3 = 1^{st}$  December,  $S_4 = 16^{th}$  December and  $S_5 = 31^{st}$  December;  $V_1$ = Falguni,  $V_2$ = Arka Komal and  $V_3$  = Nandini ;N.S. = Non significant

#### Table 2: Effect of sowing time and variety on pod length and width of French bean

	Pod length (cm)				Pod width (cm)			
	$V_1$	$\mathbf{V}_2$	$V_3$	Mean	V <sub>1</sub>	$V_2$	V <sub>3</sub>	Mean
S <sub>1</sub>	12.67	13.74	13.58	13.30	0.82	1.25	0.89	0.99
$S_2$	13.06	14.10	13.48	13.55	0.86	1.16	0.83	0.95
<b>S</b> <sub>3</sub>	11.68	14.04	12.84	12.85	0.88	1.12	0.82	0.94
<b>S</b> <sub>4</sub>	11.36	12.92	12.27	12.81	0.82	1.05	0.80	0.89
<b>S</b> <sub>5</sub>	10.85	11.93	11.67	11.48	0.79	1.01	0.78	0.86
Mean	11.93	13.35	12.77		0.84	1.12	0.82	
	S	V	VXS		S	V	VXS	
SEm±	0.21	0.17	0.38		0.02	0.2	0.03	
CD (P=0.05)	0.64	0.49	N.S.		0.06	0.04	N.S.	

 $S_1 = 1^{st}$  November sowing,  $S_2 = 16^{th}$  November,  $S_3 = 1^{st}$  December,  $S_4 = 16^{th}$  December and  $S_5 = 31^{st}$  December;  $V_1$ = Falguni,  $V_2$ = Arka Komal and  $V_3$  = Nandini ;N.S. = Non significant

Table-3: Effect of sowing time an	d variety on pod	l weight and widt	h pods per plant	of French
bean				

	Individual pod weight (g)				Pods/Plant			
	V <sub>1</sub>	$V_2$	V <sub>3</sub>	Mean	<b>V</b> <sub>1</sub>	$V_2$	V <sub>3</sub>	Mean
S <sub>1</sub>	4.70	5.11	4.99	4.94	24.13	24.47	28.53	25.71
$S_2$	4.84	5.70	5.10	5.22	28.60	25.33	27.20	27.04
<b>S</b> <sub>3</sub>	4.34	5.30	3.99	4.54	22.93	21.33	25.93	23.40
$S_4$	3.74	4.86	3.73	4.11	21.20	18.20	15.60	18.33
<b>S</b> <sub>5</sub>	2.95	4.41	3.34	3.96	14.53	11.40	13.20	13.04
Mean	4.12	5.08	4.25		22.28	20.15	22.09	
	S	V	VXS		S	V	VXS	
SEm±	0.13	0.10	0.22		0.59	0.46	1.03	
CD (P=0.05)	0.37	0.29	N.S.		1.73	1.34	2.99	

 $S_1 = 1^{st}$  November sowing,  $S_2 = 16^{th}$  November,  $S_3 = 1^{st}$  December,  $S_4 = 16^{th}$  December and  $S_5 = 31^{st}$  December;  $V_1$ = Falguni,  $V_2$ = Arka Komal and  $V_3$  = Nandini ;N.S. = Non significant

#### Table-: 4 Effect of sowing time and variety on yield of French bean

		Yield (t/ha)						
	$\mathbf{V_1}$	$V_2$	$V_3$	Mean	$\mathbf{V}_1$	$V_2$	$V_3$	Mean
$S_1$	104.44	121.76	125.13	117.11	17.64	20.29	21.27	19.73
$S_2$	120.75	132.76	127.96	127.16	19.95	24.20	22.46	22.20
$S_3$	90.34	112.24	106.76	103.11	15.23	19.21	18.26	17.57
$S_4$	70.91	86.1	68.92	75.31	12.05	14.05	11.65	12.58
<b>S</b> <sub>5</sub>	44.19	49.07	45.41	46.22	7.87	8.71	7.50	8.03
Mean	86.13	100.39	94.84		14.55	17.29	16.23	
	S	V	VXS		S	V	VXS	
SEm±	3.01	2.33	6.33		0.39	0.34	0.68	
CD (P=0.05)	10.64	6.80	18.43		1.14	0.89	1.99	

 $S_1 = 1^{st}$  November sowing,  $S_2 = 16^{th}$  November,  $S_3 = 1^{st}$  December,  $S_4 = 16^{th}$  December and  $S_5 = 31^{st}$  December;  $V_1 =$  Falguni,  $V_2 =$  Arka Komal and  $V_3 =$  Nandini ;N.S. = Non significant

Table 5: Effect of sowing time and variety on protein (%) of of French bean

	Pro	Protein (%) of fresh beans							
	V <sub>1</sub>	$V_2$	V <sub>3</sub>	Mean					
S <sub>1</sub>	2.20	1.67	1.76	1.88					
$S_2$	2.21	1.70	1.76	1.89					
$S_3$	2.17	1.65	1.71	1.84					
<b>S</b> <sub>4</sub>	2.09	1.59	1.60	1.76					
<b>S</b> <sub>5</sub>	2.04	1.57	1.55	1.72					
Mean	2.14	1.64	1.68						
	S	V	VXS						
SEm±	0.02	0.01	0.03						
CD (P=0.05)	0.05	0.04	N.S.						

 $S_1 = 1^{st}$  November sowing,  $S_2 = 16^{th}$  November,  $S_3 = 1^{st}$ December,  $S_4 = 16^{th}$  December and  $S_5 = 31^{st}$  December;  $V_1$ = Falguni,  $V_2$ = Arka Komal and  $V_3$  = Nandini ;N.S. = Non significant

# Photograph





Variety Falguni at 16<sup>th</sup> November Sowing Variety Falguni at 1st November Sowing

# **Findings:**

- ✓ Plant height, pod length, pod width, individual pod weight, number of pod, yield and protein content of fresh French beans varied significantly with respect to the sowing time.
- ✓ Irrespective of the sowing time, all the parameters except plant height varied significantly among the varieties.
- ✓ Among the varieties, the highest pod yield was recorded in Arka Komal (17.29 t/ha) followed by Nandini (16.23 t/ha) and lowest yield was recorded in the control variety i.e. in Falguni (14.55 t/ha).
- ✓ Among the sowing dates, significantly the highest yield (22.20 t/ha) was recorded in 16<sup>th</sup> November sowing followed by 1<sup>st</sup> November sowing (19.73 t/ha) and 1<sup>st</sup> December sowing (17.57 t/ha).
- ✓ Considering the interaction effect, it was evident that the highest pod yield was recorded at 16<sup>th</sup> November sowing with Arka Komal variety followed by same sowing date with the variety Nandini. Irrespective of sowing time, the highest protein content was recorded in Falguni (2.14%).

# **Future Scope:**

✓ Nutrient management and crop protection trial may be under taken in future.

# **Recommendation:**

✓ Considering the interaction effect, it was evident that the highest pod yield was recorded at 16<sup>th</sup> November sowing with Arka Komal variety followed by same sowing date with the variety Nandini. Irrespective of sowing time, the highest protein content was recorded in Falguni (2.14%)

Title of the Programme: Long Term time series analysis of data on area, production and productivity of oil seed crops and meteorological parameters (Temperature, Rainfall and Sunshine hour) of Terai Agro-climatic zone of West Bengal Project code: RRSTZ/Rabi/17-18/11

# Associate Scientist: Dr.ArunavaGhosh

# **Objectives:**

- ✓ Identification of best fitted time series model on area, production and productivity of oil seed crops and meteorological parameters under Terai Agro-climatic zone of West Bengal
- ✓ Forecasting the future values using identified best fitted model

# Materials:

- ✓ The annual data on oil seed cultivated area and production for the period from 1977-78 to 2014-15 in Coochbehar district of West Bengal collected from Statistical Abstract, Govt. of West Bengal were used for forecasting the future values using Auto Regressive Integrated Moving Average (ARIMA) models by employing the three stages (identification, estimation and diagnostic checking) iterative procedure (Box and Jenkins, 1976).
- ✓ Daily rainfall data commencing from 1969 to 2015 for Coochbeharwere collected from IMD, Pune.

# Methodology:

- ✓ A time series variable is considered for searching a good model when the variable satisfied important criteria, i.e., the series be strictly stationary under normality assumption, (stationarity implying the means, variances and autocorrelations be essentially constant over time).
- ✓ A non-stationary time series variable is to made stationary by suitable transformation before employing it for ARIMA modelling.
- ✓ An Univariate Box Jenkins (UBJ) model is represented by ARIMA (p,d,q) where p, d, q are the parameters ('p' is the order of AR process, 'd' is the order of differencing and 'q' is the order of MA process) to be estimated at which the model possesses a high predictive power and predicts the future values with high precision.
- ✓ The optimum value of p,d,q are obtained by employing the iterative finiteunconditional-least-squares method to the family of ARIMA models suspected at the identification stage. Each p+q coefficients is estimated and then tested for its

significance. The root mean square error (RMSE), mean absolute percentage error (MAPE) and normalized Basian Information Criteria (BIC) are computed.

- Adequate models are obtained by examining independence, normality, zero mean and constant variance of the residuals.
- ✓ Among all sets of models, the best fitted ARIMA is identified by judicious comparison taking into consideration of minimum value of RMSE, MAE, MAPE, BIC and maximum value of R<sup>2</sup>. The Absolute Relative Percent Forecast Error (ARPFE) is also computed for model validation.

#### **Results:**

- ✓ The results, in Table 2 reveals that in case of oilseed production variable ARIMA(2,1,2) is found to be the best model having smaller RMSE, MAE, MAPE and normalised BIC values.
- ✓ In case of oilseed cultivated area variable (Table 5), the best model is ARIMA(1,1,2).
- ✓ Best fitted models are also subjected to diagnostic checking on their residuals and the results possess all the desired properties.
- ✓ The best fitted model, ARIMA(2,1,2) for oilseed production variable (Table 3) is also found to possess a good predictive power (value of ARPFE) of about 4.16 (for the year 2013-14) and 6.90 (for the year 2014-15) respectively.
- ✓ Similarly, best fitted model, ARIMA(1,1,2) for oilseed cultivated area is also found to possess a very good predictive power (less than 4.5 percent) for both the years.
- ✓ The best fitted model shows that oil seed production (Table-4) and cultivated area (Table 6) for the year 2024-25 would be about 12.4 thousand tonnes (42.5% increase over 2014-15) and 20.1 thousand hectares (28.8% increase over 2014-15) respectively.
- ✓ Five moderate (1978, 1979, 2006, 2013 and 2014) and one severe drought years (2010) are noticed (Table-9).
- ✓ ARIMA (1,0,2) is found to be the best for prediction of yearly rainfall in Coochbehar District (Table-11).
- ✓ Model shows that yearly rainfall for the year 2018, 2019 and 2020 would be 2941.51mm, 2961.24mm and 2916.69 respectively (Table-12).

Year	Area (.000 ha)	Production (.000 tonnes)	Year	Area (.000 ha)	Production (.000 tonnes)
	()/	()/		()/	
1977-78	5.8	1.8	1996-97	14.2	8.1
1978-79	10.4	3.2	1997-98	14.0	6.1
1979-80	10.2	2.5	1998-99	12.9	6.7
1980-81	10.0	2.9	1999-2000	14.0	9.1
1981-82	9.9	3.7	2000-01	12.6	7.7
1982-83	14.2	4.8	2001-02	13.8	7.2
1983-84	13.6	4.0	2002-03	15.3	6.9
1984-85	11.8	2.8	2003-04	29.6	16.1
1985-86	11.1	3.4	2004-05	30.0	13.4
1986-87	13.7	4.3	2005-06	22.5	12.1
1987-88	11.2	3.4	2006-07	22.6	12.0
1988-89	14.1	8.0	2007-08	20.8	9.6
1989-90	12.7	6.3	2008-09	14.6	6.2
1990-91	10.3	5.3	2009-10	12.2	6.3
1991-92	11.8	8.0	2010-11	14.5	8.2
1992-93	11.8	6.1	2011-12	15.0	7.5
1993-94	13.6	7.8	2012-13	14.5	6.5
1994-95	13.1	6.9	2013-14	15.2	10.8
1995-96	13.2	6.2	2014-15	15.6	8.7

#### Table 1: Oil seed cultivated Area and Production in Coochbehar District



Figure 1: Diagram of Oil Seed Production values (1977-78 to 2014-15)



Figure 2: Diagram of Oil Seed Cultivated Area values (1977-78 to 2014-15)

<b>Table 2: Model Comparison</b>	of Oilseed Production	('000 tonnes	s) in Coochbeh	ar District
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Model	$\mathbf{R}^2$	RMSE	MAPE	MAE	BIC
ARIMA(1,0,0)	0.468	2.402	27.908	1.452	2.051
ARIMA(0,0,1)	0.453	2.435	28.545	1.524	2.079
ARIMA(1,0,1)	0.468	2.438	27.861	1.444	2.180
ARIMA(1,1,1)	0.460	2.417	28.220	1.513	2.171
ARIMA(1,1,2)	0.511	2.337	25.538	1.437	2.206
ARIMA(2,1,1)	0.459	2.458	28.179	1.507	2.306
ARIMA(2,1,2)	0.514	2.370	25.453	1.392	2.135
ARIMA(1,2,1)	0.229	2.880	32.665	1.688	2.531
ARIMA(1,2,2)	0.277	2.838	30.287	1.521	2.604
ARIMA(2,2,2)	0.253	2.935	31.721	1.624	2.776

**UnderTerai Zone of West Bengal** 

 Table 3: Validation for Oilseed Production, ARIMA (2,1,2)

Year	Observed Value ('000 tonnes)	Observed ValuePredicted Value ('000('000 tonnes)tonnes)		Absolute Relative PercentForecast Error [ARPFE(%)]
2013-14	10.8	11.25	0.45	4.16
2014-15	8.7	9.3	0.6	6.90

Table 4: Oilseed	Production	Forecast for	Ten	Years,	ARIMA	(2,1,2)
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Year	2015-	2016-	2017-	2018-	2019-	2020-	2021-	2022-	2023-	2024-
	16	17	18	19	20	21	22	23	24	25
Forecast Value	9.5	9.7	9.6	9.8	10.2	10.8	11.8	11.3	11.9	12.4
('000 tonnes)										

Table 5: Model Comparison of Oilseed Area ('000 ha) in Coochbehar District UnderTerai Zone of West Bengal

Model	$\mathbf{R}^2$	RMSE	MAPE	MAE	BIC
ARIMA(1,0,0)	0.606	3.228	12.966	1.889	2.642
ARIMA(0,0,1)	0.597	3.267	14.542	2.112	2.666
ARIMA(1,0,1)	0.635	3.158	13.122	1.862	2.698
ARIMA(1,1,1)	0.525	3.499	13.805	2.084	2.911
ARIMA(1,1,2)	0.597	3.277	12.809	1.918	2.582
ARIMA(2,1,1)	0.543	3.489	13.699	2.056	3.007
ARIMA(2,1,2)	0.595	3.340	12.821	1.911	3.022
ARIMA(1,2,1)	0.452	3.777	16.239	2.422	3.073
ARIMA(1,2,2)	0.464	3.800	15.567	2.369	3.189
ARIMA(2,2,2)	0.475	3.826	15.697	2.350	3.306

#### Table 6: Validation for Oilseed Area, ARIMA (1,1,2)

Year	Observed	Predicted Value	Residual	Absolute Relative Percent Forecast Error
	Value('000 ha)	('000 ha)		[ARPFE(%)]
2013-14	15.2	15.7	0.5	3.29
2014-15	15.6	16.3	0.7	4.49

<b>Fable 7: Oilseed</b>	Area Forecast	for Ten Years,	, ARIMA (1,1,2)
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Year	2015-	2016-	2017-	2018-	2019-	2020-	2021-	2022-	2023-	2024-
	16	17	18	19	20	21	22	23	24	25
Forecast Value	16.1	16.6	17.2	17.7	18.1	18.5	18.4	18.1	19.6	20.1
( <b>'000 ha</b> )										

# **Table 8: Yearly Rainfall in Coochbehar**

Year	Total Rainfall (mm)	Year	Total Rainfall (mm)	Year	Total Rainfall (mm)
1969	3717.7	1985	3908.92	2001	2562.5
1970	3412.5	1986	2730.8	2002	2976.6
1971	3922.407	1987	4193.5	2003	3486.8
1972	2648.4	1988	4885.1	2004	3521.7
1973	3409.4	1989	3650.6	2005	3710
1974	4319.7	1990	3383.6	2006	2568.3
1975	3272.54	1991	2968.7	2007	2808.7
1976	2562.6	1992	2566.9	2008	3941.8
1977	3313.2	1993	2350	2009	2739.2
1978	2308.2	1994	2780	2010	1529.5
1979	2468.4	1995	4351.4	2011	2853.5
1980	2511.7	1996	3624.2	2012	3437
1981	3040.9	1997	3539.4	2013	2451.5
1982	3794.7	1998	4469.7	2014	2142.4
1983	3657.1	1999	4074	2015	3062.5
1984	4638	2000	3269.3		



Figure 3: Diagram of Annual and MonsoonRainfall in Coochbehar (1969 to 2014)



Figure 4: Diagram of PercentDeviation of Rainfall

Year	% Deviation	Drought Category	Year	% Deviation	Drought Category
1969	6.84		1990	-6.17	
1970	15.17		1991	-0.29	
1971	8.92		1992	-17.62	
1972	-20.86		1995	41.57	
1973	-3.22		1996	3.11	
1974	23.76		1997	11.23	
1975	4.03		1998	32.75	
1976	-23.89		2000	5.34	
1977	-8.86		2002	-10.50	
1978	-28.61	Moderate Drought	2003	0.49	
1979	-26.36	Moderate Drought	2004	7.23	
1980	-20.59		2005	0.38	
1981	<b>-</b> 9.41		2006	-26.49	Moderate Drought
1982	24.21		2007	-15.99	
1983	15.81		2008	16.31	
1984	29.47		2009	-22.00	
1985	29.97		2010	-50.68	Severe Drought
1986	-15.24		2011	-10.77	
1987	33.03		2012	7.31	
1988	61.15		2013	-27.68	Moderate Drought
1989	3.98		2014	-30.83	Moderate Drought

Vaar	Ν	Mean	Variance	Skewness		Ku	rtosis
rear	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
1971-1985	15	3318.4111	521455.979	.208	.580	990	1.121
1986-2000	15	3522.4800	577035.272	.159	.580	951	1.121
2001-2015	15	2919.4667	407208.350	396	.580	.186	1.121
1971-2015	45	3253.4526	543225.540	.149	.354	393	.695

# Table10: Descriptive Statistics of rainfall (mm) over different span in Coochbehar

# Table 11: Model Comparison of Total Rainfall(mm) in Coochbehar District UnderTerai Zone of West Bengal

Model	RMSE	MAPE	MAE	BIC
ARIMA(1,0,1)	634.41	16.62	493.42	13.24
ARIMA(1,0,0)	693.64	18.41	551.63	13.34
ARIMA(1,0,2)	608.59	16.23	482.39	13.24
ARIMA(2,0,1)	616.08	16.05	476.63	13.27
ARIMA(2,1,1)	615.35	16.24	481.43	13.35
ARIMA(1,1,1)	731.15	19.50	584.27	13.53
ARIMA(1,2,1)	937.51	24.78	774.72	14.04
ARIMA(0,0,1)	613.65	16.99	505.72	13.09

 Table 12: Rainfall Forecast in Coochbehar, ARIMA (1,0,2)

Year	2018	2019	2020
Forecast Value (mm)	2941.51	2961.24	2916.69

# **Findings:**

- ✓ The best fitted model shows that oil seed production and cultivated area for the year 2024-25 in Coochbehar district would be about 12.4 thousand tonnes (42.5% increase over 2014-15) and 20.1 thousand hectares (28.8% increase over 2014-15) respectively.
- ✓ Five moderate (1978, 1979, 2006, 2013 and 2014) and one severe drought years (2010) are noticed.
- ✓ Model shows that yearly rainfall for theyear2018, 2019 and 2020 would be 2941.51mm, 2961.24mm and 2916.69 respectively.

**Title of the Programme:** *Modelling area, production and productivity of rice at Cooch Behar district* 

Project code: RRSTZ/Rabi/17-18/10

# Associate Scientist/s: Prof. S. Basak

# **Objectives:**

- $\checkmark$  To study the data for probable presence of any cyclical trend
- ✓ To model the time series data through ARIMA and Non-linear modelling for forecasting purpose

# Materials:

- ✓ For the present study secondary data has been collected from "Economic Review" published by "Department of Statistics & Programme implementation", Govt. of West Bengal and "Statistical Abstract" published by "Bureau of Applied Economics & Statistics", Govt. of West Bengal.
- ✓ Periods of data used are 1980-81, 1990-91 to 2013-14. The following table presents the required data for present study.

# Table 1: Year wise Area, Production & Productivity of Rice at Coochbehar District

Year	Area ('000 hec)	Production ('000 tonnes)	Productivity (kg./hec)
1980-81	272.7	277.7	1018
1990-91	305.7	401.9	1315
1991-92	314.4	398.2	1266
1992-93	315.4	405	1284
1993-94	305.1	421.2	1381
1994-95	274	340.5	1242
1995-96	301.3	383.4	1272
1996-97	293.8	400.7	1364
1997-98	273.7	369.1	1349
2000-01	291.9	517.3	1772
2001-02	279.2	466.7	1672
2002-03	273.1	457.6	1676
2003-04	276.3	515.4	1866
2004-05	269.3	473.1	1757
2005-06	280.5	545.5	1945
2006-07	239.4	445.8	1862
2007-08	293.5	518.8	1768
2008-09	309.8	500.4	1615
2009-10	274	561	2047
2010-11	275.3	656.9	2386
2011-12	273.275	600.688	2198
2012-13	277.813	670.26	2413
2013-14	273.134	727.974	3998

# Methodology:

# ARIMA Modelling

- ✓ The annual data on rice cultivated area, production and productivity of Cooch Behar district for the period from 1980-81, 1990-91 to 2013-14 were used for forecasting the future values using Auto Regressive Integrated Moving Average (ARIMA) models and nonlinear models.
- ✓ The ARIMA methodology is also called as Box-Jenkins methodology (Box and Jenkins 1976).
- ✓ The Box-Jenkins procedure is concerned with fitting a mixed ARIMA model to a given set of data.
- ✓ The main objective in fitting ARIMA model is to identify the stochastic process of the time series and predict the future values accurately.
- ✓ These methods have also been useful in many types of situations which involve the building of models for discrete time series and dynamic systems.
- ✓ Originally ARIMA models have been studied extensively by George Box and Gwilym Jenkins during 1968 and their names have frequently been used synonymously with general ARIMA process applied to time series analysis, forecasting and control.
- ✓ However the optimal forecast of future values of a time series are determined by the stochastic model for that series. A stochastic process is either stationary or non-stationary.
- ✓ The first thing to note is that most time series are non-stationary and the ARIMA models refer only to a stationary time series.
- ✓ Since the ARIMA models refer only to a stationary time series the first stage of BoxJenkins model is for reducing non-stationary series to a stationary series by taking first order differences.
- ✓ The main stages in setting up a BoxJenkins forecasting model are Identification, Estimating the parameters, Diagnostic checking & Forecasting.

# **Results**:

- ✓ In the present study the data for rice cultivated areas and production for the period 1950-51 to 2011-12 were used following the four stages of ARIMA model.
- ✓ At the Model identification stage, for forecasting rice area, production and productivity ARIMA model was estimated only after transforming the variable under forecasting into a stationary series.
- ✓ The stationary series is the one whose values vary over time only around a constant mean and constant variance.
- $\checkmark$  There are several ways to ascertain this.
- ✓ The most common method is to check stationarity through examining the graph or time plot of the data is non-stationary.
- ✓ Here it is found that all data reveals the property of non-stationarity as may be seen from the following plots of production data having mean value 451.81 and sd value 84.85.

✓ In this case, a visual inspection of the following autocorrelation function plot indicates that the SALES series is non-stationary, since the ACF decays very slowly.



Figure 1: Trend and correlation analysis for prodn

✓ Non-stationarity in mean is corrected through appropriate differencing of the data. In this case difference of order 1 was sufficient to achieve stationarity in mean as obvious from the following plot of the 1st differenced data.



Figure 2: Trend and correlation analysis for prodn(1)

- ✓ The newly constructed 1st differenced variable  $w_t$  can now be examined for stationarity.
- ✓ The graph of  $w_t$  was stationary in mean.
- $\checkmark$  The differenced series no longer has a noticeable trend.
- ✓ Instead it fluctuates around a fixed mean of 19.957.
- ✓ Differencing once appears to have introduced a stationary mean, so the nonstationarity in the original series was apparently of the homogeneous variety.
- $\checkmark$  The next step was to identify the values of p and q.
- ✓ The estimated auto correlation functions in the above plot dies out to zero quickly, suggesting that the mean of the first difference is stationary.
- ✓ The *acf* shows neither the decaying pattern suggestive of a pure AR or mixed ARMA model, nor the spike cut off pattern associated with the MA models.
- ✓ Therefore, the first differences appear to be a white noise series, suggesting the following ARIMA model for the differenced data i.e.,  $w_t = a_t$  or, (1-B). $\overline{z}_t = a_t$  where  $z_t$  is the original data series,  $a_t$  is the error term and  $\overline{z}_t = z_t \mu$ . This is also true for the area and productivity data of rice.

# Non-linear Modelling

- ✓ A good number of non-linear models are tested on the same set of data. For production and productivity data growth model is found to be the best fit with adjusted  $R^2$  value -0.804 and 0.851 respectively.
- ✓ The following table also shows the coefficient values and their significance for the growth model:

	Unstandardized Coefficients Standardized Coefficients				
	В	Std. Error	Beta	t	Sig.
Year	.026	.003	.902	9.322	.000
(Constant)	5.605	.060		93.632	.000

#### Table 2: Coefficients values

The dependent variable is *ln*(Production).

- ✓ From the above table it is observed that both coefficients are highly significant and thus the fitted model is:-  $Production = e^{5.605+0.026*year}$ .
- ✓ The following plot shows the best fit growth curve through the scatter of production data points.



# Figure 3: growth curve through the scatter of production data points

	Table 3:	Coefficients	of	productivity	v data
--	----------	--------------	----	--------------	--------

	Unstandardized Coefficients		Standardized Coefficients		
	В	Std. Error	Beta	t	Sig.
Year	.029	.003	.926	10.977	.000
(Constant)	6.800	.057		119.699	.000

The dependent variable is *ln*(Productivity).

- ✓ From the above table it is observed that both coefficients are highly significant and thus the fitted model is:-  $Productivity = e^{6.8+0.029*year}$ .
- The following plot shows the best fit growth curve through the scatter of productivity data points.



Figure 4: Growth curve through the scatter of productivity data points

- ✓ For both of production and productivity data the fitted model was validated using 2013-14 data and the forecasting error is found to be around 14%.
- ✓ For area data a  $5^{th}$  order polynomial was found to give best fit with R<sup>2</sup> value 47% only.
- $\checkmark$  Hence a superior model may be again searched if more data are available.
- ✓ However, the area data was further subjected to time series analysis to find any trend and cyclical component in the data.
- ✓ An additive model is assumed as area = trend + cyclical + error.
- $\checkmark$  A small amount of decreasing linear trend was found.
- ✓ By eliminating this trend component and smoothing out (two period moving average) the error component the cyclical component is found as depicted in the following plot:



Figure 5: Cyclical component of total rice area

✓ From the above graph it is observed that total cultivated area of rice follows a cycle of 3-4 years with two major peaks in 1991-92 & 2007-08 and one major drop in 2005-06 followed by two minor drops in 1993-94 & 2009-10.

# **Findings:**

- ✓ For the production, area and productivity data of rice the first differences appear to be a white noise series.
- ✓ The fitted models are:-  $Production = e^{5.605+0.026*year}$   $Productivity = e^{6.8+0.029*year}$
- ✓ Forecasting error is found to be around 14%.
- ✓ Area of rice cultivation follows a cycle of 3-4 years & it dropped steadily from 1991-92 to 2005-06.

# **Future Scope:**

- ✓ For Area data a superior model may be searched using more past data as and when it will be available.
- ✓ Similar analysis will also carried out for several other cereal & pulse crops in due course of time.

# **References:**

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- Rahulamin MD and Razzaque MA (2000). Autoregressive integrated moving average modeling for monthly potato prices in Bangladesh. Journal of Financial Management and Analysis 13(1): 74-80.

# Softwares used:

- SAS version 9.2
- SPSS version 17.0

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#### AWARDS

Name of the	Name of the Award/	Conferring Society	Year	Status
Scientist	Recognition			(National/
				International)
Dr. N. Shit	Young Scientist in Animal	Venus International	2017	National
	Science	Foundation (VIRA)		
	Young Faculty Award in	Education Expo-New	2018	National
	Animal Science	Delhi		
	Guest lecturer & External	Viswa-Bharati,	2018	National
	examiner (Thesis Viva-voce)	Shantiniketan		
Dr. P. Mondal	Best paper presentation	COBACAS	2017	National
	(ORAL)			
Dr. R. Mandal	Young Scientist in Genetics	Venus International	2017	National
	and Plant Breeding	Foundation (VIRA)		

### Memberships

Name of the Scientist	Name of the Journal/Society	Type of Membership
	Veterinary Council of India	Life member
	West Bengal Veterinary Council	Member of 5 years
	Indian Poultry Science Association, IPSA	Life member
	243122	
Dr. N. Shit	Society for Animal Physiologists in India	Life member
	World's Poultry Science Association, IB	Annual member
	WB Poultry Federation	Annual member
	Exploratory Animal & Medical Research	Editorial Board
	Amity Journal of Agribusiness	Editorial Board
Dr. P. Mondal	Cooch Behar Association for Cultivation of	LIFE MEMBER
	Agricultural Sciences (COBACAS),	
	Pundibari	
	Editorial Board Member for 'Journal of	Editorial Board Member
	Invertebrate Sciences' by Society for Science	
	and Technology, Bangalore (since 2018)	
	Entomological Society of India (ESI), New	Life Fellow
	Delhi (since 2008)	
	Society for Biocontrol Advancement (SBA),	Life Member
	Bangalore (since 2011)	
Dr. S. Pal	Association for Advancement of Pest	Life Member
	Management in Horticultural Ecosystems	
	(AAPMHE), Bangalore (since 2011)	
	Entomological Research Association (ERA),	Life Member
	Cooch Bahan Accordition for Cultivation of	Life Member
	A gricultural Sciences (CORACAS)	Life Member
	Pundibari (since 2014)	
Dr. S. Hembram	Association for Advancement in Plant	Life Member
Dr. 5. Hemorani	Protection	
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	Science	
	Indian Phyto-pathological Society	Life Member
Mrs. G. Kumari	Trends in Biosciences	Life Member
	Coochbehar Association for Cultivation of	Life Member
	Agricultural Sciences	
	International Journal of Agricultural Sciences	Life Member
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	agricultural sciences	
	2. The Indian Science Congress Association	Life Member
Prof. A. Ghosh	Crop and Weed Science Society	Life member
	Society for Application of Statistics in	Founder Member
	Agriculture and Allied Sciences	
Prof. (Mrs) D. Sarkar	Journal of inland fisheries society	Life member
	COBACAS	Life member
Dr. S. Dutta	Horticulture Society of India	Life member
	Indian Spice Society	Life member
	Crops and Weed Science Society	Life member
	Applied and Natural Sciences Foundation	Life member
	Forum of Scientist, Engineer's and	Life member
	Technologist	
	COBACAS	Life member
	Spice India	Annual Member since 1999

### Memberships

Dr. R. Mandal	Indian society of root crops	Life member
	Society for Advancement of Science and	Life member
	Rural Development	
	Cooch Behar Association for Cultivation and	Life Member
	Science	
	Lawarence Press – Journal of	Editorial Board Member
	Agricultural Biotechnology	
	Agriculture and Environmental Science	Editorial Board Member
	Academy	
Dr. R. Sarkar	International Association of Hydrological	Member
	Sciences	
	Indian Association of Hydrologists	Life Member
	American Society of Civil Engineers	S.M.ASCE
Dr. P. Poddar	Indian Society of Agronomy	Life Member
	Crop and Weed Science Society	Life Member

	Title of the Project	Role of the Scient ist	Funding Agency	Sancti on Budge t	Sancti on Year	Durati on
Dr. N. Shit	Scientific evaluation and cost-benefit analysis of duck rearing system special emphasis to socio-economic up- liftment through women empowerment	PI	NABARD	4.45 lakh	Sept. 2017	2 years
	Socio-economic development of weaker sections through piggery	Co-PI	RKVY	31.90 lakh	2016	03 years
	Image based identification of small animals i.e. pig & goat	Co-PI	ITRA, GOI	17.06 lakh	2017	02 years
	Production of safe broiler meat with no fear of hazardous antibiotic residue	Co-PI	RKVY	34.96 lakh	2017	03year s
Dr. P. Mondal	Residue analysis of Buprofezin 20%+ Acetamiprid 2% WP on rice	P.I.	Krishi Rasayan Exports Pvt. Ltd.	7.48 Lakhs	2016	2 Years (2016- 2018)
Dr. S. Pal	Survey of Pests and Diseases of Medicinal Plants in West Bengal	PI	NMPB, Ministry of AYUSH	34.01 lakh	Since Decem ber, 2017	3 Years
Dr. S. Hembram	Survey and surveillance for wheat blast caused by Magnaportheoryzaepath otype <i>Triticum</i> and strategic research to manage it.	Centre Co-PI	MFSM, Ministry of Agriculture, Govt. of India	24.788	2017- 18	3 Years
	Survey of pest and diseases of medicinal plants in West Bengal.	Co-PI	National Medicinal Plant Board (NMPB), Ministry of AYUSH, Govt. of INDIA	34.01	2017- 18	3 Years
	Exploration of the Soil microbial diversity of different agro-ecological zones of North Bengal for Agricultural use.	PI	Institutional project (UBKV)	12.00	2016-2017	3 Years

	T	1	1	1		1
	Evaluation of bio- efficacy, phyto-toxicity and residue of Cyazafamid 34.5% SC on potato and tomato crops.	PI	KrishiRasay an Export Pvt. Ltd, New Delhi	2.4	2017-18	2 Years
	Project on Development of a PCR based virus detection system for Solanaceousvegetatbles in North Bengal	Co-PI	Institutional project (UBKV)	6.0	2016- 17	3 Years
	Project on Collection, charecterization, in situ and ex-situ conservation of rice of North-Eastern India including the areas under jurisdiction of the University		Institutional project (UBKV)	17.5	2016-17	3 Years
	Evaluation of Bravo Top 550 SC (Chlorothalonil 40% + Defenconazole 4% SC w/w) against tomato and Chilli diseases.	Co-PI	Syngenta Pvt. Ltd.	1.4		2 Years
	To evaluate the bio- efficacy and Phyto- toxicity and residue analysis of Tricyclazole 75% WP on Paddy.	Co-PI	M/S Agrolife Science Corporation	0.975	2017- 18	1 year
	Evaluation of new fungicides offering better chemical management of Plant diseases	Co-PI	Syngenta India Limited, Kolkata	14.40	2017- 18	2years
Dr. N. Choudhuri	Bio efficacy, phytotoxicity and effect on natural enemies of some new generation insecticide molecule on different crops	Co-PI	Willowood Chemicals PVt. Ltd.	8.55La kh	2017	2years
Prof. A. Ghosh	Sustainable Resilient Farming System Intensification in Eastern IGP	Socio Econo mic Study, data analys is and APSI M modell	DFAT- ACIAR	AUS \$ 4,36,7 32.00	2014	Cont.

		inσ				
	Enhancing Pulses Production for Food and Nutritional Security, Improved Livelihood and Sustainable Agriculture in West Bengal	Socio Econo mic Study and data analys is	Department of Agriculture, Govt. of West Bengal	Rs. 19,69, 40000. 00 includi ng overhe ad charge	2018	3 years
Prof. (Mrs) D. Sarkar	Establishment of rural bio -resources of North Bengal	Co-PI	Department of Biotechnolo gy, New Delhi	96 lakh	2017	Three years
Dr. S. Dutta	Mission for Integrated Development of Horticulture	PI and In- Charg e	Directorate of Arecanut and Spice developmen t, GOI, Calicut- 673005	66.314 33 alkh for the year 2017- 18	2002- 03	Ongoin g
Dr. R. Sarkar	Improving water use for dry season agriculture by marginal and tenant farmers in the Eastern Gangetic Plains	PI	Australian Centre for Internationa l Agricultural Research (ACIAR)	81057 AUD	2014	4 years
Dr. P. Poddar	<ul> <li>'Study on Bio-efficacy, phytotoxicity and residue analysis of some herbicides and chemical in tea and non-cropped area'</li> <li>'Study on Bio-efficacy, phytotoxicity and residue analysis of some herbicides and chemical in tea'</li> </ul>	PI	Willowood Chemicals Pvt. Ltd.	11.63 lakh	2017	02 years
	'Promotion of oilseed crops in Northern districts of West Bengal for livelihood security of small and marginal farmers'	PI	Coramandel Agrico Pvt. Ltd.	2.00 lakh	2018	02 years
	optimising nutrient use efficiency under zero	PI	Govt. of India	13.635 lakh	2017- 18	01 year

	tillage operations in rice- maize cropping system in Coochbehar and Malda district of West Bengal Optimising nutrient use efficiency under zero tillage operations in rice- maize cropping system in Coochbehar and	Co-PI	Internationa l Plant Nutrition Institute	2.87 lakh	2017- 18	01 year
	Malda district of West Bengal,					
Dr. H. A. Mondal	Dissecting the 'interactome' developed at sieve element due to aphid infestation for better understanding of enhanced insecticidal effect in resistant host plant	PI	SERB, DST, Govt. of India	22.275 lakh	2016	3 year
	QualityParameterTestingoftheAcclimatizedValerianajatamansiinTeraiZone,W.BMassPropagationofValerianajatamansi,Bergeniaciliata,andPiperlongumforDistributionwithAwarenessProgram	PI	Ministry of Ayurveda, Govt. of India	23.375 lakhs	2016	3 year
	Production of quality planting materials of some important medicinal plants through Identification, multiplication, supply of health elite genotypes and capacity building programme for improving rural livelihood in Northern part of West Bengal.	Co-PI	Ministry of Ayurveda, Govt. of India	40.34 lakhs	2017	3 year
	Collection, Conservation, Digitization and Standardization of	Co-PI	Ministry of Ayurveda, Govt. of India	32.289 Lakhs	2017	3 year

protocol for Mass			
Regeneration of Selected			
Endangered, rate and			
Vulnerable medicinal			
plants of North East			
Region			

Authors	Year of	Title of the paper	Journal Name, Volume	NAAS/Scop	Publication
	publicatio		and Page No.	us	Sources (Project
	n			Index/Impac	Title/Thesis Title
				t Factor	etc.)
<b>N. Shit</b> , K.V.H. Sastry, G.	2017	Studies on metabolic hormones, sex	Indian Journal of	-	Thesis
Singh, R. Mandal and J.		steroids and mRNA expression of caspase	Poultry Science,		
Mohan.,		2, Bcl-XL gene in ovarian follicles of	Vol. 52, Issue -1		
		Japanese quail hens during stress.	Page No 70-75.		
<b>N. Shit</b> , D.K. Hajra and S	2017	Seasonal occurrence of gastrointestinal	Exploratory Animal and	4.27	Extension service
Baidya.		helminth parasites in cattle and buffaloes	Medical Research, 7(1):		
		in Bankura district, West Bengal, India.	58-63.		
G. Patra, S. Majhi, N. Shit and	2017	Effect of soya protein (soy crumbles) on	Journal of meat science	-	Thesis
S. Biswas		the microbiological and sensory attributes	and technology,		
		of chicken meat powder.	Vol. 5, Issue 1		
			Page No 9-15.		
Mondal P, Kumar R and Gogoi	2017	Azomethine based nano-chemicals:	Bioorganic Chemistry,	9.23	Preparation of
R		Development, in vitro and in vivo	70: 153-162.		Azomethine Based
		fungicidal evaluation against Sclerotium			Nano-Blocides and
		rolfsii, Rhizoctoniabataticola and			Their Evaluation
		Rhizoctoniasolani.			against Phyto-
					Pathogenic Fungi
					and Nitrifying
	2017			6.00	Bacteria
<b>Pal, S</b> . and Gupta, A.	2017	Severe outbreak of rice green semilooper,	Entomological News,	6.23	Evaluation of
		Narangaaenescens (Moore) (Lepidopiera:	127(3): 280-291. DOI:		Vibrance Maxx
		Noctuidae) along with its parasitoid	10.3157/021.127.0301		Rice 450FS against
		complex in sub-Himalayan west Bengal,			diseases and pests
					Of fice Driveto Droiget
					Filvate Project
					Sponsored by
					Syngenia india
	1			1	Limited

Satpathi, S. K., <b>Pal, S</b> ., Gurung, B., Datta, S., Kundu, A., <b>Mandal, R</b> ., Laskar, N. and Kheroar, S	2017	Effect of physical characteristics and phenolic contents on jassid and pod borer of cowpea.	University of Sindh Journal of Animal Sciences, 1(1): 8-13.	-	M.Sc. Thesis of Sumit Kumar Satpathi (A-2014- 22-M) entitled "Investigation on insect pests of Cowpea (Vigna unguiculata (L.) Walp.)" submitted during 2016
Pal S., <b>Mandal R</b> ., Sarkar S., et al.,	2017	Species diversity and community structure of arthropod pests and predators in flax from darjeeling (india).	Brazilian archives of biology and biotechnology. 60	6.64	Personal effort
S. Nandi, <b>S. Hembaram,</b> A. Adhikari, BK Tiwari and S. Dutta	2017	Host Infection beyond the Traditional Range of Sclerotium (Athelia) rolfsii with Physalis minima	Bioinformation 13(10): 333-338	GS IF 0.80	Personal effort
Deb, D., singh, J.P., Deb, S., Dutta, D., <b>Ghosh, A.,</b> and Chaurasia, R.S.	2017	An alternative approach for estimating above ground biomass using Resourcesat- 2 satellite data and artificial neural network in Bundelkhand region of India.	Environmental Monitoring and Assessment <u>https://doi.org/10.1007/s</u> <u>10661-017-6307-6</u>	7.69	Thesis Title of Dibyendu Deb:Modelling of biomass of some dominant forest species and estimation of carbon storage in a semi-arid region of India
Ghosh, A., Dey, K., Bhowmik, N., Ghosh, S.K., Bandyopadhyay, S., Medda, P.S. and Ghosh, A.	2017	Lemon cv. Assam lemon ( <i>Citrus limon</i> Burm.) quality and soil-leaf nutrient availability affected by different pruning intensities and nutrient management. <i>Current Science</i> , 112(10), 2051-2065.	Current Science	6.84	Thesis of student from F/Hort.

	-				
Dey A, <b>Sarkar D</b> , Singh M and Barat S.	2017	DNA barcoding of four ornamental fishes of Genus <i>Botia</i> from Eastern Himalaya.	International Journal of Science and Research 6(6): 608-611	IF 6.39	Breeding behaviour, embryonic development and barcoding of the ornamental loaches of terai region of West Bengal.
<b>Datta, S</b> ., Chakraborty, S., Jana, J. C., Debnath, A., Roy M. K.	2017	Effect of Different Micronutrients on Turmeric Variety Suranjana in Terai	Journal of Applied and Natural Science, 9 (3):	4.84	AICRP on Spices
and Haque S.		Region of West Bengal,	1696 -1702.		
<b>Datta, S</b> ., Jana, J. C., Bhaisare, P. T. and Nimbalkar, K. H.	2017	Effect of organic source of nutrients and biofertilizers on growth, yield and quality of turmeric ( <i>Curcuma longa</i> L.)	Journal of Applied and Natural Science 9 (4): 1981–1986.	4.84	MIDH Scheme
Chakraborty, S,. <b>Datta S</b> ., Debnath A.and.Roy M K. (	2018	Evaluation of some important ginger genotypes in terai region of West Bengal.	International Journal of Science, Environment and Technology, 7 (2) : 715-722.	3.98	AICRP on Spices
Thapa, A., <b>S. Datta</b> , A.N. Dey and Baisare, P.	2017	Advance Propagation Techniques in Important Spice Crops.	International Journal of Current Microbiology. Applied Sciences 6(9): 1979-1985.	5.38	Review paper
Chattopadhyay N., <b>Mandal R</b> and Tarafdar J.,	2017	an evolutionary analysis of rice tungro bacilliform virus collected from odisha, india	Journal of mycologypathology research. 55(3) 243-249	4.90	Thesis
Roy SK., Chakraborty M., Hijam L., Mandal H.A., <b>Mandal., Mandal R</b> ., Kale Va., Ashokappa Nv., Sur B. And Dash Sk.	2017	Variability comparison of mustard crosses in advanced segregating generations.	International journal of pure applied biosciences: 5(6): 948- 956	4.74	Oil seed Project, Dept. of GPB
Chattopadhyay N., Mandal R	2017	probable location identification of inserted	Annunls of plant	4.82	Thesis

and Tarafdar J.,		tungro resistant gene in rice cultivar.	protection science: 25(2): 324-329		
Roy S., Hijam L., Chakraborty M., Ashokappa N V., Rout S., Kale VA., Sur B., Maying B., Das A., Kundu A., <b>Mandal R.,</b> Mandal Ha.	2018	Cause and effect relationship in yield and its attributing traits in early segregating generations of mustard crosses under terai agro-climatic zones of West Bengal, India.	International journal of current microbiology and applied science. 7 (3): 1-5	5.38	Oil seed Project, Dept. of GPB
Reddy BJ., <b>Mandal R</b> ., Chakroborty M., Hijam L and Dutta P.,	2018	a review on potato and its genetic diversity	International journal of genetics: 10(2): 360-364.	4.46	Review Paper
Gharde, S. K. and Chaudhuri, N.	2017	Effect of Host Plants on the Growth and Development of the Polyphagous Defoliator <i>Cricula Trifenestrata</i> Helfer (Lepidoptera: Saturniidae)	International Journal of Bio-resource and Stress Management. 8(4):521- 528	4.65	Life system study of <i>Cricula</i> <i>trifenestrata</i> Helfer ( <u>Saturniidae</u> : Lepidoptera) towards formulation of its management strategy
<b>Chaudhuri, N</b> ., Banerjee, D., Ghosh, A. and Senapati, S.K.	2017.	Identification of prediction model on population buildup of <i>Dactynotus</i> <i>carthemi</i> HRL on safflower ( <i>Carthamus</i> <i>tinctorius</i> L.) for timely intervention	Journal of Entomology and Zoology Studies. 5(4): 1775-1779.	5.53	Safflower aphid ( <i>Dactynotus</i> <i>carthemi</i> HRL) and its management
S.K. Gharde and <b>N. Chaudhuri</b>	2018	The life history and population growth parameters of leaf eating caterpillar <i>Cricula trifenestrata</i> helfer (Lepidoptera: Saturniidae) infesting <i>Machilus</i> <i>bombycina</i> king	International Journal of Current Microbiology and Applied Sciences 7(2): 710-717	5.38	2
Patra A., Sinha AK., Rakesh S., Biswas S. and <b>Mukhopadhyay</b> <b>P.</b>	2018	Different fractions of boron in soils of alfisol and entisol of West Bengal	Journalofpharmacognosyandphytochemistry7(1):510-5137	5.21	Thesis
Sarkar D., Rakesh S., Sinha	2017	Forms of phosphorus in some acidic	International journal of	4.77	Thesis

AK. and Mukhopadhyay P.		entisols of subtropical eastern India	plant & soil science		
K. Ravi Kumar, <b>Rupak Sarkar</b> , C.P. Suresh, M.R. Bhanusree, S.K. Ghosh, M. Sattiraju and S. Chakravarty.	2017	Growth, Yield and Water Use Efficiency as Influenced by Irrigation Scheduling in Banana (Musa spp., AAA group) var. Grand Naine During Water Deficit Period in Terai Zone of West Bengal	International Journal of tropical Agriculture, 35(2), 245-258	3.49	Ph.D. Thesis
Shovik Deb, Manoj K. Debnath, Somsubhra Chakraborty, David C. Weindorf, Deo Kumar, Dibyendu Deb and Ashok Choudhury	2018	Anthropogenic impacts on forest land use and land cover change: Modelling future possibilities in the Himalayan Terai.	Anthropocene. <b>21</b> : 32-41.	Unknown	Project
Partha Sarathi Patra, Shyamal Kheroar, Ashok Choudhury, and Rajesh Saha,	2017	Responses of split application of nitrogen on the performance of <i>Kharif</i> rice ( <i>Oryza</i> <i>sativa</i> L.) in Terai zone of West Bengal.	Asian J. Soil Sci., <b>12</b> (2): 265-270:	4.34	Thesis
Partha Sarathi Patra, Md Aziz, Rajesh Saha and <b>A. Choudhury</b>	2017	Bio-efficacy of Bispyribac acid 40% SC against weed flora in Rice ( <i>Oryza SativaL</i> ).	International journal of tropical Agriculture. <b>35(2)</b> : 259-265.	3.49	Thesis
Bisweswar Mahato, Somsubhra Chakraborty, D.P. Ray, Parimal Panda, Bappa Paramanik, Naba Kishor Mahato, Arindam Kundu, Anarul Hoque and Ashok Choudhury	2017	Evaluation of chemical and biological indices for carbon and nitrogen mineralization of various organic matters used in tea garden.	International Journal of Bioresource Science. 4 (1): 47-56.	3.54	Thesis
Parimal Panda, Bisweswar Mahato, Somsubhra Chakraborty, Bappa Paramanik, Ranajit Panda, Naba Kishor Mahato, Arindam Kundu, Abhijit Mahato and Ashok Choudhury	2017	Organic Phosphorus Mineralization by Isolated Phosphorus Solubilizing Fungi.	Journal of Agriculture and Technology		Thesis
Puspendu Bikash Bag, Parimal	2017	Atmospheric nitrogen fixing capacity of	International Journal of	5.38	Thesis

Panda, Bappa Paramanik,		Azotobacter isolate from Cooch Behar	Current Microbiology		
Bisweswar Mahato and Ashok		and Jalpaiguri Districts soil of West	and Applied Sciences.6		
Choudhury.		Bengal.	<b>(3)</b> : 1775-1788.		
Valeria Cardelli, David	2017	Non-saturated soil organic horizon	<i>Geoderma</i> , <b>288</b> : 130-	10.04/IF	Thesis
C.Weindorf,Somsubhra		characterization via advanced proximal	142.	4.063	
Chakraborty, Bin Li, Mauro De		sensors.			
Feudis, Stefania Cocco, Alberto					
Agnelli, Ashok Choudhury,					
Deb Prasad Ray, Giuseppe Corti					
Panda Parimal, Choudhury As	2017	Phosphorus Solubilizing Bacteria from	International Journal of	3.54	Thesis
hok, Chakraborty Somsubhra, R		Tea Soils and their Phosphate Solubilizing	Bioresource Science. 4		
ay DebPrasad, Deb Shovik, Patr		Abilities.	<b>(2)</b> : 113-125.		
a Partha					
Sarathi, Mahato Bisweswar, Par					
amanik Bappa, Singh Anil					
Kumar, Chauhan Rajesh					
Kumar.					
Somsubhra Chakraborty, David	2017	Rapid assessment of regional soil arsenic	<i>Geoderma</i> , <b>289</b> : 72–81.	10.04/IF	Thesis
C. Weindorf,Shovik Deb, Bin		pollution risk via diffuse reflectance		4.063	
Li, Sathi Paul, Ashok		spectroscopy.			
<b>Choudhury</b> , Deb Prasad Ray.					
Sunil Kumar, Bholanath Saha,	2017	Integrated nutrient management for	International Journal of	5.38	
Sushanta Saha, Anupam Das,		enhanced yield, nutrients uptake and their	Current Microbiology		
Parthendu Poddar and Manikant		use efficiency in Rice under intensive	and applied Sciences',		
Prabhakar		Rice-Wheat cropping system'	Volume 6 Number 10		
			pp. 1958-1972		
Editors: Vijay Singh Meena,	2017	Book chapter on Biological Nitrogen	Springer .Volume 2:		
Pankaj Kumar Mishra, Jaideep		fixation for sustainable agriculture: In:	Applications in crop		
Kumar Bisht, Arunava		Agriculturally important microbes for	production and		
Pattanayak		sustainable agriculture.	protection pp 83-128		

#### **Publication from RRSTZ programme**

(1<sup>st</sup> April, 2017 to 31<sup>st</sup> March, 2018)

Authors, Year of	Journal Name, Volume and	NAAS/Scopus	Project Code and
publication, Title of the	Page No.	Index/Impact	Title of the RRSTZ
paper		Factor	Programme
Mandal R., Pal S. and	Current Agriculture Research	4.36	Project
Shit N. 2017. Unlocking	Journal, Vol. 5 Issue 1		
Genetic Diversity in	Page No 50-57.		
Selected Chickpea	-		
Genotypes using			
Morphological and			
Molecular Markers.			
Satpathi, S.K., <b>Pal, S</b> .,	The Journal of Plant Protection	-	RRSTZ/KHARIF/16-
Mandal, R., Shit, N. and	Sciences, 8(1-2): 1-6. DOI:		17/02 entitled "Eco-
<b>Sarkar, A.</b> 2016.	10.17582/journal.jpps/2016/8.1-		friendly management
Ecofriendly biointensive	2.1-6		of major insect pests
pest management modules			in cowpea"
in cowpea under sub-			<u>^</u>
Himalyan West Bengal,			
India.			
Sarkar D and Mukherjee	International Journal of	IF 5.62	RRSTZ/KHARIF/16-
A (2017).Domestication of	Fisheries and Aquatic Studies	NAAS 3.99	17/11(2)
Macrobrachiumrosenbergii	5(5):01-06		
in terai region of West			
Bengal.			

Name of the Scientist	Title of the Seminar/Symposium/ Conference/ Training	Organizing society	Duration & Year	Status (National/ International/ Regional)
Dr. N. Shit	1st Farm Innovation Congress, 2018 and National Conference on Innovative Farming for Food and Livelihood security in Changing Climate.	Society for Advancement of Agricultural innovation, BCKV	12-13 <sup>th</sup> Jan. 2018	National
	2nd Regional Science & Technology Congress, Government of West Bengal.	Siliguri College, Darjeeling	7-8 Dec. 2017	Regional
Dr. P. Mondal	National Conferenceon Enhancing Nutritional Security throughClimate Smart Farming Practices	COBACAS	17-18 <sup>th</sup> March, 2018	National
Dr. S. Pal	International Symposium on Biodiversity and Biobanking (BIODIVERSE 2018)	IIT, Guwahati	27-29 Jan, 2018	International
Gunja Kumari	Advanced Analytics In Developing Market Intelligence	ICAR-NAARM	14 <sup>th</sup> Nov. – 4 <sup>th</sup> Dec., 2017	National
Dr. R. Mandal	1st Farm Innovation Congress, 2018 and National Conference on Innovative Farming for Food and Livelihood security in Changing Climate.	Society for Advancement of Agricultural innovation, BCKV	12-13 <sup>th</sup> Jan. 2018	National
Dr. P. Poddar	National symposium on Towards Climate Smart Agriculture-A Key To Livelihood Security,	IAS, University of Calcutta, West Bengal.	9—11 <sup>th</sup> December, 2017,	National

# Annual Report 2017-18

# Regional Research Station (OAZ), Uttar Banga Krishi Viswavidyalaya

#### BACKGROUND

The **Regional Research Station** (Old Alluvial Zone) in West Bengal was formed with a motto to carry out zone specific need based research programmes befitting the requirement of the farmers of the zone. This Regional Research Station is functioning as a main research station of Old Alluvial Zone comprising three districts of W.B. *i.e.* Uttar Dinajpur, DakshinDinajpur and Malda. It was established as District Seed Farm under the Ministry of Agriculture, Govt. of West Bengal in 1955. This farm was renamed as Zonal Adaptive Research Station (ZARS) in the year 1975. Further, in view of implementation of National Agricultural Research Project (NARP) of the Indian Council of Agricultural Research (ICAR), the State Government handed over this station to Bidhan Chandra KrishiViswavidyalaya in 1990 and science then it was named as Regional Research Station (Old Alluvial Zone). After the establishment of Uttar Banga Krishi Viswavidyalaya in February, 2001, this station has been brought under the administrative control of this new University.

Many important crops like cereals, fruits, vegetables, spices, flowers, fibres etc, are widely cultivated in Uttar Dinajpur, Dakshin Dinajpur and Malda districts under the Old Alluvial Zone, (OAZ) of Northern part of West Bengal. These districts are very backward in almost all socio-economic indicators and the economic condition of this area totally depends on the agriculture. Moreover, the lack of knowledge regarding the latest agricultural technological know-how, non-availability of good quality seed materials accompanied with a little need based research findings, climate change due to Global Warming are the major causes of low productivity of these Old Alluvial Zone. However, this zone is very rich in genetic crop materials, resources and other bio-resources need to be explored.

In the above perspective, Regional Research Station (OAZ) is engaged to evolve or find out the demand-driven agriculture in a suitable basis through continuous research and extension in the existing agro-climatic situations and prevailing socio-economic condition of the farmers in the zone. At present the major areas of research in this station include evolving location specific and need based crop varieties through breeding and selection, developing the site specific field and horticultural crop production techniques, crop protection measures, identifying the suitable strategies for socio-economic development, impact assessment, suitability of resource conservation technologies, identifying the suitable soil and water management technologies, application of conservation technologies in cereals, fruits, vegetables, spices, flowers, fibres which are very common in this old alluvial zone. This is the

only research station in this zone with a view to work for zone specific need based research and extension for the improvement of farming community in broad sense.

#### **LOCATION**

Regional Research Station is located beside the Gazzole-Hilli State Highway in the Mouza of Majhian under Balurghat Block in the District of DakshinDinajpur, West Bengal with 23°57'N and 87°10' E. River Atreyee is flowing in the western side of the station. The international business corridor between India and Bangladesh is at Hilli, 22 km away from this station.



#### SOIL AND CLIMATE

The soil types of this zone are mostly clayey-loam, loam, sandy loam, acidic pH ranges from 4.5 to 6.6 and deficient in micro-nutrients. Normal average rainfall of this area is 1500-1800mm. Number of rainy days is about 72 (February to October). Maximum temperature ranges between 39-41.5°C with minimum temperature between 3.8-4.5°C. In general, climate of this station is hot and humid.

#### **STAFF STRENGTH**

Sl. No.	Staff Position	Numbers
1.	Administrative Officer	02
2.	Teaching Staff	08
3.	Non-Teaching Staff	21
4.	Field worker RRS (OAZ), Majhian	09
5.	G.K.M.S RRS (OAZ)	02
Total		42

#### LAND UTILIZATION STATISTICS of RRS (OAZ)

Sl. No.	Characteristics of Land	Approx. area in ha
1.	Cultivable land	32.76
2.	Land under buildings, Roards and bunds, khari, etc.	7.6
3.	Land under forest(deforestation is under process)	10.0
4.	Water Area	1.44
Total		51.8

\*Out of total land 10.0 ha of land is handed over to DakshinDinajpurKrishiVigyan Kendra for their activities and around 5.0 ha of land is being used for construction of college buildings of Extended Campus.

### MANDATES OF THIS RESEARCH STATION

- 1. Basic adaptive and need based Zone Specific Research to meet up the problem of the farmers of this Zone.
- 2. Innovation and Modification of eco-friendly technology specific to this zone.
- 3. Selection or preservation of plant genetic materials and resources specially land race or indigenous aromatic rice genotypes.
- 4. Improvement of crop qualitative and quantitative traits through conventional breeding approach especially in rice.
- 5. Production and distribution of quality seed for the farmer of this zone.
- 6. Extension of advanced technologies and motivation to the farming community through training and demonstration.

### **HIGHLIGHTS OF RESEARCH ACTIVITIES 2017-18**

**Expt. 1:** "Studies in the incidence of insect pest and disease on aromatic rice and their suitable management through the use of plant based product" during *kharif*, 2017.

#### **Objective:**

- 1. To study the incidence and severity of the disease.
- 2. To study the effect of Plant Products and Bio-control agents in managing the disease.
- **3.** To assess the % yield increased over control.

#### **Result/Outcome:**

Among the treatments used in the experiment, it was found that *Trichodermaviride*showed Lowest PDI against blast of rice and it was followed by Neem Oil, NSKE, Karanja oil, Ata leaf extract and Jatropha leaf extract.



Treatments	Percent Disease index (PDI)	% of disease control	
	Blast of Rice		

	Before spray	After spray	
T1= Neem Oil	1.86	4.63	55.43
(10000ppm) @10 ml/lit			
T2=Neem Seed Kernel	1.89	6.10	41.27
Extract (NSKE) @50			
ml/lit			
T3=Kanranja oil	1.59	6.12	41.07
T4= Karanja seed	1.55	6.16	40.69
kernel extract			
T5=Ata leaf extract	1.76	6.60	36.45
(1.5%)			
T6= Ata leaf extract	1.38	6.21	40.17
(1.5%)			
T7=Jathropa leaf	1.45	7.22	30.48
extract (1%)			
T8= Jathropa leaf	1.63	6.32	39.15
extract (1.5%)			
T9= Trichoderma spp.	1.44	4.51	43.42
@ 4gm/lit			
T10= Control	1.95	10.38	

# **Expt. 2:** "Effect of Bio-control agents and Chemical Fungicides on the disease incidence of *Alternaria* blight of mustard" during Rabi 2017-18 in the Old Alluvial Zone of West Bengal".

#### **Objectives:**

- 1. To study the seasonal incidence and severity of the disease.
- 2. To study the effect of Bio-control agents and Chemical Fungicides on the intensity of disease.
- 3. To estimate the additional yield of the crop over control.

#### **Result/Outcome:**

From the experiment, it was found that mean disease severity of *Alternaria* blight was lowest with Metalaxyl(8%)+Mancozeb(64%) <u>W.P@2g/lit</u>. of water followed by Mancozeb@2g/lit. of water , Zineb@2g/lit. of water , Copper oxychloride@3g/lit. of water, Carbendazim@2g/kg of seed ,Trichoderma @ 4g/kg of seed and Trichoderma spp. @ 4gm/lit.



		<i>Alternaria</i> blight
T1	Seed treatment with	33.86
	Carbendazim@2g/kg of seed	
T2	Copper oxychloride@3g/lit. of	33.23
	water	
T3	Mancozeb@2g/lit. of water	31.55
T4	Metalaxyl(8%)+Mancozeb(64%)	29.65
	<u>W.P@2g/lit</u> . of water	
T5	Zineb@2g/lit. of water	32.38
T6	Trichoderma sp. @ 4gm/lit. of	38.24
	water	
T7	Trichoderma sp. @ 4gm/kg of	34.21
	seed	
T8	Control	57.66

# **Expt. 3**:Effect of Integrated Nutrient Management on Growth and Yield of lentil (*Lens culinaris*Medikus) in Old Alluvial Zone of West Bengal.

#### **Objectives:**

- 1. To evaluate the growth and yield performance of lentil under integrated nutrient management practices.
- 2. To study the performance of organic material on growth and yield of lentil.
- 3. To find out the nutrient uptake and residual soil fertility status as influenced by integrated nutrient management practice.
- 4. To study the production economics of lentil

# **Treatment details:** The treatment combination used were as follows **Factor-I (Fertility levels):**

a) F<sub>1</sub>=Recommended dose (20-40-20 kg/ha N, p<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O) +*Rhizobium* b) F<sub>2</sub>= 75% of RDF+2.5t/ha Vermicompost+*Rhizobium*+P.S.B c) F<sub>3</sub>= 75% of RDF+5t/ha FYM +*Rhizobium*+P.S.B+ Vermicompost d) F<sub>4</sub>= 75% of RDF+5t/ha FYM +*Rhizobium*+ Vermicompost e) F<sub>5</sub> = 75% of RDF+5t/ha FYM +*Rhizobium*+ 19:19:19 (2 sprays)

#### Factor-II (Mulching material)

a)B<sub>0</sub>= No Mulch

b) B<sub>1</sub>=Straw Mulch

Variety: Moitree (WBL-77)

**Result:** First year of the experimentation was conducted during 2017-18 and it would be continued in the next year. The final results will come out after completion of the experiment in the second year.

# **Expt.4**:Performance of Direct Seeded Rice under Integrated Nutrient Management practices in Old Alluvial soil of West Bengal.

#### **Objectives:**

- 1. To study the effect of INM on growth and yield of direct seeded rice.
- 2. To study the nutrient uptake and residual soil fertility status under INM practice on direct seeded rice.
- 3. Production economics of direct seeded rice under INM.

Experimental Period: Rainy season 2017-18 and 2018-19.

#### **Experimental details:**

- i. Design of Experiments: Factorial R.B.D
- ii. Plot size: 3mx4m
- iii. Variety: Puspa
- iv. Treatment scheduled:

Factor -I	Factor-II
F <sub>0</sub> =100% RD	$S_0 = No. Spray$
F1=75% RD+ Green Manuring with Dhaincha+	S <sub>1</sub> = Spraying Vermiwash after 35and 50 DAS
FYM (5 ton/ha)	
F <sub>2</sub> =75% RD+ Brown Manuring with <i>Dhaincha</i> +	$S_2$ = Spraying Vermiwash at 35 DAS+19:19:19 at
FYM (5 ton/ha)	55 DAS

**Results:** The results will come out after completion of the experiment in the second year.

#### Expt. 5:"Study on cold tolerance of some genotypes"

#### Findings:

- Seven genotypes namely PUSPA, Swarna Sub1,Ranidhan,Shahabhagi, MTU1075,IET4094 and GB1were taken for the above mentioned research work out of which MTU4094 perform best. On the other hand Sahabaghi and GB1 perform good and both at per.
- > Data were taken on the basis of seedling parameter



Fig1



Genotypes was treated for 24 hr. In manitol, Cacl2, EDTA and Sucrose solution and thereafter they have germinated inside B.O.D. incubator at 5 to 10°C.

#### Expt. 6: "Aromatic rice germplasm collection, evaluation and conservation" (Kharif)

#### **Findings:**

37 genotypes were grown in seed bed but due to heavy rainfall and flood, all germplasm damaged.

#### Expt. 7:"Aromatic rice germplasm collection, evaluation and conservation"

#### **Research progress:**

12 genotypes again collected from ATC Fulia, Nadia and already transferred in seed bed and another 27 vareity were collected from local farmer of Tapan block, DakshinDinajpur.

During 2014 to till date the same research work was carried out and we have collected some morphological and yield attributing traits



# Expt. 8: "Studies of suitability of Soybean in DakshinDinajpur district under Old Alluvial Zone"

Soybean known as golden bean, is exceptionally nutritive and very rich protein food. Among major agricultural commodities, soybean has a prominent place as the world's most important seed legume. Due to its unique chemical composition 20% oil and 40 % protein, the crop has potential to mitigate the rampant protein energy malnutrition in India. As the crop is new to the DakshinDinajpur district under old alluvial zone varietal evaluation was conducted with following objectives.

#### **Objectives:**

- i) To identify the promising high yielding soybean varieties under old alluvial zone.
- ii) To assess the economies of production in different varieties.

#### Treatments:

13 different varieties JS335, JS20-29, NRC-37, NRC -86, PS-1347, HARDEE, PUSA 97-12,

PUSA 98-14, PS-1225, RKS-18, RAUS 5, Indra Soya- 9, PS-1092.

Among them NRC-37 gave the highest yield of 23.7 quintals per ha though the crop has to face the stress of flood during 14.08.2017 to 22.08.2017.

# **Expt. 9:** "Assessment of Polythene mulching and soil poly cover on nursery raising of Boro rice."

Raising of rice seedlings at nursery bed during December and January months in northern parts of West Bengal, India is quite problematic due to prevailing low temperature. Very often the ambient temperature during December-January may drops below 8°C. Prolonged foggy condition is not uncommon and such adverse situation intensifies with occasional rain. Farmers generally followed used the conventional wet nursery (open wet bed nursery) for raising the rice seedlings during winter months resulting in slow growth rate and yellowing of rice seedlings in this region. The growth of rice roots becomes ceased. In advance stages rice seedlings face acute deficiency of Zinc and sometimes may experience several fungal diseases resulting in seedling mortality. For these reasons farmers are compelled to sow more seeds than recommended. Frequent irrigations to the nursery bed are needed to overcome the chilling effect to rice seedlings resulted in increase in cost of cultivation in raising rice seedlings. Not only that, longer duration, sometimes may be 55-60 days, is required to get rice seedlings ready for transplantation.

Keeping such information in mind the present study is planned to evaluate the efficacy of polythene sheets as soil poly cover for raising rice seedlings during peak winter monthswith the following objectives:

#### **Objectives:**

- 1) To identify the suitable nursery raising methods to counteract the adverse effects of cold shock.
- 2) To standardise the optimum sowing time of Boro rice seeds in nursery bed.
- 3) To assess the growth of rice seedlings under varied sowing techniques.
- 4) To assess the yield performance of rice produced from different nursery raising methods.

#### Materials and methods:

- **Location:** The farm of RRS (OAZ), UBKV, Majhian, DakshinDinajpur.
- > Season and Year : Rabi, 2017 2018

#### Experiment – I:

- **Crop** : Rice
- ➤ Variety :IET 4094
- Experimental Design : Factorial RBD
- **Replication :** 03 (Three)
- Treatment Details :

Methods of nursery raising techniques (M):	Nursery sowing date (D):
M <sub>1</sub> : Open wet nursery bed	D <sub>1</sub> : 15 December, 2017
M <sub>2</sub> : Wet nursery bed under low poly tunnel	D <sub>2</sub> : 30 December, 2017
M <sub>3</sub> : Dry nursery bed under low poly tunnel	D <sub>3</sub> : 15 January, 2018
M <sub>4</sub> : Dry nursery bed with soil polythene cover	

#### <u>Experiment – II</u>:

- > Crop: Rice
- > **Variety**: One Hybrid rice (depending upon the availability)
- **Experimental Design :** Factorial RBD
- **Replication :** 03 (Three)
- > Treatment Details :

Methods of nursery raising techniques (M):	Nursery sowing date (D):
M <sub>1</sub> : Open wet nursery bed	D <sub>1</sub> : 15 December, 2017
$M_2$ : Wet nursery bed under low poly tunnel	D <sub>2</sub> : 30 December, 2017
M <sub>3</sub> : Dry nursery bed under low poly tunnel	D <sub>3</sub> : 15 January, 2018
M <sub>4</sub> : Dry nursery bed with soil polythene cover	

#### **Observations recorded:**

- Days to 4 leaf stage of rice seedlings
- ✤ Temperature variation under different nursery management practices.
- Growth parameters like, height, fresh weight and dry weight of rice seedlings under different treatments.
- Growth, yield components and yield of rice produced from different nursery management practices.

**Results**: final results will be given later on.

# Expt. 10: "Evaluation of newly released long duration paddy varieties in old alluvial zone of West Bengal"

Rice is the principal food of nearly half of human population. It is India's number one food crop in the term of area, production and annual turnover. The state of West Bengal ranks first in area and production of rice and Punjab having the highest productivity in the country. West Bengal, a state of India has rich rice genetic wealth. This wealth of genetic resources as found in rice will provide the base for future progress in rice improvement in the face of shrinking resources both biological and physical.

Production and multiplication of same genotypes in a particular situation losses genetic variability and creates genetic vulnerability. Hence there is a scope to introduce a long duration high yielding rice variety in existing rice-based cropping system in old alluvial zone. The present study aimed to find out the newly released varieties of paddy suitable for long duration under OAZ of West Bengal.

#### **Objectives:**

- i) To find out the suitable varieties to replace the existing predominant variety MTU-7029
- ii) To assess the amount of variability for different qualitative and quantitative characters present in a population of different rice genotypes.
- iii) To study the association of yield and its contributing characters.

#### Materials and methods:

Approximately 9 newly released varieties and one check variety (MTU-7029) of rice collected from farm section which were sown in seed bed and after that transplanted in 3mX 5m main plot following Randomized Block design.

No. of replication: 3

Plot size: 3m X 5m

Treatments: MTU-7029 (control), Pratiksha, MTU-1075, Ranidhan, RNR-2364, Swarna Sub-1, BNKR-1, CRDHAN-300, Sujala, Samba Sub-1.

Results:Final results will be given later on.

# Expt. 11: Research Survey: Economic analysis of *Kataribhog*&*ChiniSakkar* Cultivation in DakshinDinajpur District

The major objectives of the study were as

- 1. To determine the cost and return of *Kataribhog* cultivation in DakshinDinajpur District
- 2. To compare the cost and profitability with *aman* rice
- 3. To find out the resource use efficiency in *Kataribhog* and *aman* rice
- 4. To analyze the scope and constraints of *Kataribhog* cultivation in the district.

Data were collected from the farmers of Kumarganj block on *aman*as well as *Kataribhog* cultivation on costs, profit, resource utilization, scope and constraints.

The district of DakshinDinajpur experienced a devastating flood in last year, during *kharif* season. Kumarganj block was adversary affected by the flood. So the work will be carried out this year also. Proposals have already been submitted and subsequently permitted.

#### Research Survey: Perception study on climate change in DakshinDinajpur district

A survey in the district of D. Dinajpur had been carried out to understand the perceptions of the farmers regarding the climate change. The major objectives of the study are to assess the farmers' perception on climate change, to know the measures adopted by the farmers for mitigation and to analyze the farmers' knowledge and refinement of the same for policy aspects. Data have been

collected from the 100 farmers on different variable and analysis is being done. This is interesting to find here that farmers of the district are much more aware about the climate change now. Majority of the farmers are conscious about the bad effect of climate change particularly on agriculture. Calculations will be completed shortly.

Expt. 12: "Monitoring of Fruit fly complex through Methyl Eugenol Traps at Regional Research Station (Old Alluvial Zone), UBKV, DaksinDinajpur dist. in West Bengal " 2017-18.

Month	Fortnight	Location-1	Location-2
		RRS(OAZ), Majhian	Matasa, Hilli
May'2017	I	55	530
	II	70	620
June'2017	I	205	834
	II	252	915
July'2017	I	112	678
	II	80	602
August'2017	Ι	58	396
	II	75	309
September'2017	Ι	26	285
	II	21	201
October'2017	I	5	97
	II	16	90
November'2017	Ι	4	47
	II	1	17
December'2017	I	0	0
	II	0	0
January'2018	Ι	0	0
	II	2	0
February'2018	I	0	2
	II	3	5
March'2018	Ι	17	45
	II	6	34
April'2018	Ι	10	52
	II	28	44

Table: Fortnightly no. of Fruit fly adult trapped.

**Achievements:** Methyl eugenol trap (Smart Trap) were installed in two locations of DakshinDinajpur district of RRS(OAZ), Majhian and Matasa village under Hilli Block and the trapped adult fruit fly has been counting throughout the year. Both the locations showing highest population were counted during the month of June and July and high level of population extend up to the month of September. During winter month population level very low or absent in some period of severe cold.



Expt. 13: "Study on the seasonal incidence of pest and disease of the 04(four) hybrid variety of Maize during Rabi' 2017-18 (Continue from last year 2016-17) in the Old Alluvial Zone of West Bengal"

Maize,	Average pests population or % on 20 sq.m. area or				Natural enemies		
Hybrid	per 10 plants			(No. of Predators/Pa	rasites per 10		
variety				plants )			
	Helicoverp	Stem	Hairy	Japane	Grass	Coccinellid beetle	Spider
	aarmigera	borer	caterpill	se	hopper		_
	U U		ar	beetle			
Vishal-6405	>30%	3%	6-8%	4-5%	3-4%	0.15	0.5

Table: Incidence of Insect pests' populations on hybrid varieties of Maize (Vishal-6405).

<u>Achievements</u>: Fixed plot survey was conducted in South Dinajpur dist. at Farm of RRS (OAZ), Majhian under UBKV fortnight interval on Hybrid Maize with a variety - Vishal-6405 to observe the incidence of different insect pests and their natural enemies. The pest population were recorded on tasseling & milking stage cob borer, *Helicoverpa sp.*more damages than other pests.Hairy caterpillar and Japanese beetle & Grass hopper were act as minor pest and dominant natural enemies were found *Coccinellid*spp and spider.



### **HIGHLIGHT OF THE ONGOING PROJECTS**

# **Project 1:** "GraminKrishiMausamSewa" at Majhian under Uttar BangaKrishiViswavidyalaya, Pundibari, Cooch Behar, West Bengal, sponsored by Ministry of Earth & Science, Government of India.

#### Role of IMD, GKMS, AMFU-Majhian:

The AMFU-Majhian, Regional Research Station (Old Alluvial Zone), on every Tuesday and Fridaythe biweekly weather forecast data received from RMC, IMD, Kolkata are analyzed by a team of experts from different disciplines of Research Station and DakshinDinajpur KVK and prepare agro advisory bulletin in English and well as local language (Bengali) based on the medium range weather forecast and crop condition. The weather based advisories are to disseminate among the, NGOs, KVKs District Agricultural Office of Malda&DakshinDinajpur district, farming community of the zone through newspaper, All India Radio, Doordarshan Kolkata &Jalpaiguri on real time basis.

#### STATUS OF AGROMETEOROLOGICAL OBSERVATORY

**Date of Installation of Observatory/Automatic Weather Station:** The installation of Manual Observatory has completed on 17.03.2017 in presence of Dr. G. N. Raha, Director, MC, Ganktok, IMD, Sri SanjoyBhowal, S.A, FMO, JPG, IMD, Dr.SubhenduBandhyopadhayay, Principal Nodal Officer, UBKV, Coch Behar, Dr. Ashok Chowdhury, Director of Research, UBKV and other Officers and Scientists of this station.



**Availability of data at AMFU Majhian:** The data from AWS is available from July, 2011 to July, 2013 as the AWS is not working from August, 2013 to January, 2018 and then again repair on 22.02.2018. Now the AWS data is available from the repairing date. Manual Observatory Observational data is available from 17.03.2017.

Sl. No.	Name of Instruments	Serials No.	Remarks	
1.	Thermometer Screen	133/09	Working condition	
2.	Rain gauge	421/09	Working condition	
3.	Anemometer	1047/08	Working condition	
4.	Sun Shine Recorder with	133/91	Working condition	
	cards			
5.	Wind vane	135/09	Working condition	
6.	Evaporimeter	1480/09	Not working condition due to broken	
			measuring pan without scale inside.	
7.	Measuring Pan	1477/09	Scale missing & broken and kept in	
			store.	
8.	Pointer	1477/09	Installed	
9.	5 Cm Soil thermometer	6659 (0.0) & 6665	6659 (0.0) Installed and working	
	(2)	(+0.2)	conditionand another 6665(+0.2) is	
			broken.	
10.	10 Cm Thermometer (2)	5798 (-0.1) & 5808 (-	Not Working	
		0.1)		
11.	20 Cm Thermometer (2)	6527 (0.0) & 6548 (0.0)	Not Working	
12.	Dry Bulb (2)	5325 (0.0)	Working condition	
		5332 (0.0)	Not Working	
13.	Wet Bulb (2)	5051(-0.1)	Working condition	
		5074(0.0)	Working condition (spare)	
14.	Maximum (2)	6507 (0.0)	Working condition	
		6519 (0.0)	Working condition (spare)	
15.	Minimum (2)	6662 (-0.2)	Installed and working condition	
		6616 (-0.1)	Working condition (spare)	
16.	Soil stand (5Cm)	136	Working condition	
17.	Soil Stand (10Cm)	137	Working condition	
18.	Soil stand (20Cm)	138	Working condition	
19.	Soil Drier	508246-41208	Working condition	

The following instruments are available in working condition;-

#### Major activities during last financial year:

Bi-weekly weather forecasts are received from the RMC, Kolkata. **104** forecasts were received during this financial year 2017-18. Forecast received from RMC, Kolkata in between at 1.00 pm to 1.30 pm. During the financial year 2017-18 One hundred four (**104**) Agro Advisory Bulletins were disseminated. 10226 registered farmers to whom bulletins were disseminated through SMS.

#### List Mode of mass communication adopted for AAS dissemination:

- 1. Doordarshan, Jalpaiguri
- 2. Local cable channel, C4U
- 3. Printed media (daily newspaper):
  - I. Uttar BangaSangbad
  - II. News times
  - III. The Statesman
  - IV. Sobujsona
  - V. Ananda Bazar
- 4. RRS (OAZ) Notice Board

- 5. Website of the University
- 6. KVK Notice board
- 7. Post Office Notice board
- 8. NGO (Tagore Society, Noapara)
- 9. ADA offices, Department of Agriculture
- 10. D.D KVK of D. Dinajpur& KVK Malda
- 11. IFFCO
- 12. IMD Website
- 13. Telephonic communication
- 14. SMS through Farmers Portal

**Organization of Farmers Awareness Programme:** 03 Farmers awareness programmes were organized at Hilli and Kumargunj blocks of DakshinDinajpur district and Gajole block of Malda district. Prof.SuvenduBandyopadhyay, Principal Nodal officer and Mr.GopinathRaha, Director MC, Gangtok, IMD were present during conduction of Farmers awareness programme. 90 participants were actively participated at these Farmers awareness programmes.



Farmers Awareness Programme at DakshinDinajpur District

#### Project 2: ICAR Seed Project (Mega Seed Project)

This project is mainly for production of quality seeds and planting materials for the farmers and to increase the seed replacement rate of this zone. Foundation and Certified class of seeds of cereals, oilseeds, pulses and potato seed tubersare generally produced atthe farm area of this research station and production of planting materials of mango, guava and litchi are also beingincludedin the programme. Produced quality seeds and planting materials are sold to the farmers of this zone at reasonable price. Since 2005-06, inceptions of the project, a huge numbers of farmers are being supplied with quality seeds for better production of crops. Replacement of old varieties of field crops with the newly notified varieties is also being emphasized in the quality seed production programme. Besides supply of quality seeds, making the farming community aware through training programmeson use of quality seeds is also a mandate of this project.

Kharif							
Sl no.	Crop	Variety	Class	Quantity			
				produced in qtl			
01	Paddy	Sujala	B-F	4.73			
02		Ranidhan	B-F	1.81			
03		Puspa	B-F	3.10			
04		IET-4094	B-F	9.26			
05	Swarna Sub-1		B-F	3.40			
06	Swarna Sub-1		F-C	34.00			
07		Ranidhan	F-C	19.00			
08		MTU-1075	F-C	56.00			
09		Sahabhagi	F-C	9.05			
10		GB-1	F-C	26.00			
11		BPT-5204	F-C	3.20			
Rabi							
01	Paddy	IET-4094	F-C	6.57			
02		Puspa	F-C	2.20			
03		Sahbhagi	F-C	15.09			
04		GB-1	TL	10.53			
01	Mustard	B-9	B-F	0.55			
02		NC-1	B-F	0.19			
03		YSH-401	B-F	0.16			
04	PM-25		B-F	0.19			
05		B-54	B-F	0.16			
06		B-54	F-C	1.29			
07		Panchali	F-C	5.72			
08		Bhagirathi	F-C	0.70			
01	Lentil	WBL-77	B-F	0.60			
02		WBL-77	F-C	4.10			
03		WBL-77	C I- C II	17.14			
04		Subrata	TL	1.00			
01	Khesari	Prateek	B-F	0.08			
02	1	Ratan	B-F	0.01			
01	Pea	IPFD-10-12	B-F	0.15			
01	Urd	PU-31	B-F	0.02			

#### Seed Production programme during 2017-18:
The Regional Research Station experienced a flood like situation during middle of the August, 2017. Some seed production plots had severely been damaged due to water stagnation for a week.

## Project 3:Creation of Seed-Hubs for increasing indigenous production of pulses in India under NFSM

#### Development of pulses seed system

• Participatory seed system analysis of existing informal and formal seed systems for pulses in project areas

• Identification of opportunities and constraints to develop efficient seed production and supplysystems, including policies, and strategic seed reserve at the village/community level

• Develop a functional model of seed system(s) and validate in selected villages in these area.

• Establish Model seed production scheme(s) i.e. Village-level seed enterprises to ensure timely availability of good quality seed of improved varieties at affordable price.

- Conduct seed demand surveys to develop business plans for village-based seed enterprises
- Conduct economic evaluation to assess profitability and sustainability of small-scale seed enterprises

• Identify constraints in formal sector pulses seed delivery from Breeder-Foundation-Certified seed production chainin the target area.

Narasundar Para BangaBhumi Farmers' club was the target group of the lentil seed production during the year 2017-18. The Regional Research Station successfully lifted considerable quantities of certified lentil seeds from the growers.

# **Project 4.** "Evaluation of Bio-efficacy and Phyto-toxicity of the fungicide UPF-115 against disease complex of paddy".

#### **Objectives:**

- i. To evaluate the bio-efficacy of UPF-115 fungicide rice diseases particularly leaf spot /blight.
- ii. To evaluate phyto-toxicity of UPF-115 on rice.
- iii. To analyse the persistence and residual effect on soil, paddy straw, husk and grain.

Treatments	Dose (a.i/ha)	g/ha
T1=UPF-115	150+750	1000
T2=UPF-115	187.5+712.5	1250
T3= UPF-115	225+85.5	1500
T4=Tebuconazole25.9% EC	187.5	750
T5= Zineb75%WP	1500	2000
T6=Hexaconazole4%+Zineb68%WP	50+850	1250
T7=untreated control	-	-
T8=UPF-115(Phytotoxicity only)	375+1425	2500

# **Project 5:** "Exploration of the Soil Microbial Diversity of different agro-ecological zoneof North Bengal for agricultural use"-An Institutional Project

#### **Objectives:**

- i. Survey, isolation and characterisation of agriculturally important microbes from different eco-region of North Bengal.
- To study the structural and functional diversity of representative groups of microbes (PSB, Nitrogen Fixer and PGPR) obtained from rhizosphere samples of predominant crops of North Bengal.
- iii. Bio-chemical and molecular characterisation of the identified and potent plant growth promoting PSB, Nitrogen fixer and PGPR for plant growth promoting traits.
- iv. Evaluation of selected PSB,Nitrogen fixer and PGPR for enhancing the growth and yield of the major crops of North Bengal, viz. rice, soybean and wheat.
- v. Mapping, cataloguing and preservation of isolated and identified microbes.

# **Project 6:** Study on constraint analysis of mushroom cultivation vis-a –vis capacity building programme in DakshinDinajpur District" funded by ATMA.

#### **Objective**(s):

- i. To disseminate the technologies among the farmers of this zone.
- ii. To demonstrate the production of mushroom and its spawn to the farming community

**Project 7:**Promotion of Oilseed crops in Northern Districts of West Bengal for Livelihood Security of small and marginal Farmers funded by National Mission for oilseeds and Oil Palm, Govt. of India.

## **Project 8:**RKVY sponsored "Up-gradation of Market-Linkage Network for Promotion of Bengal Aromatic Rice"

A multi-institutional research project entitled "Up-gradation of Market-linkage Network for Promotion of Bengal Aromatic Rice" has been approved by the Director of Marketing and Ex-Officio Additional Director of Agriculture (Marketing), Government of West Bengal, under RashtriyaKrishiVikasYojana [RKVY, Stream II], where Bidhan Chandra KrishiViswavidyalaya, Mohanpur, Nadia is the lead institute for implementation of the above-said multi-institutional project during 2012-2017 and Uttar BangaKrishiViswavidyalaya is the collaborator.

**Project 9:** ICARDA sponsored project on increasing food legumes production by small farmers to strength food and nutritional security through adoption of improved technologies and governance within south-south cooperation)

Under the ICARDA project both research work and extension activities are going on

> Demonstration of improved package and practices in farmers' field

Area coverage: 32 ha (Balurghat, Tapan, Gangarampur and Kumarganj block)

Capacity Development:

- > No. of Field Days organized -5
- ▶ No. of Training on agronomic packages -5
- > Exposure visit of the farmers across the nodes (farmers exposure to Malda)
- Development of Technical bulletin 1
- > Trial plot visit and farmers' plot visit of scientist in Cooch Behar: 2 days

#### Project 10:Mission for Integrated Development of Horticulture (MIDH)-Spices

The project is mainly for production of quality seeds and seed materials of Beetle Vine, Black Peeper, Ginger and Turmeric and sold to the farmers at lower rate than the market price. Training programmes on "Advance techniques of cultivation of Betel vine, Black Pepper, Ginger and Turmeric have been given to the farmers of this zone (Uttar Dinajpur, Malda, and DakshinDinajpur).

Name of	Total	Variety	Cropping	No. of	Insect	Technology	
Block	no.	used	stage	tilleringapprox/hill	pests &	(sowing method)	
	of				Disease	Method	Coverage
	DC				infestation		area (ha)
	1	IET-	Early	5-12 nos.	Not	Line	83.0
Kumarganj	(100	4786	tillering		appears	sowing	
	ha.)	(Satabdi)			till date	SRI	2.38
						TTM	14.62
Kushmandi	1	IET-	Early	7-14 nos.	Not	Line	84.4
	(100	4094	tillering		appears	sowing	
	ha.)				till date	TTM	15.6
	1	IET-	Early	6-15 nos.	Not	Line	70.5
Harirampur	(100	4786	tillering		appears	sowing	
	ha.)	(Satabdi)			till date	DTM	10.5
						TTM	19.0
Bangshihari	1	IET-	Early	5-16 nos.	Not	Line	86.0
	(100	4786	tillering		appears	sowing	
	ha.)	(Satabdi)			till date	DTM	7.0
						TTM	7.0

#### Project 11:BGREI (as on March, 2018)

## Project 12: All India Coordinated wheat and barley Improvement Project

This research station has been acting as voluntary centre for AVT trialsunder All India Coordinated wheat and barley Improvement Project since 2015-16. Like previous years, Scientists from Directorate of Wheat Research have made their visit at the trial plots during this year (2017-18) also.

#### Trial: AVT-IR-TS-TAS

Zone:NEPZ



#### **OTHER ACTIVITIES**

#### Soil Testing:

The soil testing laboratory of this RRS (OAZ) estimates P<sup>H</sup>, E.C, Organic carbon, Nitrogen, Phosphorus and potash of the soil and recommends forsoil test based nutrient management practices at nominal cost.



#### Weather Based Agro Advisory Service:

Weather forecast data received from India Meteorological Department, Pune via RMC Kolkata on each Tuesday and Friday are analyzed by a team of experts consisting of faculty members of RRS (OAZ), SMSs of Dakshin Dinajpur KVK for weekly Agro-advisory bulletin.



#### Quality seeds and different planting materials production and distribution:

Production and distribution of quality seeds is one of the extension based institutional mandate of this Research Station to cater the needs of the quality seeds among the farmers of this zone and to increase the seed replacement rate for better productivity.





#### Vermicompost production:

This research station has produced two tons of vermicompost and supplies good quality earth worm to the farming community for larger adoption of this technology during the last year.



#### Front Line Demonstrations:

A good no of FLDS have been conducted at farmers field to show the potentiality of new technology in comparison to the old one at real farming situation under different project like MIDH, RKVY on Bengal Aromatic Rice and ICARDA funded project on Lentil.

#### Training programmes:

This research station imparted a good no.of training to the farming community of this zone under different ongoing projects like MIDH, RKVY, ICAR Seed Project (MSP) and ICARDAon lentil and during 2017-18.

S1.	Name	Designation	Pay scale with	Caste	Date of joining
No.			Grade pay		
1.	Prof. Tulsi Saran Ghimiray	IN-CHARGE, RRS	15600-39100	Gen	10.12.2001
		(OAZ)	GP Rs. 10,000		
2.	Dr. Jyotirmay Karforma	Associate Professor	15600-39100	Gen.	24.08.2014
			GP Rs. 9,000		
3.	Dr. Saikat Mookherjee	Asstt. Director of	15600-39100	Gen.	14.08.2014
		Farms	GP Rs. 6000		
4.	Dr. Jayanta Dutta	Asstt. Professor (Agril.	15600-39100	Gen.	12.07.2007
		Economics)	GP Rs. 7,000		
5.	Dr. Dipak Kr. Murmu	Asstt. Professor (Veg.	15600-39100	ST	08.07.2014
		and Spices)	GP Rs. 6000		
6.	Dr. Shyamashree Roy	Asstt. Professor	15600-39100	SC	06.06.2014
		(Agronomy)	GP Rs. 6000		
7.	Mr. Ratul Barman	Asstt. Professor (Gen.	15600-39100	SC	27.06.2014
		& Plant Breeding)	GP Rs. 6000		
8.	Dr. Tapas Kr. Pandit	Asstt. Professor (Soil	15600-39100	SC	05.11.2014
		Science)	GP Rs. 6000		
9.	Md. Ali Azgar	Asstt. Professor (Plant	15600-39100	OBC-A	08.05.2015
		Pathology)	GP Rs. 6000		
10.	Mr. Tapas Kr. Hembram	Asstt. Professor (Agril.	15600-39100	ST	31.07.2015
		Entomology)	GP Rs. 6000		
11.	Sri Chiranjit Mandal	Field Assistant	7200-25400	SC	03.11.2014
			GP Rs. 3300		
12.	Sri Naba Kishore Mahato	Field Assistant	7200-25400	Gen.	07.11.2014
			GP Rs. 3300		
13.	Sri Amiya Biswas	Field Assistant	7200-25400	Gen.	10.11.2014
			GP Rs. 3300	(PH)	
14.	Sri Partha Barman	Sr. Assistant	7200-25400	SC	02.03.2006
			GP Rs. 4100		
	Sri Gautam Kr. Saha	Sr. Lab Attendant	5400-18600	Gen.	28.05.1986
15.			GP Rs. 2900		
	Smt. Sanchita Sarkar (Saha)	Sr. Lab Attendant	5400-18600	Gen.	03.11.2014
16.			GP Rs. 1800		
17.	Sri Subhendu Sen	Junior Assistant	7200-25400	OBC	03.11.2014

#### Present staff position(as on 30.03.2018)

18.         Sri Sampad Kr. Roy         Junior Assistant         220025400 GP 8. 3300         Gen.         03.11.2014 GP 8. 3300           20.         Sri Rustam Narjinary         Junior Cashier         720025400         ST         03.11.2014           20.         Sri Swapan Biswas         Junior store keeper         720025400         SC         05.11.2014           21.         Sri Sushil Pahan         Sr. Peon         5400-18600         GP 8. 3300         Z2.09.1997           22.         Sri Kallol Chakraborty         Junior Peon         5400-18600         Gen.         03.11.2014           23.         Sri Harilal Ghosh         Junior Peon         5400-18600         Gen.         03.11.2014           24.         Md. Rafikul Mian         Tractor Driver         5400-18600         Gen.         01.08.1993           25.         Sri Narahari Das         Tractor Driver         720025400         Gen.         01.08.1993           26.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600         ST         01.08.1993           27.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600         ST         01.08.1993           28.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600         ST         01.08.1993				GP Rs. 3300		
Image: Sri Rustam Narjinary         Junior Cashier         CP Rs. 3300         CP           19.         Sri Rustam Narjinary         Junior Cashier         7200.25400         ST         03.11.2014           20.         Sri Swapan Biswas         Junior store keeper         7200.25400         SC         05.11.2014           21.         Sri Sushil Pahan         Sr. Peon         5400.18600         ST         22.09.1997           22.         Sri Kallol Chakraborty         Junior Peon         5400.18600         Gen.         03.11.2014           23.         Sri Harilal Ghosh         Junior Peon         5400.18600         Gen.         03.11.2014           24.         Md. Rafikul Mian         Tractor Driver         7200.25400         Gen.         03.11.2014           25.         Sri Narahari Das         Tractor Driver         7200.25400         Gen.         01.08.1993           26.         Sri IchandPahan         Power Tiller Operator         6400.18600         ST         01.08.1993           27.         Sri Kalyan Kr. Das         Junior Darwan         5400.18600         ST         01.08.1993           28.         Sri Kalyan Kr. Das         Junior Darwan         5400.18600         ST         01.08.1993           29.         Sri KalipadaPaha	18.	Sri Sampad Kr. Roy	Junior Assistant	7200-25400	Gen.	03.11.2014
19.         Sri Rustam Narjinary         Junior Cashier         7200 25400 (P Rs. 3300)         ST         03.11.2014           20.         Sri Swapan Biswas         Junior store keeper         7200 25400         SC         05.11.2014           21.         Sri Sushil Pahan         Sr. Peon         5400.18600         SC         05.11.2014           22.         Sri Kallol Chakraborty         Junior Peon         5400.18600         Gen.         03.11.2014           23.         Sri Harilal Ghosh         Junior Peon         5400.18600         Gen.         03.11.2014           24.         Md. Rafikul Mian         Tractor Driver         5400.18600		1 5		GP Rs. 3300		
Construction         CP Rs. 3300         CP           20.         Sri Swapan Biswas         Junior store keeper         7200-25400         SC         0.511.2014           21.         Sri Sushil Pahan         Sr. Peon         5400-18600         ST         22.09.1997           22.         Sri Kallol Chakraborty         Junior Peon         5400-18600         Gen.         0.311.2014           23.         Sri Harilal Ghosh         Junior Peon         5400-18600         Gen.         0.511.2014           24.         Md. Rafikul Mian         Tractor Driver         5400-18600          0.511.2014           25.         Sri Narahari Das         Tractor Driver         7200-25400         Gen.         01.08.1993           26.         Sri FulchandPahan         Power Tiller Operator         67 Rs. 3300         ST         01.08.1993           27.         Sri NirmalPahan         Sr. Helper Tractor & 5400-18600         ST         01.08.1993           28.         Sri KalipadaPahan         Sr. Darwan         5400-18600         ST         01.08.1993           29.         Sri KalipadaPahan         Sr. Darwan         5400-18600         ST         01.08.1993           30.         Smt. SaraswatiKisku         Field Worker         5400-18600	19.	Sri Rustam Narjinary	Junior Cashier	7200-25400	ST	03.11.2014
20.         Sri Swapan Biswas         Junior store keeper         7200-25400 (CP Rs. 3300         SC         05.11.2014           21.         Sri Sushil Pahan         Sr. Peon         5400-18600 (CP Rs. 2100         ST         22.09.1997           22.         Sri Kallol Chakraborty         Junior Peon         5400-18600 (CP Rs. 1800         Gen.         03.11.2014           23.         Sri Harilal Ghosh         Junior Peon         5400-18600 (CP Rs. 1800         Gen.         03.11.2014           24.         Md. Rafikul Mian         Tractor Driver         5400-18600 (CP Rs. 2900		3 5	0	GP Rs. 3300		
Image: Constraint of the second state of t	20.	Sri Swapan Biswas	Junior store keeper	7200-25400	SC	05.11.2014
21.         Sri Sushil Pahan         Sr. Peon         5400-18600 CP Rs. 2100         ST         22.09.1997           22.         Sri Kallol Chakraborty         Junior Peon         5400-18600 CP Rs. 1800         Gen.         03.11.2014           23.         Sri Harilal Chosh         Junior Peon         5400-18600 CP Rs. 1800         Gen.         05.11.2014           24.         Md. Rafikul Mian         Tractor Driver         5400-18600 Cr. I         Gen.         01.08.1993           25.         Sri Narahari Das         Tractor Driver         7200-25400 CF. R. 2900         Gen.         01.08.1993           26.         Sri FulchandPahan         Power Tiller Operator         5400-18600 GP Rs. 2600         ST         01.08.1993           27.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600 GP Rs. 2600         ST         01.08.1993           28.         Sri KalipadaPahan         Sr. Darwan         5400-18600 GP Rs. 2600         ST         01.08.1993           30.         Smt KalipadaPahan         Sr. Darwan         5400-18600 GP Rs. 2600         ST         01.08.1993           31.         Sri KalipadaPahan         Sr. Darwan         5400-18600 GP Rs. 2100         ST         01.08.1993           32.         Sri Sunil Barman         Field Worker		1		GP Rs. 3300		
Construct         GP Rs. 2100         Construction           22.         Sri Kallol Chakraborty         Junior Peon         5400-18600         Gen.         03.11.2014           23.         Sri Harilal Ghosh         Junior Peon         5400-18600         Gen.         03.11.2014           24.         Md. Rafikul Mian         Tractor Driver         5400-18600         Gen.         03.11.2014           25.         Sri Narahari Das         Tractor Driver         7200-25400         Gen.         01.08.1993           26.         Sri FulchandPahan         Power Tiller Operator         5400-18600         ST         01.08.1993           27.         Sri NirmalPahan         Sr. Helper Tractor & 5400-18600         ST         01.08.1993           28.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600         OBC         05.11.2014           29.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600         ST         01.08.1993           30.         Smt. SaraswatiKisku         Field Worker         5400-18600         ST         01.08.1993           31.         Sri KishanBaskey         Field Worker         5400-18600         ST         01.08.1993           32.         Sri Sunil Barman         Field Worker         5400-	21.	Sri Sushil Pahan	Sr. Peon	5400-18600	ST	22.09.1997
22.         Sri Kallol Chakraborty         Junior Peon         5400-18600 CP Rs. 1800         Gen.         03.11.2014           23.         Sri Harilal Ghosh         Junior Peon         5400-18600 CP Rs. 1800         Gen.         05.11.2014           24.         Md. Rafikul Mian         Tractor Driver         5400-18600 CP Rs. 2900         -         03.11.2014           25.         Sri Narahari Das         Tractor Driver         7200-25400 Cr. 1         Gen.         01.08.1993           26.         Sri FulchandPahan         Power Tiller Operator         5400-18600 GP Rs. 2900         ST         01.08.1993           27.         Sri NirmalPahan         Sr. Helper Tractor & 5400-18600 Vehicle         ST         01.08.1993           28.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600 GP Rs. 2600         ST         01.08.1993           29.         Sri KalipadaPahan         Sr. Darwan         5400-18600 Gr. I         ST         01.08.1993           30.         Smt. SaraswatiKisku         Field Worker         5400-18600 Gr. I         ST         01.08.1993           31.         Sri KuishanBaskey         Field Worker         5400-18600 GP Rs. 2100         ST         01.08.1993           32.         Sri Sunil Barman         Field Worker         5400-18600 GP Rs. 1				GP Rs. 2100		
Construction         GP Rs. 1800         Cen           23.         Sri Harilal Chosh         Junior Peon         5400-18600         Gen.         05.11.2014           24.         Md. Rafikul Mian         Tractor Driver         5400-18600	22.	Sri Kallol Chakraborty	Junior Peon	5400-18600	Gen.	03.11.2014
23.         Sri Harilal Ghosh         Junior Peon         5400-18600 GP Rs. 1800         Gen.         05.11.2014           24.         Md. Rafikul Mian         Tractor Driver         5400-18600          03.11.2014           25.         Sri Narahari Das         Tractor Driver         7200-25400         Gen.         01.08.1993           26.         Sri FulchandPahan         Power Tiller Operator         5400-18600         ST         01.08.1993           27.         Sri NirmalPahan         Sr. Helper Tractor & 5400-18600         ST         01.08.1993           28.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600         OBC         05.11.2014           29.         Sri KalipadaPahan         Sr. Darwan         5400-18600         ST         01.08.1993           30.         Smt. SaraswatiKisku         Field Worker         5400-18600         ST         01.08.1993           31.         Sri KishanBaskey         Field Worker         5400-18600         ST         01.08.1993           32.         Sri Sunil Barman         Field Worker         5400-18600         SC         01.08.1993           33.         Smt. RajmoniMahato         Do         5400-18600         Gen.         01.08.1993           34.         S		5	0	GP Rs. 1800		
24.         Md. Rafikul Mian         Tractor Driver         GP Rs. 1800          03.11.2014           25.         Sri Narahari Das         Tractor Driver         7200-25400         Gen.         01.08.1993           26.         Sri FulchandPahan         Power Tiller Operator         GP Rs. 2900         ST         01.08.1993           27.         Sri NirmalPahan         Sr. Helper Tractor & 5400-18600         ST         01.08.1993           28.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600         OBC         05.11.2014           29.         Sri KalipadaPahan         Sr. Darwan         5400-18600         ST         01.08.1993           29.         Sri KalipadaPahan         Sr. Darwan         5400-18600         ST         01.08.1993           30.         Smt. SaraswatiKisku         Field Worker         5400-18600         ST         01.08.1993           31.         Sri KishanBaskey         Field Worker         5400-18600         ST         01.08.1993           32.         Sri Sunil Barman         Field Worker         5400-18600         ST         01.08.1993           33.         Smt. RajmoniMahato         Do         5400-18600         ST         01.08.1993           34.         Sri BipinMurmu<	23.	Sri Harilal Ghosh	Iunior Peon	5400-18600	Gen.	05.11.2014
24.       Md. Rafikul Mian       Tractor Driver $5400-18600$ 03.11.2014         25.       Sri Narahari Das       Tractor Driver $720-25400$ Gen.       01.08.1993         26.       Sri FulchandPahan       Power Tiller Operator $5400-18600$ ST       01.08.1993         26.       Sri NirmalPahan       Sr. Helper Tractor & $5400-18600$ ST       01.08.1993         27.       Sri NarmalPahan       Sr. Helper Tractor & $5400-18600$ OBC       0511.2014         28.       Sri Kalyan Kr. Das       Junior Darwan $5400-18600$ OBC       0511.2014         29.       Sri KalipadaPahan       Sr. Darwan $5400-18600$ ST       01.08.1993         30.       Smt. SaraswatiKisku       Field Worker $5400-18600$ ST       01.08.1993         31.       Sri KishanBaskey       Field Worker $5400-18600$ ST       01.08.1993         32.       Sri Sunil Barman       Field Worker $5400-18600$ ST       01.08.1993         33.       Smt. RajmoniMahato       Do $5400-18600$ SC       01.08.1993         34.       Sri BipinMurmu       Do $5400-18600$ ST       02.03.2006			<u>.</u>	GP Rs. 1800		
Image: Second state in the second state in	24.	Md. Rafikul Mian	Tractor Driver	5400-18600		03.11.2014
25.         Sri Narahari Das         Tractor Driver Gr. I         7200-25400 CP Rs. 3300         Gen.         01.08.1993           26.         Sri FulchandPahan         Power Tiller Operator         5400-18600 SP Rs. 2900         ST         01.08.1993           27.         Sri NirmalPahan         Sr. Helper Tractor & Vehicle         5400-18600 GP Rs. 2600         ST         01.08.1993           28.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600 GP Rs. 2600         OBC         05.11.2014           29.         Sri KalipadaPahan         Sr. Darwan         5400-18600 GP Rs. 2600         ST         01.08.1993           30.         Smt. SaraswatiKisku         Field Worker         5400-18600 Gr. II         ST         01.08.1993           31.         Sri KishanBaskey         Field Worker         5400-18600 GP Rs. 2100         ST         01.08.1993           32.         Sri Sunil Barman         Field Worker         5400-18600 GP Rs. 2100         SC         01.08.1993           33.         Smt. RajmoniMahato         Do         5400-18600 GP Rs. 1800         ST         02.03.2006           34.         Sri BupinMurmu         Do         5400-18600 GP Rs. 1800         ST         02.03.2006           35.         Sri SukumarMahato         Do         5400-18600				GP Rs. 2900		
Gr. I         GP Rs. 3300         Number of the state	25.	Sri Narahari Das	Tractor Driver	7200-25400	Gen.	01.08.1993
26.         Sri FulchandPahan         Power Tiller Operator         5400-18600 GP Rs. 2900         ST         01.08.1993           27.         Sri NirmalPahan         Sr. Helper Tractor & Vehicle         5400-18600         ST         01.08.1993           28.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600         OBC         05.11.2014           29.         Sri KalipadaPahan         Sr. Darwan         5400-18600         ST         01.08.1993           30.         Smt. SaraswatiKisku         Field Worker         5400-18600         ST         01.08.1993           31.         Sri KishanBaskey         Field Worker         5400-18600         ST         01.08.1993           32.         Sri Sunil Barman         Field Worker         5400-18600         SC         01.08.1993           33.         Smt. RajmoniMahato         Do         5400-18600         GP Rs. 2100         ST         01.08.1993           34.         Sri BipinMurmu         Do         5400-18600         Ge Rs. 1800         ST         02.03.2006           35.         Sri SukumarMahato         Do         5400-18600         Ge Rs. 1800         ST         02.03.2006           36.         Sri Seven Baskey         Do         5400-18600         ST <t< td=""><td></td><td></td><td>Gr. I</td><td>GP Rs. 3300</td><td></td><td></td></t<>			Gr. I	GP Rs. 3300		
International methods         International prime         GP Rs. 2900         International prime           27.         Sri NirmalPahan         Sr. Helper Tractor & Vehicle         5400-18600         ST         01.08.1993           28.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600         OBC         05.11.2014           29.         Sri KalipadaPahan         Sr. Darwan         5400-18600         ST         01.08.1993           30.         Smt. SaraswatiKisku         Field Worker         5400-18600         ST         01.08.1993           31.         Sri KishanBaskey         Field Worker         5400-18600         ST         01.08.1993           32.         Sri Sunil Barman         Field Worker         5400-18600         SC         01.08.1993           33.         Smt. RajmoniMahato         Do         5400-18600         SC         01.08.1993           34.         Sri BipinMurmu         Do         5400-18600         GP Rs. 1800         ST         02.03.2006           35.         Sri SukumarMahato         Do         5400-18600         Ge R.         02.03.2006           GP Rs. 1800         ST         02.03.2006         GP Rs. 1800         ST         02.03.2006           36.         Sri SukumarMahato	26.	Sri FulchandPahan	Power Tiller Operator	5400-18600	ST	01.08.1993
27.         Sri NirmalPahan         Sr. Helper Tractor & Vehicle         5400-18600         ST         01.08.1993           28.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600         OBC         05.11.2014           29.         Sri KalipadaPahan         Sr. Darwan         5400-18600         ST         01.08.1993           30.         Smt. SaraswatiKisku         Field Worker         5400-18600         ST         01.08.1993           31.         Sri KishanBaskey         Field Worker         5400-18600         ST         01.08.1993           32.         Sri Sunil Barman         Field Worker         5400-18600         SC         01.08.1993           33.         Smt. RajmoniMahato         Do         5400-18600         SC         01.08.1993           34.         Sri BipinMurmu         Do         5400-18600         GP Rs. 2100         ST         02.03.2006           35.         Sri SukumarMahato         Do         5400-18600         GP.         02.03.2006           36.         Sri SukumarMahato         Do         5400-18600         GP.         02.03.2006           37.         Sri Pravas Barman         Do         5400-18600         GP.         02.03.2006           38.         Sri Sormra Mard				GP Rs. 2900		
Number         Vehicle         GP Rs. 2600         OBC         05.11.2014           28.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600         OBC         05.11.2014           29.         Sri KalipadaPahan         Sr. Darwan         5400-18600         ST         01.08.1993           30.         Smt. SaraswatiKisku         Field Worker         5400-18600         ST         01.08.1993           31.         Sri KishanBaskey         Field Worker         5400-18600         ST         01.08.1993           32.         Sri Sunil Barman         Field Worker         5400-18600         SC         01.08.1993           33.         Smt. RajmoniMahato         Do         5400-18600         Ge n.         01.08.1993           34.         Sri BipinMurmu         Do         5400-18600         Gen.         01.08.1993           35.         Sri SukumarMahato         Do         5400-18600         Gen.         02.03.2006           36.         Sri SukumarMahato         Do         5400-18600         Gen.         02.03.2006           37.         Sri Pravas Barman         Do         5400-18600         Gen.         02.03.2006           38.         Sri Somra Mardi         Do         5400-18600         ST </td <td>27.</td> <td>Sri NirmalPahan</td> <td>Sr. Helper Tractor &amp;</td> <td>5400-18600</td> <td>ST</td> <td>01.08.1993</td>	27.	Sri NirmalPahan	Sr. Helper Tractor &	5400-18600	ST	01.08.1993
28.         Sri Kalyan Kr. Das         Junior Darwan         5400-18600 GP Rs. 1800         OBC         05.11.2014           29.         Sri KalipadaPahan         Sr. Darwan         5400-18600 GP Rs. 2600         ST         01.08.1993           30.         Smt. SaraswatiKisku         Field Worker         5400-18600 Gr. II         ST         01.08.1993           31.         Sri KishanBaskey         Field Worker         5400-18600 Gr. I         ST         01.08.1993           32.         Sri Sunil Barman         Field Worker         5400-18600 GP Rs. 2100         SC         01.08.1993           33.         Smt. RajmoniMahato         Do         5400-18600 GP Rs. 2100         Gen.         01.08.1993           34.         Sri BipinMurmu         Do         5400-18600 GP Rs. 1800         Gen.         02.03.2006           35.         Sri SukumarMahato         Do         5400-18600 GP Rs. 1800         Gen.         02.03.2006           36.         Sri Seven Baskey         Do         5400-18600 GP Rs. 1800         ST         09.09.2008           37.         Sri Pravas Barman         Do         5400-18600 GP Rs. 2100         ST         01.08.1993           38.         Sri Somra Mardi         Do         5400-18600 GP Rs. 2100         ST         01.08.1993			Vehicle	GP Rs. 2600		
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42.         Habis Marak         Junior Driver         5400-18600 GP Rs. 2900         05.11.2014			Observer	GP Rs. 2000		
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## Annual Report 2017-18

# Regional Research Sub Station (OAZ), Uttar Banga Krishi Viswavidyalaya

#### Annual Report 2017-18 :

## Regional Research Sub Station (OAZ), Uttar Banga Krishi Viswavidyalaya

Regional Research Sub Station (OAZ) of UBKV located at Mathurapur – 732203, Malda, West Bengal, is 30 km away from the district headquarter. The University farm attached to the Zonal Research Sub Station has an area about 25 acres. The mandate of Research Sub Station is to maintain the germplasm of wheat, lentil, blackgram, mustard and mango for future crop improvement programme. Moreover, participatory research on Conservation Agriculture takes a lead role towards sustainable intensification of cropping system and uplifts the livelihood of small and marginal farmers through better productivity and profitability.

Participatory seed production is one of the major programme, which helped the farming community to produce good quality of seeds and fetch better market prices. RRSS has also developed collaboration with different National and International Research organizations like IIWBR, IIPR, CIMMYT, ACIAR, ICARDA, IPNI through ad-hoc projects. Climate of the region is warm and humid climate. Maximum temperature in summer goes upto 41°C and minimum temperature is found around 6°C in winter. Average rainfall of the district is around 1300-1500 mm.



RRSS, OAZ, UBKV

Soil of the farm is light loam. It consists of greater proportion of clay and little amount of sand. The bulk density (g/cc) ranges from 1.36-1.42 depending on depth of the soil from 0 to 90 cm. Other properties of soil are given below.

Name of	Soil pH	TOC (%)	Total N	Available P	Available K	Available B
Farm			(g/kg)	(mg/kg)	(mg/kg)	(mg/kg)
RRSS (OAZ),	7.4	1.3	1.0	5.2	84.9	1.5
UBKV						

#### On Farm Trials :

## 1. Evaluation of germplasms for future crop improvement programme :

Maintenance of germplasm is one of the major activities in RRSS Manikchak. The objective of programmes is to evaluate the germpalsm based on their agronomic and phonological characteristics. Moreover, the response of these germpalsm against pests and diseases also recorded to screen good entries for future crop improvement programmes. The results of evaluation of germplasms on different crops are furnished below.

i) Wheat : More than 400 germpalsms received from CIMMYT and BISA under CSISA and CRP project were screened for last six years. Thirteen had crossed IPPSN trials. Two entries (UBW 9 and UBW 8) were promoted to NIVT. However, embargo of inclusion of wheat germplasm under AIW&BIP in 2017-18, initiatives were taken to maintain the potential lines in 2017-18.

- ii) Lentil : 11 lines were maintained. Bari Musur 7 recorded highest yield of 8.47 kg/30 sq.m. (plot yield). The same was found less infested by *Stemphyllum rot.*
- iii) Black Gram : 11 lines were maintained. It was revealed that Kalo Kalai gave maximum yield (780 gm/6 sq.m). However, Tukri Kalai was found less infested by YMV and fruit borer complex.
- iv) Mustard : 14 lines were maintained. CS 54 recorded highest yield (367.65 g/1.8 sq.m.)
- v) Brinjal : 32 local cultivars were maintained, where 2 lines were found tolerant to fruit and shoot borer.

## 2. Weed management options for zero-till/strip (minimum-till) maize in EGP

In case of weed management for zero tillage maize pre emergence or post emergence application of herbicide is not individually sufficient for controlling weeds. From this experiment it is revealed that pre-emergence application of Pendimethalin (1000 g a.i/ha) along with post emergence application of Tembotrione (120 g a.i/ha) + Atrazine (500 g a.i/ha) shows the best grain yield (6999.33kg/ha).

**3.** Weed management options for zero-till/strip (minimum-till) green gram in old alluvial zone It was revealed that the maximum reduction in weed population with the highest weed control efficiency along with the maximum seed yield (809 kg/ha) and benefit cost ratio were achieved with the treatment receiving pre-emergence Pendimethalin (750 g *a.i.* ha<sup>-1</sup>) + Imazethapyr (37.5 g *a.i.* ha<sup>-1</sup>) along with post emergence Imazethapyr (75 g *a.i.* ha<sup>-1</sup>).

## 4. Weed management options for lentil in old alluvial zone

It was revealed that the maximum reduction in weed population with the highest weed control efficiency along with the maximum seed yield (1500 kg/ha) were obtained with the treatment receiving pre-emergence Pendimethalin (750 g a.i. ha<sup>-1</sup>) + Imazethapyr (37.5 g a.i. ha<sup>-1</sup>) along with post emergence Quizalofop-ethyl (50 g a.i. ha<sup>-1</sup>).

## **On-going Programme :**

- 1. Weed management options for zero-till/minimum-till dry direct seeded rice in EGP
- 2. Pest dynamics of CA based Rice-Wheat Cropping System in Old Alluvial Zone



Glimpses of RRSS Farm with Research Trials Plots

Lentil & Wheat Seed Production (Br-F)



**Black Gram Local Cultivars Evaluation** 

CA Maize : Herbicidal Trial

#### Participatory Research Programme :

#### Promotion of Conservation Agriculture :

The journey of the project "Sustainable Resilient Farming System Intensification in Eastern Gangetic Plains" started with its inception workshop in Nepal with all of the 22 partners from India and abroad which included Consultative Group of International Agricultural Research (CGIAR) institutes as **CIMMYT** (International Maize and Wheat Improvement Centre), **IFPRI** (International Food and Policy Research Institute) and **IWMI** (International Water Management Institute) and Universities from abroad as

University of Queensland, Curtin University and University of New England to name a few besides CSIRO (Commonwealth Scientific and Industrial Research Organization).

The project technically aimed towards

- · Conservation Agriculture
  - Minimum disturbance of soil (zero/reduce till or no puddling) to improve quality and mitigate climatic risk
  - Retention of residue (recycling of mineral nutrition and carbon)
  - Crop diversification (utilization of resource from different strata of soil and system sustainability)
- Nutrient Management (Site Specific Nutrient Management : better replenishment of soil fertility)
- · Integrated Crop Health Management (Pest, Pathogen and Weeds)
- · Energy Efficient Cropping Systems (save fossil energy)
- · Varietal Management (better yield and system intensification)
- · Economic Viability (better livelihood)

With more than **150** farmers participatory trials with a few technologies has been demonstrated and validated in 5 nodes of Malda, with an aim to increase the livelihood by addressing both profitability and productivity at the same time with sustainability of the smallholder agriculture in EGP.

Cropping system analysis approach for last three years has been followed as the backbone of research design for each and every location separately, targeting towards providing sustainable options to the farmers as alternative cropping systems. The three years of research have yielded in refined CA protocols for the individual crops in the cropping system and disseminated among the end users through capacity building programmes at different levels. Continuous efforts in capacity building to the service providers (mostly Farmers' associations) have paved the way to success in adoption of CA technology.

The results of the participatory research done at Malda districts with five nodes provided strong field based evidences about the benefit of conservation agriculture over conventional tillage, which essentially is the driving force for wide spread adoption of the technology. The per cent benefits may be summarized as follows for two districts under SRFSI.

The per cent benefits over conventional tillage may be summarized as follows for in the district under SRFSI.

- i. Increased Productivity
  - Rice: 0.5% to 3.2%, Maize: 2.7-7.9%, Wheat: 3.1-8.7%, Lentil 9.1-10.9%
- ii. Reduced Production Cost
  - Rice 3.0-23.0%, Maize 12.3-18.0%, Wheat 6.9-7.9%, Lentil 2.3-11.8%
- iii. Reduced Labour

Rice 35.92-46.41%, Maize 29.04-29.70%, Wheat 26.94-27.30% Lentil 14.13-14.21%

iv. Increased Profitability

Rice 28.3-92%, Maize 26.2-41.2%, Wheat 50.0-62.0% Lentil 21.5-27.0%

v. Reduced Irrigation

Rice 2.74 – 5.01%, Maize 16.17-17.16%, Wheat 10.75-16.13% Lentil 11.37-22.82%

vi. Energy Efficiency : 1.2-3.2%

#### vii. Low Environmental Footprints

Fuel consumption : 70-80% less, CO<sub>2</sub> Emission: 9.2 - 31.7% less

The details of other activities under taken in 2017-18 are furnished below.

#### Table 1. Stakeholders participation in different events during May 01, 2017 – April 30, 2018.

Time of events	No. of	Date of	No. of participants*		
Type of events	events	event	Male	Female	Total
Rabi planning/Project meeting	03	25.10.2017	110	40	150
		30.10.2017			
		6.11.2017			
	04	9.1.2018	89	31	100
		17.1.2018			
		24.1.2018			
		29.1.2018			
Kharif Update/Planning Meeting	5	22.05.2017	16	7	23
		26.05.2017	14	04	18
		26.05.2017	08	08	16
		26.05.2017	09	01	10
		29.05.2017	11	01	12
	02	2.6.2017	75	25	100
		10.6.2017			
	01	17.06.2018	85	15	100
		25.06.2018			
Exposure visit	02	10.9.2017	40	10	50
	01	16.01.2018	100		100
	02	13.02.2018	42	0	42
		17.03.2018	26	0	26
FGD/Farmers consultation meeting	01	19.5.2017	39	21	60
	01	25.6.2017	20		20
Field day	02	13.12.2017	175	25	200
		19.01.2018			
	03	14.01.2018	224	76	300
		12.02.2018			
		13.03.2018			
Capacity Building:	01	10.02.2018	25	05	30
L3: Training for farmers	02	12.5.2017	76	14	90
		21.07.2017			
	02	30.6.2017	42	18	60
		18.7.2017			
L2: Training for LSPs, Inputs Dealer, etc.	01	16.05.2017	16	-	16

	02	10.6.2017	30		30
		25.10.2017			
L2: Training for LSPs, Inputs Dealer, etc.	02	13.12.2017	31	0	31
		06.02.2018	29	0	29
L1: Training for Extension/Project staff	02	13.12.2017	13	0	13
		06.02.2018	11	0	11
Others (Farmers & LSP Interaction on	01	30.10.2017	29	8	37
CA Maize)					
	02	05.12.2017	40	20	60
		06.12.2017			
	02	03.01.2018	48	12	60
		04.01.2018			
Visit of P. K. Majumder, Agriculture	01	20.02.2018			
Advisor to Hon'ble Chief Minister of					
West Bengal					
		21.02.18			
Other Training Meeting on CA					
1. Farmers Meeting	02	13.07.2017	50	0	50
		16.03.2018	30	0	30
2. Extension Officers	01	19.01.2018	25	0	25
3. Input Dealers	01	08.02.2018	25	0	25
Total	49		1597	348	1945

**Table2:** Out-scaling of SRFSI technology (Direct Supported) interventions during May 01, 2017 – April 30, 2018.

S	SRFSI Technology	Crop	Name of area	No. of	farmers	engaged	in out-	Area
L	interventions (variety,		(node)	scaling*				covered
	fertilizers, mechanization,		implemented	Jointly	Male	Female	Total	(ha)
	herbicide, seed, CA, etc.)							
1	Var MTU 1075/(DSR)	Rice/w	Ugritola,	85		24	109	38.74
	Var MTU 1010 (MTR)	heat/	Bhaluara,					
	Var HD-2967 & BHU-35 (CA)	maize/	Mirkamari					
	Var DKC-9081, YUVRAJ GOLD,	mungb						
	BADSHA-22 & JK-502 (CA)	ean/le						
	Var SWETA, HUM-16 (CA)	ntii						
	Var MOITREE (CA)							
2	Var SS-1 (DSR)	Rice/w	Gourangapur	139		49	188	70.54
	Var IRT-4094 (MTR)	heat/						
	Var HD-2967 (CA)	maize/						
	Var DKC-9081 & JK-502 (CA)	Tenul						
	Var MOITREE (CA)							

3	Var MTU1075 (DSR) Var NABIN & MTU 1010 (MTR) Var SML-668 (RT) Var DKC-9144 (CA) Var Maitree (CA)	Rice/ Mung bean/ maize/ /lentil	kalinagar	94	21	115	38.85
4	Var MTU-1075 (DSR) Var SUPER MINIKET (MTR) Var HD-2967 (CA) Var YUVRAJ GOLD (CA)	Rice/w heat/ maize	Mahadipur	87	6	93	22.52
5	Var MTU1075 (DSR) MTU-1010 (MTR) Var HD-2967 (CA) Var DKC-9081 & YUVRAJ GOLD (CA) Var Maitree (CA) Var B-9 (CA)	Rice/w heat/ maize/ lentil/ Musta rd	Bidyanandapu r	120	13	133	31.78
6	Var MTU 1010(MTR)	Rice	Dhanjana	1	0	1	0.13
7	Var MTU 1010(MTR)	Rice	Krisnapur	2	0	2	0.40
8	Var MTU 1010(MTR)	Rice	Durgapur	1	0	1	0.13
9	Var MTU 1010(MTR)	Rice	Bhingole	3	0	3	0.4
	Total			532	113	645	203.49

**Table 3:** Out-scaling (Indirect through Convergence, spillover, etc.) of SRFSI technology interventionsduring May 01, 2017 – April 30, 2018

SL	SRFSI Technology interventions (variety,	Crop	Name of area (node)	No. of scaling*	farmers	engaged	l in out-	Area covered
	fertilizers, mechanization,		implemente	Jointl	Male	Female	Total	(ha)
	herbicide, seed, CA, etc.)		d	у				
1	Variety SS-1 under BGREI	Kharif	Mahadipur,	25		05	30	15.0
	(DSR)	Paddy	Hajratpur					
			Bidyanandap					
			ur					
2	Variety Pratiksha under	Kharif	Meghadumra	13		2	15	5.0
	BGREI (DSR)	Paddy	, Gangadebi					
3	Variety Yuvraj Gold under	Maize	Mahadipur,G	29		6	35	12.0
	ATMA (CA)		oursanda,					
			Anupnagar					
			,Kandaran					
4	Variety WBL-11 (Maitree)	lentil	Mahadipur,	23		5	28	10.0
	under BGREI NFSM-Pulse		Bidyanandap					
	(CA)		ur Anupnagar					
5	Fertilizers SRFSI Protocol in	Kharif	Mahadipur,	34		6	40	12.0
	kharif Paddy (BGREI)	paddy	Hajratpur,					

	under DSR & CA Maize (ATMA)	Maize	Bidyanandap ur, Meghdumra, Gangadehi				
6	MTR under BGREI (Variety MTU 1010)	Boro paddy	Bidyanandap ur, sahurgachi , Mahadipur, Anupnagar, Goursanda	29	6	35	6.0
7	Herbicide (SRFSI Protocol)	Maize	Jalalpur, Khanpur, Goursanda, Anupnagar, Meghdumra	92	12	104	40.0
8	Var – Kesari- 5111(BGREI Scheme) under CA	Musta red	Banial, Gazole-II G.P.	08	-	08	4.0
9	Var – Kesari- 5111(BGREI Scheme) under CA	Musta red	Rashikpur, gazole GP	01	-	01	0.13
10	Var – Kesari- 5111(BGREI Scheme) under CA	Musta red	Agampur, majhra	01	-	01	0.26
11	Var- SS-1 (BGREI Scheme)	Kharif paddy	Kalinagar, Alal G.P. Gourangapur karkach G.P.	156	30	186	100.0
12	Var – WBL 77 (Maitree) (BGREI Scheme) under CA	Lentil	Kalinagar, Alal G.P. Gourangapur karkach G.P.	25	5	30	8.0
	Total			436	77	513	218.39



Visit of Agriculture Advisor to Hon'ble Chief Minister



Visit of District Magistrate, Malda



Visit to ZT Wheat Field by Scientists from CIMMYT



Encouraging Women SHG as Local Service Provider



MTR in Ratua I Block



Seedling Factory for MTR



Visit of Joint Director of Agriculture (Planning), Govt. of WB



MTR in Gazole Block (23 days of Crop)



Visit of ZT Wheat by DDM NABARD



Exposure Visit of Farmers from different blocks in ZT Maize



## Participatory Seed Production :

The participatory seed production of pulses has been implemented under DAC &FW sponsored project "Seed Hub Pulses" and ICAR sponsored "Seed Project" following Conservation Agriculture Technology,

the protocol of which was standardized in SRFSI project. No till surface seeding followed by mulching and seed priming with bio-inoculant consortium (*Rhizobium, PSB* and *Trichoderma viride*) are main interventions adopted in the field. Average productivity of lentil (variety Maitree) enhanced from 1.4 t/ha to 2.2 t/ha. The pulse seed production scenario in last two years is furnished below.

Crop	Variety	2017-18		
		Target (q)	Production (q)	Category of Seed (F/S, C/S)
Lentil	WBL-77	400	226.5	C/S
Lentil	WBL-77	6.0	5.0	F/S
Mungbean	KM 2241	100	3.39	C/S
Mungbean	IPM 02-03	0.50	0.37	F/S
Mungbean	Meha	0.50	0.47	F/S
Mungbean	Hum 16	15	0.60	F/S
Blackgram	PU 31	0.50	0.20	F/S
Wheat	HD 2967	92.0	86.7	C/S
Rice	MTU 1075	75.0	62.3	C/S

## Infrastructure Development under DAC & FW sponsored Project "Seed Hub Pulses" :

Seed processing unit with a capacity of 100 MT was completed during March, 2018. All the equipment was procured and installed. However, infrastructure for conditional seed storage (capacity 20 MT) was completed, but the equipment such de-humidifier, cooling unit is yet to be installed.





## Promotion of Oilseed Crops :

Promotion of oilseed crops like mustard and ground nut was taken under NMOOP project on 'Promotion of oilseed crops in northern districts of West Bengal for livelihood security of small and marginal farmers' in 2017-18. The average yield of mustard was recorded 1.34 t/ha, while in case of groundnut it was 1.82 t/ha. The detail list of beneficiary is furnished below.

SI.	Name of the	Village	Block	Area	Variety	Date of
No	beneficiary			(ha.)		sowing
1	Ratan Roy	Gourangapur	Gazole	0.13	Shivani (102)	18.11.2017
2	Ananta Sarkar	Gourangapur	Gazole	0.4	B-54	04.11.2017
3	Naresh Ch. Mandal	Gourangapur	Gazole	0.67	Shivani (102)	28.10.2017
4	Sanjit Biswas	Gourangapur	Gazole	0.4	Shivani (102)	10.11.2017
5	Ramprasad Sarkar	Gourangapur	Gazole	0.4	B-54	08.11.2017

#### Table 1 : List of beneficiary in demonstration of mustard under NMOOP Project

6	Bhabesh Shil	Gourangapur	Gazole	0.53	B-54	04.11.2017
7	Thakur Das Roy	Gourangapur	Gazole	0.93	B-54	04.11.2017
8	Tanir Rahaman	Bidyanandapur	Chanchal-II	0.13	B-9	05.12.2017
9	Swapan Das	Bidyanandapur	Chanchal-II	0.13	B-9	07.11.2017
10	Amir Hossain	Habinagar	Chanchal-II	0.27	B-9	01.11.2017
11	Sk. Saidul	Bidyanandapur	Chanchal-Ii	0.27	B-54	07.11.2017
12	Haripada Das	Bidyanandapur	Chanchal-Ii	0.27	B-9	01.11.2017
13	Khas Mahammad	Ghorown	Chanchal-Ii	0.20	B-9	04.11.2017
14	Aiyub Ali	Habinagar	Chanchal-li	0.27	B-9	04.11.2017
15	Rajjak	Bidyanandapur	Chanchal-Ii	0.27	B-9	28.10.207
16	Serajul Hoque	Habinagar	Chanchal-li	0.27	B-9	29.10.2017
17	Anwar Ali	Bidyanandapur	Chanchal-Ii	0.27	B-9	29.10.2017
18	Mansur	Bidyanandapur	Chanchal-II	0.27	B-9	01.11.2017
19	Jahangir Alam	Habinagar	Chanchal-II	0.20	B-9	28.10.2017
20	Taimur Rahaman	Bidyanandapur	Chanchal-II	0.27	B-54	28.10.2017
21	Nakasu	Bidyanandapur	Chanchal-II	0.27	B-9	28.10.2017
22	Maruf Hossain	Manik Nagar	Chanchal-II	0.20	B-9	07.11.2017

## Table 2 : List of beneficiary in demonstration of groundnut under NMOOP Project

Sl.	Name of the beneficiary	Village	Block	Area	Variety	Date of
No				(ha.)		sowing
1	Atiur Rahaman	Bhowani Pur	Gazole	0.27	Tg-51	20.12.2017
2	Bangsidhar Barman	Sahil	Gazole	0.27	Tg-51	15.12.2017
3	Namijur Rahaman	Naya Para	Gazole	0.27	Tg-51	31.12.2017
4	Sk. Naimuddin	Naya Para	Gazole	0.27	TG-51	24.12.2017
5	Sukaruddin Sekh	Naya Para	Gazole	0.27	Tg-51	27.12.2017
6	Ahasan Sekh	Naya Para	Gazole	0.27	Tg-51	26.12.2017
7	Sahid Mia	Babnahar	Gazole	0.27	Tg-51	28.12.2017
8	Atindranath Barman	Sahil	Gazole	0.27	Tg-51	20.12.2017
9	Amal Barman	Sahil	Gazole	0.27	TG-51	18.12.2017
10	Maniruddin	Babnahar	Gazole	0.27	TG-51	28.12.2017
11	Samuel Murmu	Sahil	Gazole	0.27	TG-51	18.12.2017
12	Sachindranath Barman	Sahil	Gazole	0.27	Tg-51	18.12.2017
13	Rejaur Rahaman	Babnahar	Gazole	0.27	Tg-51	18.12.2017
14	Rashidur Rahaman	Bhabanipur	Gazole	0.27	Tg-51	18.12.2017
15	Kabatulla Sarkar	Babnahar	Gazole	0.27	Tg-51	20.12.2017
16	Lakshmiram Saren	Kodma	Gazole	0.27	Tg-51	20.12.2017
17	Anisur Rahaman	Bhawanipur	Gazole	0.27	Tg-51	20.12.2017
18	Akhtar Hossain	Bhawanipur	Gazole	0.27	Tg-51	19.12.2017
19	Purna Roy	Sahil	Gazole	0.27	Tg-51	30.12.2017
20	Mobarak Hossain	Bhawanipur	Gazole	0.27	Tg-51	19.12.2017
21	Ajijur Rahaman	Bhawanipur	Gazole	0.27	Tg-51	18.12.2017
22	Abrar Hossain	Bhawanipur	Gazole	0.27	Tg-51	20.12.2017

23	Dipak Roy	Sahil	Gazole	0.27	Tg-51	21.12.2017
24	Akbar Hossain	Bhawanipur	Gazole	0.27	Tg-51	17.12.2017
25	Fajlur Rahaman	Babnahar	Gazole	0.27	Tg-51	20.12.207
26	Sofikul Islam	Bhawanipur	Gazole	0.27	Tg-51	21.12.2017
27	Majibur Rahaman	Babnahar	Gazole	0.27	Tg-51	21.12.2017
28	Asraful Huda	Babnahar	Gazole	0.4	Tg-51	18.12.2017
29	Mahbub UI Anam	Bhawanipur	Gazole	0.27	Tg-51	15.12.2017
30	Sah Jamal Sarkar	Bhawanipur	Gazole	0.27	Tg-51	20.12.2017
31	Mostaque Hossain	Babnahar	Gazole	0.27	Tg-51	20.12.2017
32	Raghunath Barman	Sahil	Gazole	0.27	Tg-51	20.12.2017
33	Altafur Rahaman	Bhawanipur	Gazole	0.27	Tg-51	25.12.2017
34	Humayan Kabir	Babnahar	Gazole	0.27	Tg-51	19.12.2017
35	Abdul Hakim	Bhawanipur	Gazole	0.27	Tg-51	20.12.2017
36	Jiaur Rahaman	Babnahar	Gazole	0.27	Tg-51	23.12.2017
37	Ratan Barman	Sahil	Gazole	0.27	Tg-51	22.12.2017
38	Pauwl Hansda	Sahil	Gazole	0.27	Tg-51	23.12.2017
39	Daud Hansda	Sahil	Gazole	0.27	Tg-51	25.12.2017
40	Manjur Rahaman	Bhawanipur	Gazole	0.27	Tg-51	25.12.2017
41	Chandan Besra	Sahil	Gazole	0.27	Tg-51	25.12.2017
42	Ramesh Kisku	Sahil	Gazole	0.27	Tg-51	24.12.2017
43	Sunil Burman	Sahil	Gazole	0.13	Tg-51	22.12.2017
44	Wilson Murmu	Sahil	Gazole	0.13	Tg-51	23.12.2017
45	Mangal Kisku	Sahil	Gazole	0.27	Tg-51	23.12.2017
46	Sanatan Murmu	Sahil	Gazole	0.13	Tg-51	22.12.2017
47	Hasenujjaman	Babnahar	Gazole	0.40	Tg-51	23.12.2017
48	Amir Hossain	Babnahar	Gazole	0.13	Tg-51	23.12.2017



# Annual Report 2017-18 Regional Research Station (Hill Zone), Uttar Banga Krishi Viswavidyalaya

## **ABOUT THE STATION**

The Regional Research Station, Kalimpong represents the hilly region of Darjeeling district of West Bengal. It has two other sub-stations under its administrative control and is located at Pedong and Dalapchand respectively. The Regional Research Station at Kalimpong caters to the needs of farmers and offer solutions to the location specific problems in the hilly agro-climatic zone of West Bengal, comprising the three hill sub-divisions of Darjeeling district. The station activities are focused to conduct location specific, production and productivity oriented research in agricultural and horticultural crops and are disseminated to the farming community through KVK and state agricultural machineries.

Station	Area (acres)	Altitude (m)	Latitude	Longitude
RRS, Kalimpong	80.54	1097	27°31' N	88°28' E
RRSs, Pedong	29.00	1200	27°15' N	88°62' E
RRSs, Dalapchand	59.00	1300	22°57' N	88°36' E

#### **STAFF STRENGTH**

Sl. no.	Staff Position	Numbers
1	Teaching Staff	12
2	Non-Teaching Staff	22
3	Field worker RRS Kalimpong	50
4	Field worker/other staff RRSsPedong	10
5	Field worker of Dalapchand	11
6	G.K.M.S RRS (Hill Zone)	02
Total		107

## **STAFF POSITION**

Sl. No.	Name of the Posts	<b>S</b> *	<b>P</b> *	<b>V</b> *
1.	Associate Professor-in - Agronomy	1	0	1
2	Associate Professor-in- Horticulture	1	1	0
3	Associate Professor-in-Plant Pathology	1	1	0
4	Associate Professor-in-Genetics & Plant	1	0	1
	Breeding			
5	Assistant Professor-in-Soil Science	1	1	0
6	Assistant Professor-in-Soil Micro-Biology	1	0	1
7	Assistant. Professor-in-Ag. Economics	1	0	1
8	Asst. Professor-in-Animal Husbandry	1	0	1
9	Assistant Professor-in-Ag. Entomology	2	2	0
10	Assistant Professor-in-Ag. Extension	1	0	1
11	Assistant Professor-in-Plant Pathology	1	1	0
12	Assistant Professor-in-Horticulture	1	1	0
13	Assistant Professor-in- Genetics & Plant	1	1	0
	Breeding			
14	Assistant Director of Farm	1	0	1
15	Farm Manager	1	0	1
16	Sr. Field Assistant	2	0	2
17	Field Assistant	6	0	6
18	Lab. Assistant	4	0	4
19	Lab. Attendant	4	4	0
20	Head clerk	1	0	1
21	Cashier	1	0	1
22	U.D.C.	1	0	1
23	Clerk/ Storekeeper	3	2	1
24	Clerk cum Typist	3	0	3
25	Stenographer	1	0	1
26	Light Tractor Driver	1	1	0
27	Driver	3	0	3
28	Gardener	5	1	4
29	Peon	6	6	0
30	Watchman/Darwan	8	4	4
31	Sweeper	1	0	1

S\*=Sanctioned; P\*=Positioned; V\*=Vacant

## **OBJECTIVES**

- Development of suitable farming system.
- Identification and development of suitable cropping sequence.
- Conservation of plant genetic resources and Improvement of crop varieties.
- Management of rhizome rots in ginger.
- Soil testing and recommendations for judicious application of macro and micro nutrients in farmer's field.
- Development of fodder component of animal nutrition by fitting the crop in crop sequences and or through silvi-pastoral system.

#### SALIENT FINDINGS OF RESEARCH CONDUCTED DURING 2015-16

## **IN-HOUSE PROJECTS**

## **Crop Production**

- 1. Comparative effectiveness of Rock phosphate, Lime and FYM in relation to soil properties with particular emphasis on P availability and residual effects in successive crop were studied. Amounts of available P (kgha<sup>-1</sup>) were found at par with combined application of soil amendments (L+PR+FYM) in treatment receiving 100 % RDF at vegetative stage of the plant (30 DAS). But available Phosphorus was found to be lower at maturity of the crop that may be due to fixation of available P under treatment receiving 100% RDF (93.6 kgha<sup>-1</sup>). The levels of soil available P (kgha<sup>-1</sup>) followed the order at vegetative stage of the crop (30 DAS); 100%RDF > L+FYM+PR > FYM+PR > L+PR> L+FYM. At maturity, significantly higher soil available P was found in the L+FYM+PR treatment (113.2 kgha-1) than 100% RDF (93.6 kgha<sup>-1</sup>). During maturity, combined treatments, L+FYM+PR, FYM+PR and L+PR, had significantly higher amounts of available P 113.2, 104.1 and 102.5 kgha-1 respectively than 100% RDF (93.6 kgha-1).Study will be continued for another 2-3 years to get the residual effect of these amendments on successive crops.
- Studies on the growth and yield of ginger as influenced by different organic mulching materials under hill ecosystem revealed significant response with black polythene mulch compared to other mulching materials studied.

3. Turmeric germplasm received from AICRP (Spices) are in the second year of study for their performance in the hill zone of West Bengal under mandarin orchard.

## **Crop Protection**

- 1. Survey of Rhizome Rot and Wilt Disease Incidence of Ginger in Darjeeling Hill revealed higher disease incidence where *Ralstonia* and nematode were associated with the disease. Low to moderate disease incidence were recorded in the ginger field having preceding crops like buckwheat, coarse cereals and cruciferous crops, whereas the plots having preceding crops of solanaceous vegetables, potato, yam showed higher levels of disease incidence. Moreover it was also observed that lower disease incidence was recorded in the villages where longer crop rotation was followed. It was also noticed that the disease incidence was high in the villages where only 1-2 years crop rotation was followed. Thus from the present investigation it may be concluded that more than 3-4 years crop rotation coupled with cultivation of buckwheat, coarse cereals and cruciferous crops as preceding crop was found to be a better option for management of rhizome rot and wilt disease complex of ginger.
- 2. Seed treatment with Captan followed by three sprays of Propiconazole at 30 days interval was found to be the best in reducing the *Turcicum* leaf blight of Maize followed by seed treatment either with *Trichoderma* or *Pseudomonas* in combination with three sprays of Propiconazole, though the differences were not statistically significant (P=0.05). The most effective treatment i.e. Captan as seed treatment with three propiconazole spray had significantly higher yield (by 443%) as compared to control.
- 3. Studies to find out the suitable alternatives for sterilization of the substrate for cultivation of Oyster Mushroom (*Pleurotus sajor-caju*) revealed the substrate treated with 0.2% Dithane M 45 and 0.2% Malathion gave the best spawn run of 3.30 cm and 2.98 cm in 10 days respectively and yield of 600 g/kg of dry straw in case of Dithane M 45 and 580 g/kg. of dry straw in case of Malathion. The combined application of these two chemicals also had a synergistic effect on spawn run and yield of *Pleurotus sajor-caju*.
- 4. Efficacy of Bio-Primed Seedlings in Crop Management of Round Chilli (*Dalley Khorsani*) in Darjeeling Hills was studied and found that the effect of bio-agents,

like, *Trichoderma harzianum* (UBT-18), *Psudomonas. fluorescence* (Vpf-1) and PSB to be very effective in management of crop. It influenced root length, shoot length and vigour index but had insignificant effect on germination and damping off disease.

- 5. Survey on diseases on Mandarin was conducted in entire district. The disease were identified on the basis of symptoms and/or morphological studies of pathogens and it was found that the eight diseases *viz*. Gummosis and foot-rot caused by *Phytophthora* spp., powdery mildew caused by *Oidium tingitaninum*, felt caused by *Septobasidium* spp. Sooty mould caused by *Capnodium citri* and greening caused by *Candidatus* Liberibacter asiaticus were common in all the areas under survey.
- 6. Study on Integrated Management of Bacterial wilt of ginger caused by *Ralstonia solanacearum* under hill agro-ecological situation was conducted. The first year data showed that Soil application of lime and bleaching powder 21 days before planting followed by soil application of *Ps. fluorescence* during land preparation was very effective as compared to control.
- 7. A new disease of *Valeriana jatamansi* was reported. The studies on symptoms and morphological studies revealed that the pathogen is *Sclerotinia sclerotiorum* (Lib.) de Bary. This is the first report that *Valeriana jatamansi* is naturally infected by *Sclerotinia sclerotiorum*.
- 8. Study on bio-efficacy and phytotoxicity of Tolfenpyrad 15% EC on vegetables were undertaken. The best control of DBM and aphid and the highest yield of cabbage were recorded in Tolfenpyrad 15% EC treated plots @150 g ai./ha. No phytotoxic symptoms were observed. The product was found relatively safe to beetles and spiders. The best control of aphid, jassid and white fly on okra were recorded in Tolfenpyrad 15% EC treated plots @150 g ai./ha. No phytotoxic symptoms were observed. The product was found relatively safe to beetles and spiders. The best control of aphid, jassid and white fly on okra were recorded in Tolfenpyrad 15% EC treated plots @150 g ai./ha. No phytotoxic symptoms were observed. The product was found relatively safe to beetles and spiders.
- 9. Documentation on the seasonal incidence of major insect and mite pests of chilli (*Capsicum annum* L.) cv *Dalley* and of major insect pest and natural enemies of okra in hill agro-climatic zone of West Bengal has been made and will be continued for 2 years.
- 10. Roving and fixed plot survey was carried out to identify insect pests, their natural enemies and occurrence of new pests in *kharif* paddy. Rice leaf folder

(*Canaphalocrosis medinalis*), Caseworm (*Nymphula depunctalis*), Yellow stem borer (*Scirpophaga incertulus*), Gundhi bug (*Leptocorisa varicornis*) and grass hopper were the main pest. Rice hispa (*Dicladispa armigera*), Green leaf hopper (*Nephotettix* sp), Rice ear cutting caterpillar (*Mythimna separata*), Brown plant hopper (*Nilaparvata lugens*) and White backed plant hopper (*Sogotella furcifera*) were recorded as minor pests. The natural enemies of rice insect-pests viz., *Trichogramma* sp, Damsel flies, Spiders, ladybird beetle, Crickets, predacious larva of Carabid beetle, long horned grass hopper, dragonfly and birds were recorded from the rice field. Enumeration of insect pests and natural enemies associated with *Kharif* paddy will be continued for the 3 years.

11. Population dynamics of insect pests in okra and common bean were studied at RRSs, Pedong. In okra, maximum population of white fly, jassid, shoot borer and aphid during August and September during vegetative stage. The maximum infestation of blister beetle, red cotton bug and fruit borer was recorded in reproductive stage in September to November. In beans, maximum population of bean aphid was recorded during July to September (in vegetative stage). The maximum infestation of blister beetle and pod borers was recorded in reproductive stage in September to October. White fly and leaf hopper/ jassid, pod bug, sting bug were recorded as minor pests. Studies on population dynamics will be repeated.

#### **Crop Improvement**

- Identifying traditional rice germplasm with useful traits is an important activity in rice improvement. Systematic studies on the morphological traits in the local cultivars are being studied following standard evaluation system (SES) for rice developed by IRRI. 14 local cultivars have been collected for on farm conservation and use in future research programme.
- Characterization of local chilli cv. *Dallay* using descriptors for *Capsicum* spp developed by IPGRI is being studied with the objective of isolating desiring lines for use in future research programme. A total of 63 characters are being studied (Plant descriptors-19; Inflorescence & fruit-38; Seed-6).

3. Large variability exists for bean *Phaseolus vulgaris* L. The station presently has 20 collections of local beans. A collaborative research programme is underway with *Lok Chetna Manch*, an NGO working in rural and remote areas of Darjeeling hills.

## ALL INDIA COORDINATED RESEARCH PROJECTS (AICRPs)

Sl. No.	Project	Incharge	Funding Agency
1,	AICRP on Floriculture	Ms. S. Pradhan	
2.	AICRP on MAP & B	Mr. S. Baskey	

#### **AICRP on Floriculture**

- Ninety three species under 32 genera of orchids are being maintained at Pedong Centre under low cost UV-sterilized agro-shade net covered orchidarium. Thirty different hybrids of Cymbidium are also being maintained and evaluated at RRS (HZ) Kalimpong centre. Some of the species are rare, endangered or already extinct in the wild.
- 2. Among the Cymbidium species, *Cymbidium devonianum* produced highest number of flowers (27.49).
- 3. The species namely, Coelogynenitida, Cymbidium devonianum, Cymbidium tigrinum, Paphiopedilum venustum, Paphiopedilum hirsutissimum, paphiopedilum insigne, Paphiopedilum spicerianum, Paphiopedilum fairrieanum have been found superior for pot cultivation.
- 4. Cymbidium hybrids revealed significant differences were observed for most of the vegetative and flowering parameters studied. Cymbidium cv. Golden girl recorded highest number of pseudobulbs per plant (12.11), pseudobulb length (12.85 cm) and leaf number per plant (34.52). Early flowering was reported in Kennywine (346.05 days). Highest number of spikes/plant (6.54), number of flowers per spike (18.63), and longest vase life (41.52 days) was recorded in var. Kennywine. The flowering duration was recorded maximum in Tal Graig Sutherland (62.72 days) which was statistically at par with Kennywine (62.48 days). Largest flower size was recorded

in December Gold (14.55 cm) while Minishara Artishion reported smallest flowers (8.02 cm).

- 5. Among the hybrids, Golden girl, Kennywine, December gold, Culvetra Sydney performed exceedingly well in Kalimpong region with respect to both vegetative and flowering parameters and can be recommended for commercial cut flower production.
- 6. Among the 12 genotypes of gerbera, Goliath, Red Explosion, Sangria, Sunway, Kalimpong Red and Kalimpong pink produced good quality flowers and can be recommended for commercial cultivation in Darjeeling hills of West Bengal.
- 7. Pre-treatment with NaOCl (1000ppm + 0.1% tween 20) and wet storage in water at 13-15° C for 6 days was found to be most suitable for increasing the post-harvest life of cut anthurium stems.
- 8. In *Alstroemeria*, the varieties Pluto and Pink Panther performed better and can be recommended for commercial cultivation.
- 9. Among the different growing medias studied, *Alstroemeria* cv. Pluto performed best in the media consisting of ((Sand + soil + FYM) + vermicompost + cocopeat (2:1:1;v/v) with respect to vegetative and reproductive parameters.

#### AICRP-MAP & B

- A number of exploration trip and collection has been made in Swertia chirayita, Valeriana jatamansi, Centella asiatica, Acorus calamus and Berginia ciliate and a good number of germplasm has been registered with NBPGR, New Delhi
- 2. MLT evaluation of promising lines of Indian *Valeriana jatamansi* for yield and quality is under progress with healthy seedlings having been transplanted into the main trial field in recommended design and plant spacing.
- Evaluation of promising accessions of Bach (*Acorus calamus*) under Multi-location Trial (IVT) is under progress.
- 4. Studies on month-wise severity of fungal disease Alternaria leafspot (Alternaria alternata) in Swertia chirayita, highest disease was recorded during May-June while lowest incidence was recorded during December-January.

- 5. Epidemiological study of fungal disease *Cladosporium* leaf blight (*Cladosporium tennuissimum*) in *Swertia chirayita* showed highest disease incidence during August-September and lowest during January –February.
- 6. Herbal garden has been developed and presently 33 locally available medicinal plants are maintained at the station. The objective is to collect all available species.

## **GOI FUNDED PROJECT**

Gramin Krishi Mausam Sewa, AMFU-Kalimpong

Funding Agency: India Meteorological Department, Ministry of Earth Science, GOI.

Nodal Officer: Shri Koushik Roy

Research Associate: Dr. Agniswar Jha Chakraborty,

Meteorological Observer: Mr. Surajit Halder

#### **Brief report on Project work**

- Weather forecast data received from India Meteorological Department, Pune via RMC Kolkata on each Tuesday and Friday are analyzed by a team of experts consisting of faculty members of RRS (Hill Zone) and SMSs, Darjeeling KVK Kalimpong for Weekly Agro-advisory bulletin. Location specific Agro-advisory bulletin is prepared with the help of advisory board members based on the information on weather forecast, crop condition obtained from the farmers' field (such as crop growth stage, incidence of pest attack and diseases and water stress and livestock status) and past weather condition. Ninety five (95) advisory bulletins were prepared and disseminated in 2015-16.
- The mass dissemination of these bulletins is done twice a week (Tuesdays and Fridays) through IMD Agromet division (Pune), RMC (Kolkata), Agricultural Meteorology Division website, UBKV University website, ADAs of different blocks of Hill Zone, notice board (RRS, Hill Zone) and DJKVK.
- E-bulletin also generated in Tuesday and Friday in Farmers Portals.
- Crop and animal advisory were sent to the farmers through SMS using Farmers Portal.
- 70,844 number farmers of Darjeeling district were benefitted by this service.

- Recording of meteorological data from automatic weather station, RRS (HZ), UBKV, Kalimpong on regular basis.
- Conducted Farmers' Awareness Programmes during 2015-16 in the three blocks of Kalimpong (Gorubathan, Kalimpong-I and Kalimpong-II) regarding the GKMS project and to register their mobile numbers.
- Provide Meteorological Data for the different research purpose.

## **EXTERNALLY FUNDED PROJECTS**

Sl. No.	Project	PI	Funding
			Agency
1.	Study on bio-efficacy and phytotoxicity of	Mr. B. Patra	Coromondal
	Tolfenpyrad 15% EC in vegetables		International
			Pvt. Ltd.

## **VOLUNTARY CENTRE**

Sl. No.	Project	PI
1.	All India Wheat & Barley Improvement Programme	Dr. T. S. Ghimiray
2	All india Coordinated Rice Improvement Programme	Dr. T. S. Ghimiray
3	All India Coordinated Research Project on Mandarin	Dr. S. Gurung

## **EXTENSION ACTIVITIES**

- Farm advisory services
- On-farm testing
- Imparting technical know-how to the farmers
- Training for farmers, farm women and Extension functionaries.
- Pamphlets/booklets.
- Conducting Field day/Farmers Day.

## **MEETS/FARMERS TRAINING ORGANIZED**

- National Consultative meet on Large Cardamom on 18<sup>th</sup> September 2015 at Anand Portico, 9th mile Kalimpong.
- Two Days Farmers' Seminar on **Production and Protection Technologies on Major Cash Crops of Darjeeling Hills** from 16th to 17th March 2015 at Mungpoo, Kalimpong.

- Two Days Farmers' Training on **Cultivation of Ginger and Large Cardamom** at Lingsey Village, Kalimpong II under MIDH-Spices Scheme on 26th and 27th September 2015.
- Three one day "Farmers' Awareness Programmes" were organized in the three blocks of Kalimpong Sub-division (Gorubathan, Kalimpong-I and Kalimpong-II) under GKMS project on 02.03.2016, 03.03.2016 and 10.03.2016.

## FARM ACTIVITIES

The farm activities involve production of different crops pertinent to the region with emphasis on production of quality seed material. The crops include crucifers, leafy vegetables, pulses and oilseeds, potato, ginger, large cardamom etc. During *rabi* 2015-16, the farm produced 16.2 quintals of cole crops especially cabbage, cauliflower and broccoli,15 quintals of potato and 5 q of leafy vegetables(Rai sag, spinach). The farm also produced also9.5 q quality seeds of ginger and 2 q soybean.

Sl. No.	Name of Crop	Area (acre)
1	Ginger	1.5
2	Green Gram	1.5
3	Green Pea	0.5
4	Mustard	2.0
5	Tomato	0.3
6	Research Block	3.0
7	Large cardamom	1.0
8	Potato	1.0
	Total	10.8

#### Existing area under cultivation as in March 2016

 SI No	Name of Cron	Κσ
51. 110.	Tunic of crop	ng
1	Ginger	1980
2	Soybean	100
3	Green Gram	25
4	Maize	
	i NLD	30
	ii A de Cuba	25
	iii Dewaki	25

## Area Expansion

An area of 37 acres has been brought under cultivation with maize, ginger and mandarin. It is proposed to cover 32 acres of farm area with different crops during 2016-17 as given in the following table:

Sl. No.	Name of Crop	Area (acre)	Required planting/seed materials
			(kg)
1	Ginger	20	2500
2	Turmeric	3.0	300
3	Maize	6.0	80.0
4	Bhindi	0.5	5.0
5	Brinjal	0.5	150 g (seed)
6	Large cardamom	2.0	10,000
Total		32	

## **OTHER ACTIVITIES**

- 1. Celebration of 69<sup>th</sup> Independence day on 15<sup>th</sup> August 2015
- 2. Celebration of Republic day on 26<sup>th</sup> January 2016
- 3. Krishi Mela 2016

## **INFRASTRUCTURE AND LOGISTICS**

Administrative building, Guest house, Staff quarters, Godown, Threshing floor and Farm office.

## Infrastructure and logistics required

- Research building
- Staff quarters
- Boundary wall
- Campus all weather roads
- Farm land terracing
- Farm approach roads for movements of farm machinery
- Irrigation facilities, water harvesting structures
- Auditorium

## FACULTY

#### Name: Dr. Sumit Chakravarty

Designation: Associate Professor-cum-Associate Director of Research Specialization: Forestry Contact No: 9434082687 Email Id: c\_drsumit@yahoo.com; sumit@ubkv.ac.in

#### Name: Dr. Tulsi Saran Ghimiray

Designation: Associate Professor Specialization: Genetics & Plant breeding Contact No.: 7797913259 Email ID: ghimiraykpg@gmail.com

## Name: Dr. Sarad Gurung

Designation: Assistant Professor Specialization: Pomology and PHT Contact No.: 9434429066 Email ID: sgurung\_hort@rediffmail.com

#### Name: Dr. Biplab Tudu

Designation: Assistant Professor Specialization: Agricultural Entomology Contact No.: 9932382475 Email ID: btudu\_bckv@rediffmail.com

## Name: **Mr. Hriday Kamal Tarafder** Designation: Assistant Professor Specialization: Soil Science & Agril. Chemistry Contact No. : 8697335105 Email ID: hridaykamalt25@gmail.com

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#### Name: Dr. Sajeed Ali

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## Name: Mr. Sibdas Baskey

Designation: Assistant Professor Specialization: Plant Pathology Contact No.: 9734452339 Email ID: baskeysibdas83@gmail.com

#### Name: Mr. Biswajit Patra

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## Name: **Mrs. Sumita Pradhan** Designation: Assistant Professor Specialization: Floriculture

Contact No. : 9564017005 Email ID: <u>ss-bajrachrya@yahoo.com</u>

## Name: **Mr. Kousik Roy** Designation: Assistant Professor Specialization: Agronomy Contact No. : 8902430449 Email ID: <u>Roy.kousik64@gmail.com</u>
### LIST OF SUPPORTING STAFF

Sl. no.	Name	Designation		
Non-Teaching Staff, RRS, UBKV, Kalimpong				
1	Sri. John Mukhia	Sr. Store Keeper		
2	Sri. Madan Kumar Bhujel	Sr. Assistant		
3	Smt. Bishnu Tamang	Jr. Assistant		
4	Sri. Edward FitzPatrick	Sr. Peon		
5	Smt. Laxmi Gurung	-do-		
6	Smt. Leela Gurung	Lab. Attendant		
7	Smt. Sanju Chettri	-do-		
8	Miss Punam Pariyar	Sr. Peon		
9	Smt. Jyoti Ghimirey	Lab. Attendant		
10	Sri. Raju Pradhan	Jr Assistant		
11	Sri. Tshering Thendup Bhutia	Driver		
12	Sri. Netra Prasad Sharma	Lab. Attendant		
13	Sri Vishal Chhetri	Jr Cashier		
14	Smt. Geeta Sharma	Field Assistant		
15	Sri. Nirmal Bagdas	Sr. Driver		
16	Miss Prerna Pradhan	Jr. Asst.		
17	Miss. Kalpana Gurung	-do-		
18	Smt. Uma Sherpa	Sr. Peon		
19	Sri. Bikram Chettri	Jr. Peon		
20	Smt. Regina Pradhan	Jr store keeper		
21	Smt Rupa Rai	Jr Peon		
22	Sri Deepak Tamang	Cook		
GKMS (	Gramin Krishi Mousam Sewa, RRS Kalim	pong		
23	Dr. Agniswar Jha Chakraborty	R.A		
24	Sri Surojit Haldar	Met. Observer		
Field Worker, RRS Kalimpong				
25	Sri. Tek Bahadur Chettri	Mali		
26	Sri. Bishnu Prasad Nirola	-do-		
27	Sri. Johny Tamang	F/W		

28	Smt. Puspa Subba	-do-
29	Smt. Sheela Gurung	-do-
30	Smt. Kamala Sharma	-do-
31	Smt. Tara Gurung	F/W
32	Miss Sashi Gurung	F/W
33	Sri. Bhim Kr. Chettri	F/W
34	Sri. Mahendra Gurung	Sr. Mali
35	Miss Rita Chettri	F/W
36	Smt. Shantamit Lepcha	-do-
37	Smt. Dhanrati Tamang	-do-
38	Smt. Bishnu Chettri	-do-
39	Smt. Puspa Pradhan	-do-
40	Sri. Sunil Pradhan	-do-
41	Sri. Bimal Gurung	-do-
42	Smt. Kalpana Gurung	-do-
43	Smt. Narmaya Gurung	-do-
44	Smt. Munna Tamang	-do-
45	Miss Punam Gurung	-do-
46	Smt. Champa Chettri	-do-
47	Smt. Sumitra Tamang	-do-
48	Smt. Maily Gurung	-do-
49	Smt. Shyammaya Rai	-do-
50	Smt. Amrita Sharma	-do-
51	Smt. Manmaya Tamang	-do-
52	Miss Kali Chettri	-do-
53	Smt. Durgamaya Chettri	-do-
54	Smt. Maiya Sarki	-do-
55	Smt. Krishnamaya Gurung	-do-
56	Sri. Bir Bdr. Tamang	-do-
57	Smt. Sashi Rai	-do-
58	Smt. LaxmiTamang	-do-
59	Sri. Bijoy Tamang	-do-
60	Sri. Manoj Tamang	Mali
61	Smt. Bal Kumari Chettri	F/W

62	Smt. Anu Chettri	-do-
63	Smt. Ujata Gurung	-do-
64	Smt. Asha Gurung	-do-
65	Sri.Tejoshi Khawas	Field Assistant
66	Sri.Suresh Mahato	-do-
67	Sri Binay Chettri	-do-
68	Sri Dipendra Lama	-do-
69	Sri. Hem K. Gurung	Mechanic
70	Sri. Fauda Singh Mangrati	Sr. Darwan
71	Sri. PremTsh. Lepcha	Sr. Darwan
72	Sri. Prem Tshering Lepcha	Sr. Darwan
73	Sri. Laxman Roka	Sr. Darwan
74	Sri. Kumar Gurung	Guest House helper
RRSS, Pedong Farm		
75	Sri. Abdulay Bhutia	F/W
76	Sri. Nima Tshe. Tamang	F/W
77	Sri. Pempo Tsh. Bhutia	F/W
78	Sri. Khilman Rai	F/W
79	Sri. Kumar Pradhan	F/W
80	Sri. Subash Subba	F/W
81	Sri. Phuchung Bhutia	Darwan
82	Sri. Mahesh Gurung	Field Assistant
83	Sri. Manish Gurung	Field Worker
84	Sri. Neema Tamang	-do-
Dalapchand Farm		
85	Sri. Mani Gurung	F/W
86	Sri. Arjun Rai	F/W
87	Sri. Bal Bahadur Tamang	F/W
88	Sri. Harka Raj Rai	F/W
89	Sri. LakpaTamang	F/W
90	Sri. Kumar Kami	F/W
91	Sri. Dhan Bahadur Kami	F/W

92	Sri. Birdhoj Rai	F/W
93	Smt. Pokchey Bhutia	F/W
94	Smt. Nermit Lepcha	F/W
95	Sri. Dil Bahadur Rai	Senior Darwan

LIST OF RETIRED STAFF DURING 2015-16

Sl. No.	Name	Post held
1.	Sri. S.K Khawas	Overseer (Grade 1)
2.	Sri. M.B Tamang	F/W
3.	Smt. Harkamaya Gurung	F/W
4.	Sri. Pempa Tamang	F/W
5.	Sri. Thamchay Bhutia	F/W
6.	Sri. Punya Prasad Boral	SrDarwan

### **OBITUARY**

"I have passed the mountain peak and my soul is soaring in the firmament of Complete and unbounded freedom; I am in comfort, I am in peace."

> Smt Krishnamaya Gurung F/W Smt Amrita Sharma F/W Sri Bhisma Rai Sr. Mali

Sadly missed along life's way. Quietly remembered every day: No longer in our life to share. But in hearts, you are always there.

MAY YOUR SOUL REST IN PEACE

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### LIST OF TRAININGS/WORKSHOP/SEMINAR ATTENDED

#### Short course/winter school/summer school/CAFT training

- Short course on "Recent Advances in Mass Production of Biological Control Agents" from 1<sup>st</sup> to 10<sup>th</sup>September 2015 at NCIPM, New Delhi.(Dr. B. R. Sharma, Dr. Sajeed Ali)
- Short course on "Integrated Farming System: An Approach towards Livelihood Security and Natural Resource Conservation" from 15<sup>th</sup>-25<sup>th</sup> September 2015 at ICAR Research Centre for NEH, Manipur Centre, Imphal. (Dr. S. Gurung)
- 21 days CAFT training on "Pesticides Application in Agro Ecosystems: Its Dynamics and Implications" 29<sup>th</sup>September-19<sup>th</sup> October 2015 at CAFT, Department of Agricultural Entomology, TNAU. (Mr. B. Patra)
- 4. Short course on "Modern Integrated Crop Breeding Tools -Breeding Management System" from 18th 27th January 2016 at IIRR, Hyderabad. (**Dr. T. S. Ghimiray**)

#### Seminar/Symposium/Training/Workshop/Group Meeting attended

- International Symposium on Next Generation Approaches for Sustainable Development of Hill and Upland Horticulture from 5th to 7th November 2015 at Sikkim University, Gangtok. (Dr. B. R. Sharma, Dr. Sajeed Ali, Dr. S. Gurung, Mr. S. Baskey, Mr. B. Tudu, Mr. B. Patra, Smt. S. Pradhan)
- 2. International Symposium on Sustainable Horticulture 2016, on 14-16th March, 2016 at Mizoram University, Aizawl.(Mr. S. Baskey, Mr. B.Tudu)
- National Conference on Bioresources Management for sustenance of ecosystem and Livelihood. COBACAS in collaboration with UBKV, Pundibari, November 26th- 29, 2015.( (Dr. B. R. Sharma, Dr. Sajeed Ali, Dr. S. Gurung, Mr. S. Baskey, Mr. B. Tudu, Mr. B. Patra, Mr H. K. Tarafdar, Mrs. S. Pradhan, Mr. B. Thapa)
- National symposium on "Sustainable agriculture for food security and better environment" held on December,17-18,2015 at BCKV, Kalyani, Nadia, India. (Mr. S. Baskey)

- 5. National Symposium on integrating agri-horticulture and allied research for food and nutritional security in the era of global climate disruption held on March,o4o6,2016 organized by ICAR research complex for NEH region, Umiam, Meghalaya at Imphal, Manipur, India.(Mr. S.Baskey)
- UGC Sponsored National Seminar on Advances in Biology: Eastern Himalayan Perspective from 3rd to 4th October 2015 at Kalimpong College, Kalimpong. (Dr. B. R. Sharma, Dr. Sajeed Ali, Dr. S. Gurung, Mr. S. Baskey, Mr. H. K. Tarafdar)
- 7. National Seminar on Sustainable agriculture for food security and better environment, on 17-18th December, 2015 at BCKV, Kalyani, West Bengal.(Mr. B.Tudu, Mr. B.Patra)
- National Seminar on Resource Based Inclusive Agriculture and Rural Davelopment: Opportunities and Challenges, Faculty Centre for IRDM, Ramkrishna Mission Vivekananda University in association with APBI, University of Calcutta. 15-16th January, 2016. (Mr. B.Patra)
- 9. State Level Seminar on Horticulture Entrepreneurship Development in North Bengal at Majhian,Balurghat, West Bengal on 3rd -4th March 2016. (**Mr. B. Patra**)
- Training-cum-Workshop on "Agriculture Knowledge Management, ICTs and Portals" from 21st to 24th April 2015 at Kalimpong. (Dr. T. S. Ghimiray, Dr. B. R. Sharma, Dr. Sajeed Ali, Dr. S. Gurung)
- Workshop on innovative agricultural extension model for effective outreach, on
   22nd July, 2015 organized by IARI and North Bengal Science Centre, at Siliguri,
   West Bengal (Dr. B.R. Sharma, Dr. B. Tudu)
- 12. Workshop on "Production, Protection and Post-Harvest Technologies on Mandarin from 18th to 19th February 2016 at Sittong, Kurseong. (Dr. B. R. Sharma, Dr. Sajeed Ali, Dr. S. Gurung, Mr. B. Patra, Mr. B. Tudu, Mr. H.K. Tarafdar)
- *13.* Hill Rice Workshop organized by IIRR, Hyderabad at ICAR Research Complex for NEH, Umiam, Barapani on 27th February, 2016 (**Dr. T.S. Ghimiray**)

- 14. XXIV Annual Group Meeting of All India Coordinated Research Project on Floriculture at Sher-E-Kashmir University of Agricultural Sciences and Technology, Shalimar Campus, Srinagar from 17-19 April, 2015 (Mrs. S. Pradhan)
- 15. XXIII Group meeting of the All India Coordinated Research Project on Medicinal, Aromatic Plants and Betelvine. September 28-1st oct, (2015). DMAPR, Anand, Gujrat. (Mr. S. Baskey, Mr. K. Roy, Mr. B. Thapa)
- Group Meeting on "Brainstorming Session on Indian Citrus Industry held on 15th November 2015 at Sikkim University, Gangtok, Sikkim.(Dr. B. R. Sharma, Dr. Sajeed Ali, Dr. S. Gurung)
- 17. Group Meeting of All India Co-ordinated Research Project on Fruits. March 03-06,
   2016, PAU, Ludhiana, Punjab (Dr. S. Gurung)
- 18. 1st Review meeting of All India Coordinated Research Project on Medicinal, Aromatic Plants and Betelvine. 25th May, (2015). DMAPR, Anand, Gujrat.(Dr S. Baskey)
- 19. Model training course on value addition and post-harvest management medicinal and aromatic crops organized at ICAR Directorate of Medicinal and Aromatic plants Research, Anand, Gujrat from December 03-10,2015.(**Dr. S. Baskey**)
- 20. National Science Day at Kalimpong Science Centre, Kalimpong, West Bengal on
  28th February 2016. (Dr. Sajeed Ali, Dr. S. Gurung)

### **Trainings Imparted**

- Training on Provisions of protection of plant varieties and farmers right act 2001, on 30th June, 2015 organized by IARI Regional Station, Kalimpong and PPV& FR, Govt. of India, at Kalimpong, West Bengal. (Dr. T. S. Ghimiray, Dr. B. R. Sharma, Dr. B. Tudu)
- Three farmers training programme on Package of Agricultural Machinery for Paddy Cultivation under SMAM 2014-15 organized by Darjeeling KVK, UBKV, Kalimpong.(Mr. Koushik Roy)
- Farmers training programme on sustainable practices of Darjeeling mandarin and large cardamom at IARI regional Station, Kalimpong on 13th January 2016 (Dr. Sajeed Ali, Dr. S. Gurung)
- Training programme on Plant protection aspects of oil palm, May 12, 2015 organized by Assistant Director of Agriculture(Administration), Sadar Subdivision, Jalpaiguri. (Mr. B. Patra)
- 5. Training programme on IPM on Rice, September 8, 2015 organized by Assistant Director of Agriculture, Malbazar. (Mr. B. Patra)
- 6. Training programme on IPM on Potato, January 6, 2016 organized by Assistant Director of Agriculture, Malbazar. (**Mr. B. Patra**)
- 7. Training programme on IPM on Brinjal, February 12, 2016 organized by Assistant Director of Agriculture, Sadar Block, Jalpaiguri. (**Mr. B. Patra**)
- 8. Training programme on Safe use practices of pesticides, February 18-19, 2016 organized by RRS(HZ) and Darjeeling KVK. (Mr. B. Patra)
- 9. Training on Cultivation aspect of Floriculture crops on October 7, 2015 organized by Darjeeling KrishiVigyan Kendra, Kalimpong.(**Mrs S. Pradhan**)
- 10. Training on Cymbidium cultivation on January 16, 2016 organized by Darjeeling KrishiVigyan Kendra, Kalimpong and NABARD.( **Mrs S. Pradhan** )
- Training on Cymbidium cultivation on February 5, 2016 organized by Darjeeling KrishiVigyan Kendra and Directorate of Cinchona Plantation.(Mrs. S. Pradhan)

### **Extension bulletins**

- 1. Booklet on Farmers' Right in Local Language (Dr. T. S. Ghimiray)
- 2. Leaflet on SRI in vernacular language (Dr. T. S. Ghimiray)
- Leaflet on Ginger Disease and insect-pests in vernacular language (Dr. Sajeed Ali, Dr. B. R. Sharma & Mr. B. Patra)
- 4. Leaflet on True Potato Seeds in Local Language (Dr. T. S. Ghimiray)
- Leaflet on Agrometeorology for the farmers in vernacular (Nepali) language.(Mr Koushik Roy)

### **Student related activities**

- Conducted study tour of 2<sup>nd</sup> year B.Sc (Ag) Hons. students of UBKV to south Bengal.(Mr. B.Patra)
- 2. Conducted study tour of 4<sup>th</sup> year B.Sc (Ag) Hons. students of UBKV to south India.
   (Mr. K. Roy)

### **Awards and Recognitions**

- Awarded best paper presentation to Dr. Sajeed Ali at the International Symposium on the paper entitled "Efficacy of Bio-primed seedlings on crop management of round chilli in Darjeeling hills at Next generation approaches for sustainable development of hill and upland horticulture held on November,5-7,2015 at Central University Sikkim, Gangtok, Sikkim, India.
- 2. Awarded best paper presentation to Dr. Sajeed Ali at National Conference on the paper entitled "Symptom expression of Turcicum leaf blight disease of maize" at Bio resources Management for Sustenance of Ecosystem and Livelihood, on 26-29th November, 2015 at UBKV, Pundibari, West Bengal.

### **Examiners of Other Universities**

- 1. College of Agriculture, OUAT, Chiplima, Odisha. (Dr Sajeed Ali)
- 2. College of Horticulture and CAEPHT, Ranipool, Sikkim. (Dr Sajeed Ali)
- Practical Examination of Higher Secondary Examination. (Dr. Dr Sajeed Ali, Dr. S. Gurung, Mrs. S. Pradhan)



Integrated Disease Management on Rhizome rot complex of Ginger

# AICRP (Floriculture)



Germplasm collection of local orchid species, RRSs Pedong, Kalimpong Centre



Germplasm collection of local orchid species, RRSs Pedong, Kalimpong Centre



Germplasm collection, evaluation and maintenance of Cymbidium hybrid, RRSs Pedong, Kalimpong Centre



Collection of local orchid species, RRSs, Pedong, Kalimpong Centre



Germplasm collection of Dendrobium species, RRSs Pedong, Kalimpong Centre



Collection of local orchid species, RRSs Pedong, Kalimpong Centre

### **GRAMIN KRISHI MAUSAM SEWA**



### योक प्रिमताममा कृषक सचेतना कार्यक्रम

थियो । ग्रामीण कृषि मन्सन सेवा योजना

(जीकेएमएस) अन्तर्गत आज सम्पन्न

क्त कार्यक्रममा कृषि विभागकी सह-निर्देशक ज्यासन लेपचा, नोडल अफ़िसर कौसिक रोय, डा. बीआर शर्मा, डा. साजिद अलि, डा. प्रणब बर्मा, डा. ए झा, सुरजीत हलदार आदिले कषकहरुलाई उक्त योजनाबारे जानकारी गराएका थिए।

मौसम परिवर्तनसँग जुइनको निम्ति कसरी कृषि अनि पशु सम्पदाई संरक्षण गर्न सकिन्छ सो बारे जानकारी गराएका थिए। उक्त जीकेएमएस योजना कार्यान्वई गर्नको निम्ति राज्य सरकारसित सुमधुर सम्बन्ध राखेर कृषकहरुको लाभको निम्ति धेरै काम गर्न सकिने छ भन्ने जानकारी विभागका सह-प्रध्यापक कौसिक रोयले दिएका छन्।



उत्तर बङ्गाल कृषि विश्वविद्यालयले खण्ड-१ को योक प्रिमताममा कृषि



### गोरुबथानमा कृषकहरूलाई लिएर जनचेतना कार्यक्रम



# पेदोङमा कृषक सचेतना शिविर

एफबू अज्ञालिक गवेषणा केन्द्र पहाडी अक्षल उत्तर बंग कृषी विश्वविद्यालयको आयोजनामा अनि अर्थ साइन्स मन्त्रालय भारत सरकार साथै मेटोलजिकल विभागको प्रायोजनामा पेदोङ ग्राम पत्रायत भवनमा संयोग कार्यक्रम सम्पन्न गाँवा । उक्त जाववार्य गरेए । यहा । यहा । यहा । कार्यक्रममा एएमएफ्यूका नुइल अफिसर गर्दा कुनै कुनै विषयमा ध्यान पुन्याउनु कैसीक रोय, विशेयज्ञ डा. विनय राज पर्ने साथै कस्तो परिकारले गरिंदा धेरै शर्मा, फल विशेवज्ञ डा. सरद गुरूङ, फसलहरू उत्पादन गर्न सक्ने जानकारी चक्रवति, मेट्रलोजिकल अबजबर एस

पेदोङ, १० मार्च (निस)ः आदिको विशेष उपस्थिति रहेको थियो। उपायहरूबारे अवगत गराए। यसरी नै उक्त एक दिवसीय सचेतना शिविरमा स्थानीय ४० जना कृषकहरूले निम्ति लगाइनु पर्ने टीका करणहरूबारे सहभागिता जनाएका थिए। कार्यक्रममा उपस्थित कृषकवर्गलाई विभिन्न विदाका उपस्थित विशेषयज्ञहरूद्वारा विभिन्न कृषी विशेषयज्ञहरूले क्यी उत्पादनमा वर्तमान मौसम परिवर्तनले कसरी असर ग्रामीण कृत्री मौसम सेवामाधि कृषक पारिरहेको विशेषबारे विस्तृत रूपमा निम्ति करतो व्यवस्था गरितु पर्ने साथ सचेतना कार्यक्रम सम्पन्न गरियो। उक्त जानकारी गराए। यसरी नै खेती किसान खादानको व्यवस्थाबारे पनि अवगत माटो विशेषयज्ञ डा. एचके तरफदार, गराइयो। यसका साथै कृषकहरूले उक्त कार्यक्रममा उपस्थित कृषकवर्गको किरा विशेषयज्ञ डा. विश्वजित पात्रा, वैज्ञानीक पद्धतीको माध्यमबाट पनि संक्षुत जानकारी मोबाइल नम्बर पनि ाना स्वरंभवेश का सर्वाया भगा, अस्तार्थ प्रक्राण गण्डमार के पुरा प्रकृत गरिएको सिंही हिंदी स्वरंभ स्वरंभ स्वरंभ इन्हर- रेक्स सिंहयक दिदेश गांवल फरतरहरू लगाउन स्वरंभ बताइयो। प्रकृत गरिएको थियो। वस तामाइ, रिसर्व एसोसिएट ए झा अकोंतिर गृह पालित पशु प्राणीहरूबारे अन्तर्गत कृषी बुलेटी मोबाइल जानकारी गराउँदै पशु प्राणीहरूलाई नम्बर मार्फत मौसम परिवर्तनको

पशु प्राणीमा लाग्ने विभिन्न रोग थामको पनि जानकारी गराए। समग्रहमा फसल, फलफुल, माटोको व्यवस्थापन साथै पशु प्राणीहरू पालन पोशनको गराएको वियो। कार्यक्रममा उपस्थित कृषकहरूले कृषी फसलसाथै पशु प्राणी सम्बन्धि विभिन्न प्रश्नहरू गरेका विए। हल्दार, पशु विशेयझ डा. राकेश रोय संक्रमन गर्ने विभिन्न रोग धामका सूचनाहरू सूचित गरिने पनि बताइयो।



Farmers' Training under GKMS and media coverage

# **EXTENSION ACTIVITIES OF RRS (Hill Zone)**





Workshop on Mandarin at Sittong

Distribution of Certificates to participants



Workshop for farmer at Mangpoo



**Rice field visit with KVK scientists** 



Mandarin field visit at Sittong



Large cardamom field visit at Pala

# **VOLUNTARY CENTRE (Mandarin)**





Seed bio-priming with Trichoderma

Seed bio-priming with Azotobacter



Nucellar seedlings of mandarin bioprimed with *Trichoderma* 



Kali Jyambir- Phytophthora resistant root stock for Mandarin



Tool stock for Mandarin

A newly established Mandarin orchard under AICRP (voluntary centre)

# **CROP PROTECTION** (Agril. Entomology)



Blister beetle in Okra plot



**IPM on Cole crops** 



Frit fly trap in round chilli



Infestation of DBM on cabbage



Infestation of cabbage aphids



Infestation of semilooper on cabbage

# AICRP ON MAP AND B



Field view of different Bach accessions under IVT



Field view of different promising lines of Indian Valerian under MLT evaluation



Field view of different germplasm of Pakhanbhed



Field view of different germplasm of Mandukparni



**Field view of Chirota** 



Field view of Bojho



Visit of MIC ( Agriculture)



Brain-storming session on mandarin at Central University of Sikkim



National consultative meet on large cardamom



Celeberation of Technology week and *Rabi krishi mahotsav* in collaboration with Darjeeling KVK



Trials on rice in collaboration with IIRS (Voluntary centre)



# Research product (No of research articles per faculty member having NAAS rating of over 6.0 in 2017)

Total journal papers having NAAS rating over 6.0, published in 2017: 25

Please find attached the list. The faculty members of UBKV has been highlighted in each of the paper.

### Paper

NAAS rating

- Rana, V., Patel, N.R., Chattopadhyay, C., Kumar, A. (2017) Development of forewarning model for brown plant hopper in rice using satellite and meteorological data. J. Agrometeorology 19: 192-195.
- Deb, D., Singh, J. P., Deb, S., Datta, D., Ghosh, A., Chaurasia, R.S. (2017)
   An alternative approach for estimating above ground biomass using Resourcesat-2 satellite data and artificial neural network in Bundelkhand region of India. *Environmental Monitoring and Assessment* 189: 576.
- Chakraborty, S., Man, T., Paulette, L., Deb, S., Li, B., Weindorf, D.C., Frazier, M. (2017) Rapid assessment of smelter/mining soil contamination via portable X-ray fluorescence spectrometry and indicator kriging. *Geoderma* 306: 108-119.
- Datta, D., Deb, S. (2017) Forest structure and soil properties of mangrove ecosystems under different management scenarios: Experiences from the intensely humanized landscape of Indian Sunderbans. *Ocean and Coastal Management* 140: 22-33.
- Chakraborty, S., Li, B., Deb, S., Paul, S., Weindorf, D.C., Das, B.S. (2017) 10.04 Predicting soil arsenic pools by visible near infrared diffuse reflectance spectroscopy. *Geoderma* 296: 30-37.
- Chakraborty, S., Weindorf, D.C., Deb, S., Li, B., Paul, S., Choudhury, 10.04 A.,Ray, D.P. (2017) Rapid assessment of regional soil arsenic pollution risk via diffuse reflectance spectroscopy. *Geoderma* 289: 72-81.
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