BOOF OF ABSTRACTS

International Symposium on

Food Security Dilemma: Plant Health and Climate Change Issues

December 7-9, 2012

Venue: FTC (Lake Hall), Kalyani, West Bengal, India

Collaborator :

NABARD

NATIONAL BANK FOR AGRICULTURE AND RURAL DEVELOPMENT

Editors: **M. R. Khan**
Shantanu Jha
Chitreshwar Sen
Hirak Banerjee
Tapas Biswas

2006

TOGETHER WE WILL PROTECT OUR CROPS

Association for Advancement in Plant Protection
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सचिव एवं महानिदेशक
Dr. S. AYYAPPAN
SECRETARY & DIRECTOR GENERAL

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MESSAGE

It gives me immense pleasure to learn that the Association for Advancement in Plant Protection (AAPP), Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal, India is organizing an International Symposium on **'Food Security Dilemma: Plant Health and Climate Change issues'** during 7-9 December, 2012.

It is highly befitting to hold this Symposium especially when there is a shortage of food grains owing to the rising demand and overall economic growth in the country. Furthermore, we are to face the challenge of the projected change in climate and its possible impact in crop productivity. I personally feel that the deliberations of the Symposium will throw light on the strategies and action plans to mitigate these issues in the perspective of globalization.

I extend my best wishes to the organizers and the participants on the joyous occasion and hope that the Symposium will go a long way in creating opportunities for the experts, scientists, farmers and other stake-holders to interact and share their experiences in bringing about the food security under climate change scenario.

I wish the endeavour all success.

(S. Ayyappan)

Dated the 26th November, 2012
New Delhi

About the Symposium

Food Security is an issue that is being discussed repeatedly at different platforms. Why another International Symposium is a posture that may be bagging many minds. After all, it is stated that India has a surplus of food grains in its godowns that are literally overflowing. But is this existing surplus enough when parts of the globe particularly many countries in Africa are going hungry? When, in spite of the surplus Ca.25% months hungry in India? More importantly, does it warranty a continuity of this surplus situation? These are the uncertainties which led the Expert Committee of the Planning Commission review the work done in the current plan period and identified food security as the key issue for the entire next (12th) plan period.

AAPP has been constantly trying to address some of these vexing issues and focussed on the problem related to food security *vis-a-vis*. sustainable agriculture in its earlier symposia organised by it. The first symposium organised by the AAPP in 2007 (entitled National Symposium on Plant Protection: Technology Interface) tried to identify the technology related issues in devicing innovative and safe management strategies and pin-pointed several lacunae needing urgent attention. These included

(i) Improved technologies related to molecula diagnostics, (ii) The industry research wing end state holders mismatch, (iii) Improved natural and biocontrol strategies that are environment friendly looking beyond the existing trichodermas, (iv) Improved IPM strategies and (v) Safe use of the currently promising biotechnological tools. It was suggested that these be re-evaluated in another two years or so.

Accordingly, a follow-up second National Symposium was organised by AAPP in 2009 entitled National Symposium on 'Climate Change, Plant Protection and Food Security Interface.' This Symposium, participated internationally identified climate change as an additional and important paramater to be inducted into the framework of plant protection and food security through sustainable agricultural strategies. The plenary of this Symposium identified the fundamental issues why are climate change and water at the environmental front and use of biotech tools for producing genetically engineered bio-products be it the producer plants or management of microbes are key issues that need to be addressed. It was suggested that impacts of progress in these agenda may be re-evaluated after two years at an International platform. The basic emphasis as far as AAPP was concerned in securing food for the nation and the world through holistic plant protection strategies and the impact of environment on such strategies.

Given the above scenario the industry interface becomes cardinal as the pesticide characteristics need to be altered to attain sustainability. Further the role of the climate change and water use efficiency as are likely to play in optimising and stabilizing food production need to be erratically evaluated. A final parameter of critical importance is proving to be the soil health that needs to be maintained both in its fertility and microbial loads under the intensive cropping system that are envisaged.

To achieve stable food production through improved protection including nutrient supply, it is obvious that other than the bureaucracy and public sector services. The industry, the NGO's and elite farmer groups will play a key role that will make for success or failure of this approvals.

Finally, the existing tools of plant health management, be of pesticides, microbrial and nutrient management and most importantly, the production and supply of hybrid seeds of lasting qualities need to be refurbished and polished to achieve desirable integrates management strategies that need to be revised.

Keeping all this in view, this International Symposium is designed to address all these issues by bringing to the fore not only research scientists but also industry related professionals, the relevant NGO's and th representation of small and marginal farmers with the hope this holistic approach will be able to define guidelines for a system and / or approach that will lead to stable, sustainable holistic crop and agricultural production system.

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Prof. B.N. Panja
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Programme Summary (Technical)

Keynote address

ISFS-001 **Shashi Sharma**
Global food security issues

Technical Session - 1
Critical parameters in future food security-I: Chemical use in Agriculture
Chairman: A Ragupathy
Co-Chairman: Anjan Bhattacharyya

ISFS-002 **A. Regupathy and R. Ayyasamy**

Need and scope for rational use of pesticides for food security in India

ISFS-003 **Dipak Kumar Hazra** *et al.*

Formulation technology: key parameter for food safety with respect to agrochemical use in crop protection

ISFS-004 **M. Moniruzzaman** *et al.*

Carbofuran movement and dissipation in brinjal (*Solanum melongena* L.) cultivated soil under subtropical weather in Bangladesh

Concurrent Poster Session-I (005 - 034)

ISFS-005 **C.K. Kundu** *et al.*

Bioefficacy of Clethodim 24% EC for weed management in blackgram

ISFS-006 **Biswajit Pramanick** *et al.*

Bioefficacy of different herbicides for weed management in transplanted *kharif* rice

ISFS-007 **N. Karam And S. K. Mandal**

Relative toxicity of Rynaxypyr 20% Sc (coragen) against natural enemies of insect pests

ISFS-008 **Dipak Mandal** *et al.*

Bioefficacy of few new groups of insecticide against cotton jassid (*Amrasca biguttula biguttula*)

ISFS-009 **Sourav Ghosh** *et al.*

Relative efficacy of some acaro-insecticides against Rice Panicle Mite (*Steneotarsonemus spinki* Smiley)

ISFS-010 **Srujani Behera** *et al.*

Studies on the economical spray schedule of mancozeb for the control of purple blotch disease of onion

ISFS-011 **Mukesh K. Singh** *et al.*

Analysis of pesticide residue in water from different sources in Delhi and NCR region

ISFS-012 **ChinmayBiswas** *et al.*

Effect of chemical elicitors on pests and disease incidence in jute under field condition

ISFS-013 **Srabani Debnath and P. S. Nath**

Bioefficacy and phytotoxicity of Trifloxistrobin 25% + Tebuconazole 50 % (Nativo 75 WG) against sigatoka disease (*Cercospora musae*) of banana in West Bengal

ISFS-014 **R. Dangmei and P. S. Nath**

Bioefficacy and phytotoxicity of Trifloxistrobin 25% + Tebuconazole 50 % (Nativo 75 WG) against leaf blight disease (*Exserohilum turcicum*) of maize in West Bengal

ISFS-015 **K. More** *et al.*

Comparative field efficacy of some insecticides against aphid on okra in Gangetic plains of West Bengal

ISFS-016 **Amitava Konar** *et al.*

Efficacy of some insecticides against cutworm and molecricket of potato in West Bengal

ISFS-017 **A. Chakraborty** *et al.*

Study of bioefficacy of Eugin 5EC against late blight and Antirot 10DP against soil and tuber borne diseases of potato in West Bengal

ISFS-018 **Shweta** *et al.*

Miceller Kinetics- the key parameter for the preparation of environmental and user friendly water based microemulsion formulations

ISFS-019 **Dipak Kumar Hazra** *et al.*

Requirements of user and environment friendly new generation pesticide formulations for clean environment and food

ISFS-020 **B. Tudu** *et al.*

Bioefficacy of spiromesifen against broad mite of jatropha

ISFS-021 **M. M. Ahmed** *et al.*

Studies on efficacy of new generation acaricides against red spider mite of tea and their effect on natural enemies at terai region of West Bengal, India

ISFS-022 **P. K. Dey** *et al.*

Field efficacy of thiacloprid against important pests of soybean in West Bengal, India

ISFS-023 **A. K. Somchoudhury** *et al.*

Role of Buprofezin- an IGR in IPM of mango hoppers

ISFS-024 **T. B. Maji** *et al.*

Evaluation of Buprofezin 70 DF, an insect growth regulator for eco-friendly management of jassid (*Amrasca bigutulla bigutulla* Ishida) in okra

ISFS-025 **S. K. Gunri** *et al.*

Effect of post emergence herbicide on summer groundnut (*Arachis hypogaea* L.) in new alluvial zone of West Bengal

ISFS-026 **Y. Rupert** *et al.*

Evaluation of Fluopyram 200 + Tebuconazole 200 – 400 SC against anthracnose of chilli

SFS-027 **M. L. Chatterjee** *et al.*

Sulfoximine- a new insecticide from new class of chemistry to manage sap feeding insect pests of rice

ISFS-028 **S. Dutta** *et al.*

Evaluation and scheduling of fungicides for management of foliar leaf blight disease of wheat in the Gangetic alluvial zone of West Bengal

ISFS-029 **S. Nandi** *et al.*

Evaluation of different fungicides for management of damping off of cabbage

ISFS-030 **Ashim Kumar Dolai1** *et al.*

Plethora- a new ready-mix insecticide for better management of tomato fruit borer

ISFS-031 **Dipankar Mandal and Rini Pal**

Efficacy of some fungicides against tikka disease of groundnut

ISFS-032 **Y. A. Shinde** *et al.*

Efficacy of various insecticides against pod borer, *Helicoverpa armigera* (hubner) in chickpea

ISFS-033 **Sandip Patra** *et al.*

Bioefficacy of new diamide insecticides against diamond back moth (*Plutella xylostella* L.) on cabbage

ISFS-034 **Bilash Chandra Das** *et al.*

Studies on the effect of insecticides against pigeon pea pod borer (*Helicoverpa armigera* H.) and pod fly (*Melanagromyza obtusa* M.)

Concurrent Session - 1
Climate change *vis-à-vis* issues food security
Chairman: VUM Rao
Co-Chairman: SA Khan
Rappoteur: Saon Banerjee

ISFS-035 **V.U. M. Rao** *et al.*

Climate change and agricultural risk management

ISFS-036 **Joyashree Roy** *et al.*

Climate variability and farmers' challenges: experience from river basins in India

ISFS-037 **G. C. Debnath**

Climate change - possible impacts on agriculture and food security in India

ISFS-038 **Bikash C. Sarker** *et al.*

Egg plant adaptation and yield potential under elevated CO_2 and soil water stress

ISFS-039 **Oyerinde A. A. and G. T. Oyerinde**

Assessment of the impact of climate change on honey production in Nigeria

ISFS-040 **Ishwar Chandra Gupta** *et al.*

Incidence pattern of pod borers in pigeonpea (*Cajanus cajan*) in relation to abiotic factors in Gangetic plains of West Bengal

Concurrent Poster Session-I (041 - 052)

ISFS-041 **D M Firake** *et al.*

Crop-pest scenario under changing climate of north eastern Himalaya, India

ISFS-042 **Anil kumar** *et al.*

Computation and validation of radiation balance components along eastern end of monsoon trough over Ranchi, Jharkhand India

ISFS-043 **Anil Kumar** *et al.*

Rainfall and temperature trend analysis over Ranchi region of Jharkhand

ISFS-044 **Anil Kumar** *et al.*

Using fast response sensor (10HZ) data over land surface during summer monsoon and thunderstorm period

ISFS-045 **A. A. Oyerinde and G. T. Oyerinde**

Evaluation of effects of climate change on increased incidence of cowpea pests in Nigeria

ISFS-046 **Sunil Kumar** *et al.*

Studies on progress of pigeon pea wilt incidence in relation to weather parameters

ISFS-047 **S.Maji** *et al.*

Agrometeorological indices and its impact on growth and yield of potato under dates of planting and N-doses in the Gangetic plains of West Bengal

ISFS-048 **S. Debnath** *et al.*

Climate change and food security relations of banana (*Musa* spp.) and preliminary mitigation strategy for West Bengal conditions

ISFS-049 **D. Mandal** *et al.*

Has the weather gone erratic: elementary weather risk analysis from the farmers' perspective

ISFS-050 **Bijan Kumar Das**

Recent climate change and invasion of herbivorous insects

ISFS-051 **Abdus Sattar and S. A. Khan**

Rainfall trend analysis and crop planning of Gaya district of Bihar

ISFS-052 **Mukul Chandra Kalita**

Management practices due to climate change for increased production of winter rice, pumpkin and cowpea in Assam

Technical Session - 2
Possible biotechnological interventions in field and horticultural crop improvement for stress management
Chairman: Amita Pal
Co-Chairman: PK Chakrabarty
Rappoteur: Somnath Bhattacharya

ISFS-053 **Amita Pal**

Current understanding of molecular defence mechanism in resistant *Vigna mungo* genotypes upon MYMIV infection

ISFS-054 **P.K. Chakrabarty and C.D. Mayee**

Impact of molecular biology and biotechnology in plant pathology research

ISFS-055 **Somnath Bhattacharyya** *et al.*

Identification of superior alleles for P-deficiency tolerance in rice

ISFS-056 **Shamsul H. Prodhan**

Development of abiotic stress tolerant rice (*Oryza sativa* L.) to attain food security with environmental safety

ISFS-057 **A. Mondal** *et al.*

Extracellular enzymatic activities and biochemical constituents associated with the virulence of *Rhizoctonia solani* isolates from rice in West Bengal

Concurrent Poster Session-II (058 - 062)

ISFS-058 **Bidhan Roy and Asit B. Mandal**

Agrobacterium-mediated genetic transformation of indica rice for abiotic stress tolerance

ISFS-059 **A. K. M. Mohiuddin** *et al.*

Development of improved double-haploids through anther culture of indica rice (*Oryza sativa* L.)

ISFS-060 **A. N. Tripathi** *et al.*

Molecular characterization of *Fusarium moniliforme* (Sheld.) isolates based on SSR markers

ISFS-061 **G. T. Behere** *et al.*

Two species into one: DNA barcoding in the genus *Henosepilachna* (Coleoptera: Coccinellidae)

ISFS-062 **P. Satya** *et al.*

Evolution of resistance gene analogs in jute: implications for population structure determination

Competition paper presentation Session
Competition papers for '*Shashya Suraksha Yuva Pratibha*' Award
Chairman: CD Mayee
Rappoteur: Hirak Banerjee

ISFS-063 **B. S. Gotyal** *et al.*

Efficacy of *Lantana camara* essential oil and leaf extracts against Almond moth, *Cadracautella* (Walker)

ISFS-064 **Suvendu Mondal** *et al.*

Molecular approaches for rust and late leaf spot disease management in groundnut

ISFS-065 **Tushar Kanti Dutta**

Biological and molecular differences in host recognition of root-knot nematodes, *Meloidogyne incognita* and *M. graminicola* in tomato and rice

ISFS-066 **S. K. Sahoo**

Studies on the incidence and management of mustard aphid (*Lipaphis erysimi* Kaltenbach), the key pest of *Brassica* crop

ISFS-067 **Someshwar Bhagat**

Exploration of microbial resources for the management of plant diseases

ISFS-068 **Dhananjoy Mandal and Biplab Das**

Integrated disease management of tomato yellow leaf curl virus of tomato

ISFS-069 **P. Barma** *et al.*

Bioecology of two spotted red spider mite (*Tetranychus urticae* Koch.) infesting pointed gourd (*Trichosanthes dioica* Roxb.)

ISFS-070 **Sutanu Sarkar and Somnath Bhattacharyya**

Molecular markers linked with Bruchid resistance in *Vigna radiata* var. Sublobata and their validation

ISFS-071 **Sandip Debnath and Somnath Bhattacharyya**

Whole genome transcriptional analysis of rice-arsenic interaction in presence of arsenic in irrigation water and soil

ISFS-072 **Ashis Roy Barman and S. Dutta**

Assessment of variability and unraveling the biochemical factors involved in the pathogenesis of *Xanthomonas campestris* pv. *campestris* on cabbage

Technical Session - 3
Pest profile of field and horticultural crops vis-à-vis climate change issues
Chairman: SB Sharma
Co-Chairman: Megha N Parajulee

Concurrent Poster Session-II (082 - 102)

ISFS-084 **Pronobesh Halder** *et al.*

Plant mites in association with some important crops

ISFS-085 **P.Nagamani** *et al.*

Pest scenario of pigeonpea and chickpea at Anantapur

ISFS-086 **N. A. Deshmukh** *et al.*

Population dynamics and seasonal incidence of fruit flies in guava ecosystem of north eastern Himalaya

ISFS-087 **Pathipati Usha Rani and Kurra Sandhya Rani**

Spodoptera litura feeding stress induced biochemical and enzymatic changes in sweet potato, (*Ipomoea batata* L.) plants

ISFS-088 **Pathipati Usha Rani and Kanuparthi Prasanna Lakmi**

Nutritional changes in castor and rice plants due to herbivore insect attacks

ISFS-089 **Tanya R. Marak and Srikanta Das**

Biochemical variations of different *Alternaria* species on different crops

ISFS-090 **G. M. Lone** *et al.*

Report of *Xiphinema diversicaudatum* (Micol, 1923 and 1927; Thorne, 1939) (Dorylaimida :Longidoroidea) from rhizosphere of apple trees of Baramulla Kashmir , India

ISFS-091 **T. N. Goswami and A. K. Mukhopadhyay**

Studies on the distribution pattern of diamondback moth, *Plutella xylostella* (L.) on cabbage under Gangetic alluvial condition of West Bengal, India

ISFS-092 **P. P. Dhar** *et al.*

Diversity of acarine fauna in tea ecosystem

ISFS-093 **T. M. Ghule and S. Jha**

Population dynamics of some important insect pests of bitter gourd (*Momordica charantia* L.)

ISFS-094 **Sabyasachi Pal** *et al.*

Diagnosis and pathogenicity of root knot nematode (*Meloidogyne incognita)* on passion fruit (*Passiflora edulis*) in West Bengal

ISFS-095 **Matiyar Rahaman Khan** *et al.*

Infestation of citrus root knot nematode, *Meloidogyne indica* Whitehead, 1968 on citrus and bt-cotton from Gujarat, India

ISFS-096 **B. N. Panja** *et al.*

Disease profile of tuberose along with the identification of resistant germplasm(s), critical environmental parameters and chemical for the management of important tip blight disease

ISFS-097 **Kiran Kumari** *et al.*

Effect of morpho - chemical traits of okra fruit on the incidence of *Amrasca biguttula biguttula* Ishida

ISFS-098 **Baburam Murmu** *et al.*

Soil nematodes and plant nematodes associated with potato based cropping systems in West Bengal

ISFS-099 Pravin Vitthala Ingle and Bijan Kumar Das

Life history of *Danaus chrysippus* (L.) (Lepidoptera: Nymphalidae) and its interaction with milkweed host plants

ISFS-100 D. K. Misra *et al.*

Diseases of ber (*Zizyphus mauritiana* Lamk) a minor fruit in India

ISFS-101 Krishna Karmakar and Pranab Debnath

Population dynamics of rice sheath mite, *Steneotarsonemus spinki* Smiley (Acari:Tarsonemidae) on rice cultivar IET-4786 in West Bengal, India

ISFS-102 Vipul H. Wagh *et al.*

Influence of weather variables on whitefly and *Spodoptera litura* insects of tomato under gangetic alluvial region of West Bengal, India

Concurrent Session - 3
Critical parameters in future food security-I: Water
Chairman: Surajit Mallick
Co-Chairman: Supratik Sarkar
Rappoteur: Kallol Bhattacharyya

ISFS-110 Surajit Mallick

Water Resources and its management for food security

ISFS-104 D. K. Kundu

Potential and prospects for enhancing water productivity in agricultural production systems

ISFS-105 M. Hasan

Protected cultivation and drip fertigation technology for ensuring water, food and nutritional security in modern India

ISFS-106 Arunabha Pal *et al.*

Use of geotextile for tomato (*Lycopersicon esculentum*) production and soil erosion control under red & laterite agroecosystem

Concurrent Poster Session-II (107 - 110)

ISFS-107 S. B. Goswami *et al.*

Effective water management practices in terms of productivity and water expense efficiency of tuberose

ISFS-108 Sanjit Pramanik *et al.*

Fertigation – a water and nutrient saving technology for banana

ISFS-109 Angira Prasad Mahata *et al.*

Effect of pitcher irrigation with mulching on brinjal (*Solanum melongena*) production in red & laterite soils of West Bengal

ISFS-110 **Pijush Das and S. B. Goswami**

Crop water productivity of rice-toria relay cropping in relation to nutrient management under lowland rice ecosystem

Technical Session - 4
Innovative management of fastidious entities, primarily plant viruses
Chairman: SM Paul Khurana
Co-Chairman: PS Nath
Rappoteur : KK Biswas

ISFS-111 **SM Paul Khurana**

Biotechnology in detection and diagnosis of plant viruses for enhanced food production

ISFS-112 **J. Tarafdar** *et al.*

Threatening and emerging viruses of important vegetable crops in West Bengal

ISFS-113 **K. K. Biswas** *et al.*

Genomics, genetic diversity, diagnostics, geographical distribution and biotechnological management of *Citrus tristeza virus* in India

ISFS-114 **M. K. Yadav**

First report of natural occurrence of *Cowpea mild mottle Carlavirus* in soybean from India

ISFS-115 **P. D. Nath**

Virus disease problem in important horticultural crops of north eastern region of India: improved diagnostics

Concurrent Poster Session-II (116 - 121)

ISFS-116 **A. Samad** *et al.*

Phytoplasma: high risk pathogen to medicinal and aromatic crops

ISFS-117 **Amrita Banerjee** *et al.*

Molecular characterization of *Banana bunchy top virus* based on DNA R segment from Meghalaya: A new member of "Pacific-Indian Oceans" group

ISFS-118 **Shruti Godara** *et al.*

Incidence, occurrence and characterization of begomoviruses associated with cotton leaf curl diseases in northwest India

ISFS-119 **Avijit Tarafdar** *et al.*

Characterization of *Citrus tristeza virus* and determination of genetic variability in northeast and south India

ISFS-120 **Maitry Paul and P. D. Nath**

Evidence of *Citrus liberibacter asiaticus* and *Citrus liberibacter africanun* causing Citrus greening diseases in north eastern states of India

ISFS-121 **Nabanita Ghosh** *et al.*

Studies on the incidence and detection of bhendi yellow vein mosaic virus (YVMV) in the Gangetic plains of West Bengal

Technical Session - 5
Soil health and crop productivity *vis-à-vis* pest management
Chairman: SK Sanyal
Co-Chairman: Pradip Dey
Rappoteur: Tapas Biswas

ISFS-122 **P. Dey**

Soil-test-based site-specific nutrient management for realizing sustainable agricultural productivity

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Keynote address

Shashi Sharma

ISFS-001

Keynote address

Global food security issues

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It is a matter of immense concern that about two billion people presently suffer from hunger and malnutrition worldwide. About 25,000 people die every day of hunger or hunger-related causes. In less than 40 years the human population will increase by another 2 billion people to reach 9 billion. The challenging question is - how and when we are going to achieve food and nutrition security for all these people?

Innovation in agriculture and food production through science and technology will continue to contribute towards increasing the food production necessary to meet the world's growing food needs. Heavy reliance on improving crop yields to continue delivering global food security could be risky in an environment of decreasing availability of arable land and water, combined with increasing exposure of the food chain to pest risks.

More than 30 per cent of the world's food - enough to feed more than 2 billion people - is currently lost in the food value chain. Pests cause significant production and post-harvest food losses world-wide, particularly in many food-insecure developing countries. In addition, enough food to feed many millions of people is wasted in developed and some developing countries.

Globalisation of food production and distribution has enhanced the potential for pests to disperse to new regions, find new vectors, new hosts, new environments, and new opportunities to evolve into damaging species and strains. The increase in rapid transport systems and movement of people and goods, accompanied by climate change has increased the threat of new pests impacting on food chain. The majority of the food insecure developing countries lack effective biosecurity planning to safeguard their food production, storage and food trade. Food distribution, without underpinning biosecurity risk management, can be extremely risky. Importing food may provide a short term food security solution if enough money is available for these purchases, but may sow seeds for a long term intergenerational food insecurity problem if biosecurity risks are not carefully managed.

Our planet Earth is about 4.5 billion years old and it is estimated to be able to sustain life for billions of years more. Human beings have been here for about 200,000 years. If we are aiming for sustainable food security for thousands of future generations then wisdom, knowledge and innovative thinking must be the key drivers of leadership and direction of the global food security mission. Our food security strategies must be based on a long term vision extending over many generations. A short sighted approach inevitably will lead to long term intergenerational food insecurity.

A 3P strategy – Produce, Protect and Provide - would be an integral part of this long term food security mission:

Produce food sustainably - Food production must not compromise the long term productive capacity of land and water ecosystems. Productive capacity of land is the 'principal resource', food production practices and technologies are 'investment strategies', and harvest or production is 'dividend' earned. We must live on 'dividends' while the 'principal resource' remains intact forever. Food production practices and technologies must enhance the productive capacity with negligible degradation impact on the environment and biodiversity.

The outbreak of the Ug99 strain of stem rust in Uganda, to which over 80 per cent of the world's wheat varieties have no resistance, has revealed the risks associated with our dependence on a very limited number of plant species for food, and the need for a commitment and shared responsibility for global biosecurity to limit pest impacts. Consideration must be given to diversify and expand the portfolio of food crops or sources as a part of food security strategy. There are about 400,000 known plant species; approximately, 30,000 are edible plant species, yet only 20 species provide 90 per cent of our food supply. We have, at hand, other potentially promising, yet under-utilised plant species. There is a need to develop contingency plans in case major food crops, such as wheat, rice and maize, suffer from devastating pest attacks, especially if several staple crops are affected simultaneously.

Billions of dollars are spent exploring and understanding the universe and examining whether life exists or existed on other planets. It is, therefore, surprising that even after 10,000 years of cultivation, there is limited understanding of the biological diversity in the soil. In this 21st century we must discover and understand the spectrum of soil biodiversity in all the agro-ecological systems. This may revolutionise the use of microbial biodiversity in increasing crop productivity and sustainability of productive capacity of land.

Protect food from loss in the value chain – We must secure the global food value chain from loss or waste, and ensure biosecure food production and post-harvest storage is a priority in developing countries. At the same time we must aim to achieve zero tolerance to food waste in the developed and developing countries.

Provide biosecure food to regions and communities in need – We must ensure biosecurity for the globalisation of the food value chain to ensure that food trade and distribution do not expose the recipient/importing regions to biosecurity risks.

Agriculture and therefore managed food production is about 10,000 years old. It is about time we looked back and assessed our performance over the past 10,000 years to identify what worked, what did not, what lessons we can learn, and then looked forward to create a food and agriculture vision for the next 10,000 years. We should aim to develop a mission for next 1000 years and plan for 100 years. It may appear impossible to envision 10,000 years when we have a life span of around 100 years, and with global governance and management processes geared towards relatively short term envisioning. However, this is a challenge we need to meet head on as a priority. It is like driving a long distance - from Kolkata (India) to Rome (Italy) in the night. As long as we have a map and clarity about our final destination, the 50 metre road visibility, enabled by the car's headlights, would be enough to take us to our final destination. A long term vision with clear mission and plan is fundamental to reaching our destination of food security for all for ever.

'*Shasya Suraksha Mahajnani*' Award 2012

At the beginning of the year 2012, we at AAPP decided to hold an International Symposium on '*Food Security: Plant Health and Climate Change Issues*' which you all have joined now. We also decided to felicitate and honour a scientist who has excelled throughout his / her service life through a lifetime achievement award called succinctly the ***'Shasya Suraksha Mahajnani'*** award. It was felt that the award was to be bestowed very carefully every three years to those who have excelled and left an imprint on sustainable Agriculture through Plant Protection. The award was also to consider the contribution of the Awardee through his active life of thirty years or more and has helped in the planning, development and successful implementation of strategies of crop protection and sustainable agriculture and preferably has also contributed to generation and judicious deployment of adequate manpower throughout the Nation. He /she must have preferably been a teacher of repute (PhD. & M.Sc. dissertation guidance) and formally recognized through specialized awards.

The award consists of a shawl, a citation, a memento and a cheque of not less than Rs25,000 to be raised to Rs1,00,000 as more funds become available.

Subsequently, in a Governing Body meeting held to decide on the first awardee for this project, the name that came up strongly and almost unanimously was of Prof. (Dr.) C. D. Mayee .

Dr. Charuudatta Digambarrao Mayee was born on 15th July, 1946 in a village called Saharkherda in the district of Buldhana, Maharashtra and passed his milestone examinations, Matric B.Sc (Ag.), M.Sc (Ag.) in the first division and was a gold medalist at IARI when studying for his Ph.D. (1972) degree having scored an OGPA of 4/4. He also took advanced courses in German language both in India and Germany. He was a post doc fellow, the AVH fellow at University of Hohenheime, Germany in 1980-82, 1986 and was awarded the degree of D.Sc. (Honoris Causa) from RAU, Pusa, Bihar in 2009; OUAT, Bhubaneswar (2009) and AAU, Jorhat (2010).

During his service career, Dr. C. D. Mayee held numerous important positions and he excelled in each of them. These included (i) Asstt. Virologist, PAU, Ludhiana (1972-74), (ii) Plant Pathologist (Rice), RRS, PAU, Kaputhala (1974-75), (iii) Professor and Head MAU, Parbhani (1975-91, 1993-95), (iv) Vice-Chancellor, MAU, Parbhani (1997-2000), (v) Director, Central Institute of Cotton Research, Nagpur (2000-05), (vi) Agricultural Commissoner, Govt. of India (2003-04) and finally, (vii) the Chairman of ASRB, New Delhi (2004 -11). In these academic and administrative capacities he guided many projects as professional

and was held in high regard as teacher, research scientist, guide and an administrator.

During his illustrious career, Dr. Mayee had traveled the length and breadth of the country and also visited at least 19 different countries abroad.

In recognition of his contributions as a scientist, a planner, a guide and an administrator Dr. C. D. Mayee received 20 awards and honours including the (i) Suntabala Roychoudhary Gold Medal at IARI (1972), (ii) Alexander Von Humboldt fellow of Germany, (iii) Dr. B. Viswanath award by IARI (2005), (iv) Life time achievement award (2009) at Lucknow and (v) Doda Raghav Reddy Award by PPAI, Hyderabad for his outstanding contributions in agriculture in general and plant protection in particular.

The professional recognitions included (i) President IPS, 1997-98, (ii) President, SMPP Udaipur (2005-07), President SPPS, New Delhi (2006-10), and Fellow of NAAS, New Delhi (2008), besides being member of a large number of technical committees in academic and professional Institutions from time to time .

To cut a long story short, in recognition of his significant and land-mark contributions in different teaching, research and extension positions (23 years), in management positions (16 years), leadership in man-power generation through guidance for M.Sc. (30) and PhD. (20) students, mega demonstrations and technology transfer and finally judicious deployment of scientists (as Chairman, ASRB) and in recognition of his publications (200 research papers, 6 books). The Governing body of the AAPP, decided unanimously to deliver it's first, prestigious '*Shasya Suraksha Mahajnani Award*' - A life-time achievement award to PROF. (DR.) CHARUDATTA DIGAMBARRAO MAYEE .

The award is presented on 7th December, 2012 at the inaugural session of International Symposium on 'Food Security Dilemma: Plant Health and Climate Change Issues'.

Rat control in paddy field - through an innovative trap

Mr. Debashis Roy

Village- Ganki, P.O - Ganki, P.S – Khowai, District- Khowai, PIN- 799207, Tripura, India

Profile

Education: Graduate

Resources owned:

i) Land : 0.80 ha
ii) Water bodies with irrigation capacity: 0.16 ha
iii) Animal Resources including fish and Poultry: Yes
iv) Farm Machinery: Hand spryer, Sickle, Spade etc

Description of Innovation

To prepare the structure of the trap (fig a, b, c), a 2-3 ft long bamboo having 8-10 cm diameter with one node at middle portion and two big holes at both ends is taken. The thick end of another dry and vibrant bamboo stick of about 7-10 ft. length is inserted into one of the above mentioned holes. On the other hand one jute rope (3-4 mm diameter) and one iron wire (1-2 mm diameter) having 5-6 ft length of each is tied at distal thin end of the bamboo stick very tightly. Now the other end of the rope is inserted through one small hole and tied by making a knot at outside after passing it just through another small hole of opposite side of the 1st one. Both the holes are made at 5-7 cm distance from 2nd big hole side of the 1st bamboo. So, the whole structure is now shaped like a bow. Similarly the another end of iron wire is tied just making a 3/4th circle through it at inner side of the same big hole by inserting the wire through another two small holes made at 4-5 cm distance from the side of 2nd big hole. The food bait for rat is kept inside of the bamboo hole just behind the rope. When rat is attracted to eat the food, it has first to cut the rope. Within a moment just after cutting the rope the distal end of bamboo stick acts just like a spring with straight movement. So, the coming rat is trapped by iron wire for reducing its circle diameter inside the bamboo hole.

Practical utility

Rat management is a real challenge in crop growing. Zinc phosphide based food bait or iron made mechanical rat trap are used to kill or trap rat. The efficiency of the technology is not up the mark being achieving 30-40% level of control. The management cost per hectare area varies between Rs. 750 to 1000. The average per unit cost of such innovative structure is around Rs. 10-15 which is much less than the cost of mechanical iron made commercial rat control trap. The success rate to control field rat that comes in touch and cut the rope inside the bamboo hole at trapping end of the structure is almost 100 %. Presently, all the farmers of village *Ganki* and another village nearby of *Sonatola* have already adopted the technique.


Fig.a


Fig.b


Fig.c

Technical Session - 1

Critical parameters in future food security-I:
Chemical use in Agriculture

Chairman: A Ragupathy
Co-Chairman: Anjan Bhattacharyya

ISFS-002

Need and scope for rational use of pesticides for food security in India

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Indian economy and security is largely dependent on food grain production. Hence agricultural development continues to remain the most important objective of Indian planning and policy. Green revolution has been achieved by the use of high-yield varieties of seeds, advanced irrigation technologies and agricultural chemicals. In the process of development of agriculture, pesticides have become an important tool as a plant protection agent for boosting food production. Inorgnics were the few earliest chemicals used for pest control; sulphur for fumigating houses in 1000 B.C.E., arsenic about C.E. 900 in China, lead arsenate in the mid-nineteenth century, copper oxychloride and lime sulphur in about 1880. Mercury based fungicides were used early in the twentieth century. The major drawback to using the in organics is that they do not breakdown as they are based on chemical elements. The introduction of other synthetic insecticides – organophosphate (OP) insecticides in the 1960s, carbamates in 1970s and pyrethroids (SP) in 1980s and the introduction of herbicides and fungicides in 1970s - 1980s contributed greatly in pest control and agricultural output.

The farmers give top priority to the chemical control because of the certain inherent advantages in pesticides. More than seventy per cent of the farmers in India are rural based with low rate of literacy. Use of pesticides require less knowledge of pest biology and agro ecosystem than other alternative tactics. The farmers are more prone to chemical control due to rapid remedial action against the target pest and rapid control of an existing pest problem. Use of pesticides decreases the amount of planning by the farmer. Moreover, the farmers are convinced about the predictable level of control achieved with pesticides when compared to other means of control. Pesticides provide control of some pests/under certain situations where no other effective tactics previously available as in the case of termites, locusts, storage pests , invasive pests, and vectors of plant , animal and human diseases.

Termites: Earlier aldrin, dieldrin. heptachlor,toxaphene were used as seed treatment, soil applicationa and for treating the building structures. With the cancellation of all uses of these compounds, relativlely less persistent chlorpyriphos and neonicotinoids like imidacloprid and thiamethoxam are used.

Locusts: Dieldrin is retained for use under the supervision of Directorate of Plant Protection Quarantine and Storage, Faridabad, India.

Invasive pests: When there is an outbreak of pests and invasive pests the chemical control is the first choice as in the case of sugarcane woolly aphid, *Ceratovacunao lanigera* (Zentler) (acetamiprid), polyphagous pink hibiscus mealybug, *Maconellicoccus marginatus* (Green), cotton mealy bug, *Phenococcus solenopsis* Tinsley and new invasive papaya mealybug, *Paracoccus marginatus* (dimethoate, acephate, buprofezin,

profenophos + neem oil), till the effective natural enemies are identified and mass multiplication technology perfected on commercial scale.

Storage pests: The pest problem in ware houses is effectively solved by air charging (DDVP, malathion), stack spraying (malathion)and by fumigation (aluminium phosphide).

Mites: Mites especially in tea plantations are effectively managed by selective acaricides (ethion.fenpyroximate)

The benefits of pesticides had been recognized in (i) improving productivity and food security, (ii)Vector disease control and (iii) quality of food grain production, which stood at a mere 50 million tonnes in 1948-49, had increased to estimated 217.3 million tonnes in 2006-07. Earlier the quantity food to be Imported was 10 million tons in 1965-66 and 11 million tons in 1966-67 tagged with certain conditions. The food has to be transported from 12000 miles away and done in installment only lasting for two weeks only. A diet containing fresh fruit and vegetables far outweigh potential risks from eating very low residues of pesticides in crops. Vector-borne diseases like yellow mosaics, leaf curl, bud necrosis, phytoplasma like diseases, banana bunchy top are most effectively tackled by killing the vectors. Insecticides are often the only practical way to control the insects that spread deadly diseases. The dearth of labour necessitates use of herbicides in vast areas of rice, sugarcane and plantation crops.

On the one side their importance is recognized in agriculture and public health bringing enormous socio-economic benefits and on the other side the alleged potential risk for the ecological balance . However, exposure to pesticides both occupationally and environmentally causes a range of human health problems. A vast majority of the population in India is engaged in agriculture and is therefore exposed to the pesticides used in agriculture. Although Indian average consumption of pesticide is far lower than many other developed economies, the problem of pesticide residue is very high in India. Reports of pesticide residue in several product on the export has affected the export of agricultural commodities.

For the past four decades efforts have been made to reduce the risk of exposure to pesticides, especially insecticides. New types of insecticides, more selective than conventional ones have been developed to be more safer and fit well into IPM and IRM as resistance development occurred due to limited number of target sites exploited by conventional insecticides. Development bio-rational insecticides with novel modes of action like neonicotinoids (imidacloprid, thiamethoxam, acetamiprid), chitin synthesis inhibitors (diflubenzuron, buprofezin), ryanodine receptor modulator (flubendiamide) and recently, fermentation products (avermectins, emamectin benzoate), pyroles (chlorfenapyr) and pyrozoles (fenpyroximate) devoid of cross resistance to conventional insecticides fit well into IRM. The key strategy for minimizing human exposure to pesticides is discussed in terms of the rational use of pesticides through regulation of pesticide , proper application technologies such as precision of pesticide application and accurate timing of application , exploiting pesticide efficacy and selectivity and integrated pest management .

ISFS-003

Formulation technology: key parameter for food safety with respect to agrochemical use in crop protection

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If the credits of pesticides include enhanced economic potential in terms of increased production of food and fibre, and amelioration of vector-borne diseases, then their debits have resulted in serious health implications to man and his environment. It has been estimated that the world-wide deaths and chronic illnesses due to pesticide poisoning number about 1 million per year. Ideally a pesticide must be lethal to the targeted pests, but not to non-target species, including man. Unfortunately, this is not so the controversy of use and abuse of pesticides has surfaced. The rampant use of these chemicals, under the adage, "*if little is good, a lot more will be better*" has played havoc with human and other life forms. A very small fraction of all applied pesticides is directly involved in the pesticidal mechanism. This implies that most of the applied pesticides find their way as 'residue' in food chains where they undergo concentration and exert potential, long term, adverse health effects. Their concentration in food samples varies greatly not only from region to region and year to year but also from one specific food item to another within the same food group. Perusal of the residue data on pesticides in samples of fruits, vegetables, cereals, pulses, grains, wheat flour, oils, eggs, meat, fish, poultry, bovine milk, butter and cheese in India indicates their presence in sizeable amounts. Pesticides in developing countries in Asia and Pacific region are mainly available dust, wettable powder, emulsifiable concentrates, solutions, etc. These types of formulations are regarded now as in 'conventional', 'old technology' or 'classical' or 'traditional' because of their increased in dose rate or repeated applications to get desired bio-efficacy. These higher doses and repeated applications lead to accumulate pesticide residues in food commodities along with environmental pollution. Conventional formulations, because of their characteristics i.e. dustiness and use of volatile organic solvents (VOCs) in their preparation maximize several problems like pesticide residues in food and finished products etc. The economic impact of pesticides in non-target species (including humans) has been estimated at approximately $8 billion annually in developing countries. Because of the huge benefits which man accrues from pesticides, these chemicals provide best opportunity to those who juggle with the risk-benefit equation. With the increasing awareness of toxic effects of conventional formulations, there is a significant trend towards switching over from such pesticide formulations using petroleum and organic solvent based constituents to user and environment friendly water based pesticide formulations. The developed world has progressed substantially in this regard to develop eco-friendly formulations which are safer to food and the environment. These formulations would not only replace toxic, non-degradable ingredients/adjuvants of the conventional formulations but also increase the bio-efficacy of the products through incorporating latest technologies including size reduction (WP to SC, SL to ME), increased coverage of applied surface area (EC to ME/Nano-formulations), reduced wastage (Dust/WP to Controlled Release Formulations) and dose rates of applied same pesticides to improve

food quality with minimum pesticide residues. Suspension Concentrates, Water Dispersible Granules, Emulsion in Water, Micro-emulsion, Combination Formulations, Effervescent Tablets, Floating Tablets, seed treatment formulations etc. are some of the formulation types that come under this category of safer formulations for the production of safe and clean food.

ISFS-004

Carbofuran movement and dissipation in brinjal (*Solanum melongena* L.) cultivated soil under subtropical weather in Bangladesh

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An experiment was designed with a view to determine the horizontal and vertical movement and also to observe the trend of dissipation of carbofuran residues in subtropical soil where carbofuran (furataf 5G) was applied at the rate 30 kg/ha at 30 days after establishing of brinjal seedlings. The highest concentration of carbofuran residues was detected (5.534 ± 0.124) ppm at 5 cm depth of the application point soil at 0 days after application (DAA) but the concentration started to dissipate with increasing the time and it become almost half (2.120 ppm) at 7 DAA and dissipation reached at the peak (0.0603 ppm) at 105 DAA. The vertical movement was assured by detecting carbofuran residues at 15 cm soil depth of the plant base. At 0 DAA, there were no residues detected while the concentration of carbofuran residues was emerged (0.8115 ± 0.0796 ppm) at 3 DAA. But the concentration reached to the peak (2.273 ± 0.293 ppm) at 7 DAA. Subsequently the residue started to decline and it becomes (0.070 ± 0.011) ppm at 105 DAA. The horizontal movement of carbofuran was also confirmed by analyzing the soil samples collected from 5 cm and 15 cm soil depth at the middle points of two rows at different DAA. Carbofuran residue (0.074 ppm) at 5 cm depth was first found after 7 DAA which reached at the peak at 35 DAA (0.179 ppm) and then it started to dissipate gradually and decreased to 0.045 ppm at 105 DAA. Almost similar movement was also observed at 15 cm depth of soil for horizontal movement. Major findings of this research that carbofuran can disperses into the soil from applied point to untreated zone both vertically and horizontally which may cause soil and water pollution. Plant and fruit also can be contaminated. But good news is that carbofuran residues can be dissipated rapidly in subtropical weather due to high temperature, high humidity and may be high microbial activity.

ISFS-005

Bioefficacy of Clethodim 24% EC for weed management in blackgram

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A field experiment was carried out with blackgram crop (var. Sarada) for two consecutive years (2010, 2011) at Central Research Farm (New Alluvial Zone), Gayeshpur, Nadia, West Bengal (23°N latitude, 89° E longitude, altitude 9.75, medium land having 6.90 pH, 0.045% total N, 45 kg/ha available P_2O_5 and 240 kg/ha available K_2O) during the kharif season. Eight treatments (including hand weeding treatment at 20 and 40 days after planting and unweeded control) were tried in a Randomized Block Design with three replications. The experimental result revealed that hand weeding twice gave the highest seed and stover yield (1016 and 3512 kg/ha respectively) which, however, statistically at par with Clethodim 24% EC along with non ionic surfactant and ammonium sulphate (T_1). This herbicide offered promising control of all categories of dominant weeds and finally gave second highest seed and stover yield (995 and 3487 kg/ha respectively), exhibiting no phytotoxicity symptom on blackgram. Thus it leads to a conclusion that the tedious, time consuming and costly hand weeding can profitably be replaced by the application of Clethodim 24% EC along with non ionic surfactant and ammonium sulphate, which has been found to be the most cost saving and a safe weed control weed control treatment. This treatment is also promising in obtaining higher grain yield by controlling weeds at a satisfactory level can be considered instead of hand weeding twice with respect to benefit : cost ratio.

ISFS-006

Bioefficacy of different herbicides for weed management in transplanted *kharif* rice

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A field experiment was carried out with kharif Rice crop [var. *Satabdi* (IET-4786)] for two consecutive years (2009 and 2010) at Central Research Farm (New Alluvial Zone) (23°N latitude, 89° E longitude, altitude 9.75 meters), Gayeshpur, Nadia, West Bengal. The experiment was laid out in RBD with eight treatments (T_1: Imazosulfuron 10% SC @ 40 g.a.i/ha at 5 DAT, T_2: Imazosulfuron 10% SC @ 50 g.a.i/ha at 5 DAT, T_3:

Imazosulfuron 10% SC @ 60 g.a.i/ha at 5 DAT, T_4: Imazosulfuron 10% SC @ 100 g.a.i/ha at 5 DAT, T_5: Ethoxysulfuron 15% WDG @ 15 g.a.i/ha at 10 DAT, T_6: Oxadiargyl 80% WP @ 100 g.a.i/ha at 10 DAT, T_7: Two hand weeding at 20 DAT and 40 DAT and T_8: Unweeded control) replicated thrice. The experimental result revealed that hand weeding twice gave the highest grain and straw yields (4.77 and 6.03 t/ha respectively), which, however, statistically at par with the treatment Imazosulfuron 10% SC @ 100 g a.i./ha applied at 5 DAT. This herbicide offered promising control of all categories of dominant weeds and finally gave second highest grain and straw yields (4.55 and 5.68 t/ha, respectively), exhibiting no phytotoxicity symptom to the rice crop. The second highest dose of Imazosulfuron 10% SC i.e. @ 60 g a.i./ha also resulted promising grain and straw yield (4.27 and 5.31 t/ha respectively). So, the findings of the experiment provide us with a great opportunity of using chemical herbicides to manage the labour crisis and minimize the cost of cultivation, therefore, maximizing benefit cost ratio.

ISFS-007

Relative toxicity of Rynaxypyr 20% Sc (coragen) against natural enemies of insect pests

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Relative toxicity of rynaxypyr 20% SC (Coragen) was determined in the laboratory at fixed temperature (25 ± 1ºC) and R.H. (70 ± 5%) against two important natural enemies i.e., *Trichogramma chilonis* Ishii. pupae and *Bracon brevicornis* Wesm. adults. Two common insecticides viz. cartap hydrochloride 50% SP and cypermethrin 10% EC were taken as standard check. Parasitized egg cards of *Corcyra cephalonica* Stainton containing pupal stages of *T. chilonis* after 4 days of parasitization were dipped in insecticidal solutions at different concentrations, dried under the fan and kept inside glass vials. The mortality of pupae was recorded after adult emergence. In case of *B. brevicornis*, castor leaf strips were dipped in insecticidal solutions, dried under fan and were lined inside specimen tubes. Ten newly emerged *Bracon* females were released within the tubes and mortality of adults recorded after 24 hours. LC_{50} and't' values were calculated following standard statistical methods. Among the insecticides tested against *T. chilonis*, cartap hydrochloride 50% SP was the most harmful while rynaxypyr 20% SC; the safest. Cartap hydrochloride 50% SP and cypermethrin 10% EC were 12.53 and 10.13 times more toxic than rynaxypyr 20% SC, respectively. The 't' values suggested that, rynaxypyr 20% SC was significantly less toxic than cartap hydrochloride 50% SP and cypermethrin 10% EC. Rynaxypyr 20% SC was the least toxic to the adults of *B. brevicornis* while cartap hydrochloride 50% SP

being the most toxic. Cartap hydrochloride 50% SP and cypermethrin 10% EC were 32.36 and 27.09 times more toxic than rynaxypyr 20% SC, respectively. The 't' values between rynaxypyr 20% SC and cartap hydrochloride 50% SP, and rynaxypyr 20% SC and cypermethrin 10% EC were significant at 1% level. Considering its effect on natural enemies, it is concluded that rynaxypyr may be a safer alternative to the conventional insecticides.

ISFS-008

Bioefficacy of few new groups of insecticide against cotton jassid (*Amrasca biguttula biguttula*)

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An experiment was conducted to test the effect of few new groups of insecticides against one of the important sucking pest on cotton (*Gossypium hirsutum*); cotton jassid (*Amrasca biguttula biguttula*) in the Institutional research farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal during the pre-*kharif* season of 2012. Seven numbers of insecticides with three concentrations along with untreated control, altogether twenty-two treatments replicated three times were done in the experiment. The insecticides *viz* imidacloprid 17.8 % SL @ 0.2, 0.3 and 0.4 ml/L; acetamiprid 20 % SP @ 0.2, 0.3 & 0.4 gm/L; clothianidin @ 0.2, 0.3 and 0.4 gm/L; dinotefuron 20 % SG @ 0.2, 0.3 and 0.4 gm/L; sulfoxaflor 24% SC @ 0.1, 0.2 and 0.3 ml/L; thiamethoxam 25 WG @ 0.2, 0.3 and 0.4 gm/L and spiromesifen 24 % SC @ 0.75, 1 & 1.5 ml/L were applied two times at fifteen days interval. Among the treatments, the most effective insecticide in controlling the jassid population was dinotefuron 0.4 gm/L followed by the same at 0.3 gm/L. The order of bioefficacy on the basis of per cent reduction of cotton jassid over control plot was: dinotefuron > clothianidin > sulfoxaflor > thiomethoxam > imidacloprid > acetamiprid > spiromesifen.

ISFS-009

Relative efficacy of some acaro-insecticides against Rice Panicle Mite (*Steneotarsonemus spinki* Smiley)

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Rice (*Oryza sativa* L.) is an important cereal crop and staple food for more than 65 per cent of the world's population. Various insects attack standing and stored rice. Among them, about 20 insect pests have major significance in different rice growing regions of India. Among these mites being microscopic are least studied. Mites are generally overlooked in the field and the damage induced by them is usually assessed on the basis of their feeding response. The present experiment was carried out at the Rice Research Station located at Chinsurah, Hooghly, West Bengal, during June 2011 to November 2011 with a view to evaluate relative efficacy of some acaro-insecticides against the mite. The experiment was laid out in Randomized Block Design (RBD) with four replications for each treatment. Insecticides viz. Fipronil 5% SC, Profenofos 40% + Cypermthrin 4%, Spiromesifen 240SC, Profenofos 50% EC, Dicofol 18.5% EC, Fenazaquin 10 EC, Monocrotophos 36SL, Phorate 10G were sprayed twice at 15 days interval (at 50DAT and 65DAT). The mean number of motile stages of mite per 2 cm sq. leaf sheath and their damage were observed randomly from 10 plants at before and after each spray. Profenofos 50% EC were found to be most effective with 96.17 percent reduction in mite population followed by Dicofol 18.5% EC with 92.47 percent. In respect to percent yield increase over control plot again profenofos 50% EC was proved to be the best with 103.87% yield increase followed by Dicofol 18.5% EC with 88.71%.

ISFS-010

Studies on the economical spray schedule of mancozeb for the control of purple blotch disease of onion

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Onion is one of the most important and indispensable item in every kitchen as condiment and vegetable. The crop has gained the importance of a cash crop rather than vegetable crop because of its very high export potential. The yield of onion crop is very much affected by the disease purple blotch. First symptoms of the disease occurred on older leaves, 54–69 days after transplanting. Purple blotch (c.o. *Alternaria porii)*

symptoms are first observed as small, elliptical, tan lesions that often turn purplish-brown. The experiment was conducted on the economical spray schedule of mancozeb for the control of purple blotch disease of onion var. sukhsagar was carried out during the *Rabi* season in 2010-2012 at C' Block Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal. The trial consisted of five treatments involving spraying of mancozeb @ 0.25 % at every 15, 30, 45 and 60 days interval along with control for its efficacy against Purple blotch disease of onion.Disease intensity in all monitored crops increased as plants matured until harvest but never exceeded 30 % due to fortnightly applications of mancozeb. A regular spray schedule is critical for management of this disease. The spray schedule is intensified later in the season during periods of prolonged leaf wetness and high relative humidity. The result showed that the lowes0t disease incidence and severity were observed in 15 days interval, which has been reflected in the highest bulb yield of onion as compare to the control. The experimental result showed that spraying of mancozeb @ 0.25 % at 15 days interval was best, followed by at 30 days interval, for effective controlling Purple blotch disease of onion. However, further studies are necessary to determine the optimal spray schedule of mancozeb for foliar disease management.

ISFS-011

Analysis of pesticide residue in water from different sources in Delhi and NCR region

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Water is essential natural source required for all living organisms in the world. Indiscriminate use of pesticide causes many adverse effects on environment. Even the municipal water supply of Delhi is not free of contaminants like pesticides, heavy metals, organic and other microbial contaminants. People either have to boil or purify drinking water before use. We cannot afford to be careless about the kind and quality of water which we drink. In literature many pesticides like Organochlorine (DDT isomers, HCH isomers, Endosulfan isomers, Aldrin, Dieldrin Dicofol, Heptachlor, Heptachlor epoxide, and Organophosphorus (Chlorpyrifos ,Dimethaoate, Ethion, Malathion, Parathion methyl, Phorate, Phosphomidon, Quinalphos, Prefenophos) have been detected in water from different sources of Delhi and NCR region. Thus the present study was carried out to determine the actual status of pesticidal contamination in the water bodies in Delhi and NCR region. 25 water samples (Ground, River, Canal, Drinking water supplied by MCD, Delhi) were collected from different location of East, West, North, South, Central region of Delhi and NCR region on monthly basis. The samples were processed followed by clean-up and analysed for multi pesticide residue using multi-residue method by GC-ECD,GC-FPD and was confirmed by GC-MS under full scan as well as selected ion

mode (SIM).The limit of quantification (LOQ) value of pesticides was less than their maximum residue limit (MRL) value. The percentage recovery studies were found in between 60-110. Some of the water samples were found contaminated with DDT isomers, Alachlor, Butachlor, Pendimethalin but none of the pyrethroids were detected in any sample.

ISFS-012

Effect of chemical elicitors on pests and disease incidence in jute under field condition

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A field experiment was conducted to study the effect of pre-treatment with some chemical elicitors on the pests and disease incidence in jute. The seeds of JRO 8432 were treated with different chemical elicitors *viz*. chitosan @ 5.0%, salicylic acid @ 1.0mM,indole acetic acid (IAA) @ 1.0mM; beta amino butyric acid (BABA) @ 5mM , di-potassium hydrogen phosphate (K_2HPO_4) @ 50mM, calcium chloride ($CaCl_2$) @ 25mM andcarbendazim @ 0.1% for 15 minutes. Foliar applications of the above-said chemicals were made at one month intervals. The infestation of stem weevil was about 19.65% in untreated check, but it was lowest in calcium chloride (11.25%) and salicylic acid (11.31%) treated plots. Similarly jute semilooper infestation was 22.1% in control plots. The infestation was lowest in calcium chloride (11.01%) followed by IAA (12.44%) and salicylic acid (13.97%) treated plots. Carbendazim, salicylic acid, bêta amino butyric acid (BABA) and calcium chloride significantly reduced stem rot incidence to 3.14, 3.77, 3.85 and 4.5% respectively. But in untreated plots the stem rot incidence was 12.2%. Soluble protein content of untreated jute seedlings was recorded as 12.63 mg/g of tissue. But seed treatment with salicylic acid, carbendazim, calcium chloride and IAA drastically increased soluble protein content to 31.13, 30.08, 29.57, and 25.83 mg/g respectively. Spraying of chemical elicitors also increased the soluble protein content but not to that extent. After two weeks of spray soluble protein contents were 19.0, 19.0, 18.83 and 18.40 mg/g in case of salicylic acid, chitosan, carbendazim and dipotassium hydrogen phospahte (K_2HPO_4) treated plants. Phenol content of untreated jute seedlings was 1.18 mg/g whereas it was 3.07, 2.82, 2.60 and 2.45 mg/g in case of seed treatment with carbendazim, chitosan, salicylic acid and IAA respectively. The phenol content was as high as 4.36 mg/g in case of chitosan spray followed by carbendazim (4.32mg/g), calcium chloride (3.63 mg/g) and K_2HPO_4(3.47 mg/g) spray.

ISFS-013

Bioefficacy and phytotoxicity of Trifloxistrobin 25% + Tebuconazole 50 % (Nativo 75 WG) against sigatoka disease (*Cercospora musae*) of banana in West Bengal

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Field experiment was conducted in Horticultural Research Farm, Mandoury, Bidhan Chandra Krishi Viswavidyalaya, West Bengal with eight treatments viz., T_1 Untreated Control, T_2 Trifloxistrobin 25% + Tebuconazole 50% - 75WG, T_3 Trifloxistrobin 25% + Tebuconazole 50% - 75 ,T_4 Trifloxistrobin 25% + Tebuconazole 50% - 75WG WG, T_5 Trifloxistrobin (Flint), T_6 Tebuconazole (Folicur) 250 EC, T_7 Tebuconazole (Folicur) 250 EC and T_8 Hexaconazole 50 EC (Contaf 50 EC) in order to evaluate the efficacy of fungicides against sigatoka disease of banana during two consecutive years of 2010 and 2011. The treatments were evaluated over the grown up susceptible banana cultivar singapuri following Randomized Block Design with three replications. Foliar spraying was commenced at sixty days after planting followed by another two sprayings at ten days interval of the first spraying. All the fungicides with different doses were found significantly superior over untreated control. The treatment with Trifloxistrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 87.5 +175 g a.i./ha concentration followed by Trifloxistrobin 25% + Tebuconazole 50% - 75WG @ 75 +150 g a.i./ha concentration. The fruit yield was also significantly superior in those treatments. No phytotoxic effect was observed when higher doses of fungicide were applied over the crop.

ISFS-014

Bioefficacy and phytotoxicity of Trifloxistrobin 25% + Tebuconazole 50 % (Nativo 75 WG) against leaf blight disease (*Exserohilum turcicum*) of maize in West Bengal

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Experiment was conducted with all standard and recommended packages of agronomy practices such as tillage, spacing, manuring, irrigation and insect control for cultivation of the crop at Instructional Farm, Jaguli, Bidhan Chandra Krishi Viswavidyalaya, Nadia. Five fungicides with 8 treatments *viz* T_1 Untreated

Control, T_2 Trifloxistrobin 25% + Tebuconazole 50% - 75WG T_3 Trifloxistrobin 25% + Tebuconazole 50% - 75 T_4 Trifloxistrobin 25% + Tebuconazole 50% - 75WG, T_5 Trifloxystrobin (Flint) 50 WG, T_6 Tebuconazole (Folicur) 250 EC T_7 Propiconazole (Tilt) 25 EC and T_8 Mancozeb 75 WP in order to evaluate the efficacy of fungicides against leaf blight disease of maize during two consecutive years of 2011 and 2012. Treatments were evaluated following randomized block design (RBD) with three replications. The test fungicides were applied as foliar spray with knap sack sprayer fitted with hollow cone/triple action nozzle. The first spraying was done at the appearance of visible symptoms (35 days after sowing) and subsequently another spray was applied at 14 days after first spray. All the fungicides with different doses were found significantly superior over untreated control. The most effective treatment was Trifloxistrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 87.5 + 175 g a.i./ha concentration followed by Trifloxistrobin 25% + Tebuconazole 50% - 75WG @ 75 + 150 g a.i./ha concentration. The grain yield was also significantly superior in those treatments. No phytotoxic effect was observed when higher doses of fungicide were applied over the crop.

ISFS-015

Comparative field efficacy of some insecticides against aphid on okra in Gangetic plains of West Bengal

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A field experiment was conducted during Kharif season of 2009-10 and 2010-11 at Adisaptagram Block Seed Farm, Hooghly, West Bengal to find out the population of aphid, *Aphis gossypii* (Glover) on okra. The incidence of aphid was initiated during early stage of the crop growth, *i.e.* in the second week of July of both the years. Then the population of aphid was increased gradually to reach its peak during first week of September (39.28 aphids/3 leaves) when minimum and maximum temperature was 26.10°C and 33.50 °C; minimum and maximum R.H. was 72.57% and 97.57% with 1.6 mm rainfall and persisted throughout the crop period with low incidence. Efficacy of some insecticides was also evaluated against aphid on okra. Among the different treatments imidacloprid 17.8%SL @ 30g a.i./ha was found most effective in reducing the population of aphids followed by acephate 75SP @300g a.i./ha; dimethoate 30EC @ 300g a.i./ha; chlorpyriphos 50 EC + cypermethrin 5SC @ 300g a.i./ha; chlorpyriphos 20EC @ 350g a.i./ha; spinosad 45SC @ 60g a.i./ha and emamectin benzoate 5SG @ 18gm a.i./ha respectively than untreated control. Maximum net return was obtained from emamectin benzoate treated plots but the cost benefit ratio was recorded from imidacloprid treated plots (1:12.16).

ISFS-016

Efficacy of some insecticides against cutworm and molecricket of potato in West Bengal

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A field investigation was conducted to evaluate the efficacy of some insecticides against soil pests *i.e.* cutworm (*Agrotis ipsilon;* Noctuidae: Lepidoptera) and molecricket (*Gryllotalpa africana*; Gryllotalpidae: Orthoptera) infesting potato at Adisaptagram Block Seed Farm, Mogra, Hooghly, West Bengal during 2007-08 and 2008-09. The field trial was conducted in Randomised Block Design with six treatments and five replications. Among the various treatments for management of soil pests of potato (cv. Kufri Bahar) *i.e.* cutworm and molecricket, soil treatment of phorate 10G @ 15kg/ha at planting + drenching the ridges with chlorpyriphos 20EC @ 2.5ml/L of water on appearance of pest was found most effective in decreasing the incidence of cutworm and molecricket and recorded maximum healthy tuber yield (31.66) followed by soil treatment at planting with phorate 10G @ 15kg/ha + drenching the ridges with imidacloprid 17.8 SL @ 0.004% (2ml/10 L of water) on the occurrence of the pest (T_6) than other treatments as well as control. Both the treatments was more or less equally effective to decrease the incidence of cutworm and molecricket.

ISFS-017

Study of bioefficacy of Eugin 5EC against late blight and Antirot 10DP against soil and tuber borne diseases of potato in West Bengal

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A field experiment was conducted to evaluate the bio-efficacy of Eugin 5EC (based on garlic extract) against late blight and Antirot 10DP (based on jojoba seed dust against soil and tuber borne diseases of potato (variety: Kufri Chandramukhi) in West Bengal. In case of late blight the Per cent Disease Intensity (PDI) was recorded at 7 days interval starting from first appearance of the disease following 1-9 scale. Incidence percentages of tuber borne diseases were recorded at the time of harvesting. For evaluation of bio-efficacy of Eugin 5EC against late blight, six treatments were considered (*i.e.* T_1= spraying of Eugin 5EC @ 2.5 ml/lt of water, T_2= Eugin 5EC + Mancozeb 75WP @ 2.5 ml Eugin + 1.5 g Mancozeb /lt of water, T_3= Eugin 5EC +

Mancozeb 75WP @ 2.0 ml Eugin + 2.0 g Mancozeb /lt of water, T_4= Mancozeb 75WP @ 3.0 g/lt of water, T_5= Cymoxanil + Mancozeb @ 0.3% and T_6= untreated control). Considering both PDI of late blight and tuber yield of potato, spraying of Eugin 5EC + Mancozeb 75WP @ 2.5 ml Eugin + 1.5 g Mancozeb /lt. of water (*i.*e. T_2) exhibited the best result against late blight disease (PDI 21.35% and yield 18.60 t/ha) as compared to untreated control *i.e.* T_6 (PDI 67.05% and yield 11.00 t/ha). For evaluation of bio-efficacy of Antirot 10DP against soil and tuber borne diseases of potato also, six treatments were considered (*i.e.* T_1= application of Antirot 10DP @ 7.5 Kg/ha, T_2= Antirot 10DP + Urea @ 7.5 Kg Antirot + 15.0 Kg Urea /ha, T_3= Antirot 10DP + Mixed fertilizer @ 7.5 Kg Antirot + 75.0 Kg Mixed fertilizer /ha, T_4= Carbendazim 50WP @ 1.0 g/lt of water, T_5= Bleaching powder @ 20 Kg/ha and T_6= untreated control). Considering incidence percentage of tuber and soil borne diseases and tuber yield of potato, application of Antirot 10DP +Mixed fertilizer @ 1.0 kg Antirot + 75 kg Mixed fertilizer/ha (*i.*e. T_3) exhibited the best result against brown rot (2.90%), scab (4.20%) and soft rot (1.59%) giving the best tuber yield (24.64 t/ha) as compared to untreated control (i.e. T_6) where the per cent incidence of brown rot, scab and soft rot were 6.71, 10.16 and 2.74% respectively giving the tuber yield 19.49 t/ha.

ISFS-018

Miceller Kinetics- the key parameter for the preparation of environmental and user friendly water based microemulsion formulations

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Chloropyriphos is a broad spectrum, moderately toxic organophosphate insecticide. Eemulsifiable concentrates and granules are the two dominant formulations of chlorpyriphos, which contain organic solvents, dusts with potential environmental pollution. Water-based pesticide microemulsions have become one of the most promising pesticide formulations instead of the conventional pesticide formulation in recent years, which indeed have been a good insecticidal performance and a minimal impact on the environment. The microemulsion is known as the green pesticide formulations for using less organic solvents and less polluting to the environment with high effectiveness. It is in the direction of the pesticide's sustainable development, and is a new pesticide formulation to replace the EC. The organophosphorous pesticides like Chloropyriphos are most commonly used for household as well as crop pest management but most of the formulations of these pesticides are organic solvent based because of their hydrolytical unstability. Since

microemulsions are known to stabilize the active molecules which are hydrolytically unstable and also thermo-labile so, in this paper we have tried to optimize the conditions for the stabilization of hydrolytically unstable chloropyriphos in water based microemulsion system.Water, less-toxic organic solvents, co surfactants and surfactants were employed to explore the preparation of chloropyriphos pesticide microemulsion based on the phase diagram method, and the optimal ratios of various components were chosen, forming the best chloropyriphos pesticide microemulsion region. chloropyriphos microemulsion was successfully obtained through the further trials of screening of heat storage and cold storage stability experiments. The organic solvent, surfactant and kinds of additives were researched in the procession of preparing the chloropyriphos microemulsion. The more green environment-friendly and extremely development potential chloropyriphos microemulsion formulation was obtained.

ISFS-019

Requirements of user and environment friendly new generation pesticide formulations for clean environment and food

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The basic objectives of pesticide formulations are not only to control pests to increase food production with optimized biological activity, but also to improve the quality of safety in use and clean environment. In past, most of agrochemical formulations were based on simple solutions in water-miscible solvent (SL), emulsifiable concentrates in a petroleum-based solvent (EC), or dusts (DP) and wettable powders (WP). The presence of petroleum-based solvents and dusty powders in these conventional formulations generally create safety hazards in use and have a negative impact on food quality and environment. These types of formulations are regarded now as 'old technology or classical or traditional' because of their increased in dose rate or repeated applications to get desired bio-efficacy and ultimately endanger safety of food quality, humankind as well as environment. Most government regulatory authorities, including the Indian Government, are now feeling the requirement to replace these conventional formulations and to encourage pesticide industries to develop formulations which are cleaner and safer for user, have minimal impact on foods, environment, and can be applied at the lowest dose rate. This has led to develop water-based liquid formulations such as suspension concentrates (SC), oil-in water emulsions (EW) and microcapsules (CS) etc. There has also been a move away from dusty powders towards water dispersible or soluble granules (WG/SG). These types of formulations are regarded as new generation formulations or user & environment friendly pesticide formulations. This paper describes about new pesticide formulations, their increasing demand by regulatory authorities and introduction by pesticide formulation companies.

ISFS-020

Bioefficacy of spiromesifen against broad mite of jatropha

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With the exponential rise in petroleum prices and increase in demand for petroleum products around the world, the price of crude oil would remain high for a long time. Besides price of crude oil, diminishing petroleum reserves and awareness of the increased environmental consequences of emissions from petroleum-fuelled engines are some other concerns for the search of an alternative and renewable fuel for diesel engines. The seed oil of jatropha (*Jatropha curcas)* belonging to Euphorbiaceae family has been found a promising and commercially viable alternative to diesel. The National Biofuel Policy launched on September, 2008 keeps the target of blending biodiesel with petroleum diesel at a proportion of 20% by the year 2017. In West Bengal jatropha suffers from the attack of broad mite, *Polyphagotarsonemus latus* causing severe damage to the plant vitality by sucking cell sap from the apical leaves. An acaricide, spiromesifen 240 SC was evaluated against the mite and its impact on two associated predatory mites *viz., Amblyseius* sp. and *Agistemus* sp. was also studied. Experiments were laid out at ZARS, Nalhati, West Bengal, India following RBD with six treatments and four replications during pre-*kharif* season of 2010 and 2011. The treatments were applied with knapsack sprayer as high volume spray. Number of motile stages of broad mite was counted from 2 randomly tagged leaves from five random plants per plot in the apical portion of the plant before application and 7^{th}, 14^{th}, 21^{st}, 28^{th} and 35^{th} days after application of treatment. The numbers of damaged leaves out of total leaves per branch per plant were also counted on five randomly tagged plants on the same day of observation. The increase or reduction of population of predatory mites *viz., Amblyseius* sp. and *Agistemus* sp. was worked out based on their number on five random leaves from each of the five random plants per plot on 14^{th} day after spray. These data along with yield were analysed statistically. The pooled data revealed that spiromesifen @ 120 g a.i./ha was significantly the best treatment in reducing the mite population, percent leaf damage along with yield increase. This treatment was followed by spiromesifen @ 96 g a.i./ha. Spiromesifen was also safer to the natural enemies compared to other acaricides *viz.,* propergite and dicofol.

ISFS-021

Studies on efficacy of new generation acaricides against red spider mite of tea and their effect on natural enemies at terai region of West Bengal, India

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Tea is the most liked beverage around the world. Assam is the highest black tea producing state in India (50.7%) followed by West Bengal (22.1%) with well defined agroclimatic niche area *viz.,* Darjeeling, Terai and Dooars. Recent records revealed that from being a sporadic pest before 1950, the red spider mite, *Oligonychus coffeae* (Nietner) (Fam: Tetranychidae), has attained the key pest status on tea in N. E. India particularly after phasing out of tetradifon, a persistent acaricide. An attempt was made to evaluate the comparative efficacy of some recently introduced acaricides in India against red spider mite of tea and their effect on the most effective predatory mite in the tea ecosystem. The experiments were conducted at Kamalpur Tea Estate, Upper Bagdogra, Terai region, West Bengal, India in the post rainy season of three consecutive years, 2009, 2010 and 2011 following RBD with three replications. Observations were recorded using a 10X hand glass at different days after treatment from ten random leaves chosen from ten random bushes of each plot leaving the border row. Observations on the incidence of predators were recorded at 7 days after spraying. The three year pooled data revealed that etoxazole 11 EC @ 400 ml/ha was the best treatment in reducing the red spider mite population followed by etoxazole 11 EC @ 300 ml/ha, spiromesifen 240 SC @ 400 ml/ha, etoxazole 11 EC @ 200 ml/ha, hexythiazox 5 EC @ 500 ml/ha and propargite 57 EC @ 1000 ml/ha. Etoxazole treated plot remain free from the red spider mite even after 35 days after treatment. Etoxazole also found to be least toxic to the three important group of predatory mite *viz, Amblyseius, Agistemus* and *Cunaxa* prevalent in tea ecosystem. So, etoxazole may favourably be considered to incorporate in the control schedule of red spider mite of tea.

ISFS-022

Field efficacy of thiacloprid against important pests of soybean in West Bengal, India

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Soybean [*Glycine max* (L.) Merril] is an important pulse and oilseed crop. Being a legume it fixes atmospheric nitrogen through symbiotic association with *Rhizobum* bacteria. To boost production of edible oil soybean has a good prospect in West Bengal with its high yield potentiality. The crop provide source of food, space and shelter to the insects with its luxuriant growth accompanied by green, soft and succulent foliage. Among the 20 insect pest species infesting soybean crop recorded in India, girdle beetle (*Obereopsis brevis* Swedenboard) and sucking insect pests such as thrips (*Thrips tabaci*) and aphids (*Aphis gossypii*) cause severe damage and consequent yield reduction in West Bengal. Thiacloprid (240 SC), a neonicotinoid compound was evaluated for its field efficacy against these important pests of soybean. Experiments were laid out following RBD with five treatments and four replications during *kharif* (rainy) seasons of 2009 and 2010 at the Gangetic Alluvial Zone of West Bengal. Treatments were applied twice at seven days interval starting at the ETL of the pests as high volume spray with knapsack sprayer using hollow cone nozzle. The incidence of girdle beetle was recorded as the number of insect per meter row length form five random spots per plot while the number of the motile stage of the thrips and aphids were recorded from five apical leaves of five randomly tagged plants per plot leaving the border row before application of treatment and on 1st, 3rd and 7th days after treatment. The studies revealed that thiacloprid @ 180 g a.i./ha was significantly the best treatment in reducing the population of girdle beetle, thrips and aphids in both the seasons. Thiacloprid @ 150 g a.i./ha was the next best treatment in reducing the pest population. Reduction of the pest population was also reflected in increasing the yield of soybean. These two treatments were significantly better than other conventional systemic insecticides *viz*., triazophos and profenofos.

ISFS-023

Role of Buprofezin- an IGR in IPM of mango hoppers

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India is the largest producer of mango accounting for 41% of the world's mango production. West Bengal has been recognised as a mango Export Zone. The mango hoppers are the key pest of mango causing severe damage by sucking sap from bud, inflorescence and early fruit setting stages resulting in drying of flowers,

premature fruit drop and poor yield. Natural enemies of mango hoppers are almost ineffective to hold on the population below economic threshold level (ETL). The repeated applications of chemical pesticides create contamination problems restricting the export of mango. Incidentally Buprofenzin, an insect growth regulator (IGR) was found to play an important role in management of the sucking insect pests. Experiments were laid out during the years 2008 and 2009 following the Good Field Practices and Buprofezin was found very effective in controlling mango hoppers compared to imidacloprid. It was very safe to natural enemies and unlikely to cause any contamination problems. Based on field experiments, Applaud-25 SC (Buprofezin) may be recommended @ 1.0-2.0 ml/l of water at bud, inflorescence and fruit setting stages at an interval of 15days in IPM programme of mango. The implications of the studies will be documented at length in the main text.

ISFS-024

Evaluation of Buprofezin 70 DF, an insect growth regulator for eco-friendly management of jassid (*Amrasca bigutulla bigutulla* Ishida) in okra

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Jassid (*Amrasca bigutulla bigutulla* Ishida) is one of the major insect pests of okra (*Abelmoschus esculentus* L.) causing about 50 percent yield loss due to severe attack of this pest. Therefore, experiment was conducted for two seasons at Central Research Farm, Gayeshpur, BCKV, Nadia, West Bengal to evaluate buprofezin 70 DF, an insect growth regulator, against this pest in okra. The experiment was laid out in randomized block design with four replications. The insecticide was applied @ 150 and 200g a.i./ha. and performance was compared with imidacloprid 17.8 SL @ 20g a.i./ha., acephate 75 SP @ 562.5g a.i./ha., and an untreated control. Spraying of insecticides was done twice at 20 days interval based on the economic threshold level (2 jassids/leaf). The jassid population was recorded at before spraying, 7 and 15 days after spraying from five randomly selected plants in each plot avoiding border effect. The observations were recorded from three leaves per plant *i.e*., from top, middle and bottom portion of the plants. Among the different treatments, the lowest population of jassid per leaf (0.92 and 0.69) was recorded in the treatment, buprofezin 70 DF @ 200g a.i./ha followed by buprofezin 70 DF @ 150 g a.i./ha (1.0 and 0.72), imidacloprid 17.8 SL @ 20g a.i./ha (1.47 and 1.06) and acephate 75 SP @ 562.5 a.i./ha (1.55 and 1.11) which were significantly superior over untreated control (3.90 and 2.41) during both seasons, respectively. The greatest reduction of insect population was recorded (71.19% and 76.53%) in buprofezin 70 DF @ 200g a.i./ha closely followed by buprofezin 70 DF @ 150g a.i./ha (70.08% and 74.26%) during both seasons, respectively.

ISFS-025

Effect of post emergence herbicide on summer groundnut (*Arachis hypogaea* L.) in new alluvial zone of West Bengal

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A field experiment was conducted during summer season of 2010 and 2011 at District Seed Farm, Kalyani under Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India to evaluate different post emergence herbicides on groundnut variety TAG 24 in new alluvial zone of West Bengal. Results revealed that all the herbicidal treatments as well as weed free check resulted in significant increase in yield and yield attributing characters of groundnut along with reduction in the weed population and weed biomass production, compared to un-weeded control. Among the post-emergence herbicidal treatments, best response was observed from application of quizalofop Ethyl @ 100g a.i./ha. Among all the herbicidal treatments, pre-emergence application of pendimethalin @ 1.0 Kg a.i./ ha along with one hand weeding, recorded highest pod yield (2675 kg/ha), haulm yield (3123 kg/ha), number of pods/plant (17.3), shelling % (71.3) and SMK % (91.4) as compared to post emergence herbicidal treatments. This might be due to application of pendimethalin as a pre emergence, suppresses the weed growth at early stage of the crop as a result of better crop stand. Among the post-emergence herbicidal treatments pod yield, haulm yield and yield attributes of groundnut was found maximum with the treatment received post emergence application of quizalofop Ethyl @ 100 g a.i. /ha. Weed control practices by chemical and/or mechanical means gave significantly higher pod yield of groundnut as compared to un-weeded control and pod yield of groundnut was decreased up to 26-47 % in un-weeded condition. Among the herbicidal treatments maximum gross return (Rs.80550), net return (Rs.55937) and B: C ratio (3.27) were recorded in the treatment received pre-emergence application of pendimethalin @ 1.0 kg a.i. / ha along with one hand weeding.

ISFS-026

Evaluation of Fluopyram 200 + Tebuconazole 200 – 400 SC against anthracnose of chilli

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The experiment was conducted at Jaguli Instructional Farm , Bidhan Chandra Krishi Viswavidyalaya, Nadia, with all standard and recommended packages of agronomy practices such as tillage, spacing, manuring, irrigation and insect control for the cultivation of the crop, Four fungicides with 7 treatments with different

doses viz T1 Untreated Control, T2 Fluopyram 200 + Tebuconazole 200 – 400 SC (150 ml/ha), T3 Fluopyram 200 + Tebuconazole 200 – 400 SC (200 ml/ha), T4 Fluopyram 200 + Tebuconazole 200 – 400 SC (250 ml/ha), T5 Fluopyram 25 EC (100 ml/ha), T6 Tebuconazole 500 SC (200 ml/ha) and T7 Hexaconazole 50 EC (500 ml/ha) for the evaluation of Fluopyram 200 + Tebuconazole 200 – 400 SC against Anthracnose of chilli. The test fungicides were applied as foliar spray with ASPEE sprayer. 500 litres of water/ha was mixed with the test fungicides and first spraying was done at 70 days after sowing (DAS) when the initial symptoms (Fruit rot) of the disease were appeared on the plants. These were followed by two more sprays at 10 days interval. Total 4 observations were recorded. The severity of the disease was recorded one day before each spraying. All the test fungicides significantly control the disease over untreated control. Significant maximum disease control was recorded in Fluopyram 200 + Tebuconazole 200 – 400 SC (250ml/ha) and it was at par with Fluopyram 200 + Tebuconazole 200 – 400 SC (200ml/ha). Significant higher yield was recorded in those treatments. No phytotoxic symptoms was recorded when higher doses was applied on the crop.

ISFS-027

Sulfoximine- a new insecticide from new class of chemistry to manage sap feeding insect pests of rice

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Rice sap feeding insect, brown planthopper (*Nilaparvata lugens*) is a key pest in most of the rice growing geographies of Asia including India. It can assume serious proportions to cause severe yield loss if proper and timely management practices are not implemented. Many conventional insecticides were used for a long time with growers obtaining average control of this pest. In the last 15 years, different neonicotinoid insecticides introduced helped growers to successfully manage that insect pest. Due to continuous and indiscriminate use of neonicotinoids, frequent control failures by this class of insecticide became evident over the last few years, especially in the China, Japan, Indonesia and Indian subcontinent. Farmers resorted to using various methods due to non-availability of suitable insecticides to control brown planthopper (BPH). Industry and academicians suspected that it has evolved resistance to neonicotinoid chemistry, as the pest is notorious for resistance development and resurgence are frequently encountered. Sulfoxaflor, the first product from sulfoximines a new class of insect control agents, exhibits broad spectrum insecticide efficacy against rice sap feeding insect pests, BPH (*Nilaparvata lugens*), white-backed plant hopper (*Sogatella furcifera*), and green leafhopper (*Nephotettix virescens*). In particular, sulfoxaflor, due to its novel mode of action, exhibits high potency and lack insecticidal cross-resistance that is particularly useful in insecticide resistance management programmes. Field experiments were conducted to evaluate its efficacy against sap-feeders of rice. Sulfoxaflor at 75 g.ai/ha provided better management of BPH for more than two weeks, equivalent to

that of buprofezin (200 g. ai/ha) and better than of imidacloprid at 75 g a.i /ha. Sulfoxaflor showed excellent fit with high levels of insecticidal potency in all field experiments against all sap feeders and showed fewer hazards to natural enemies. It has novel mode of action with high acute toxicity to all hemipteran pests, because of insecticidal symptoms accompanied by discriminative action with quick knock down effect. Sulfoxaflor is very safe to non-target organisms that prove the high selectivity action to hemipteran group of insect pests particularly plant hoppers and leafhoppers.

ISFS-028

Evaluation and scheduling of fungicides for management of foliar leaf blight disease of wheat in the Gangetic alluvial zone of West Bengal

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Wheat (*Triticum aestivum* L.) is one of the most important cereal crops contributing about 20% of total food grain requirement in the world. West Bengal is not considered as the traditional wheat growing zone in India but of late wheat area and productivity have been gaining momentum because of increasing trend of wheat consumption among the urban and middle class rural people. It has acquired good popularity among the farmers as the cultivation cost and water requirement are lesser than that of the *boro* paddy. The main constraint in wheat production in North-Eastern India as well as West Bengal is the leaf blight disease complex. The foliar diseases of wheat are very common and destructive in West Bengal, India. . Since, several pathogens are associated with the leaf blight of wheat and several mixed symptoms appear, it can easily be termed as a "complex". Yield loss of wheat ranging from 27-56.6% in North-eastern and North-western plains has been reported due to incidence of leaf blight disease complex. Keeping in view of higher incidence of leaf blight in West Bengal, field trials were conducted to develop effective management strategies through evaluation of fungicides and their proper scheduling. The seed treatment was also used alone and in combination with foliar sprays. The foliar sprays were given at the initiation of the disease and in few treatments repeated after 15 days interval. The average incidence of leaf blight disease was lowest in plots where seed treatment with Vitavax power (Carboxin + Thiram) @ 2.5 g/kg of seed was followed with two sprays of Propiconazole 20 EC (0.1 %). The highest average yield of wheat (41.2 t/ ha) was obtained in plots where seed treatment with Vitavax power (Carboxin + Thiram) @ 2.5 g/kg of seed was followed with two sprays of Propiconazole 20 EC (0.1 %). Thus, seed treatment with Vitavax power (Carboxin + Thiram) @ 2.5 g/kg and two foliar sprays with systemic fungicide Propiconazole 20 EC (0.1 %) should be given to effectively management leaf blight disease complex and increase the yield of wheat in the Gangetic alluvial zone of West Bengal.

ISFS-029

Evaluation of different fungicides for management of damping off of cabbage

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Cabbage also known as white cabbage is one of the most popular vegetables in the world. Cabbage was introduced in India in the Mughal period by the Portuguese, however, it became popular during the British period. Traditionally, cabbage is grown to a larger extent in the southern, eastern and coastal areas of India and cauliflower occupies more area in northern India. However, after the development of tropical hybrids it now produced almost round the year widely throughout the country. In India the major cabbage producing states are Uttar Pradesh, Bihar, Orissa, West Bengal, Assam, Maharashtra and Karnataka and other important growing states are Haryana, Rajasthan, Gujarat, Uttaranchal, Himachal Pradesh and Nilgiri hills of Tamil Nadu. India is the second largest producer of cabbage in the world. Cabbage is fairly high source of glucosinolates (40-90 mg/100g fresh), predominantly sinigrin and glucobrassicin which have prominent anti-carcinogenic property. Biotic and abiotic stresses are the major constraints in cabbage production. Among the biotic stresses, damping off is the destructive fungal disease in nursery beds, especially during early season. In pre-emergence damping off, the growing points are killed in the initial stages of seed germination before they come out through the soil. In post-emergence damping off, the seedlings topple over the ground due to collar rotting and rapid shrinking of the cortical tissue of the hypocotyls. Keeping in view of higher incidence of damping off in early season cabbage in West Bengal, field trials were conducted to develop effective management strategies through evaluation of different fungicides. The evaluation of different fungicides in consecutive two years showed Propamocarb 540 + Fosetyl 310 – 840 SL at 3ml/L of water is the best fungicides followed by Propamocarb 722 SL and Fosetyl Al 80 WP for controlling of damping off diseases upto 47.58 % in 2010 & 48.74 % in 2011 and enhancement of seedling growth. Thus, soil drenching with Propamocarb 540 + Fosetyl 310 – 840 SL at 3ml/L for two times at 10 days interval should be given to effectively manage damping off disease of cabbage and enhance the seedling growth during early season cabbage cultivation in the Gangetic alluvial region of West Bengal.

ISFS-030

Plethora- a new ready-mix insecticide for better management of tomato fruit borer

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During the past three decades, efforts have been made to reduce the risk of human exposure to pesticides specially insecticides. There is a great demand for safer and more selective insecticides that spare natural enemies and nontarget organisms. Consequently new types of insecticides have been developed by agrochemical companies. Although they are mostly synthetic but they are more selective than conventional insecticides. The limited number of target sites exploited by conventional insecticides has created problems with resistance to these insecticides. The present investigations were conducted to test the effectiveness of new ready-mixed insecticide- Plethora (novaluron 5.25+ indoxacarb 4.5SC) at different concentrations in comparison with novaluron, indoxacarb and lamda-cyhalothrin in controlling two important lepidopteran insect pest i.e. *Helicoverpa armigera* and *Spodoptera litura* on tomato. Field experiments were conducted for two consecutive years during 2009 - 2011. Each insecticide was tested with the recommended dose and the experiment was laid out in Randomised Block Design (RBD) with six insecticides with a control. The observation on damage incidence and yield were determined and compared.The overall good performance including favourable benefit cost ratio was noted when plethora (novaluron 5.25+ indoxacarb 4.5 SC) was applied at 825 ml/ha$^{-1.}$ This new ready mixed insecticide reduced the population of *Helicoverpa armigera* up to 100% within three days after third application and reduced the population of *Spodoptera litura* within ten days after first application that led to increases in yield. Novaluron performed well specially against *Spodoptera litura* and indoxacarb showed better performance against *Helicoverpa armigera* but lamda-cyhalothrin showed comparatively lower performance than other selected insecticides. It was also evident from the field observations that plethora (novaluron 5.25+ indoxacarb 4.5 SC) was very safe to three important predators (i.e. *Menochillus* sp. *Chrysoperla* sp. and *Syrphus* sp.) recorded in tomato field. The chemical plethora used in the experiment is highly effective to lepidopteran insect pest with two novel modes of action *viz*. chitin biosynthesis inhibition creates abortive moulting by novaluron and blockage of axonal sodium channel causing rapid cessation of feeding and paralysis by indoxacarb. This insecticide is quite safe to non target organisms and quickly degraded to non toxic products and has potential scope to fit in Integrated Pest Management systems.

ISFS-031

Efficacy of some fungicides against tikka disease of groundnut

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Groundnut is one of the important oilseed crops in Odisha. It is a valuable cash crop cultivated by many of small farmers, because of its economic and nutritional value. Tikka disease is a major disease of groundnut which may cause yield losses of more than 50% (Mc Donald and Fowler, 1977). So, the present investigation was carried out to know the efficacy of certain fungicides against tikka disease of groundnut. Field experiments were conducted during *rabi*, 2011 and 2012 at research farm of RRTTS, Chiplima, Sambalpur, Odisha. The experiment was laid out in a randomized block design (RBD) with three replications. A recommended fertilizer dose was applied in all the plots and standard agronomic practices were followed to raise the crop. Variety Smruti was sown during both the seasons. Seven commercially available fungicides viz. Chlorothalonil, Propiconazole, Mancozeb, Hexaconazole, Carbendazim, Thiophanate methyl and Carbendazim+Mancozeb were tested against the disease. The fungicides were sprayed thrice at 15 days interval. It was found that all the treatments were effective to reduce the incidence of the disease. Among the treatments foliar spraying of Chlorothalonil (0.2%) was found most effective in both the years and was followed by Carbendazim + Mancozeb (0.1%). Percent disease control in two years pooled mean revealed that the maximum disease control was noticed in the plants treated with Chlorothalonil and was followed by Carbendazim + Mancozeb. A maximum increase of yield was achieved with spraying of Chlorothalonil.

ISFS-032

Efficacy of various insecticides against pod borer, *Helicoverpa armigera* (hubner) in chickpea

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An experiment was conducted during *rabi* season 2009-10 to evaluate efficacy of various insecticides against chickpea pod borer, *Helicoverpa armigera* (Hub.) in chickpea at Experimental field of Department of Entomology, Live Stock Farm, Adhartal, JNKVV, Jabalpur (M.P.). The experiment was laid out in a randomized block design with seven treatments (6 treatments+1 control) replicated thrice. The results revealed that, Spinosad @ 73 g *a. i.* / ha was found to be most effective as it recorded lowest larval population (0.34 larvae/metre row length), it was followed by Emamactin benzoate @ 11 g *a.i./*ha (0.35 larvae/mrl),

Rynaxypyr @ 40 g *a.i.*/ha (0.36 larvae/mrl), Indoxacarb @ 60 g *a.i.*/ha (0.39 larvae/mrl), Flubendiamide @ 50 g *a.i.*/ha (0.44 larvae/mrl) and Fenpropathrin @ 100 g *a.i.*/ha (0.72 larvae/mrl) but all of them were at par with each other. The highest seed yield of 18.88 quintal/ha was harnessed by treatments Spinosad @ 73 g *a.i.*/ha with 6.44 q/ha increased yield over untreated control. The next best treatments which recorded higher seed yield included Emamactin benzoate @ 11 g *a.i.*/ha (18.44 q/ha), Rynaxypyr @ 40 g *a.i.*/ha (16.76 q/ha), Indoxacarb @ 60 g *a.i.*/ha (16.19 q/ha), Flubendiamide @ 50 g *a.i.*/ha (15.98 q/ha), and Fenpropathrin @ 100 g *a.i.*/ha (14.80 q/ha) with 5.89, 4.31, 3.74, 3.53 and 2.36 q/ha increased yield over untreated control.

ISFS-033

Bioefficacy of new diamide insecticides against diamond back moth (*Plutella xylostella* L.) on cabbage

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Diamond back moth (*Plutella xylostella* L.) is one of the major insect pests of cabbage which causes considerable yield loss every year in different parts of the country. To control this pest, the farmers have been using insecticides intensively on the crop thereby leads to develop resistance of the pest to almost all the conventional insecticides. Therefore, a field experiment was conducted to evaluate the efficacy of two new insecticides of diamide group with three doses (recommended, lower and higher the recommended doses) against diamond back moth on cabbage. Experiment was laid out in Randomized Block Design with three replications for each treatment during *rabi* season, 2011-12. Cabbage (cultivar: Rareball) seedlings were transplanted in plot of 9.0 m^2 area with 45cmX 45cm spacing. Flubendiamide 480SC @ 20, 40 and 60 g a.i. /ha, Chlorantraniliprole 18.5 SC @ 15, 30 and 45 g a.i. /ha and Chlorpyriphos 20EC @ 250 g a.i./ha were sprayed twice at fifteen days intervals. Results revealed that both Flubendiamide and Chlorantraniliprole at recommended and higher doses were found very effective against target pest with more than 90 percent reduction of larval population over control. Yield was highest in the plots treated with Chlorantraniliprole @ 45 g a.i./ha (53 t/ha) followed by Flubendiamide @ 60 and 40 g a.i./ha with 52.67 and 51.33 t/ha, respectively whereas in Chlorpyriphos (standard check) treated plots yield was 44.50 t/ha. The lowest yield was recorded in control plots (36.33 t/ha). Both Flubendiamide and Chlorantraniliprole were selective to natural enemies associated with cabbage ecosystem.

ISFS-034

Studies on the effect of insecticides against pigeon pea pod borer (*Helicoverpa armigera* H.) and pod fly (*Melanagromyza obtusa* M.)

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Pigeon pea is the second most important pulse crop after chickpea in India. The low yield of pigeon pea is due to several reasons especially the gram pod borer (*Helicoverpa armigera* Hübner) and pod fly (*Melanagromyza obtusa* Malloch) which cause severe damage and associated yield losses across pigeon pea growing regions of the country. Hence, a field trial was conducted during *kharif* season, 2011 at Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India to study the effect of some insecticides and their mixed formulations against pigeon pea pod borer and pod fly. The experiment was laid out in Randomized Block Design (RBD) with three replications for each treatment. Insecticides viz. novaluron 10% EC, indoxacarb 14.5% SC, emamectin benzoate 5% SG, lambda-cyhalothrin 5% EC, thiamethoxam 25% WG, fipronil 5% SC, novaluron 5.25%+indoxacarb 4.5% SC, novaluron 5.25%+fipronil 4% SC and indoxacarb 14.5% SC+thiamethoxam 25% WG were sprayed twice at 15 days interval. The mean number of pod borer larvae and pod fly maggots per plant and their damage were observed randomly from five plants at before and 5, 10 and 15 days after each spray. Mixed formulation of novaluron 5.25%+indoxacarb 4.5% SC @ 80 g a.i./ha and novaluron 5.25%+fipronil 4% SC @ 80 g a.i./ha, were found to be most effective with cent percent reduction of *Helicoverpa* larval population whereas in case of pod fly, novaluron+fipronil @ 80 g a.i./ha and fipronil @ 50 g a.i./ha were the best with 72.5% reduction of pod fly population for each treatment. The highest yield was also recorded in novaluron+fipronil @ 80 g a.i./ha treated plot (18.6 q/ha) followed by novaluron+indoxacarb and fipronil treated plot with 16.4 and 16.2 q/ha, respectively while in control plot it was only 7.5 q/ha.

Concurrent Session - 1

Climate change *vis-à-vis* issues food security

Chairman: VUM Rao
Co-Chairman: SA Khan
Rappoteur: Saon Banerjee

ISFS-035

Climate change and agricultural risk management

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Climate change is characterised by higher average temperatures, changing rainfall patterns ,rising sea levels and more extreme events like droughts, floods and cyclones. Developing countries like India are particularly vulnerable because their populations depend directly on agriculture for their livelihoods. The warming trend in India over the past 100 years (1901 to 2007) was observed to be 0.51^{0} C with accelerated warming of 0.21°C per decade since 1970. The projected impacts are likely to aggravate yield fluctuations of many crops with impact on food security. There is a need to address the issue of climate change and its impacts on Indian agriculture for suggesting mitigation and adaptive measures

Impact of climate change on agriculture and allied sectors Agriculture

All India Network Project on Climate Change studied the impacts of climate change on major crops, livestock, fisheries, soils and other biotic factors and they are:

- Shifts in sowing time and length of growing seasons, increased rate of evapotranspiration and quick depletion of soil nutrient reservoir.
- Without adaptive mechanism, yield loss in wheat by 6 million tones and rice yields by 6% for every one degree increase in temperature was estimated.
- Field experiments using 'Temperature gradient tunnels' revealed that increase of temperature from 1 to 4 ^{0}C caused reduction in grain yield of rice (0-49%), potato (5-40%), green gram (13-30%) and soybean (11-36%). However, chickpea, registered 7-25% increase in grain yield with increase in temperature up to 3 ^{0}C, and reduction by 13% with further 1 ^{0}C rise in temperature.
- A significant decrease in average productivity of apples in Kullu and Simla districts of Himachal Pradesh due to inadequate chilling requirement for fruit setting and development was observed. Shift of apple belt to higher elevations of Himalayas was observed
- Tobacco caterpillar consumed 39% more castor foliage under elevated CO_2 conditions than controlled treatments.

Crop simulation studies indicated reduction in maize yields by -6.83% in 2030 and~-14% to -25% in 2080. The negative impacts are more in Bihar, Chhattisgarh, Gujarat, Madhya Pradesh, Karnataka, Orissa, Tamil Nadu and Uttar Pradesh. Coconut yields are likely to increase by 4, 10, and 20% in 2020, 2050 and 2080, respectively, in the states of western coast. The simulation results indicate a positive impact of future climate (combined change in temperature, rainfall and CO_2 levels) on the productivity of soybean and groundnut(8 to 12%).

Without adaptations, the total potato production in India may decline by 2.61 and 15.32 % in the year 2020 and 2050, respectively.

Water requirement in four crops, viz., wheat, maize, sorghum and pearl millet indicated 2.2 and 5.5 % increase in 2020 and 2050, respectively in India

Livestock

A rise of 2 to 6°C in temperature is expected to negatively impact growth, puberty and maturation of crossbred cattle and buffaloes. The low producing indigenous cattle are found to have high level of tolerance to these adverse impacts than high yielding crossbred cattle.

Global warming may result in a loss of 1.6 and 15 million tones of milk production by 2020 and 2050,respectively. Based on temperature-humidity index (THI), the estimated annual loss in milk production at the all-India level by 2020 is valued at Rs. 2661.62 crores at current prices.

Poultry

The analysis of long-term mortality data revealed increase in mortality with ambient temperature rise in broiler, layer and native chickens. Peak mortality was observed at 38 to 39°C temperature (13.5%).

Fisheries

During past 30 years period, spawning activity of *Nemipterus japonicus* reduced in summer months and shifted towards cooler months. Indian mackerel is able to adapt to rise in sea surface temperature by extending distribution towards northern latitudes, and by descending to deeper depths.

The total average fish landing in Ganga river system declined from 85.21 to 62.48 tonnes from 1959 to 2004.

Risk management

The main adaptation strategies to minimize risk include intensifying search for genes for stress tolerance across plant and animal kingdom; intensifying research efforts on marker aided selection and transgenic development for biotic and abiotic stress management; development of heat and drought tolerant genotypes; conversion of C^3 plants to C^4 plants; development of new land use systems; evolving new agronomy for climate change scenarios; explore opportunities for restoration of soil health; use multipurpose adapted livestock species and breeds;

Development of contingency plans for weather related risks, enhancement research on applications of short, medium and long range weather forecasts for reducing production risks; development of knowledge based decision support system for translating weather information into operational weather management sources; development of pest and disease forewarning systems.

The important mitigation options include efficient water and nutrient management options to enhance use efficiency; evaluate carbon sequestration potential of different land use systems including conservation agriculture and agro-forestry; identify cost effective opportunities for reducing methane emission in ruminants by modification of diet, and in rice paddies by water and nutrient management. Renewed focus on nitrogen fertilizer use efficiency with added dimension of nitrous oxide mitigation.

Weather based Insurance

These are linked to the underlying weather risk defined as an index based on historical data (for example, for rainfall, temperature, snow, etc.) rather than the extent of loss (for example, crop yield loss). Insurance generally pays based on actual damages, while weather insurance pay based on the difference between a negotiated "strike price" and the actual weather (or the total of weather related index). As the weather index is objectively measured and is the same for all farmers, the problem of adverse selection is minimized.

ISFS-036

Climate variability and farmers' challenges: experience from river basins in India

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Field studies in six river basins across India shows that there is consensus among farmers about the increasing frequency of extreme climatic events. These are leading to growing uncertainty in farmers' income and price volatility in the agricultural product market. Nature and intensity of extreme events vary across river basins. Despite diversity in climatic events, the farmers' challenges can be proactively addressed through strategically planned new market based incentives promoting sustainable water resource management for agriculture. Such strategic planning can help address multiple challenges and barriers towards sustainability transition in agriculture in India. However, there is need for streamlining multilevel governance structure and institutions which can happen only through multi actor involvement and institutional reforms. At the scientific study level such need assessment and solutions are often identified and suggested. Often, farmers also realize the need for such interventions to reduce vulnerability to predicted climate extremes and variability. However, policy inertia is acting as a major barrier in most of the case study sites towards sustainability transition.

ISFS-037

Climate change - possible impacts on agriculture and food security in India

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Climate change, now a days is one of the most vigorously debated topics on Earth. In popular understanding, climate change is the rise in temperature in the earth's atmosphere, commonly known as global warming, resulting from increase in concentration of green house gases and the consequent trapping of radiations in the atmosphere. Climate change in IPCC usage refers to 'change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer' (Climate Change 2007: Synthesis Report).Its impact and vulnerability is growing concern worldwide including India. Climate change is being recognized as a major threat to present day society because of its adverse impacts on ecosystem, agricultural productivity, water resources, socio-economy and sustainability in a global as well as regional basis. The Intergovernmental Panel on Climate Change (IPCC) in its fourth assessment report (AR4) states with very high confidence (90% probability of being correct) that human activities, since industrialization have caused the planet to warm by about 1 ^{o}C. Observational studies, based on over hundred years of data collected by the India Meteorological Department (IMD) over the Indian region, have shown warming of about 0.5 ^{o}C per 100 years on an all India average basis. Spatially, this is manifested as regions of higher values, and even pockets of cooling, over different parts of India. Future projections of climate change using global and regional climate models, run by Indian Institute of Tropical Meteorology (IITM) with different IPCC emission scenarios, indicate temperature changes of about 2 – 5 ^{o}C and increase of about 5-10% in summer monsoon rainfall. It is also projected that number of rainy days may decrease by 20 to 30% which would mean that the intensity of rainfall is expected to increase. Extremes in temperature and rainfall also show increase in their frequency and intensity by the end of the year 2100.

Agricultural production in a particular year is affected most directly by the nature and magnitude of various climatic elements namely, temperature, precipitation, cloud cover, wind etc. during the year. Inter annual variability of these elements determines stability of available food supplies to the people. In addition to the normal variability of the climatic elements there are evidences of increase in greenhouse gases in the atmosphere leading to climate change. It is also projected that the buildup of green house gases will continue to make the climate change situation critical. Agriculture is strongly influenced by weather and climate. Climate change can therefore be expected to impact on agriculture; particularly it is a threatening established aspect of farming systems. The ill effect of climate change is mostly attributed due to increasing concentration of CO2 and other greenhouse gases. It is postulated that climate change, at least as far as CO_2 concentration effects are concerned, may prove advantageous as it is an essential reactant in photosynthesis

to produce organic matter. However, increased temperature may reverse the beneficial effect of CO_2 on grain yield, presumably under irrigated conditions particularly in C3 plants. In the absence of irrigation, crop yields may in fact be reduced. The following observations are relevant for assessing the effects of climate change, on crop yields:

a. The highest yields in C3 crops are obtained around a mean daily temperature of $15^{O}C$ and in C4 crops around $30^{O}C$.

b. The temperature optima for vegetative growth and the reproductive phases are often different. An increase of temperature beyond a mean of $22^{O}C$ causes sterility in rice resulting in reduced grain yield, though it has no effect on photosynthesis. In wheat, an increase in mean temperature above $16^{O}C$ results in a decrease in grain weight and a poor yield.

Indian agriculture is highly dependent on the spatial and temporal distribution of monsoon rainfall. Long term analysis of Indian monsoon data indicates that different regions are sensitive to precipitation extremes in different ways. Crop yield in the upper Ganges basin is linked to total precipitation during the relatively short growing season and is thus sensitive to drought. Conversely, the lower Ganges basin was sensitive to pluvial flooding and the Brahmaputra basin demonstrated an increasing effect of precipitation variability on crop yield, in particular drought. Simulation studies of climatic models portray a negative impact of future climatic variations on agricultural output. For instance, in most places of north India, grain yields will decline by 15-17 percent for every two-degree centigrade rise in temperature. In Rajasthan, production of pearl millet will decline by 10-15 percent for every two-degree centigrade rise in temperature. In Madhya Pradesh, soybean yields will decline by five percent for every three-degree centigrade rise in temperature. Overall, an increase of two-degree centigrade in temperature will reduce rice production by about 0.75 tons per hectare and an increase of $0.5^{O}C$ in winter temperature will reduce wheat production by about 0.45 tons per hectare.

In Jharkhand, Orissa and Chhattisgarh, severe droughts will reduce rice production by 40 percent of the total production. (Lal et al. 2010).

Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life(FAO). Therefore, food security has four components viz., food availability, stability of food supply, access to food and food utilization. All of them are interconnected. In the light of analytical evidences and predicted impacts, climate change will affect food security through its four components. Also, the effects will be through both the channels of availability and accessibility. Climate change will affect long-term as well as short term food security, through the dimension of food availability, while long-term effects will be driven by shrinking of yield rates and arable land, supply shocks owing to natural calamities will set short-term effects in motion. On the other hand, negative impacts of climate change on food security induced through lack of accessibility may result with or without the occurrence of non-availability. Decrease in production and

supply of food items puts inflationary pressure on markets even when such decrease is not large enough to cause non-availability or the incidence of per capita availability of food falling below per capita sufficiency. Food inflation severely affects the affordability of vulnerable population and, in turn, their accessibility to food markets.

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ISFS-038

Egg plant adaptation and yield potential under elevated CO_2 and soil water stress

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The possible changes in regional precipitation patterns due to future climate change are projected and also a continual increase in air temperature and CO_2 concentration are expected. The present study the effects and possible interaction of elevated CO_2 and water stress on adaptation by changing chlorophyll and proline content, leaf water potential, relative water content and osmolality in eggplant (*Solanum melongena* L. cv. Senryo No. 2). Egg plant seedlings were cultured to maturity in environment controlled growth chamber using atmospheric ambient CO_2 (365~370 ppm) and elevated CO_2 (700 ppm). In both CO_2 environments, two levels of conditioned water treatments were frequently watering (control) and 21-d interval watering for simulating periodical water stress and recovery of stress. Leaf water potential and relative water content decreased with water stress but exibited little improvement under elevated CO_2. The Chlorophyll-a (Chl-a), Chlorophyll-b (Chl-b) and total carrotenoid content were higher in stressed plants and elevated CO_2 enhanced this effect in the eggplant leaves. Osmolality increased more by 4 and 3 times, and proline synthesis increased 95 and 34 times in water stressed under ambient and water stressed eggplants under elevated CO_2 environments, respectively, than well-watered during longer water stress. The proline content reversibly returned to their initial level after recovery of stress, which seemed to be a part of survival mechanism during stress. Elevated CO_2 increased fruit yield by 1.6 times over ambient CO_2 at well watered condition, while 10 times over water stress in pot. Therefore, eggplants evidently have an adaptive potentiality under elevated CO_2 during water shortage condition.

ISFS-039

Assessment of the impact of climate change on honey production in Nigeria

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Global warming is the rising average temperature of Earth's atmosphere and oceans. Since the early 20th century, Earth's average surface temperature has increased by about 0.8 °C (1.4 °F), with about two thirds of the increase occurring since 1980. Warming of the climate system is unequivocal, and scientists are more than 90% certain that most of it is caused by increasing concentrations of greenhouse gases produced by human activities such as deforestation and the burning of fossil fuels. Honey is the most important primary product of beekeeping, both from quantitative and economic points of view. The history of honey usage parallels that of man and in virtually every culture evidence can be found of its use as a food source and as a symbol employed in religious, magical and therapeutic ceremonies. Increase in honey production can be linked to better environmental or climatic conditions. The need to ascertain the impacts of climate change informed this study. Findings from this study that was conducted in the University of Abuja STEP B Apiary showed longer rainy season up to October in 2010 and 2011 beekeeping seasons. The resultant effect of this was the reduction in the volume of honey harvested from the respective hives with a shortfall of about 3 litres of honey per hive between the harvest of 2010 and 2011 beekeeping seasons. This in turn decreased the return on investment from the sales of harvested honey beekeepers in the region.

ISFS-040

Incidence pattern of pod borers in pigeonpea (*Cajanus cajan*) in relation to abiotic factors in Gangetic plains of West Bengal

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Field studies on incidence pattern of different species of pod borers on pigeonpea var. 20/105 as well as the effect of weather parameters viz. maximum and minimum temperature (T_{Max} and T_{Min}), maximum and minimum relative humidity (RH_{Max} and RH_{Min}) and rainfall, conducted during 2005-06 (main crop) and 2006-07 (ratoon crop) at the research plots of AICRP on Tropical Fruits, BCKV located cat Mondouri, Nadia, West Bengal revealed that on main crop, incidence of *Apion clavipes* and *Melanagromyza obtusa* started during 4th

and 5th standard week (SW), respectively and both the borer pests reached on peak during 8th SW. The larval population of *Catochrysops strabo*, *Maruca testulalis* and *Helicoverpa armigera* was first observed during 52nd SW and peaked up to 2nd SW, whereas, *Cletthara floccifera* appearing in the same time reached its peak during 1st SW. On ratoon crop, maximum population of both *A. clavipes* and *M. obtusa* have been recorded during 3rd SW. Both *Maruca* and *Cletthara* appeared during 47th SW and their peak incidence was noticed during 51st SW and 49th SW, respectively. The population of *Catochrysops* was observed first during 47th SW and reached its peak during 51st SW, whereas, *Helicoverpa* population peaked up to 1st SW appearing at 51st SW. Two other species i.e. *Exelastis atomosa* and *Clavigralla gibbosa* have been recorded on ratoon crop only. Highest larval count of *Exelastis* has been recorded at 52nd SW, whereas, *Clavigralla* reached its peak during 4th SW. The population of *C. strabo*, *M. testulalis*, *H. armigera* and *C. floccifera* was positively correlated with RH_{Min} and the correlation was found negative for remaining weather parameters in both the years of experimentation. Population of *M. obtusa*, *A. clavipes* and pod borer complex (as a whole) was positively correlated with T_{Max} and T_{Min} in 1st year though the correlation has been found negative in 2nd year of study, whereas, RH_{Max} and RH_{Min} had negative correlation on their incidences in both the years. All the weather factors had negative correlation on incidences of *E. atomosa* and *C. gibbosa*. Regression analysis revealed that only in case of *A. clavipes*, abiotic factors had significant impact in both the years. The effect of abiotic factors was also found significant on the incidence of *H. armigera* and pod borer complex (as a whole) in the ratoon crop only, while, in main crop, significant impact of weather parameters has been obtained on population development of *M. obtusa*.

ISFS-041

Crop-pest scenario under changing climate of north eastern Himalaya, India

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The effect of fast changing climate is now being seen on all types of ecosystems and insects are also the victims of climate change. Insects populationed are tend to shift their range and habitat as intended by rising temperature ranges. As a result, several changes in pest composition have taken place in the north eastern hill region of India. Root aphid, *Tetraneura* spp. and white grub, *Holotrichia* spp. are becoming major pest of upland/*jhum* paddy in several parts of Meghalaya. Root aphid incidence has also been observed in groundnut, maize and pulses, especially rice-bean. Besides, whorl maggot, *Hydrelia philipinna* is emerging as major pest of rice in the region. Recently, severe incidence of stem borer, *Chilo partellus* was also observed in maize almost after 12 years. Three species of aphid *viz*., *Liphaphis erysimi, Myzus persicae* and *Brevicoryne brassicae* are found attacking brassicaceous crops. Outbreaks of pine lappet moth, *Kunugia latipennis* and

litchi stink bug, *Tessaratoma javanica* were observed in the region during 2011 and 2012, respectively. Severe incidence of litchi trunk borer, *Aristobia testudo* was first observed on guava during 1997 and recently the same pest has also observed in pigeonpea. Besides, swarms of grasshopper, *Aularches miliaris* has also been observed in Nagaland and adjoining areas.

ISFS-042

Computation and validation of radiation balance components along eastern end of monsoon trough over Ranchi, Jharkhand, India

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The solar radiation estimates performed well in comparison with ground-based pyrenometer data with computed used the micrometeorological tower air temperature data on one meter height from the open field and Stevenson screen surface observatory temperature data. The measurements was made at an experimental site in BIT, Mesra showed that the net radiation was best characterized when the observed solar and the observed longwave radiation products were combined. While net radiation is highly dependent on solar radiation, the importance of longwave radiation increases with increasing cloud cover. The modelled radiation estimates were comparable to the temperature-based Hargreaves estimates of solar radiation, evapotranspiration and clear sky longwave radiation. Penman-Monteith model gave very good results, which requires both shortwave and longwave radiation products to validate with the one meter height air temperature as well as surface observatory temperature for the consecutive year at experimental site which gives closed trend with less deviation among the direct computed pyrenometer.

ISFS-043

Rainfall and temperature trend analysis over Ranchi region of Jharkhand

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The analysis of long-term rainfall and maximum temperature data over Ranchi region of Jharkhand revealed that mean maximum temperature in April for the period from 2001 to 2010 was 0.4 to 0.6 ^{0}C higher than that of 1991-2000. Out of the total mean annual rainfall of 1398 mm, 80 to 83 % was received during south-west monsoon season (June to September), 6.5 % (92.4 mm) during October to December, 3.7 % (52.4 mm) during January to February and 7.5 % (104.7 mm) during summer season.

ISFS-044

Using fast response sensor (10HZ) data over land surface during summer monsoon and thunderstorm period

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Current work presented the analysis of thunderstorm, dusty wind event occurred in Ranchi region of Jharkhand during the summer season. The analysis was classified as three cases. Case I: Lightening associated with thunderstorm (19th May, 2008), Case II associated with dusty/gusty wind (6th March, 2009) and Case III associated with lightning and thunderstorm (21st March, 2009). The severe thunderstorm condition was observed and quantified by fast response and slow response sensor, which was augmented on the 32 meter micrometeorological tower. The friction velocity (u *) was 1.019 m/sec and the lowest value was 0.062 m/sec computed during the thunderstorm and lightening. A sudden peak of u* was noted just before the onset of thunderstorm. The horizontal shear was 2.18 N/m^2 and the lowest value was 0.01 N/m^2 during the thundering with association of lightening. The maximum sensible heat flux during thunderstorm was 292 W/m^2 and the lowest value was -439.9 W/m^2. The certain changes occurred in RH among the six levels and the lowest RH was 18.61 % at 11:30 hr. The day temperature recorded at one meter height was 32.49 ^{0}C at 11:18 hr and then slightly decreased up to two and a half degree at 15:58 hrs and specifically the temperature at 32 meter height reduced by 7-8^{0}C at 16:56 hr.

ISFS-045

Evaluation of effects of climate change on increased incidence of cowpea pests in Nigeria

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Insect response to rise in atmospheric temperature and carbon dioxide differ from one region to the other. The latest assessment report from the Intergovernmental Panel on Climate Change (IPCC) predicts an increment in mean atmospheric temperature from 1.1 to 6.4°C toward the year 2100 with equally increasing atmospheric carbon dioxide (CO_2). Such climatic changes could profoundly affect insect's population on essential crops. This study was conducted during the 2010 and 2011 cropping season in the University of Abuja (Nigeria) in order to determine the impacts of climate change on the population of insects associated with cowpea production in the region. The result showed an increase in the number of taxa encountered on the

cowpea field from 21 to 31orders of insects in the 2010 and 2011 cropping seasons respectively. Also, no significant difference was established in the forms of destructions recorded at the various growth stages of the cowpea plant in the study. Therefore the advent of increased fauna on cowpea established in this study portrayed a need to find possible ways to reduce the emission of Greenhouse gases in the region in order to ameliorate the effects of induced global warming on cowpea production in the country and also provide effective control of the identified pest in order to maintain or stall their resurgence.

ISFS-046

Studies on progress of pigeon pea wilt incidence in relation to weather parameters

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Wilt of pigeonpea (*Cajanus cajan* L.) incited by *Fusarium udum* (Butler) is a serious threat to the production and productivity of this crop in India and abroad. In Bihar, 18.3 per cent average incidence of wilt has been reported. Since wilt disease of pigeonpea was first recorded by E.J. Butler in 1906 from Pusa, Bihar, no systemic work has been carried out in progress of this disease with times and correlation with weather parameters. Therefore present study was aimed at to correlate the weather parameters with disease incidence and progress of wilt of pigeonpea. Effect of soil texture on wilt incidence revealed maximum wilt incidence of 74.75 per cent in loam soil and least in clay soil (49.50%). The effect of soil pH on disease indicated maximum wilt incidence (51.50 %) at soil pH 5 followed by pH 7 (47.25%). Correlation coefficient between wilt incidence and pH of the soil revealed that wilt incidence was negatively (-0.960*) and significantly correlated with soil pH. Correlation coefficient (r) between the wilt incidence and weather factors in pigeonpea cultivar ICP 2376 showed a negative and significant correlation between disease incidence and minimum temperature (^{0}C), soil moisture (%), rainfall (mm) and number of rainy days and observed 'r' values were -0.591*, -0.987**, -0.593** and -0.664*, respectively, whereas it was non significant with R.H at 7hrs (-0.223) and 14hrs (-0.527). Maximum temperature and soil temperature had negative and non significant correlation and observed 'r' values were lower i.e. 0.141 and 0.170, respectively. Population *F.udum* was positively (0.706**) and significantly correlated. Best fitted equation for prediction of wilt disease on cultivar ICP 2376 is Y =177.419+0.021(*F. udum* population) +0.308(Soil temp.^{0}C)-6.347 (Soil moisture %); R^2 = 0.980

ISFS-047

Agrometeorological indices and its impact on growth and yield of potato under dates of planting and N-doses in the Gangetic plains of West Bengal

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Agro meteorological indices indicate the relationship between the crop and weather factors. The temperature and bright sunshine hour significantly affect the growth and yield of potato. Sensitivity of potato to the changing temperature is pivotal particularly in West Bengal because of its short duration and mild nature. However, no systematic study is available. To address the problem, a two year study on potato (Kufri Jyoti) was carried out at the District Seed Farm, B.C.K.V. The potato planted on five dates starting from 15th November (D_1-15th Nov, D_2 – 22nd Nov, D_3 – 29th Nov, D_4 – 6th Dec and D_5 – 13th Dec) with two N-doses (N_1=200kg/ha, N_2=150 kg/ha) having four replications in a split plot design. The growing degree day (GDD) and the helio thermal unit (HTU) were measured following standard procedure. The GDD requirement was highest when the crop was planted on 15th November; however, no definite trend was recorded with the delayed planting. In general, GDD requirement declined with delay in planting. Among the different phenophases, tuber initiation to dehaulming recorded the maximum GDD requirement. The total dry matter (TDM) decreased with the increment of GDD beyond 800 degree day irrespective N-doses and dates of planting (DOPs). The HTU requirement was maximum under D_1 planting in the first year but under D_4 planting in the second year. The tuber initiation to dehaulming phase required maximum HTU. The yield of potato reduced significantly with the increment of HTU beyond 7200 degree day hour. Under higher N dose, 46.8% variation in yield could be significantly attributed to the variation in HTU whereas, under low N dose 45.9% variation in yield could be significantly explained through the variation in HTU. About 46.8% variation in yield could be assigned to the HTU under different DOPs. The study indicated the changing climate scenario in the two different years which was evident in the variation of GDD and HTU in two different years. In general, increased GDD or HTU because of increasing temperature during tuber initiation to dehaulming phase invited lower yield.

ISFS-048

Climate change and food security relations of banana (*Musa* spp.) and preliminary mitigation strategy for West Bengal conditions

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Banana (*Musa* spp.) is the fourth important economic and food-security commodity of agriculture after rice, wheat and milk and hence, it deserves strong mitigation strategy against its possible vulnerability due to climate change/variability. The formulation of mitigation strategy is complicated due to lack of specific and dedicated information on impact of climate variability/change on phenology of banana. With this background, observations were recorded on climate data (temperature, precipitation, evapo-transpiration, sunshine hour) along with crop phenology and pest dynamics during 2008-12 by frequent visit to banana germplasm blocks (comprising of 110 genotypes) of AICRP on Tropical Fruits, BCKV and farmers' fields in Nadia, Hooghly and 24 Parganas (North) districts in West Bengal. Analysis of the climate data has successfully corroborated the climate variability/change with some of the notable observations on banana phenology and pest-dynamics and distribution, like vegetative phase cold injury in Martaman (Musa AAB) and Grand Naine (AAA) banana, hail storm injury in all genotypes, caeser-shooting in Martaman variety, impaired bunch development in Bara Beglo (ABB), seasonal variation in colour development in Red banana (AAA), longitudinal fruit split in G. Naine and Robusta (AAA), population buildup of spider mite in summer canopy of plantation, congregated phoretic-mites on pseudostem weevil, leaf damage by red pumpkin weevils, marked presence of the predator-lady bird beetle and destruction of plantation by cyclones posing top most threat to banana cultivation in West Bengal. Preliminary mitigation strategies include i) choice of suitable variety with respect to planting time and agro-climate region; ii) survey, identification, selection and evaluation of superior/adaptable clone/genotype suitable for variable & changed climatic conditions; iii) adjusted/modified POP : a) adjusted planting time, b) bunch covering, c) bunch feeding , d) plantation floor management – mulching, cover cropping, e) promotion of efficiency of irrigation and water use and dissemination of conservation management practices; and iv) continued research efforts on understanding the climate change-ecosystem-social system interactions with banana for food security.

ISFS-049

Has the weather gone erratic: elementary weather risk analysis from the farmers' perspective

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As much as 80% of the variability in agricultural production is due to the variability in weather conditions. A risk analysis based upon the probability assessment of the weather change was considered necessary to help farmers take decision-making for agricultural planning and practices. To study whether the weather at Sriniketan, Birbhum, West Bengal ($23^0 39'$ N, $87^0 42'$ E and 58.9 M AMSL) and its surrounding area has gone erratic or not over the years 1966 to 2010. Monthly and weekly deviations from normality of variables were juxtaposed against mean values of the same in the field experiment period 2002-2005. During 2004-05 in the 3rd week of January precipitation received 27.4 mm, with 17.6 ^{0}C mean temp and mean RH 85.1% which was critical for LB of normal-season potato and early tomato. During 2002 -2005, when rice transplanting is done, max T and min T were higher by 2.4%, 1.6% and 1.8%, 1.5% respectively in July and August than normal. Rainfall received in June 12%, 19%, 38% and July 37%, 36%, 57% lower than normal during 2002-03, 2003-04 and 2004-05 respectively. This proved to be a great setback for rice transplanting for short and medium duration varieties. Further, in August and September 12%, 12% and 18%, 57% higher rainfalls than normal were received during 2002-03 and 2004-05 respectively. During 2003-04, rainfall received in August and September were lower than normal by 25% and 57% respectively. This was the period when the normal-season rice was in the mid- to late-vegetative stage for medium duration varieties. In the 38th, 39th, and 40th weeks received 168%, 245% and 50% higher rainfall than normal during 2004-05,2002-03 and 2003-04 respectively, *i.e.* causing delay for *rabi* (winter crop) planting than for normal years. During September and October, humidity and Max T were observed higher than normal and also deviated from normal, chances for infestation of sheath blight, neck blast and brown plant hopper, mealy bug in rice. Thus there are strong indications that weather at Sriniketan, being between 200 and 300 km from the coast, has gone erratic.

ISFS-050

Recent climate change and invasion of herbivorous insects

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Climate change is altering vital aspects of the environment like temperature and precipitation, the frequency of extreme weather events, as well as atmospheric composition and land cover. Global mean surface temperatures have increased by approximately 0.6°C in the last century, the largest 100-year increase for the last 1000 years, and is predicted to increase by another 1.4 to 5.8 °C by 2100. This contemporary anthropogenic climate change is comparable with the prehistoric Paleocene–Eocene Thermal Maximum (PETM, 55.8 MYA), an abrupt global warming event (temperatures rose by ~5°C in 10,000 years) linked to a transient three times increase in concentration of CO_2. There are many evidences to believe that climate change is greatly affecting the distribution of species and composition of communities around the world. The present paper reviews the key impacts of global warming on invasion of herbivorous insects to new areas. As insects are ectothermal animal, temperature directly affects insect herbivores, and they must respond to the changing conditions to survive.

Generally insect abundance increases with rising temperatures as development time and growth rates accelerate; furthermore, food consumption of insects may increase with rise in temperature and CO_2 concentration. Thereby, it has generally been predicted that there will be an increase in the intensity of herbivore pressure on plants in changing condition leading to resource scarcity and increased competition.

The geographical ranges of species are primarily limited by climatic and geographical barriers to dispersal. Species' intrinsic characters related with dispersal as well as availability of suitable hosts also determine the ranges. Many scientists agree that climate change will alter destination habitat of phytophagous insects and increase vulnerability to invasion because of resource scarcity, increased competition, and disruption of community interactions which can arise when species of different trophic levels differ in their sensitivity to rising temperature, leading to mismatched phenologies and/or dispersal patterns. Many insect species have already shifted their geographical distributions in response to recent climate change. The effect of warming on the distribution of herbivorous insects will not be uniform globally; the effect is more pronounce in the temperate zones. Insect species- richness is increasing in the cool habitats of the planet. Higher latitudes and altitudes will probably see a shifting range of species as temperatures increase and species migrate from adjacent, previously warmer climates. In the tropics, many insect species appear to be living at or near their thermal optimum; tropical environments could very well become too hot, dry and once the temperature gets above the thermal optimum, fitness levels will most likely decline forcing to explore for new hospitable habitats. In general, the geographical range of insect species may be shifting pole-ward.

The study on insect damage censuses on fossil leaves in the Bighorn Basin of Wyoming (at mid latitude in Northern hemisphere) positioned before, during, and after the PETM warming event indicated that amount

and diversity of insect damage significantly increased during PETM, later decreased after the PETM, as temperature again declined. This indicates that the temporary increases in damage diversity was an influx of herbivores to the mid latitude regions, rather than an *in situ* diversification and accommodation.The effect of warming on the distribution will also vary among species. Specialist insect species are declining in abundance in the United Kingdom. Generalists and widely distributed insects will respond poorly. Highly mobile insects are expected to respond more readily to global warming by evading unfavourable environments. Poor dispersers will no longer exist or they must adapt the new situation by adaptive genetic processes. Warmer climate may also help the insects to disperse over greater distances by increasing their flight activity.

Climate change are also increasing the severity of extreme weather events like strong winds, currents and wave action which are expected to facilitate the long distance migration expanding insect range suddenly. Global warming is likely to provide new opportunities for introductions to areas where introduced species were not able to survive previously. The absence of coevolved enemies in this new ecosystem also allows invasive species to be more successful. Invasive alien species displace or damage native fauna and flora, often places agriculture and natural resources at increased risk. Some of these changes are likely to bring the distributions of formerly separated species into geographic contact to generate a major shift in levels of introgression between species, whereas other changes may separate populations of a single species and lead to eventual divergence. Biological invasions are not new to the history of life on Earth. What is of concern however, is the extraordinary rate at which the invasions are now taking place. This requires global attention and action.

ISFS-051

Rainfall trend analysis and crop planning of Gaya district of Bihar

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Food production in India is still a gamble in the hands of monsoon system despite phenomenal technological advancements in the fields of irrigation management, and crop improvement, production and protection strategies. Rain water management is vital for successful raising of crops in the rainfed regions, since crop production in a vast net sown area of the country is still dependent upon rainfall. So, proper understanding about distribution pattern of rainfall resources analyzed through modern agroclimatic methods at micro-level is required for efficient crop planning under rainfed condition. In the present study, daily rainfall data of Gaya district of Bihar for the period from 1969 to 2003 were collected from IMD, Pune and analyzed through several approaches for identifying water availability period for crop planning in the district. Based on the results of the investigation, suitable crop planning for the district has been suggested. The average annual rainfall of the district is 1112.1 mm received in 56 rainy days. Of the total annual rainfall, monsoon, post

monsoon, winter and summer seasons contributed 86.5, 6.1, 2.9 and 4.5 %, respectively. Gaya being mostly an undulating topography and receiving most of the annual rainfall during monsoon season, there is scope for rain water harvesting for pre-sowing and supplemental irrigations for *rabi* crops. The coefficient of variation of monthly rainfall from June to September ranged from 39.1 (July) to 72.3 % (June). Monthly rainfall during July and August is relatively more dependable as shown by lower CV values. Rainy season starts in the district during 25 standard meteorological week (SMW) and terminates during 42 SMW and thereby, providing with an average length of rainy season of 16.6 weeks. At 75 % probability, referred to as a probability of obtaining an assured amount of rainfall for crop planning under rainfed condition, at least 25 mm rainfall could be expected from 27th to 33rd SMW. Results suggest that *kharif* rice might face water stress at reproductive to maturity stage, which could be managed by proving one or two supplemental irrigations. Weekly average rainfall during 25-38 SMW ranged from 32.9 to 89.7 mm. After 38th SMW, the amount of rainfall decreased drastically. Initial and conditional probabilities of rainfall for critical limits of 10, 20 mm, 30 and 40 mm have been worked out for suggesting better rainfed crop planning in the district. Results of trend analysis in respect of rainfall over different seasons and length of growing season have also been reported.

ISFS-052

Management practices due to climate change for increased production of winter rice, pumpkin and cowpea in Assam

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A field experiment was conducted in farmers field during 2009-10 to develop agronomic management practices for increased production of winter rice - pumpkin – cowpea cropping sysyem in Karimganj district of Assam. The experiment was laid out in a randomized block design with three replications. There were three treatments Viz. Farmers practice, Improved practice and recommended management practices. Five villages were considered in each block. There ware three blocks *viz.* North Karimganj, South Karimganj and Dullovechera in Karimganj district of Assam. The monetary net return and B:C ratio were highest under the recommended management practices than improved practices and Farmers practices for all the three crops. Recommended practices in Dullovchera block recorded highest production of winter rice, pumpkin and cowpea in both the years. Changes in climate was observed as evidenced by increased mean annual temperature by 3 to 6^{O}C. The warming was relatively greater in winter and post monsoon seasons and rainfall increased by 10% at Karimganj district of Assam. Accordingly recommended pesticides were used in winter rice – pumpkin - cowpea cropping system to control the attack of stemborer in rice, wasp in pumpkin and aphids is cowpea. Chlorpyriphos 20 EC @ 2 ml/litre of water and Malathion 50 EC @ 1.5 ml/litre of water were applied to control stemborer and wasp & aphids respectively.

Technical Session - 2

Possible biotechnological interventions in
field and horticultural crop improvement for stress management

Chairman: Amita Pal
Co-Chairman: PK Chakrabarty
Rappoteur: Somnath Bhattacharya

ISFS-053

Current understanding of molecular defence mechanism in resistant *Vigna mungo* genotypes upon MYMIV infection

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Yellow mosaic disease in black-gram is caused by Mungbean yellow mosaic India virus (MYMIV) transmitted by the whitefly *Bemisia tabaci*. The whitefly delivers the virus through proboscis to the phloem cells of the host plant. Chlorotic, irregular, yellow patches on the leaves of the susceptible plants are characteristic symptoms of virus infection; photosynthetic efficiency of the diseased plants declines and as a consequence yield of the crop is affected. The yield penalty reaches to the extent of cent percent when infection occurs at the juvenile stage of the plant. MYMIV belongs to the genus Begomovirus, the predominant variety of Geminiviruses in Indian subcontinent. Geminiviruses are characterized by their unique particle morphology, bipartite genome composed of circular, single stranded DNA designated as DNA A and DNA B, which replicate via rolling circle method. Interactions between *V. mungo* and MYMIV can lead either to a successful infection (compatible response) or resistance (incompatible response). In incompatible interactions, the pathogen associated molecular patterns (PAMPs) are recognized by the NB-LRR protein products encoded by plant disease resistance (R) gene. We have isolated one such candidate gene, *CYR1*, the encoded protein sequence comprised of 1176 amino acids with coiled coil structure at the N-terminus, central nucleotide binding site (NBS) and C-terminal leucine-reach repeats (LRR) that belongs to non-TIR-NBS-LRR subfamily of plant *R* genes. *CYR1* transcript was unambiguously expressed during incompatible plant virus interactions. Enhanced transcript level upon MYMIV infection suggests involvement of the *CYR1* gene in conferring resistance against the virus. *In silico* constructed 3D models of LRR region of the host protein and MYMIV-coat protein/PAMP revealed that the unique CYR1-LRR forms an active pocket and successively interacts with PAMP during docking. This phenomenon of host pathogen interaction is like that of receptor and ligand that has been elucidated by *in silico* studies. Such recognition induces signaling pathways that ultimately results in changes of the host gene expression pattern and synthesis of pathogenesis related proteins. To understand the incompatible interaction of *V. mungo* during MYMIV infection at the molecular level comprehensively, genomic and proteomic approaches have been undertaken in our laboratory. More than 300 differentially expressed ESTs and 109 differentially abundant proteins have been identified during compatible and incompatible interactions. Seven functional categories of differential genes/proteins have been identified, which are energy/metabolism, photosynthesis, stress/defense, signal transduction, transcription, transport and secondary metabolism related. The involvement of these proteins in different metabolic pathways in an orchestrated manner will be discussed briefly.

ISFS-054

Impact of molecular biology and biotechnology in plant pathology research

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Molecular Plant Pathology is one of the fastest moving and most exciting fields in biology which is directly benefited from advances in molecular biology and recombinant DNA technology. Advances in molecular biology research in recent years have started showing potential in diagnosis and management of plant diseases. These have been applied to both pathogen and plant, allowing understanding of the organism themselves and of the complex plant-microbe interactions leading to compatibility or incompatibility. Areas of research that received major thrust in Plant Pathology are: i) Molecular characterization of pathogens and functional genomics, ii)Identification of molecular markers for disease resistance, Marker-assisted selection and MAB. iii) Development of molecular diagnostic tools , iv) Disease resistant transgenic plants.

Molecular Plant Pathology in India is at a stage of infancy witnessing modest beginning during early 1990s. During last one decade considerable progress has been made on various aspects of Molecular Plant Pathology, ushering a new era where engineering disease resistant transgenic plants will be highly feasible. In India molecular approaches are being employed readily at present to characterize plant pathogens, delineate genetic diversity, develop molecular diagnostic tools, identify molecular markers for marker-aided selection of *R* genes and develop disease resistant transgenic plants with respect to a number of host-pathogen systems. These studies will help in precise diagnosis of pathogens, understand molecular basis of plant-microbe interactions, and develop disease transgenic plants against major diseases. Advances made in cotton pathology at CICR, Nagpur, towards realization of these objectives in four major thrust areas are indicated.

Characterization of pathogen gene

Studies on molecular basis of cotton-*Xanthomonas axonopodis pv. malvacearum (Xam)* system done by us showed that the genes governing pathogenicity and EPS production in this bacterium reside on plasmids. Two Plasmid-borne pathogenicity genes *pthN* and *pthN2* were cloned from an African strain of *Xam*. *pthN* is a 3.6 kb (AF016221) gene responsible for causing water soaking symptoms on cotton. The 132 KD predicted protein exhibited unique features suggestive to its role in protein-protein and signal transduction pathway. It has 13.5 leucine-rich repeats (LRR) at the centre, leucine zipper (LZ) and nuclear localizing signal (NLS) sequence at the C-terminal end and Tn*3 like* inverted repeats at both the ends. The features like LRR and LZ are indicative of DNA-DNA interaction with plant host genes. Most of the *R* genes cloned from plants also possesses LRR and nucleotide binding sites (NBS) suggestive of their interaction role in host-pathogen interaction and recognition. The 102-bp LRR at the centre of the gene govern host-specific water soaking phenotype. The gene pleiotropically encodes HR in bacterial blight resistant cotton. Detailed information on various components of host-pathogen interaction and mechanism of *R* gene mediated signal transduction

for disease resistance can lead to development of suitable disease management strategies. Characterization of strains of cotton leaf curl virus showed recent breakdown of resistance in cotton in North India to be due to emergence of recombinant strains of the virus.

Molecular markers and Marker assisted selection

Although conventional plant breeding has made significant impact on improvement of resistance against diseases, the time consuming process of making crosses and backcrosses and the selection of the desired resistant progeny often makes it difficult to adequately keep pace with evolution of virulent pathogens. Moreover, precise monitoring and evaluation of resistance in a vast area are hard due to difficulties in inoculum production, maintenance, laborious inoculation procedures and several factors responsible for creating successful infection. Under such circumstances monitoring resistance through identification of molecular markers linked to disease resistance trait is highly prudent approach. Markers once identified can not only be used for tagging and cloning of the linked genes but and also in marker assisted selection and breeding of the desired phenotype. Five cotton lines were screened for resistance against race 18 of *Xam*. *G. hirsutum* cottons Acala 44 and Ganganagar Agethi were highly susceptible while, IM216, S295 and 101-102 B were completely resistant. Genetic crosses affected using two susceptible lines of cotton, Acala44 and Ganganagar Ageti and three resistant lines viz., IM216, S295 and 101-102B showed F1s of each of the four crosses viz. Acala-44 X IM216; Ganganagar Agethi X IM216; Ganganagar Agethi X S295; and Ganganagar Agethi X 101-102B, to be completely resistant. The F2 segregating populations of each of the four crosses phenotyped for bacterial blight resistance showed inheritance of resistance gene in the 3:1 ratio, indicating single gene dominance of resistance allele. Polymorphism between contrasting parents for BBR was surveyed using 40 RAPD and 798 SSR markers. The per cent polymorphism among the parental lines ranged from 6.0 to 9.1. The informative SSR markers were mostly co-dominant and are being used for genotyping F2 mapping population to tag genes for bacterial blight resistance. Once the genes are tagged they would be used for marker assisted selection of BBR in cotton.

Molecular diagnosis of pathogens

The first important step in management of a plant disease is to correctly identify the organisms that cause it. Rapid identification of the causal pathogen allows for the appropriate control measures to be applied, prevent development of epidemic and implement quarantine regulations. Diagnosticians today have an array of methodologies to help identify plant pathogens and the diseases they cause. The cultural methods that require isolation and identification of pathogens are relatively slow and often require skilled taxonomists to identify the pathogens. Laboratory procedures may take days or even weeks to complete and are in some cases, relatively insensitive. Fastidious microorganisms, which do not grow on artificial media, are very difficult to identify and detect by conventional methods. The conventional methods of diagnosis are not always conclusive, for example similar symptoms can be caused by different pathogens. Similarly closely related organisms, say races or biotypes of an organism, are difficult to discriminate on the basis of morphological characters. Advances in biotechnology have enabled rapid and precise detection of plant pathogens. The greatest efforts have been on the development of diagnostics based on nucleic acid and serological

technologies. Using these approaches we developed validated protocols for detection of bacterial, viral and fungal pathogens of cotton.

Xam is a seed-borne pathogen of quarantine significance. The African strains of the pathogen are not present in India but are rampant in the countries in Africa or USA with whom seeds are frequently exchanged. A rapid and simple PCR protocol was developed which could detect the pathogen in seed or plant tissues. The primers designed based on the sequence of pathogenicity gene *pthN* can detect the presence of pathogen by amplification of 0.4 kb DNA fragment, irrespective of the geographic and pathogenic races. The PCR amplification is accomplished with whole cells without the need for extraction of DNA. A patent on a ready-to-use PCR diagnosis kit for detection of the bacterium in seeds has been filed (E-2/509/2010-MUM). A Rapid PCR protocol enabled detection of CLCuV infection, both symptomatic as well as latent, in cotton. The primers developed based on the sequence of coat protein gene of CLCuV can detect virus not only in infected cotton but also in weed hosts and whitefly vectors.

Fungal pathogens can be identified at the species level by primers designed based on selected conserved sequences like the rRNA gene cluster followed by further characterization of the amplified fragment. The rRNA gene cluster became very popular for a number of reasons; it has several hundred copies per genome and it carries highly conserved and variable regions. Sequences of the rRNA subunits have been used for taxonomic and genetic studies, while conserved regions of the internal transcribed spacers (ITS) and the intergenic spacers (IGS) have been targeted for fungal detection. Using nucleotide sequences of internal transcribed spacer regions of rRNA genes, PCR protocols for detection of five economically important fungal pathogens of cotton viz., *Rhizoctonia solani, R. bataticola, Ramularia areola, Alternaria macrospora and Myrothecium roridum,* were developed. Primers pRSol and pRBat were specific to strains of *R. solani* and *R. bataticola* and supported amplifications of rDNA fragments of 255 and 400 bp, respectively. Primer pRare indiscriminately detected four strains of *R. areola* isolated from four cultivated species of cotton by supporting amplification of a universal amplicon of 372 bp while, isolates of *Myrothecium roridum* could be detected through generation of an amplicon of 350 bp using a set of primer pMror. Strains of *A. macrospora* could be identified by amplification of a DNA fragment of 542 bp using primer pAmac and differentiated from other species of *Alternaria* by PCR-RFLP of the rDNA product with *Ban*II, *Hae*III and *Mse*I restriction endonucleases. Besides PCR, number of molecular approaches has also been used to differentiate races and biotypes of pathogens. A race 18-specific RFLP marker was developed to differentiate this highly virulent race from other prevalent races of *Xam*. PCR-RFLP approach was successfully used to differentiate isolates of *R. areola* that infects diploid and tetraploid cottons.

A twig Imprint blot method was developed for serological detection of the virus in the infected cotton plants. The antibody used for serological detection of CLCuV was developed against the fusion protein expressed in *Escherichia coli*. When probed with antibody it could readily recognise cotton leaf curl virus infection in the stems of infected cotton squeezed against the nitrocellulose membrane.

Disease resistant transgenic plant

Plants can suffer from infections caused by fungi, bacteria, viruses, nematodes, and other pathogens. Various

high-tech approaches have been proposed to protect plants from harmful afflictions. To date, most interest has been focused on virus resistant transgenic plants, but using biotechnology to confer resistance to fungi, bacteria, or nematodes has also been gaining attention.

Transformation of plants with pathogen derived resistance (PDR) factors has become a potential tool for engineering resistance against diseases especially those that are caused by viruses. The term used for transformation of plants with portion of pathogen genome, frequently gives rise to lines of plants that are resistant to pathogens from which the sequence was derived. Expression of literally any part of a plant virus gene can confer PDR. Most common are the transgenic plants expressing viral coat protein through antisense approach. This gene is being targeted by number of researchers for developing resistance against several plant viruses. Besides coat-protein mediated resistance, resistant plants have also been engineered by expression of viral replicases, proteases, movement proteins, satellite virus RNA, viral antisense RNA and untranslated regions of viral genes. Efforts are also on to develop virus resistant transgenic crops through dsRNAi-mediated gene silencing approach. Besides CP, viral replicase genes are potential targets for RNAi mediated disruption and resistance against viruses.

Five inverted repeat constructs involving C2 (pBInAR-int-AC2-SA of 12 kb), CP (pBSK-int-CP-SA of 12.1 kb), MP (pBSK-int-MP-SA of 11.9 kb), βC1 (pBSK-int-βC1-SA of 12.1 kb) and βV4 (pBSK-int-βV4-SA of 12.1 kb) were generated in *Agrobacterium tumefaciens* strain EHA105. Transformation of *G. hirsutum* cvs. HS6 and LH 2076 was done by Agrobacterium, independently harbouring inverted repeat constructs of C2 and CP genes by shoot organogenesis and *in planta* methods. In all 12 PCR positive events of CICR-HS6-AC2 and three events of CICR-HS6-CP CP were established. Contained greenhouse trial for CICR-HS6-AC2 (3events) and CICR-HS6-CP (2 events) were conducted at CICR regional Station Sirsa. Transgenic cotton (T0) positive for presence of inverted repeat construct by PCR and Southern hybridization were screened against whitefly borne CLCuV in glasshouse. Some transformants showed delayed development of disease and supported 1000 times less virus compared to untransformed cotton as revealed by Qt-PCR.

Genetic engineering enables new ways of managing fungal infections. Introducing genes from other plants or bacteria encoding enzymes like chitinase or glucanase is one of the commonly employed approaches for genetic engineering of resistance against fungal pathogens. These enzymes break down chitin or glucan, respectively, which are essential components of fungal cell walls. Chitinases belong to group of PR proteins that constitute the second line of plant defense. Using conserved as well as degenerate primers a 1.3 kb full length novel, class I chitinase gene was amplified and cloned from *G. hirsutum* cv. LRA5166. Analysis of sequence revealed the gene to be unique to upland cotton (GenBank # HM 125506). When expressed in *G. arboreum,* resulting cisgenic cotton conferred enhanced tolerance against fungal diseases. The cisgenic plant expressed chitinase activity two times higher than the wild type *G. arboreum* and delayed pathogenesis of grey mildew and Myrothecium leaf spot diseases.

ISFS-055

Identification of superior alleles for P-deficiency tolerance in rice

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Phosphorous fixation in soils with a high content of free ferric oxides and aluminum in the clay fraction is a widespread problem and limits access of plants to P even if it is present in the soil. Problem is acute in red-lateritic tract especially of upland situation. Therefore, a set of one hundred fifty of rice genotypes comprising of adopted upland and lowland lines as well as small grain aromatic Bengal landraces were grown in P-deficient as well as P-sufficient soil. P-uptake ability of these genotypes was compared when they were grown in P-sufficient as well as in P-deficient soil. Several genotypes accumulated significantly more P per plant under both high-P (>50mg/kg of soil) and low-P (<5mg/kg of soil) available conditions. Inheritance of root growth parameters in seedling stage at P-deficient situation was deciphered from a bi-parental segregating population. Haplotyping of genotypes by two linked markers, Pup1-K29 and Pup1-K42, did not show any correlation with their P-acquisition efficiency, so, they were less diagnostic for assessing Pup1 locus in Indica germplasm. Apart from *Pup1* linked markers, expression of the following genes responsible for P-uptake, *Pstol1*, *Pht1, Pht2, Pht6, Pht8, Ptf1, and Nrr* was compared by real-time quantitative PCR between one tolerance and sensitive genotype. Comparing gene expression and root growth in P-deficient situation, *Pstol1, Pht1, Pht8, and Ptf1* were further validated in a set of rice genotypes having differential P-acquisition ability and root growth. Number of genotypes with superior alleles of these three genes, were identified as observed from higher expression in root, better yield and higher root biomass in P-deficient situation. Modern concept of alleles and Strategies for pyramiding of these genes in high yielding semi-dwarf cultivars and their relevance at modern rice improvement program for P-deficient situation will be discussed.

ISFS-056

Development of abiotic stress tolerant rice (*Oryza sativa* L.) to attain food security with environmental safety

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Crops are affected by many types of abiotic stresses such as salt, drought, and freezing. Among these stresses, salinity is one of the major factors limiting crop production in the world. Development of salt tolerant rice is, therefore is a significant research objective in agricultural biotechnology. An important requirement for crop and environmental improvement is the introduction of new genetic material in to the cultivated lines via single/ multiple genes introduction, through genetic engineering. In this research we were able to establish an efficient *Agrobacterium* mediated transformation method in both Japonica (cv. Nipponbare) and Indica rice (*Oryza sativa* L. cvs. BR-5, Kasalath and Kataribhog). The *Agrobacterium tumefaciens* strain, EHA101, harboring the binary vector pIG121Hm/Km/*kat*E were used for the transformation of Nipponbare, Kasalath and BR-5 cultivars and pIG121Hm/Km/GUS was used for transformation of Kataribhog rice. The vector contains β-glucuronidase (GUS) gene as a reporter gene and hygromycin resistance (HPT) as well as kanamycin resistance gene (NPTII) as selection agent and *kat*E the desired gene in the T-DNA region. Total genomic DNA was isolated from the transgenic plants and presence of the transgenes were confirmed by PCR and Southernblot analysis and expression of *kat*E gene was detected by RT-PCR. Catalase activity of transgenic T1 plants are about 1.5 to 2.5 fold higher level than those of wild rice plants. Landrace Indica rice Kasalath were able to grow for more than 20 days in the presence of 250 mM sodium chloride and produced seeds for more than three months in the presence of 100 mM sodium chloride. On the contrary notransgenic rice plants could not survive even for 10 days in the presence of 50 mM sodium chloride. Introduction of a single gene significantly improved the salt tolerance of Indica and Japonica rice. In this research work we report the application of genetic engineering in staple food rice for stress areas improvement to bring food security with safe environment.

ISFS-057

Extracellular enzymatic activities and biochemical constituents associated with the virulence of *Rhizoctonia solani* isolates from rice in West Bengal

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Twenty one isolates of *Rhizoctonia solani* were isolated from different infected rice fields from different agro-ecological regions of West Bengal. Cellulase and pectinase activities of those isolates were detected using CMC and pectin agar media, respectively. Diameter of the clearing zones on those media represented the level of such enzymatic activities of each isolate. Mycelial protein, carbohydrate and phenol contents were also recorded. The virulence of those isolates was studied using rice cultivar (MTU 7029) under greenhouse condition. Majority of the *R. solani* isolates of rice of West Bengal were belong to moderate to highly virulent group. The correlation of the biochemical constituents and enzymatic activities with virulence of the *R. solani* isolates was performed. Pectinase activity and mycelial carbohydrate content were the two most important biochemical constituents significantly contributed towards the virulence of *R. solani* isolates in rice system and only pectinase activity can able to explain the virulence of *R. solani* isolates by 76%.

ISFS-058

Agrobacterium-mediated genetic transformation of indica rice for abiotic stress tolerance

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Genetically transformed plantlets were regenerated from embryogenic calli of indica rice (*Oryza sativa* L.) var. Annada upon co-cultivation with *Agrobacterium tumefaciens* strain C58C1 (pEXSOD10). It harbours superoxide dismutase (Fe-SOD) gene under the transcriptional control of CaMV35 promoter and T_7 terminator along with a transit peptide sequence. Transformation efficiency was found to be 65.83%.

Molecular analysis involving PCR and Southern blot showed integration of Fe-SOD in the genome of Annada. Transgenic status was confirmed by the survival ability of the tillers of presumptive transgenic rice plants through methyl viologen test. The tillers of non-transgenic plants were found to be gradually dried-up after methyl viologen treatment for 16h. It prospects immense scope towards abiotic stress management through scavenging of super oxide radicals.

ISFS-059

Development of improved double-haploids through anther culture of indica rice (*Oryza sativa* L.)

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An intensive study was carried out to achieve green plant regeneration as well as double haploids from anthers of advanced breeding lines, BR 802-78-2-1-1. Out of 6 media components, combined responded by callus induction only in KA (no salt) by 7.05% and in KC (5.0 g/l NaCl) by 4.04%. Data based on seed morphological characteristics were subjected to cluster analysis for grouping into types; designated as AC (anther culture) and numbered in ascending order of transfer of anther culture derived plants to pots. At least eight types of variants with a wide range of differences were conceivable including a type similar to the parent, BR 802-78-2-1-1. Comparative analysis showed that all the variants had plant height lower than the parent. In respect of effective tillers, an important indicator of grain yield, AC165 and AC192, produced 100% effective tillers and only 4 and 3% grain sterility, respectively. The spikelet number per panicle was 306 and 294 in AC165 and AC192, respectively. AC171 produced very long and slender grain. The physiological characteristics and performance of the AC lines reveal the potentiality of the double haploids in fixing segregating populations. The H1 types will be grown for confirmation of homozygosity in the Transplanted Aman and Boro seasons and further yield trails leading to variety development.

ISFS-060

Molecular characterization of *Fusarium moniliforme* (Sheld.) isolates based on SSR markers

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Genetic variability among 30 isolates 15 exotic and 15 indigenous of Fusarium moniliforme were studied using 13 pairs of SSR primers. Using these primers, a total of 65 loci were obtained with 30 isolates. The number of bands per primer varied widely among these primers, with an average number of bands per primer was 5 while the amplified fragment size ranged from 100 bp to 3000 bp. Two SSR primers viz. primer LC-282 for isolate FmI16 and primer LC-292 for isolate FmI28 exhibited unique band size in 700 bp and 800 bp, respectively. All the test isolates were clearly seperated into four major clusters. UPGMA based dendrogram depicted higher values for Jaccard's similarity coefficient (0.885) and bootstrap value (69.9%) for identical haplotype of two isolates FmE2 and FmE8. The polymorphism information content (PIC) and the average expected gene diversity (Hi) value was also 0.568 and 0.292, respectively while the cophenetic correlation (r) were 0.854. The principal co-ordinate analysis (PCoA) exhibited relative similarities between the dendrograms and the score plots. In general, the isolates from the same host species could not grouped together in the same cluster. Distribution of isolates based on molecular analysis was in poor congruence with their host preference/association as well as geographical locations.

ISFS-061

Two species into one: DNA barcoding in the genus *Henosepilachna* (Coleoptera: Coccinellidae)

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Coccinellids of the subfamily Epilachninae are phytophagous beetles and majority of them are distributed in tropical and sub-tropical regions of the World. Large number of the species of the genus '*Henosepilachna*' feed on both cucurbitaceous or solanaceous plants and some are important pests which cause severe economic losses to the plants. Identification of the species within the genus *Henosepilachna* is very difficult

because of presence of overlapping external morphological characters like patterns of black spots on elytra of adults. Reliable identification could only be possible based on minute variation in genitalia characters. The efforts were made to develop the species specific DNA barcodes based on standard DNA barcoding region of the Cytochrome oxidase I (COI) gene of mitochondrial genome. The adults of *Henosepilachna* spp. were collected from cucurbits and were divided into four groups according to the size and numbers of the black spots on the elytra. Molecular characterization was undertaken on, five samples from each group. Preliminary results based on limited sample size indicated that, irrespective of elytral patterns of adult coccinellids, DNA sequences were grouped into two species; *Henosepilachna pusillanima* and *Henosepilachna septima*. Moreover, many non-synonymous nucleotide mutations were observed in *H. septima* group, which shows that additional species could be harbouring in this group as well.

ISFS-062

Evolution of resistance gene analogs in jute: implications for population structure determination

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Resistance gene analogs (RGAs) are crucial for plant defence response against pathogen attack. More than 60 resistance genes and RGAs have been identified in plant that share conserved motifs. Genetic polymorphism revealed by amplification of the conserved structural motifs in RGAs is an effective method for genetic diversity analysis, and has recently gained importance in population structure determination. We have examined the structure of a population of jute (*Corchorus olitorius*) using RGA polymorphism (RGAP) for 15 resistance genes from different species. Results show that RGAP reveals high polymorphism (>80%), higher allele number and more discrimination power. Phylogenetic analysis identified three distinct clusters in *C. olitorius* in correspondence to geographical diversity. Population genetic analysis revealed conserved population structure in varieties, while germplasm exhibited population admixture. The implications of these variations suggest that RGAP can be used for population differentiation and identifying small sub0structures in large population.

Competition Paper Presentation Session - 2

Competition papers for
'*Shashya Suraksha Yuva Pratibha*' Award

Chairman: CD Mayee
Jury Members: Hirak Banerjee

ISFS-063

Efficacy of *Lantana camara* essential oil and leaf extracts against Almond moth, *Cadracautella* (Walker)

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Products based on plant extracts and phyto-oils can be an alternative to the conventional insecticides and fumigants. *Lantana camara* (Family: Verbenaceae), is a well-known medicinal plant. Information about its bioefficacy against insect pests is very less. Leaves of *L. camara* was subjected to extraction with methanol and hexane. Extracts from leaves were further partitioned with solvents of varying polarity. Fresh leaves of *L. camara* chopped and essential oil in pure form was collected through hydro distillation. Thus the various extracts obtained LC-1, LC-2, LC-3, LC-4, LC-5 and azadirachtin technical and essential oil were further evaluated for their bio efficacy against different stages of Almond moth, *Cadracautella*. Insecticidal activity was observed with film residue method against early and late eggs, early, middle, late larvae and early, late adults. Observations were taken after 24hrs. Seed protectant activities of these extracts were evaluated by mixing the extracts with seeds in five doses and releasing freshly hatched larvae. The efficacy of extracts was evaluated with different fractions with different parameters like per cent weight loss, per cent seed damage and per cent adult emergence.Fumigant activity of essential oil was evaluated against egg, larva and adult stages at 6, 12, 24 and 48 hrs exposure periods. Effect of different concentrations of extract was also studied on percent germination, insecticidal, fumigant, seed protectant and effects on germination of different extracts were compared. Insecticidal toxicity of various extracts of *L. camara* and azadirachtin against *C. cautella* showed that toxicity of extracts was dose dependent. Matured eggs were more tolerant than young ones against, LC-1, LC-2, LC-3 and LC-4 extracts. Extracts LC-3 and LC-4 showed lowest LC_{50} values against egg stage of *C. cautella*and found to be more tolerant to eggs against al the extracts. Only extract LC-3 was effective against larval stage of *C. cautella* respective of their age. Based on lethal concentrations middle aged larvae showed higher LC_{50} values compared to early and late larvae. Old adults were found to be more susceptible against extracts. Only LC-3 and LC-4 extracts were effective on adults. Efficacy of extracts of *L. camara* on wheat seeds were studied to control infestation of *C. cautella* and it was found that percent weight loss and seed damage was reduced as the concentration was increased. Among the various extracts LC-4 showed maximum reduction in percentage weight loss. At higher doses of 2 and 5gm/kg All extracts showed reduced percent seed damage but efficacy of extract LC-4 showed significant low percent seed damage with doses, 0.5, 1.0, 1.5 gm/kg Adult's emergence could not be observed with highest treatment concentration of all the extracts. Extracts LC-3 and LC-4 showed reduced adult emergence even at lower doses.

ISFS-064

Molecular approaches for rust and late leaf spot disease management in groundnut

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Groundnut (*Arachis hypogaea* L.) is one of the important oilseed crop grown in India in 4.93 million hectares with a production of 5.64 million tonnes (FAOSTAT 2010). Majority of the cropped area is under rainfed cultivation. During the rainy season, the foliar diseases like rust (*Puccinia arachidis* Speg.) and late leaf spot (LLS) (*Phaesariopsis personata* Berk & Curtis.) infect the crop and reduce the pod yield upto 50% and also affect seed quality. Genetic resistance is always preferred over the other control measures as it is economical and environment friendly. In order to select the resistant genotypes from segregating populations, we need tightly linked molecular markers which can be used for more efficient selections of ideal plants even in the absence of disease epiphytotics. Further, very tightly linked markers would help to identify ideal recombinants which could be free from linkage drag of any undomesticated traits. Initially, we detected molecular diversity on selected genotypes consisting of 11 rust and LLS resistant and nine susceptible varieties/breeding linesin groundnut. Marker association analysis revealed that four markers were significantly associated with both rust and LLS disease resistance. Based on the genetic diversity, the two most diverse genotypes, VG 9514 (resistant) and TAG 24 (susceptible) were crossed and a mapping population was developed. In the F_2 inheritance of disease resistance was studied. It was found that the rust resistance is controlled by a dominant gene and the late leaf spot resistance is controlled by two duplicate recessive genes. Based on bulk segregant analysis and genotyping of the F_2 population, two RAPD markers were identified for the rust resistance gene. The same F_2 population was advanced through single seed descent method and a RIL population was developed. By using the available sequence database at NCBI, we designed around 500 genomic and genic SSR markers and tested their polymorphism between parents. Phenotyping of the RIL population at four different locations for two seasons revealed that the rust resistance among the RILs distributed bimodal fashion. Genotyping of the RILs with 200 SSR and 40 transposable element (TE) markers revealed a genetic linkage map with 24 linkage groups covering about 1400 cM distance. Based on mapmaker analysis we found two flanking SSR markers and a closely linked EST-SSR marker (1.9 cM) for rust resistance gene. Identification of breeder friendly markers is always required for easy handling and efficient selection. Breeder friendly markers include those markers which can be easily resolved in normal agarose electrophoresis. Most of the presently developed TE markers are fall under this category and well resolved in 1.5% agarose gel in 30 min. Genotyping of RILs with prescreened TE markers along with bulk segregant analysis detected a marker that is linked to rust resistance gene at 3.8 cM. This marker along with the identified EST-SSR marker showed promise to the groundnut breeder to select efficiently the desirable resistant genotypes from a large number of segregating population. In BARC, research on development of large number of segregating population in different genetic backgrounds and selection of ideal resistant genotypes through marker assisted selection is underway.

ISFS-065

Biological and molecular differences in host recognition of root-knot nematodes, *Meloidogyne incognita* and *M. graminicola* in tomato and rice

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Plant parasitic nematodes are gaining considerable importance worldwide due to their devastating effects on crops leading to major economic downturn. Nematodes are attracted to plant roots via soluble and gaseous attractants produced by root itself or by attendant rhizosphere microorganisms. Just how nematodes move through soil to locate plant roots is poorly understood but is of considerable importance to predict the important role nematode play in soil ecosystems. Investigation was conducted to compare and contrast the differences in host recognition of root-knot nematodes, *Meloidogyne graminicola* and *M. incognita* on rice and tomato in pluronic gel medium resembling natural three dimensional soil environment. A significant preference of *M. incognita* for tomato and *M. graminicola* for rice was observed in attraction bioassay reassured by penetration and development study in different host plants. Thus, either the blend of attractants and repellents are different in good and poor hosts; or, relatively long range attractants along with shorter range repellents might affect nematode movement patterns. Therefore, plant volatiles like small lipophilic molecules emitted by root exudates of tomato and rice were isolated through solid phase extraction to investigate their effect on root-knot nematodes. The semiochemicals present in those molecules negatively influenced the behavior of *M. incognita* and *M. graminicola* in stylet thrusting, motility and mortality bioassay. Therefore, it is proposed that lipophilic molecules present in both tomato and rice root exudates play important roles during the interaction of Meloidogyne spp. with their host plants and that they might exert a repellent, or allellopathic effect on these nematodes. Western blot analysis with different Polyclonal and Monoclonal antibodies showed major differences among the protein profiles of the two nematode species. Thus evolutionary adaption of these root-knot nematodes to their preferred hosts might have led to variability in their gene/protein profile which could also contribute to their differential behaviour outside and inside of the different host crops.

ISFS-066

Studies on the incidence and management of mustard aphid (*Lipaphis erysimi* Kaltenbach), the key pest of *Brassica* crop

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Mustard aphid, *Lipaphis erysimi* (Kalt.), is the most serious insect-pest of rapeseed- mustard and responsible for causing the yield losses ranging from 35.4 to 96 per cent depending upon weather condition. The experiment was carried out to assess its' incidence, yield losses due to its' attack and their management through non-chemical and chemical means during the winter seasons of 2009-10, 2010-11 and 2011-12 at the Pulses and Oilseeds Research Station, Berhampore, Murshidabad, West Bengal. The natural appearances of the aphid on the yellow sarson variety, Binoy (B-9) was observed from 52nd standard week, with the peak population on 6th standard week and the aphid disappeared after 10th standard week. Monitoring of the alate aphid was also done by using yellow sticky trap to find out the time of their first appearance and disappearance from the field. Studies on the screening of the germplasm against mustard aphid revealed that TKM 10-2, PT 303, SKM B-817, T 6342, LET 36, RTM 1212 and T 27 were found to be less preferred by the aphid (low A.A.I.I. rating <2.0). Among the different chemical insecticides evaluated for their bio-efficacy against *L. erysimi*, Dimethoate 30EC and Oxy-demeton methyl 25 EC were proved to be more effective. The plots treated with Dimethoate and Oxy-demeton methyl recorded minimum aphid infestation in most of the observations, there by produced more yield ranging from 1151.6 to 1310.3 kg seed/ha. Incremental cost benefit ratio indicated that most favourable return was obtained under Dimethoate 30 EC (1:20.8 & 1:13.3) followed by Oxy-demeton methyl 25 EC (1:16.8 & 1:9.1), while poor incremental benefit-cost ratio was observed in Fipronil 5SC (1:5.8 & 1:2.1) and Acephate 75 SP (1:7.1& 1:4.3) during the year 2010-11 and 2011-12, respectively.

ISFS-067

Exploration of microbial resources for the management of plant diseases

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Microbial resources play an important role in biocontrol of plant diseases and pests and biocontrol is a major component in an integrated disease management framework. In the era of extensive use of chemical pesticides, it is a best alternative for the management of plant diseases as it is not only effective enough to

manage the plant disease effectively but also negating the development of resistance in several plant pathogens towards any chemical pesticides. Biological control of plant pathogens is the use of one or more biological processes to lower inoculum density of the pathogen or reduces its disease producing activities, plant pathogens include fungi, several kinds of prokaryotic microorganisms (bacteria, actinomycetes and mycoplasma), nematodes, seed plants, viruses and viroids. Biological control may be defined as "reduction of inoculum density or disease producing activities of a pathogen or parasite in its active or dormant state by one or more organisms accomplished naturally or through manipulation of environment, host antagonists, or the pathogen itself or mass introduction of one or more antagonists". Biological control is much neglected, not because it does not work but because not enough research is done on it. Biological control has worked, is working and can, if we desire it, greatly extend its success. Furthermore, indiscriminate use of chemical pesticides has led to pollution of soil and water ecosystem and environment as whole. This is ultimately comes to the food chain and causing serious health hazards to living organisms. Keeping this point of view, the challenging research task was taken to develop appropriate and effective biocontrol technology for the management of plant diseases in India.

Several fungal bioagent *Trichoderma* species have been isolated and characterized and established biocontrol potential and successfully used for integrated management of diseases of vegetables, spices, pulses and fruit crops since last about ten years of my professional carrier. These isolates have been isolated from Mizoram, Garo Hills of Arunachal Pradesh, West Bengal and Andaman and Nicobar Islands, Karnataka, Andhra Pradesh, Maharashtra, Madhya Pradesh, Jharkhand, Manipur, Tripura, etc. The potential isolates of this bioagents have been deposited in MTCC Chandigarh (16 isolates) and the gene sequence (29 isolates) have been submitted to NCBI database which are available online in its website (www.ncbi.nlm.nih.gov). Twenty nine isolates of *Trichoderma* have also been deposited to NBAIM, Mau. The mass production technology of *Trichoderma* spp. and *Pseudomonas fluorescens* in agricultural byproducts as well as talc based carrier preparations standardized and developed. These biocontrol preparations were used as different delivery systems for the management of many soil borne and foliar diseases of vegetables (tomato, bhendi chilli, brinjal, frenchbean), spices (ginger and black pepper), pulses (mungbean and chickpea) and fruit crops (Mango). Four new species of *Trichoderma* viz., *T. erinaceum, T. ovalisporum, T. asperellum* and *T. brevicompactum* have been reported 1st time from India. Several species of PGPR and endophytic bacteria were also characterized and established their biocontrol potentiality in different crops. Gene sequences of these bacteria were also submitted to NCBI gene bank. Several isolates of *Trichoderma* from different parts of India are under characterization for their biocontrol traits and expected to come out some new and potential isolates for the management of plant diseases.The short shelf life of biocontrol formulation is a major concern and this is one of the reason for not popularized to its potential level. The enhanced shelf life of biocontrol preparations by using organic substrates/polymers is also evaluated and found positive results, however it needs more study to come out to a level of CIB registration.

ISFS-068

Integrated disease management of tomato yellow leaf curl virus of tomato

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An on farm experiment was conducted during 2009-10 and 2010-11 at Chopra, Uttar Dinajpur, West Bengal, India for Integrated Disease Management of Tomato yellow leaf curl virus (TYLCV) of tomato transmitted by whitefly, a serious pest of tomato in northern parts of West Bengal. The experiment was conducted in RBD design with four treatments and eight replications. The treatments were T_1 (Farmers' practice): Seedling raising from open nursery with indiscriminate use of pesticides (cypermethrin, quinalphos, triazophos, monocrotophos) on standing crop; T_2: Nylon net (40 mesh) cover nursery followed by 4 sprays (15 days interval) of imidacloprid and thiamethoxam alternatively on standing crop as well as in the bund + rouging of infected plants; T_3: Root dipping of seedling with imidacloprid form open bed nursery followed by 4 sprays (15 days interval) of imidacloprid on standing crop; T_4: Spray the seedling 2 times at nursery stage in open bed nursery followed by 4 sprays (15 days interval) of imidacloprid on standing crop. From the experiment it was revealed that the percentage of disease incidence was highest in T_1 (48.97 and 44.02) and lowest in T_2 (20.77 and 26.24) during 2009-10 and 2010-11 respectively. Production per ha was highest in T_2 (38.46 and 35.2 t ha^{-1}) and lowest in T_1 (26.92 and 28.0 t ha^{-1}) during 2009-10 and 2010-11 respectively. Percentage of yield was increased 42.87, 13.08 and 19.47 in T_2, T_3 and T_4 respectively over T_1 during 2009-10, whereas it was increased 20.4, 17.1 and 14.3 during 2010-11. Net return per ha followed the same trend in both the years in case of T_2 (Rs. 1, 70, 896 and Rs. 1,21,750) and in T_1 (Rs. 1,00,076 and Rs. 85,250), but T_3 and T_4 was lower than the T_2. In both the years Benefit: cost ratio were also highest in T_2 1 (2.74 and 2.34) and lowest in T_1 (2.13 and 2.03). From the results it may be concluded that the T_2 was the best among all the management practice.

ISFS-069

Bioecology of two spotted red spider mite (*Tetranychus urticae* Koch.) infesting pointed gourd (*Trichosanthes dioica* Roxb.)

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An experiment was undertaken at Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Gayespur (at 23°N latitude and 89°E longitudes), Nadia, West Bengal, India with the objective to study the incidence pattern and bio-ecology of mite pest of pointed gourd along with the role of major abiotic factors on the oscillation of population. Peak incidence was obtained in last week of April to first fortnight of May during all the three years of study. Study on spatial distribution showed that the population was always of contagious type and their biology was worked out. Incubation period, larval period, protonymphal period, deutonymphal period, longevity of the adult male and female were 3-4 days, 1-2 days, 2-3 days, 13-16 days and 17-21 days, respectively at 28°C temperature and 80% relative humidity. Results revealed that mite population had high positive significant correlation with maximum temperature (r = +0.797) and bright sun shine hours (r = +0.622). Conversely both morning and evening RH% were significantly negatively correlated (r = -0.650 and -0.539 respectively). Similarly total rainfall also had negative correlation (r = -0.289) and feebly so. Predictive models were developed from pooled data of two years (2008 and 2009) observations on population *vis-à-vis* weather factors one with irrespective of whether they had significant effect on population performance or not and another with the significant ones. The predicted population when compared with actual population observed during 2010 for vindication of worth of the equation developed for each pest which was found to be more or less perfect fit.

ISFS-070

Molecular markers linked with Bruchid resistance in *Vigna radiata* var. Sublobata and their validation

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Bruchid, *Callosobruchus chinensis* (L.) is an important pest of *Vigna radiata* during storage. RFLP and PCR based markers identified, linked with bruchid resistance gene in wild accession of greengram (*V. radiata* var. Sublobata) either collected from Madagaskar or Australia. Whether these markers will be useful for marker

assisted introgression of bruchid resistance gene from the Indian accession into the existing cultivars are not known. Here, we employed two STS based markers which were found earlier, to be linked with bruchid resistance gene in Australian accession ACC41. Only one primer pair, STSbr1 showed polymorphism among Indian Sublobata accession (Sub2) and other twelve green gram cultivars. Analysis of 113 segregating lines (F6) of a cross between a popular cultivar of West Bengal, B1 and Sub2 showed a cent percent co-segregation of resistant locus with the polymorphic fragment. STSbr1 behave as a dominant marker among Indian genotypes although it has been shown earlier a co-dominant banding pattern between ACC41 and other Australian Susceptible cultivars. Other STS marker, STSbr2, does not produce any polymorphic fragment among Sub2 and 18 greengram genotypes. STSbr1 employed in screening of 50 green gram accessions and found high efficiency in screening of bruchid resistant genotypes also. So STSbr1 will be useful for marker assisted selection and germplasm screening for development of bruchid resistant greengram.

ISFS-071

Whole genome transcriptional analysis of rice-arsenic interaction in presence of arsenic in irrigation water and soil

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Detailed transcriptomic analysis of rice genotypes was executed when the crop is grown in arsenic contaminated ground water (irrigation source in farmer's field 0.66 mg/L) and soil (Olsen extractable arsenic in soil is 4.8 mg/kg). RNA was extracted from the stem (culm) from two *Indica* genotypes, Satabdi and Palman which was used for the Affymetrix (60K) Gene Chip Rice Genome array. A total of 89 probe sets were significantly up-regulated above 2-fold and 49 sets were significantly down-regulated below 2-fold in both the genotypes. No Glutathione S-transferases gene was found to respond more than 3 fold change in both the genotypes. Probably, Glutathione S-transferases genes were not active in stem for detoxification of reactive electrophillic compounds by catalyzing their conjugation to glutathione. But three members of Glutathione S-transferases genes, Os01g0353400, Os10g0530500 and Os01g0949900, were found to respond in either genotype in more than 3 fold. So these three members might have some role in differential accumulation of As in grain or stem. Two methyltransferase genes, Os10g0118200 and Os10g0118000 were found to respond more than 3 fold up-regulation in both genotypes. Nine up or down regulated genes, *viz,* Os02g0555300, Os03g0775700, Os04g0340300, Os05g0119700, Os07g0443500, Os09g0275400, Os12g0112000, Os01g0534700, substantially responsive and validated among two contrasting genotypes, Satika and TN1 using real time PCR. Satika is a low arsenic accumulator in grain where as TN1 is a high accumulator. Os01g534700, an ATP binding cassette (ABC) transporter, a member of multidrug resistance protein,

showed equal expression in stem of both the genotypes when grown in control soil. The expression of this gene had undergone approximately seven and thirteen fold enhancement in Satika-stem and TN1-stem respectively, when grown in presence of 5mg/kg of arsenate. Whereas, expression remained approximately same in Satika-grain for all three treatments but it enhanced three fold in high accumulating genotype, TN1. So, expression of this gene might have a role in grain or translocation from stem to grain. Expression of a terpenoid synthase domain containing protein, Os04g0340300, was most contrasting among the two genotypes. In Satika, it was non-responsive even after the presence of arsenic at the rate of 5mg/kg or 10mg/kg of soil where as TN1 showed 23 and 36 fold increase of expression respectively in the same conditions. When this gene was further validated in a set of nine genotypes with differential arsenic accumulation, it showed a high significant correlation with arsenic accumulation in brown rice.

ISFS-072

Assessment of variability and unraveling the biochemical factors involved in the pathogenesis of *Xanthomonas campestris* pv. *campestris* on cabbage

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Black rot of crucifers caused by *Xanthomonas campestris* pv. *campestris* (Pammel) Dowson (*Xcc*) is the most important disease substantially damaging the crops by 10–50% in favorable environmental conditions. The pathogen infects a large number of cruciferous plants, including agriculturally important crops like cole crops (broccoli, cabbage, cauliflower, and knol khol), turnip, radish, oliferous brassica crops, ornamental plants, and weeds. Initially, the black rot disease was reported on cabbage from Bombay, Maharashtra in India in 1928 and now, it occurs across the country. *Xanthomonas campestris* possesses interspecies variations on the level of pathovars, haplotypes, serogroups, and races. The variations in pathogen population's structures not only enable them to exhibit differential pathogenicity, antibiotic sensitivity, but also help them to break down the disease resistance. Hence, the present study focuses on morphological, pathogenic, biochemical and molecular variation among *Xanthomonas campestris pv. campestris* isolates of West Bengal and the host–pathogenic interaction in cabbage – *Xcc* system. Thirty one isolates of *Xcc from* cabbage and cauliflower, two *Xanthomonas axonopodis pv. citri* isolates associated with lemon were isolated from different agro-ecological region of West Bengal and one each isolate of *Xanthomonas campestris* pv. *punicae*, *Xanthomonas axonopodis* pv. *malvacearum*, *Xanthomonas oryzae* pv. *oryzae* obtained from Division of Plant Pathology, IARI, New Delhi were used in the present study. Cultural characteristics revealed considerable diversity among the *Xcc* isolates. Protein profiling technique employed to detect the variations among the 18 *Xcc* isolates and four other *Xanthomonas* sp. Based on protein profiling *Xcc* isolates

exhibited approximately 66 % similarity among themselves. Bands with Rf value 0.26 and 0.38 in protein profiling were found to be specific for *Xcc* and may be used as protein marker for detection of *Xcc*. Four isoenzymes were used for variability analysis with *Xcc* isolates and among other xanthomonads. Based on isozyme profiling *Xcc* isolates exhibited approximately 58 % similarity among themselves. The band of Rf value 0.44 in α- esterase and Rf value of 0.39 in β-esterase may be used as protein marker for detection of *Xcc*. RAPD technique employed to detect the variations among 9 *Xcc* isolates and four other *Xanthomonas* sp. About 17 - 45 % similarity existed among different *Xanthomonas* sp. except *Xam* (*Xanthomonas axonopodis* pv. *malvacearum*) but 38-100% similarity existed among *Xcc* isolates. Protein profile, isozyme variability and RAPD analysis of W.B. isolates of *Xcc* has indicated that the diversity among the isolates does not correlated with their origin. *Xcc* isolates were clearly distinguished from other *Xanthomonads* by ERIC-PCR technique. Correlation of ERIC-PCR banding pattern with virulence of *Xcc* identified several bands as markers of virulence. ITS-RFLP could not separate *Xcc* isolates from other xanthomonads. In the course of cabbage-*Xcc* interaction, there was gradual and steep increase in PAL activity up to 5th days after inoculation (2.09 fold). The suppression of PAL leads to the weakening of defense mechanisms in *Xcc* inoculated plants in the early stage of infection. Highest increase in POX activity was observed at 5th DAI (3.38 fold). However, a progressive and rapid decrease in POX activity was noteworthy in 7, 9 and 11 DAI. A gradual increase in SOD activity was also found in *Xcc* inoculated cabbage plant up to 7 DAI (1.78 fold) afterwards a gradual decline in SOD activity was observed up to 11 days after inoculation. Induction of POX-1 at three days of inoculation and enhanced band intensity of POX-1 and POX-4 up to 5 days after inoculation was observed. These two isomers might be related with the susceptible cabbage host and *Xcc* interaction. Induction of SOD-1 might also be associated with susceptible host-pathogenic interaction. PAL and phenol content was found to play significant role in host-pathogen interaction in cabbage-*Xcc* system.

ISFS-073

Biocontrol potentiality and molecular variability of fluorescent pseudomonads against fungal and bacterial plant pathogens

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Plant growth promoting rhizobacteria (PGPR) have profound effects in improving fitness of plants against diseases by virtue of their ability to induce systemic resistance (ISR), promotion of plant growth and improving plant health for better competitive ability. Therefore, PGPR-mediated management of plant diseases has become one of the eco-friendly and highly effective component for the integrated management of plant diseases. In the current experiment, seventy six rhizobacteria were isolated from rhizospheres of

citrus, brinjal, cabbage and potato collected from Gangetic Alluvial regions of West Bengal. Ten of which were found to be highly effective *in vitro* against bacterial (*Xanthomonas campestris* pv. *campestris*, *Xanthomonas axonopodis* pv. *citri* and *Ralstonia solanacearum*) as well as fungal (*Rhizoctonia solani*) pathogens of national and international importance. Citrus rhizosphere found to harbour maximum number of fluorescent pseudomonads (citrus > potato> cabbage > brinjal). The isolates were identified as *Pseudomonas aerugenosa* by biochemical and molecular identification techniques. Isolate PT-1 was highly effective against *X. axonopodis* pv. *citri* (*Xac*). Inoculation of PT-1 in citrus leaf followed by challenge inoculation of *Xac* after 24 hr at a ratio of 8:1 (PT-1 : *Xac*) caused maximum reduction (72 %) of *X. a.* pv. *citri* induced susceptible reaction (SR). Salicylic acid, siderophore, and HCN production and protease and chitinase activity of the rhizobacterial isolates were highly and positively correlated with the ability to antagonise bacterial and fungal pathogens, respectively. Step wise regression technique revealed that the combination of biochemical variables (HCN, IAA and siderophore production against bacterial diseases; chitinase and protease activity for fungal pathogens) jointly contributing 94.4 % and 98% of variability of antagonistic potentiality of rhizobacteria against bacterial and fungal pathogens, respectively. These variables may be used as predictors of biocontrol potentiality of rhizobacteria. Cluster analysis based on Jaccard's *coefficient* followed by ERIC-PCR mediated genomic fingerprinting of these rhizobacterial isolates showed location specific and antagonistic potentiality specific divergence in the dendogram thus re-emphasising the importance of ERIC-PCR for the identification and selection of effective fluorescent pseudomonads against destructive plant pathogens.

ISFS-074

Discovery of a single DNA promoter switch that changes the *Photorhabdus* bacterium between insect-pathogen and nematode-symbiont forms

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Photorhabdus is a gram negative gammaproteobacteria that lives in an obligate symbiosis with the insect parasitic nematode *Heterorhabditis.* Together, they parasitize and kill insects and are being used worldwide for insect biological control. Since last 35 years researchers were trying to understand the molecular mechanisms underlying this nematode-mutualist to insect-parasite transition, but without success. Here, we discovered that a single DNA promoter switch regulates this transition. This promoter switch is located on an

invertible DNA element located upstream of *m*aternal *ad*hesive *f*imbriae (mad) on *Photorhabdus* chromosome, and flips ON to initiate mutualism (M-form) and OFF to turn into a pathogen (P-form). A recombinase upstream of mad fimbrial operon, *madR,* flips the switch OFF whereas an orphan recombinase, *madO*, flips the switch ON. The M-form cells are radically different from P-form cells as M-form cells are ~7 times smaller, do not produce secondary metabolites, are more tolerant to antibiotics and are not pathogenic to insects. M-form cells are present throughout all the mutualistic stages in the nematodes, and are the first cells to colonize the offspring infective juveniles. In summary, this study provides us with an understanding of the molecular mechanism that govern the tripartite interactions of *Photorhabdus* bacterium, *Heterorhabditis* nematodes and their insect hosts, and opens up ways for better exploitation of *Photorhabdus* for insect biological control and plant protection.

Technical Session - 3

Pest profile of field and horticultural crops
vis-à-vis climate change issues

Chairman: SB Sharma
Co-Chairman: Megha N Parajulee

ISFS-075

Climate change and pest management: horizontal and vertical distribution of existing pests as result of climate change and possible modifications in management strategies

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Global surface temperature has increased by approximately 0.74°C in the last century, and further warming of 1.1 to 6.4 °C is predicted to occur by 2100. Global warming would have a substantial impact on pest species physiology, distribution and phenology, and also on biodiversity and ecosystem services. Temperature directly affects the survival, development, reproduction and movement of individual insects and thus the potential distribution and abundance of a particular insect species. Most studies have concluded that insect pests will generally become more abundant (more types and higher densities) as temperatures increase, through a number of inter-related processes, including range extensions and phenological changes, as well as increased rates of population development, growth, migration, and overwintering. Climate change (global warming) has a direct influence on insect pest range extension. Many insect species, especially those in the temperate zone, have been found to shift their distribution to a higher latitude or altitude in concert with climate warming. For example, over the past 32 years, the pine processionary moth (*Thaumetopoea pityocampa*) has expanded 87 km at its northern range boundary in France and 110-230 m at its upper altitudinal boundary in Italy. If the host plant and insect pest phenological synchrony becomes uncoupled during climate warming, insect dynamics could be adversely affected. However, under climate-warming conditions, most temperate insects such as *Nezara viridula* (Heteroptera: Pentatomidae) will likely benefit mostly as a result of increased winter and spring survival and advanced post-diapause reproduction. As increased temperature can advance development and phenology, it is possible that the warming climate may result in increased number of insect generations, potentially requiring more insecticide applications to maintain populations below economic thresholds. Such increased insecticide use frequency could lead to increased probability of insects developing resistance to insecticides. With climate warming in mid- to high-latitude regions, insect pests are generally expected to become more abundant. Pests such as aphids and sap-suckers in general have short development times and massive capacity for reproduction, which are particularly sensitive to temperature changes. Modeling studies indicate that higher temperature could generally increase aphid abundance, but increased temperature could also decrease growth of some aphid species, depending on their thermal requirements and host specificity.

Natural enemy is an important factor in pest regulation. The distribution and abundance of natural enemies is also likely to be affected by changes in climate. The development rates of predators and parasitoids are influenced by temperature as with their hosts but, in general, their lower thermal threshold is higher than for

their hosts. Thus, at low temperatures, their impact on pest populations tends to be relatively small, but as temperatures rise, this impact becomes increasingly more significant. Parasitoids depend on a series of adaptations to the ecology and physiology of their hosts and host plants for survival. They represent the third trophic levels and are expected to be highly susceptible to changes in environmental conditions. Preliminary modeling studies show that annual variation in the degree of phenological asynchrony may be an important destabilizing factor for natural enemies. The study on plant-aphid-parasitoid model under climate change suggests that, while parasitoids do have an impact on the aphid population dynamics, they do not necessarily alter the aphid response to climate change. In contrast, studies suggested that higher temperatures increase the effectiveness of coccinellid predators in reducing aphid numbers. The effect of global warming on biology and behavior of arthropods varies with species, which may result in changes in trophic structures of the ecosystem. Consequently, it could also result in geographical asynchrony and ecosystem instability. For example, biological control of the European corn borer (*Ostrinia nubilalis*) is only effective in some selected portions of its ecological range. The effect of global warming on plant and herbivore interactions has generally been predicted to increase the intensity of herbivore pressure on plants. For example, global warming could expand the range of key pests of maize in North America, and these range expansions could have substantial economic impacts through increased seed and insecticide costs and decreased yield. A similar phenomenon would be expected in the Indian subcontinent agroecosystems. It has been demonstrated that climate warming could pose a profound impact on arthropod complex in both ephemeral and stable agroecosystems. These effects could occur upon different ecological levels, from individuals to populations and communities. While precise impacts of climate change on arthropods and other pest species are not entirely clear because the effects are not consistent across species, the bulk of current research evidence indicates that there will be an overall increase in the frequency and degree of outbreaks of a wider variety of arthropods, pathogens, and weeds, necessitating the need for more research toward retooling our current IPM practices.

ISFS-076

Status and prescriptions for research on pest dynamics in relation to climate change

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Future of our nation's crop protection depends on how well we are upgrading our skills of research and development in tune with the changing scenario of resource potential, land and labour and the capital. The changes on evolutionary and ecological scales of the pests manifested due to interaction effects of ecosystem

components both biotic and abiotic determine the injury and damage status of pests on crops and commodities at a given time. Increasing temperature, altered precipitation and humidity, increased frequency of extreme weather events and increasing CO_2 level are the major climate change factors that are likely to influence pests. Climate change has the potential to affect pest behavior and biology with impacts on their management, crop yield, quality, and environmental health. While higher temperatures could reduce the reproductive potential of key agricultural pests, rise of winter temperature could accelerate survival of some species. Extension or decrease in geographical range of pests, hot spot locations, resting stages of insects and pathogens, shift in pest and natural enemy dynamics in relation to host phenology and shorter life-cycles and more generations resulting in pest outbreaks have been hypothesized and proved in many cases. As the climate change would affect the crop phenology and the associated crop production practices the implications are that the significant change in pest phenology, their management and effectiveness. New environmental pests and Trans boundary insect pests could emerge as major threat of agriculture. The efficacy of bio rationals and even insecticides will change under climate change conditions leading to adoption of higher and frequent on pest control measures. On the positive side there would be space and time for the natural mortality factors that could bring equilibrium of agro ecosystems. The climate change altering the susceptibility or resistance of host plants for better or worse need to be captured soon to exploit or to manage the situations, respectively. Capturing of direct and indirect effects of climate change is crucial for adapting our pest management. In India, plant protection research has been largely normative, and no focused studies partitioning the role of climatic variability/change in changing the pest scenario across crops are available, although countable controlled studies on effect of CO_2 on plant phenology and in turn on few insect pests are available. The lack of state of art or modern infrastructure facilities to simulate the future climate scenario and suitable network to capture the dynamic nature of pest are rated as major limitations. The approach towards the understanding of the potential effects is to use identification, modification and testing of appropriate models with capacity to include micro and macroclimate data, short and medium range weather and climate variation along with historical crop, climate, and pest/disease and management data. Accurate prediction is possible only when we have quality and extensive data base across various locations of the country where pests are sampled. On short term, use of historical crop, climate, and pests and management data *vis a vis* current conditions provide ample and immediate scope of understanding effects of climate variability and plan for adaptive plant protection strategies. Indian Council of Agricultural Research through the Division of Natural Resource Management launched in February, 2011, National Initiative on Climate Resilient Agriculture (NICRA) a network project to enhance resilience of Indian agriculture to climate change and climate variability through strategic research and technology demonstrations. Under the programme, component of strategic research includes the study of 'pest dynamics in relation to climate change across crops of rice, pigeonpea, groundnut, and tomato' considering the food and nutritional security of the nation. Assessment of changes in crop-insect pest/pathogen/beneficial interactions through

explorative and literature surveys, characterizations (taxonomical, genetic, biological, behavioral ecological), and web enabled multi-site-multi season documentation of pest scenario besides pest forewarning for present and future climatic scenarios are the goals attended to. Real time pest surveillance (RTPS) is the major activity with an objective of generating quality data and identification of pest shifts across the country. Experience so far indicates that snapshots of identifying emerging pest problems, and integrating places and researchers for RTPS and modeling makes it credible to address issues relating to climate resilient agriculture to attain food security.

ISFS-077

Climate change and plant diseases in India – an introspection

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Effect of climate change on agriculture or more precisely on diseases of agricultural crops is multidimensional. Research on the effects of climate change on plant disease continues to be limited in India, although some striking progress has been made in other countries. Parametric and non-parametric analysis of climatic data indicated that there was highly significant variation in some parameters for particular weekly averages across decades and over years for all the nine locations (Pantnagar, Kanpur, Faizabad, Dholi, Rahuri, Parbhani, Patancheru, Bangalore, Coimbatore), which indicated that at those locations there has been significant change in climate for those parameters. The rise in temperature at Kanpur may have been beyond the tolerance limit of *Aceria cajani*, the mite vectoring Sterility Mosaic Virus of pigeonpea, which could have influenced decline in the disease there. On the other hand, the weather factors might have shifted in favour of the vector at Bangalore that may have resulted in rise of the disease on the crop there. Climate change may have also influenced Phytophthora blight incidence at Kanpur and Pantnagar in mutually opposite directions. While Alternaria blight is increasing on pigeonpea in Andhra Pradesh, Cercospora leaf spot is on the rise on the crop in Karnataka and Stemphylium blight is growing on lentil, chickpea in some parts of India, which could be due to the effects of climate change. Root rot of oilseeds Brassica is an emerging threat for rapeseed-mustard production system, recently reported from the farmers' field in some pockets of the country. Some isolates of *Alternaria brassicae* sporulated at 35^{o}C and several isolates had increased fecundity under higher RH, it seems that as per recent changes towards warmer and humid winters, being in line with current projections for future climate change, existence of such isolates could pose more danger to the oilseed Brassicas due to Alternaria blight in times to come. Several diseases have been noted to be showing higher level of infestation on different field and horticultural crops in India, which shall be discussed. However, with change in climate, the pathogen-weather relationship is also bound to change apart from behaviour of the

hosts, newer varieties, cropping practices, etc. Dynamic models incorporate the recorded data of each crop season for a particular pest to suitably revise itself and thus remain stable, relevant enough to continue providing accurate forecast. The lecture also looks at different strategies to cope with effects of climate change on diseases of crops with a proposal for Integrated Decision Support System (IDSS) for Crop Protection Services that suggest the operational focus, research priorities and aspects of capacity building.

ISFS-078

Aphid-weather relationships in mustard

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The rapeseed-mustard occupies the highest area among all the winter crops grown in West Bengal. The aphid, *Lipaphis erysimi* (Kalt.) is the most serious biotic constraint, causing a yield loss of as high as 90 % in mustard crop. The aphid incidences differ due to variation in seasons and places of crops grown. Since the weather conditions play a dominant role in the population build-up of aphid, studies on aphid-weather relationships are needed for devising appropriate weather-based forewarning tool. With this objective in view, a field experiment was conducted in the 'C' Block Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani in the winter season of 2003-04. The 'Bhagirathi' variety of mustard which was grown without any application of pesticide was sown on ten dates starting from 15 October. For counting of aphid population, ten plants were randomly selected from each plot. Number of aphids was counted twice a week from 10 cm top main shoot of each plant and average aphid population for each sampling date was determined. Results revealed that the first incidence of aphid varied from 20 November to 4 January over different dates of sowing, whereas the peak incidences varied from 4 to 22 January. Correlation coefficients between aphid population recorded on different dates and mean maximum and minimum temperatures prevailing on the dates of aphid observations and 1 to 5 days prior to the aphid observation dates revealed that both maximum (day) and minimum (night) temperatures demonstrated negative correlation with aphid population in different dates of sowing. Night temperature showed greater correlation values than those exhibited by day temperature. When data pooled over different dates of aphid observations and different dates of sowing, both day and night temperatures had exhibited consistently significant negative correlation with aphid population. Accumulated growing degree day, heliothermal unit and photothermal unit, sunshine hours and temperature range from dates of sowing to different aphid observation dates over all the dates of sowing registered significant positive correlation with aphid population. By considering significant weather parameters, regression equations for prediction of time of onset of peak incidence of aphid have been developed. Aphid-weather diagrams as an aid to farmers' advisory have also been prepared. It is concluded that results emanated from this study could be useful for issuing forewarnings to the farmers against aphid incidence in mustard crop grown in the New Alluvial agroclimatic zone of West Bengal.

ISFS-079

Understanding the plant responses to pest feeding

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Plants and insects have been interacting for millions of years. Since many insect species are adapted to use plants as their main food components, a battle between plants and plant feeding insects started and it continues even today. Plants learned to tolerate these attackers for their survival. Since plants do not have effective immune system compared to animals they evolved sophisticated defense mechanisms to withstand the insect attack, mainly by reconfiguring their metabolism to produce compounds that are toxic, repellent or anti digestive to the feeding insects. The plant defenses mainly composed of direct and indirect defenses. Alkaloids, Phenolics, Proteinase inhibitors (PIs), Cyanogenic glucosides, Glucosinolates etc. act as direct defenses influencing the feeding insects behaviour and physiology (being toxic, growth or feeding inhibitors). Often they inhibit the digestive processes of insects, thus preventing the further feeding.

Understanding this phenomenon is important in order to understand the plant resistant mechanisms and also will aid us in development of effective pest management strategies with eco-friendly approach. Our research at the Biology Division of Indian Institute of Chemical Technology mainly deals with the defence strategies involved in the plant-insect interactions. The responses of different crop plants such as rice, castor, brinjal and sweet potato due to infestation of various insect pests with different feeding modes were studied. Insect feeding induced oxidative stress and enhanced secondary metabolites such as phenols and phenolic acids in plants. Total carbohydrates, proteins and amino acids content in infested plants differed with respect to the feeding mode of insect. Qualitative and quantitative changes in enzymes (peroxidase, catalase superoxide dismutase), phenols and phenolic acids (cinnamic acid, chlorogenic acid, syringic acid) revealed the efficiency of plants counter reaction towards insect feeding. These phenols also exhibited potent antifeedant and antinutritive activity against *Spodoptera litura* F. and *Achaea janata* L. Our results showed conclusive evidence that insect feeding induces stress in plants that leads to the elicitation of defense mechanisms in the form of production of plant secondary metabolites.

ISFS-080

Infestation of root knot nematode *(Meloidogyne)* in different crops of West Bengal, India

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Root knot Nematode (*Meloidogyne* spp.) infested root samples collected from rhizosphere of crops *viz.* rice, tomato, cucumber, dolichos, frenchbean, brinjal, jute, bittergourd, okra, poi, basella, amaranths, pointed gourd, bitter gourd, ridge gourd, cucumber, pumpkin, cabbage, spinach, papaya, potato, coriander etc. and some weeds from different locations of Bankura, Birbhum, Burdwan, Coochbehar, Darjeeling, Jalpaiguri, Kolkata, Murshidabad, Nadia, North 24-Parganas, South 24-Parganas, Purulia, Paschim Medinipur districts of West Bengal were examined for identification of *Meloidogyne* spp. associated with the crops. Infected root samples were processed by NaOCL-acid Fuchsin method for identification of *Meloidogyne* spp. Identification of species was done on the basis of perineal patterns, morphometrics of different stages and biochemical studies of some populations of *Meloidogyne*. Morphometric studies of *Meloidogyne* populations from different crops revealed occurrence of *Meloidogyne incognita* (Kofoid & White, 1919) Chitwood, 1949 and *Meloidogyne javanica* (Trueb, 1885) Chitwood, 1949 infesting primarily on vegetables, jute, and fruit crops while *Meloidogyne graminicola* Golden and Birchfield, 1965 was found infecting rice and some weeds in rice fields. Isozyme phenotype and malate dehydrogenase (mdh) analysis of nine populations from West Bengal with *M. javanica* as standard check in each enzyme phenotypication studies also revealed occurrence of *M. incognita* and *M. javanica* infesting crops in West Bengal. Infestation of *M. incognita* was found in almost all the crops (except rice and poi) in most of the districts (except Paschim Medinipur, Jalpaiguri, Coochbehar and South 24-Parganas) while *M. javanica* was found in the crops viz. brinjal, frenchbean, tomato, poi, basella, cabbage, spinach, okra and jute grown in Bankura, Burdwan, Coochbehar, Jalpaiguri, Nadia, 24-Parganas (North), 24 Parganas (South) and Purulia districts. Rice root knot nematode, *M. graminicola* was found only rice and some weeds (*Jussiaca suffruticusa*, *Echinochloa* spp., *Cyperus* spp. etc.) in Bankura, Nadia, North 24-Parganas and Paschim Medinipur, districts of West Bengal.

ISFS-081

Branch gall of mango (*Oligotrophus mangiferae* Keiffer) – its bio-ecology and management

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The branch gall, *Oligotrophus mangiferae* Keiffer has recently appeared in serious proportion in the major mango growing districts of West Bengal, India. The present study had been taken up regarding the biology, population dynamics and management of this pest. Branch gall is a univoltine species. Emergence of adults from gall could be found from 2nd week of February, which continued up to 2nd week of March. Incubation, larval and pupal period lasted for 3-5 days, 315days and 30-45 days respectively. Eggs were laid singly throughout the young vegetative shoots by puncturing the tissue. A full grown larva was yellow in colour with a clear dark brown constriction on head. Initially the pupa was creamy white in colour which gradually turned light yellow and finally blackish. Adults were grey in colour and 2-3mm in length. A single species of parasite (*Tetrastichus* spp.) was found to emerge from the gall. Pruning at 30 cm had been found to be most effective in managing the pest. Spraying of thiamethoxam @ 0.008%, imidacloprid @ 0.006% and monocrotophos @ 0.005% gave effective control of the pest.

ISFS-082

Plant parasitic nematodes - a potential economic pest of crops

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Parasitic nematodes have caused loss in productivity for the farmers. The microscopic size and frequent lack of characteristic symptoms on host plant coupled with the endoparasitic nature resulted in widespread dissemination in different plants. Once established and distributed, they are rarely eliminated. Under favorable conditions, they can increase to destructive levels in a short time. Their great biological and ecological diversity make them potential economic pests of several Crops. Among them Root knot nematodes cause galls on roots with necrotic areas in several places thereby aggravate secondary infections. Infested seedlings planted show reduced growth and defoliation and many do not survive the dry season as seen in coffee and fruit plants. In rice *ufra* nematode, white tip nematode and root knot nematode are of special importance and they find a place in regulatory pest list of several Countries. Grain yield losses range from 5 – 100 %, 21 – 46 % and 16 – 32 % in different agro-climatic zones for *ufra*, white tip and rice root knot infestations respectively. *Hirschmanniella, Macroposthonia* and *Tylenchulus* are also important nematode

pests. *Heterodera avenae* and *Anguina tritici* are important nematodes of wheat. Cash crops like cotton are known to be infested with several species of *Meloidogyne, Rotylenchulus, Hoplolaimus, Pratylenchus* etc. The same groups are reported to damage several condiment and medicinal plants. *Meloidogyne incognita, Meloidogyne javanica* and *Pratylenchus zeae* are known to be the most important parasitic nematode of commercial crops like sugarcane worldwide. In India species of *Meloidogyne* causes 27.20%, 16.62%,14.10% and 12.85% losses in tomato, brinjal, okra and chilli, respectively. Root lesion nematodes and burrowing nematodes affect the anchorage and flow of nutrients of several plantation crops like banana reducing the productivity. In India economic loss due to burrowing nematode is estimated to be 12.02 to 21.8% in banana plantations. *Bursaphelenchus cocophilus* is known to affect young and adolescent coconut palms and pine trees. The citrus nematode *Tylenchulus semipenetrans* caused wilting, leaf drop, cortical sloughing and root death in citrus orchards. In addition to the above mentioned nematodes several others including species of *Nacobbus, Heterodera, Ditylenchus, Belonolaimus, Rotylenchulus* etc are known to attack several types of vegetables worldwide. Potato cyst nematodes has been recorded from many countries of the world. In India, beside potato it has been reported from tomato and brinjal also. *Meloidogyne, Rotylenchulus, Tylenchorhynchus, Pratylenchus, Helicotylenchus* are also important pests of fibre crops. *Heterodera zeae* and *Pratylenchus zeae* are known to be important nematodes of maize in India. *Meloidogyne sp., Rotylenchulus reniformis* and *Heterodera cajani* are known important nematodes of oilseed crops. In groundnut species of *Meloidogyne* are known to cause 21.60% yield loss. Several species of *Aphelenchoides, Tylenchorhynchus, Hoplolaimus, Pratylenchus* are also important pests of several crops. Besides causing direct crop loss, nematodes also inflict monetary loss resulting from trade restrictions imposed due to the presence of quarantine nematode pests.

ISFS-083

Preliminary survey on rice nematodes in Manipur, north east India

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Rice (*Oryza sativa* L.) cultivation is the primary agro - economic industry in Manipur. In this region, during 2008-2009, the total area under rice was 195.99 ha with a total production of 468.33 tones with an average yield of 2389.44 kg per hect. Estimated permanent area for cultivation during 2000-01 was 117.20 and it increased to 127.07 during 2008-09. Tripp lealliance of pests, pathogens and weeds take a heavy toll on the yield of rice. There are four main nematode groups which produce drastic damages in rice crops. They are rice root rot diseases caused by *Hirschmanniella* spp., rice stem disease, *ufra* caused by *Ditylenchus angustus*, rice root knot nematode diseases caused by *Meloidogyne* spp., cyst nematode diseases caused by *Heterodera* spp. and white tip disease caused by *Aphelenchoides besseyi* cause a yield loss up to 20 - 100%. Because of

the difficulties in identification, many nematode pests of rice had gone unnoticed in the past and symptoms caused by the plant parasitic nematodes were taken as to be caused by other insect pests and thus inappropriate control measures were adopted in some regions especially in far North Eastern regions due to lack of knowledge of symptoms and pathogenicity caused by the parasitic nematodes. During a survey for soil and plant parasitic nematodes associated with the rice plants during the years 2008– 2011, symptoms caused by root knot nematode and rice stem nematodewere observed in rice growing fields of Imphal East, West and Thoubal Districts of Manipur. Yellowing of leaves, stunting, browning and chlorosis of leaves on the above ground parts of the plant, curling of leaves and panicles were characteristic symptoms observed. On further observation, the symptoms were found to be caused by *Meloidogyne graminicola* and *Ditylenchus* sp. The symptoms caused by the nematodes in rice plants are illustrated in the paper with their photographs. Further keen survey, study on the pathogenicity of rice nematodes and their appropriate control measures in the agro – climatic conditions of Manipur are suggested in the paper.

ISFS-084

Plant mites in association with some important crops

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Plant mites are the major constrains and considered as the major pest of different agricultural crops now a days. Owing to their microscopic size they are difficult to detect therefore difficult to control. These tiny organisms have a considerable capacity to survive in adverse conditions and have wide host range like chilli, okra, brinjal, jute, coconut, rose etc. In this present investigation a large number of mites were collected from the leaves of different crops from different places in West Bengal, India during 2010-2011 and identified in the laboratory. The symptoms of damage by different phytophagus mite were also observed in different crops. It was observed that *Tetranychus urticae* (Koch) was the major one infesting many crops like brinjal, okra, rose, marigold, pointed gourd and dolichos bean. Huge population of *Polyphagotarsonemus latus* (Banks) was observed in chilli, jute and greengram. Perianth mite, *Aceria guerreronis* (Keifer) was recorded infesting coconut. This mite is a menacing pest of coconut. Almost all varieties probably have some level of susceptibility to this mite. Apart from phytophagous mites, some predatory mites were also identified from different crops among which, *Amblyseius ovalis* (Evans) was identified from rose, *Amblyseius largoensis* (Muma) from litchi and *Amblyseius longispinosus* (Evans) from rose, beans and okra. The present investigation may help to identify the major and frequently occurred mite pests of different agricultural crops for development of effective management strategies.

ISFS-085

Pest scenario of pigeonpea and chickpea at Anantapur

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Anantapur district is one of the major pigeon pea and chick pea producing district in the Andhra Pradesh, India accounting for about 10.1% (2.11 m ha) in area and 7.46% (1.45 million tonnes) in production of pulses in the state. Pigeonpea plants severely affected by powdery mildew in second fortnight of July sown crop whereas less infestation was recorded in first fortnight of June during 2010-11 and 2011-12. Most affected varieties in were LRG-41 followed by LRG 130 and PRG 158. Crop sown in second forth night July with per cent disease index was 67.30, 49.67 and 29.16 respectively. In first forth night of June sown crop recorded 28.57, 25.79 and 15.86 respectively by using 0-9 scale in randomly selected fields in Reddypalli, Rotrayapurum, Mallenipalli, Thumalla, Chakraypeta villages. Severe infections result in heavy defoliation, pods were shriveled and shrunken. The infestation of *Batocera* in the Pigeonpea was recorded 1st time and infestation was ranged 17-26.6%. The Chakrayapeta was most affected whereas minimum infestation of 17.97% was recorded in Mallenipalli villages. The average length of scrapping damage was 20.65 cm with coverage of an average diameter of 2.21 cm. Chickpea was affected by new strain of *Sclerotium rolfsii* . In Anantapur and chickpea varieties JG -11, JG-130 and JAKI- 9218 were found highly susceptible.

ISFS-086

Population dynamics and seasonal incidence of fruit flies in guava ecosystem of north eastern Himalaya

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Fruit flies are the most destructive pest of several fruit crops and often cause heavy losses (upto 90%) in the region. Management of fruit flies using chemical pesticides is very difficult and not feasible due to its complex life cycle and residue problem in fruits. Proper understanding of life cycle and seasonal activity of fruit flies are therefore essential to develop effective management practices against fruit flies in the region. Furthermore, unlike other parts of the country, guava has only one distinct fruiting season in the region. Therefore, studies on population dynamics and seasonal abundance of fruit flies (2010-12) were carried out in guava orchard in mid hills of Meghalaya. *Bactrocera dorsalis* and *B. cucurbitae* (Diptera: Tephretidae) are two major fruit fly species attacking guava in the region, thus traps based on pheromone lures of these two

species were installed in the orchard and population of fruit flies were monitored at weekly basis. *B. dorsalis* was found to be more dominant species than *B. cucurbitae*. Activity of *B. dorsalis* was higher during August to the December, being maximum (92.75 /trap) during mid of the September and reduced steadily at the end of December. Major activity of *B. cucurbitae* was found during September to December and highest (34.5 /trap) activity was observed during early December. The monitoring data generated from this investigation would be helpful to formulate timely management practices in the region; so that damage caused by fruit flies could be reduced substantially.

ISFS-087

Spodoptera litura feeding stress induced biochemical and enzymatic changes in sweet potato (*Ipomoea batata* L.) plants

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Tobacco cut warm, *Spodoptera litura* Fab (Noctudiae: Lepidoptera) is a worldwide pest whose caterpillars defoliates the sweet potato, *Ipomoea batata* L crops thereby altering the leaf quality and reducing the yield. An attempt was made to know the impact of *S. litura* infestation in the form of quantitative and qualitative changes in the leaf biochemical constituents such as amino acids, carbohydrates, proteins, secondary metabolites like phenols and also oxidative enzymes. The total free amino acids, proteins, and phenols have been enhanced in plants fed on by *S. litura*, whereas total carbohydrates content was reduced in infested sweet potato leaves over healthy ones. Enzyme analyses after pest infestation showed that the treatment significantly increased the activities of foliar peroxidase (POD), phenyl alanine ammonia lyase (PAL) and superoxide dismutase (SOD). A decrease in poly phenol oxidase (PPO) enzyme activity was evident in pest infested plants. An elevated levels of individual phenolics acids like chlorogenic acid, caffeic acid and cinnamic acids were monitored through HPLC in infested plants compared to normal healthy plant leaves. With this we conclude that the *S. litura* feeding on plants induce changes in biochemical components as well as certain secondary metabolites as a defense response of the plant thereby altering the plant's physiology.

ISFS-088

Nutritional changes in castor and rice plants due to herbivore insect attacks

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Effects of herbivory were studied on two plants, castor (*Ricinus communis* (L)- Kranti susceptible) and Rice (*Oryza sativa* (L) -TN1 Susceptible) for qualitative and quantitative changes in primary metabolites-proteins, amino acids and carbohydrates. These are required for the growth and development of pests and also are involved as precusors in defence metabolism. Four major pests of our interest on castor are capsule borer, *Dichocrocis punctiferalis* (Guenée), semilooper, *Achaea janata* (L), tobacco cutworm, *Spodoptera litura* (Fabricius) and sucking pest, *Empoasca flavescens* (Fabricius). A comparative study on biochemical changes induced in rice seedling by folivorus caterpillar, leaf folder (LR), *Cnaphalocrosis medinalis* (Guene´e). (Lepidoptera: Pyralidae), yellow stem borer (YSB) *Scirpophaga incertulas* (Walker), (Lepidoptera: Pyralidae), and a sucking pest, brown plant hopper (BPH) *Nilaparvata lugens* (Stal),(Homoptera: Delphacidae) has been made and compared with that of healthy rice plants. For castor plants, reduction in the amino acid content was observed in pest-infested plants than the control plants in all the treatments except that of *A. janata* infested plants. The damage caused by the leaf chewing insects- *A. janata* and *S. litura* resulted in the increased carbohydrate content. There was a significant decrease in carbohydrates due to sucking pest, and borer insect attack. Protein content varied differently for all four pests. Rice plants clearly showed differences for various modes of feeding. The quantities of biochemical constituents were increased by the feeding of leaf eating larvae than. sucking pests. *Scirpophaga incertulas* infestation resulted in slight protein concentration increase compared to normal healthy plants. The biochemical changes are thus implied in the plant defence mechanisms.

ISFS-089

Biochemical variations of different *Alternaria* species on different crops

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Alternaria solani (Ellis and Martin) Jones and Grout is an economically important pathogen widely distributed throughout the world and cause devastated disease on tomato, potato, chilli, brinjal and other members of the Solanaceae family. The characteristic symptoms of this pathogen causing disease are dark

brown to black concentric rings which produce a target board effect. The loss due to this pathogen causing disease is widely varied between 55-75% according to host, time of attack and environmental conditions. Biochemical variability among isolates of *Alternaria solani* was determined based on isozyme variability and protein profiling. Isozyme analysis revealed considerable diversity among *Alternaria solani* isolates. Of the three isozyme tested in native polyacrylamide gel electrophoresis (PAGE), two (α- and β- esterase) produced well resolved electrophoretic phenotypes that could be used as markers for the isolates. In the similarity matrix derived from hierarchical cluster analysis indicated that potato and chilli isolates and brinjal and tomato isolates were closely related to each other through their isozyme profile bands. Identical protein profiles were obtained for all the four isolates with respect to major bands. Highest band was observed on chilli isolate (0.34mg/g) followed by potato isolate (0.32mg/g), brinjal isolate (0.30mg/g) and lowest in tomato isolate (0.27mg/g). So, it was concluded from the above experiment that *Alternaria solani* isolate infected on brinjal and tomato were to some extent similar, whereas potato and chilli were different among the isozyme and protein profiles observed.

ISFS-090

Report of *Xiphinema diversicaudatum* (Micol, 1923 and 1927; Thorne, 1939) (Dorylaimida :Longidoroidea) from rhizosphere of apple trees of Baramulla Kashmir , India

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Xiphinema diversicaudatum (Micol, 1923 and 1927; Thorne, 1939) the dagger nematode of order dorylaimida and super family londidoroidea is described and illustrated from rhizosphere of apple trees of Baramulla,Kashmir India and is recognized by female body diamentions as : L= 4.9 (4.0-5.5) mm; a=74 (57-92); b= 9.1 (6.6-11.14); c= 78 (61-134); V= 43 (39-46); odontostylet = 143 (130-157) µm; odontophore = 85 (70-97) µm; total stylet length =223 (200-254) and the other taxonomic characters were foun as the Body curved, slightly flattened Lip region low, smoothly rounded, continuous with body contour. Amphids stirrup-shaped, just post labial, with cresentic slits, almost as wide as the lip region. Spear (=odentostyle) hollow, needle-like, 134 µm long, distinctly furcated at base. Spear (=odentophores) 75 µm long, with prominent tripartite basal flanges. Oesophagus a narrow tube enlarging in its last quarter to form a muscular cylindrical bulb 100 µm long by 25 µm wide; a 3 µm long mucro resemling spear tip present in the wall of oesophagus 32µm behind odontophore. Retractor muscles of the stylet (odontostylet + odontophore) attached to the basal flanges anteriorly and extending to the body wall behind the middle wall of anterior slender part of oesophagus. Body cuticle 3.5-4.7 µm thick near middle; external layer 0.30-0.45 as thick as

the inner one. Odontostylet and odontophore averaging 143 and 85 µm long, respectively. Oesophageal bulb 3.3-5.0 times as long as wide, with dorsal oesophageal gland nucleus near its anterior end and nuclei of the anterior of sub-ventral glands near its middle.Vulva transverse slit at 39-46 (43% body). Gonads paired, symmetrical, opposed and reflexed at the oviduct. Uteri near vagina form a well developed ovijector. Each oviduct and uterus joined through a sphincter Z. A prominent Z organ containing 10-20 (13) irregular globular bodies 3-10 µm in diameter present in each uterus. Pre rectum 7 to 12 times body-width long; rectum shorter than anal body-width. Ventral surface of tail usually convex although less than dorsal surface, about one anal body-width long.

ISFS-091

Studies on the distribution pattern of diamondback moth, *Plutella xylostella* (L.) on cabbage under Gangetic alluvial condition of West Bengal, India

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Cabbage variety 'Green Express' was transplanted in the field at C.R. Farm of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal during three consecutive cabbage seasons i.e. early cabbage, on season cabbage and late cabbage in the years 2007 and 2008. Recommended package of practices were followed throughout the crop seasons except any pesticide application. Fourty plants were randomly selected from the field for larval count of diamondback moth at 5 days interval starting from the 16th day transplanting. The data on the original counts were arranged in the frequency distribution. Mean ($\bar{x}$)and Variance (s^2) were worked out for the date wise observations following usual statistical procedures. On the basis of mean and variance, statistical tests were then applied to confirm the distribution pattern of diamondback moth. Different indices were calculated as per the procedure suggested by *Elliott* (1977).Various indices like dispersion parameter 'K', index of dispersion (I_d), reciprocal of the exponent K, Cole's index, Charlier Coefficient, Lloyd index of mean crowding and Lloyd index of patchiness confirmed that the distribution pattern of the diamondback moth larvae in three crop seasons during the years 2007 and 2008 in the Gangetic Alluvial Region of West Bengal was aggregative in nature.

ISFS-092

Diversity of acarine fauna in tea ecosystem

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Species diversity may be taken to denote the number of species in a given area of any particular group or groups. The number of species in an ecosystem is ecologically important since the species diversity seems to increase as the community becomes more stable. Severe disturbance cause a marked decline in the diversity. A great diversity also indicates the availability of a large number of niches.The studies were undertaken in three different tea growing states i.e. Assam, West Bengal and Tripura in North Eastern region of India with marked ecological variations among these states as well as within the state during 2006-2009. Three tea estates were chosen randomly in each core (being one to four cores in different states). One hundred bushes were again randomly selected to take observations from only ten bushes of almost similar type of age and the clone. More than forty new predatory acarines were reported belonging to several families. Some groups like Phytoseiidae, Stigmaedae, Bdellidae and so on were predominant groups. Similarly, the plant feeding acarines also showed wide variations in their distributions among three agro climatic zones.

ISFS-093

Population dynamics of some important insect pests of bitter gourd (*Momordica charantia* L.)

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Study was carried out on population dynamics of some important insect pests of bitter gourd melon fruit fly (*Bactrocera cucurbitae* Coq.), Epilachna beetle (*Henosepilachna septima* Dieke) and red pumpkin beetle (*Aulacophora foveicollis* Lucas). The maximum population of epilachna beetle was found in the month of February to March, 2011 and the highest leaf damage (37.3%) was observed in first week of March, 2011. The epilachna beetle population was found to increase with the increase in temperature expressing significant correlation both with maximum and minimum. However, the rainfall and relative humidity showed negative correlation with the population development of the pest. The maximum fruit damage up to 88% with 17.78 fruit fly grab per fruit was observed in first week of March, 2011. Maximum percentage of flower damage (37.5%) by red pumpkin beetle could be observed in first week of March of the year. The population of grub per fruit and the percentage of fruit damage showed positive significant correlation only with maximum temperature and no definite correlation with rainfall and relative humidity could be worked out. Therefore, this can be inferred that damage of bitter gourd by insect pests increases with increase of temperature.

ISFS-094

Diagnosis and pathogenicity of root knot nematode (*Meloidogyne incognita)* on passion fruit (*Passiflora edulis*) in West Bengal

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Passion fruit (*Passiflora edulis* Sims) is grown in the Nilgiris, Coorg, Wynad, Malabar in the south, Himachal in the north and many states in north eastern part of India. The orchards at Khanpui (Aizawl), Mizoram showed decline of passion fruit trees and the infested plants showed thickening of large as well as small roots. The association of root knot nematode on the declining plants was confirmed through this investigation. The root samples from infested passion fruit tree were collected from the large orchards at Khanpui (Aizawl), Mizoram. The preliminary examination of thick-root as well as small roots with small swelling under the stereoscopic microscope was confirmed with the presence of mature females on infected roots. Further morphological studies based on mature female, male and juveniles revealed occurrence of *Meloidogyne incognita-type*. Efforts were made to multiply the population on the passion fruit trees and a standard pathogenicity test with the pure population of root knot nematode (*M. incognita*) on passion fruits was undertaken under pot conditions. The seedlings of passion fruits of three week-old was transplanted into plastic pots containing 1000cc sterilized soil and freshly hatched second stage juveniles (J2) was inoculated with 0 (water), 5, 50, 250, 500, 2500 and 5000 J_2 through preparation of homogeneous nematode suspension. After six months, plants were harvested and plant growth parameters (shoot length, fresh shoot weight, root length, root weight), root galling (on 1-5 scale), egg mass production and soil and root populations were observed. Reproduction factor (RF) was determined (RF=Pf/Pi, where Pf represents final and Pi initial population of nematode). Nematode inoculation at different levels on passion fruit showed significant effect on plant growth parameters, gall index, egg mass index and final population over uninoculated plant. RF of root-knot nematode was reduced with the increase in the inoculums levels and the highest RF (~87.27) at the minimum inoculums level (1 J_2/100cc soil) and lowest (~0.69) at the maximum inoculums level (1000 J_2/100cc soil). Results indicated clearly damage threshold level of *M. incognita* on passion fruit was 1 J_2/100cc soil.

ISFS-095

Infestation of citrus root knot nematode, *Meloidogyne indica* Whitehead, 1968 on citrus and bt-cotton from Gujarat, India

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Citrus is cultivated in large area (approximately 10 km radius) of Kharva village (Taluka Mehsana) of Mehsana district of Gujarat. Infestation of root knot nematode in citrus is exactly located at 23^0 31.707N, 72^0 27.636E (GPS) and bt-cotton is becoming popular in the fields previously had citrus orchards infested with root knot nematodes. The areas of bt-cotton are rapidly increasing in the state particularly in the Mehsana district of Gujarat and crop fields are heavily infested with root-knot nematode. Cotton crop is grown in a sequence of either cotton(*kharif*)- mustard/wheat(*rabi*) or castor (*kharif*)-cotton (*kharif*). Currently the areas under cotton are about 10,317 ha in Meshana Taluka of Gujarat. The citrus root knot nematode, *Meloidogyne indica* Whitehead, 1968 was first time reported on citrus from Delhi, India (Whitehead, 1968) and nearly after 40 years, this nematode species was encountered at Jagudan and Kherva villages of Mehasana district, Deesa of Banaskantha and Anand district of Gujarat on citrus (kagzi lime). This nematode species has taken a good footing on citrus growing areas of Gujarat (around 10km radius of Mehsana district). Nematode infested plants exhibited symptoms almost similar to dieback or decline of old plants. Inspection of citrus orchards and bt-cotton, chill, castor and brinjal grown on fields where previously citrus orchard revealed occurrence of M. indica infestation had on citrus as well as on bt-cotton. The association of nematode was confirmed through examination of roots of infested plants. The nematode species produced atypical root gall on both the crops while the typical galls observed on brinjal and chilli in surrounding fields was identified *as M. incognita* (Kofoid & White) Chitwood 1949. The detail morphology and morphometrics (n=20) of female, perineal patterns, males and second stage juveniles (J2) of *M. indica* was undertaken for confirmation and further description of the species.

ISFS-096

Disease profile of tuberose along with the identification of resistant germplasm(s), critical environmental parameters and chemical for the management of important tip blight disease

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The disease spectrum of the commercially important tuberose crop and identification of resistant/ tolerant germplasm(s), environmental parameters and suitable chemical for the control of important disease are lacking in West Bengal. Present research programmes have taken up to investigate on those aspects. Diseases like stem- or collar- rot (*Sclerotium rolfsii*), leaf spot (*Alternaria polyanthi*), irregular leaf spot (*Cladosporium* sp.), tip blight (*Phoma* sp.) and anthracnose (*Colletotrichum gloeosporioides*) have been found to appear on this crop in West Bengal and their pathogenicities were firmly established after isolation. Except stem/ collar rot, all other diseases of tuberose are being reported for the first time from West Bengal. Of these, leaf tip blight disease has been identified as the most severe, important and yield limiting disease. Out of fourteen tuberose germplasms screened against *Phoma* leaf tip blight disease, one germplasm (Arka Nirantan) was found resistant, five (Hyderabad Double, GKTC - 4, Sikkim selection, Swarnarekha and Phuler Rajani) moderately resistant, seven (Hyderabad single, Calcutta Single, Vaibhav, Prajjal, Rajat Rekha, Calcutta Double and Sringer) moderately susceptible and one (Subhashini) susceptible. Result of simple correlation studies between percent disease index (PDI) and environmental parameters [maximum (X_1)- and minimum (X_2)- temperature, maximum (X_3)- and minimum (X_4)- relative humidity, rainfall (X_5) and bright sunshine hour (X_6)] indicated that maximum relative humidity had highly significant positive but maximum temperature and minimum relative humidity had highly significant negative relation with PDI. However, following step down regression analyses, maximum temperature (X_1), minimum relative humidity (X_4) and amount of rainfall (X_5) were identified as critical parameters influencing tuberose tip blight disease severity. The linear prediction equation for tip blight disease severity was $Y\ (PDI)^{**} = 96.54 - 3.19X_1^{**} + 0.56\ X_4^{**} - 1.22\ X_5^{**}$. Out of six chemical fungicides tested against tip blight disease, Score (Diffenconazole) and Amister (Azoxystrobin) @ 0.1% appeared to be promising fungicides in reduction of tip blight disease severity and augmentation of flower stick production.

ISFS-097

Effect of morpho - chemical traits of okra fruit on the incidence of *Amrasca biguttula biguttula* Ishida

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The experiment was conducted at Indian Institute of Vegetable Research, Varanasi during rainy season in the years 2008 and 2009. The observations on morphological and biochemical fruit characters were recorded on 20 selected okra genotypes of different susceptibility groups screened against A. b. biguttula. The effect of morphological characters of okra fruits / leaves on jassid infestation revealed that hair density on upper as well as lower leaf surface of resistant germplasms / varieties was higher as compared to highly susceptible germplasms / varieties and the difference was observed statistically significant. The correlation coefficients between jassid infestation and fruit length (r = - 0.44 and -0.53), hair density on fruit (r = - 0.44 and - 0.47), hair density on upper leaf surface (r = - 0.47 and - 0.46) and hair density on lower leaf surface (r = - 0.57 and - 0.59), had negative and significant impact while fruit diameter (r = 0.38 and 0.30) had positive and non significant impact and number of seeds fruit^{-1} (r = - 0.10 and - 0.10) had negative and non significant impact on jassid infestation during 2008 and 2009, respectively.The biochemical analysis of the fruits indicated that the resistant germplasms / varieties had higher nitrogen, protein, potassium, phenol, ascorbic acid, carbohydrate, chlorophyll 'a', chlorophyll 'b' and total chlorophyll content as compared to highly susceptible germplasms / varieties. The jassid infestation had significant negative relationship with nitrogen (r = - 0.58 and - 0.60), protein (r = - 0.58 and - 0.60), potassium(r = - 0.47 and - 0.51), phenol (r = - 0.64 and - 0.74), chlorophyll 'a' (r = - 0.79 and - 0.82), chlorophyll 'b' (r = - 0.81 and - 0.85) and total chlorophyll (r = - 0.71 and - 0.79), while, significant positive association with ascorbic acid (r = 0.48 and 0.52) and carbohydrate (r = 0.69 and 0.71) during 2008 and 2009, respectively.

ISFS-098

Soil nematodes and plant nematodes associated with potato based cropping systems in West Bengal

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Survey on association of plant and soil nematodes in potato based cropping system in West Bengal was investigated during the year 2008-09 and 2009-10. Soil *s*ampling was done at regular interval from 20 sites of Nadia (5), Burdwan (5), Hooghly (5) and Bankura (5) districts of West Bengal. Dynamics and diversity of soil nematode populations were estimated in potato-fallow-rice, potato-sesame-rice, potato-rice-rice, potato-rice-vegetable, potato-vegetable-vegetable and potato-vegetable-flower cropping systems at different locations. The major soil and plant parasitic nematodes (PPNs) genera associated with cropping sequence were identified as *Meloidogyne, Tylenchorhynchus, Hoplolaimus, Helicotylenchus, Hirschmanniella, Criconemoides, Rotylenchulus* and *Tylenchus.* The relative abundance of PPNs and other free living groups in soil were recorded. The nematode populations in potato base cropping systems showed considerable qualitative as well as quantitative variations with locations and crop sequences of West Bengal. Among the PPNs, root knot nematode (*Meloidogyne incognita/M. javanica*) and rice root nematode (*Hirschmanniella mucronata*/*H. oryzae*) were found in densities of 172 and 176/200cc soil in Burdwan, 126 and 170/200 cc soil in Hooghly, 93 and 63/200cc soil in Bankura and 91 and 31/200cc soil in Nadia, respectively. Similarly, stunt nematode (*Tylenchorhynchus* spp.*)* was observed in population density of 192/200cc soil in Bankura, 180/200cc soil in Nadia, 172/200cc soil in Burdwan and 169/200cc soil in Hooghly. The occurrence of *Helicotylenchus* spp. at 50-124/200cc was recorded in all the four districts. *Hoplolaimus* was recorded only in Nadia (52/200cc soil) and Hooghly (5/200cc soil). A relatively low density (4-101/200cc soil) of reniform nematode (*Rotylenchulus reniformis*) was found only in Nadia, Burdwan and Hooghly. Other nematodes like *Tylenchus*, *Criconemoides* and *Aphelenchus* was found at very low densities. Free living nematodes include rhabditids, cephalobids, dorylaimids, mononchids, aphelenchids in field soils were found in high densities varying from 1208-1504/200 cc soil in most of sampling sites. Among the crop sequences, potato-fallow-rice cropping sequence showed relatively least numbers of PPNs while high populations of *Meloidogyne incognita, R. reniformis, Tylenchorhynchus* spp. were recorded in potato-vegetable-rice cropping system. The saprozoic nematode index (SNI) was estimated to be high in potato-fallow-rice cropping system.

ISFS-099

Life history of *Danaus chrysippus* (L.) (Lepidoptera: Nymphalidae) and its interaction with milkweed host plants

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Biology and behaviour of Plain Tiger *Danaus chrysippus* (L.) (Lepidoptera:Nymphalidae) on two host plants namely, *Calotropis procera* and *Pergularia daemia* (family Asclepiadeceae) were studied at Kalyani, Nadia, West Bengal. The female butterfly lays only one silvery white, bullet-shaped egg per leaf probably to avoid overcrowding of the caterpillars. The incubation period is three days. The caterpillar has five larval instars with duration of 9 – 12 days during May- June months. The larvae are very conspicuous with brilliant coloration. The full grown caterpillar is about 23 – 34 mm long. Caterpillars are known to accumulate cardiac glycosides from their host plants and become unpalatable to the predators. Their striking habitus, therefore, is a form of warning aposematic coloration. The pupa is 13.5–5.5 mm long, smooth and pale green in colour with an uncommon shape; hangs from the lower surface of leaves; pupal period is 5 – 6 days only. The life cycle was completed in 18–21 days during May- June. The sexually dimorphic butterflies are also with shiny attractive warning aposematic coloration and known to carry toxic glycosides sequestered during larval stage. *P. daemia* is found here a better host plant of *D. chrysippus* than *C. procera.* All larval instars of *D. chrysippus* showed latex canal sabotaging behaviour like scrapping or trenching on the leaf lamina or petiole notching during feeding on the milkweed hosts. In addition to physiological adaptation to appropriate the toxic chemical defences of its host plants, D. chrysippus also employed behavioral tactics to reduce exposure to latex. Moreover, this insect was not found to utilize properly the hues biochemically open niche present in the locality. These indicate that insect-host plant interactions are in a dynamic state of evolution and a co-evolutionary arms race is operating in this plant-herbivore system.

ISFS-100

Diseases of ber (*Zizyphus mauritiana* Lamk) a minor fruit in India

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Ber (*Zizyphus mauritiana* Lamk, Family Rhamnaceae) is one of the important fruit crops of arid and semi arid zones of the world. In India, it is considered as a minor crop but recently the crop is attaining the status of cash crop in some areas of eastern India including West Bengal with increasing its acreage and production. With the rapid expansion of area under commercial cultivation, the crop suffers several biotic and abiotic stresses. The research interest on the diseases of ber has much not been given and the importance of crop remains under estimated. However, the crop is affected by large number of serious diseases. The present investigation was underatken in the Gangetic alluvial zone in eastern India on seasonal occurrence of diseases on some important high yielding as well as local cultivars viz. Gola, Banarasi Kadke, Narkeli, Umran, Madhu Kul etc. Disease affected plant parts were collected throughout the year from different districts of West Bengal and causal agents were identified. Two years observation revealed occurrence of six different diseases viz. black leaf spot, rust, anthracnose, powdery mildew, red rust and a leaf yellowing with green island symptom (caused by an unidentified causal agent) on ber were recorded and pathogens involved were identified. Seasonal variations of all the above diseases were also assessed.

ISFS-101

Population dynamics of rice sheath mite, *Steneotarsonemus spinki* Smiley (Acari:Tarsonemidae) on rice cultivar IET-4786 in West Bengal, India

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Rice sheath mite, *Steneotarsonemus spinki* Smiley (Acari:Tarsonemidae), is found as a serious pest of rice under Bengal Basin of West Bengal, India during wet season. The mite appeared during tillering to panicle emergence with a maximum during early ripening stage of the crop causing characteristic brownish specks on the sheath and on the grains resulting poor yield. Considering the graveness of the mite attack, present experiment was undertaken with a view to study the population dynamics of rice sheath mite to understand the persistence of the mite in the field and to find out strategy to manage the mite in rice crop by staggered

transplanting at 5th of each month commencing from June, 2009 and was continued to May, 2010. 25 days old seedlings were used which was sown during 10th of each month. The seedlings were transplanted in 2m x 25m plots with 10 cm x 20 cm spacing. Altogether 12 staggered transplanting has been done through out the year. Recommended dose of feritilizers and agronomic practices were done to keep the uniformity of growth of the plants. The mite population per square centimeter area of leaf sheath was observed at regular 10 days interval commencing from 40 days after transplanting taking 1 tiller from each of the selected 10 hills situated across the diagonal line of each plot and the data on mean mite population of 10 observations thus obtained has been considered. The result revealed that the mite start to population build up during August at late tillering stage and attain maximum in between 25th September to 5th of October. No mite population was observed in November, December and January transplanted crop.

ISFS-102

Influence of weather variables on whitefly and *Spodoptera litura* insects of tomato under gangetic alluvial region of West Bengal

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Tomato (*Lycopersicon esculentum* Mill.) is considered one of the most important solanaceous vegetable crops in West Bengal, India for local consumption and exportation purposes. Tomato plants are subjected to attack by various insect pests such as whitefly and *Spodoptera litura.* Although insect pests have been a problem in agricultural and horticultural crops through the centuries, phenomenon of pest outbreaks have increase with the change of pest complexities, in the last few decades. The population dynamics of different insect pests of tomato varies according to change in weather parameter. Weather variables such as max. and min RH, rainfall and sunshine hours had significant negative influence on whitefly population. Whitefly population was initiated at about 39 SMW and attaining max. population at 46 SMW. *Spodoptera litura* population was initiated at 40 SMW and attaining max. population at 48 SMW. Whereas, max-temp. min-temp. and rainfall had negative influence on *Spodoptera litura* population. Based on the incidence and abundance pattern of various insect pests, a holistic approach can be developed based on time scaled precautionary measures in the gangetic alluvial region of West Bengal.

Concurrent Session - 3

Critical parameters in future food security-I: Water

Chairman: Surajit Mallick
Co-Chairman: Supratik Sarkar
Rappoteur: Kallol Bhattacharyya

ISFS-103

Water Resources and its management for food security

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Water is a prime natural resource which is indispensable for all forms of life. Access of fresh water thus considered as universal human right. Presently, sustainable management of this important resource Is becoming the key issue at any macro or micro region for future development. Due to over population, per capita water resources of India is very low among the South and South East Asian countries. In addition, rapid growth of industrialization ,diversion of land use and possible climate changes affect the availability of water particularly for agricultural use and will be more scare in future with possibility of water conflicts among different user groups. To avoid such scenario, all walks of the society should rethink on various issues regarding supply augumentation, conservation and allocation of water resources. For integrated water resource development and management, planners, researchers, government departments, water users should concentrate on the following aspects.

- Integrated development of surface as well as ground water and encouragement of its conjunctive use.
- Increasing the irrigation efficiency through modern methods of irrigation.
- Decreasing the gap between irrigation potential created and utilized.
- Encouragement of participatory irrigation management.
- Reduction of green water losses.
- More uses of waste water.
- Development of education particulerly water literacy.

ISFS-104

Potential and prospects for enhancing water productivity in agricultural production systems

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Agriculture sector will continue to remain the major user of water in India but the share of water allocated to irrigation is likely to decrease by 10-15% in the next two decades. Current productivity or use efficiency of irrigation water (WUE) is so low that most, if not all, of our future water needs could be met by increased efficiency alone, without development of additional water resources. Improving water use efficiency by 40% would be required to counterbalance the need for additional withdrawals for irrigation over the next 25 years from additional demand for food. Productivity or use efficiency of irrigation water is defined broadly as the

volume or value of crop output per unit of water used. Improving WUE in agriculture will require an increase in marketable crop yield per unit of water removed by plant and a reduction in water losses from the crop root zone. There are many promising strategies for enhancing WUE. They include (i) an increase in crop water productivity (an increased marketable crop yield per unit of water taken up by crop), (ii) a decrease in water outflows from the crop root zone other than that required by plants, (iii) an increase in soil water storage within the crop root zone through better soil and water management practices at farm and catchment scales, and (iv) reallocating water from lower-valued to higher valued uses. Adoption of novel irrigation technologies for crop production and multi uses of water with introduction of fishery, dairy and other enterprises in the farming can further enhance productivity and use efficiency of water in agriculture. Although the research focus on water productivity is relatively new, gap between the available knowledge to enhance water productivity and its beneficial application appears quite large. It is obvious that technological changes which increased crop yields per unit of land have so far been the major source of the rise in productivity per unit of irrigation water. Since genetic improvements for raising the productivity of land further are within the realm of possibility, they can, at the same time, significantly raise water productivity, especially if such genetic improvements are targeted towards saving of water. These improvements include the development of crop varieties with better tolerance to drought, cool seasons which reduce evaporation and evapo-transpiration, and saline conditions. Biotechnology has a great potential for raising crop yields and imparting yield stability under adverse environments. In India, technological changes to improve water productivity by raising crop yields seem to hold a better promise in the short and medium-term than the attempts to improve use efficiency of water, which can be expected to produce significant results only in the long-run, owing to the political constraints, and managerial and institutional bottlenecks besetting these efforts. Besides technological advancement, favorable public policy to create conducive socio-economic environments is required for enhancing water productivity in the agriculture sector of our country. Farmers tend to reallocate land and water to high-value crops in response to the changing demand. As incomes rise, consumer demand shifts away from some of the water-intensive crops like rice to products from water-saving enterprises like horticulture. However, trade and price policies and policies on input subsidies, including on irrigation water, would determine whether farmers would be induced to switch over to water-conserving cropping patterns. Globalization opens up opportunities for countries faced with water scarcities to specialise in the production and export of water-saving crops and import water-intensive ones. Our country faced with water scarcity, can safeguard its food security by entering into collaborative arrangements with such countries that have abundant water resources, for production and exchange of foodgrains. Governments in the states and at the center need to accord highest priority to the renovation and modernization of the existing systems, which account for nearly 40% of the irrigated area from the major and medium irrigation projects. Modernization of the delivery systems and the distribution channels for the existing projects would have a high pay-off, as they would facilitate a clear definition of property rights or entitlements of farmers and their effective enforcement. They would also facilitate the adoption of measures by the water users to improve water-use efficiency and productivity.

ISFS-105

Protected cultivation and drip fertigation technology for ensuring water, food and nutritional security in modern India

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Production of vegetables and flowers is significantly influenced by the seasonality and weather conditions. Striking a balance between all-season availability of high quality vegetables with minimum environmental impact, and still to remain economically competitive in this time of globalization, is a major challenge for the modern technology of crop production. The crop productivity is influenced by the genetic characteristics of the cultivar, growing environment and management practices. Under open field cultivation, while the other factors could be taken care of, it is not possible to effect control on the environment around the plant. The plant's environment can be specified by five basic factors, namely, light, temperature, humidity, carbon dioxide and nutrients. The main purpose of protected cultivation is to create a favorable environment for the sustained growth of plant so as to realize its maximum potential even in adverse climatic conditions. Greenhouses, rain shelters, plastic tunnels, mulches, insect-proof net houses, shade nets etc. are used as protective structures and means depending on the requirements and cost-effectiveness. Besides modifying the plant's environment, these protective structures provide protection against wind, rain and insects. Protected cultivation offers several advantages to produce vegetables and flowers of high quality and yields, thus using the land and other resources more efficiently. The irrigated agriculture provides the crop water productivity of about 2.5 t/ha and the overall irrigation efficiency is only about 30% as compared to world average of 4 t/ha. In the above scenario it is necessary to have the irrigation system in which both the crop water productivity and irrigation efficiency increase considerably. Moreover the food habits are changing throughout the world as people want more quality fruits and vegetables as dietary supplement. Drip irrigation and fertigation have become the most viable and efficient technology options in such a situation. It provides several advantages in the context of crop agronomy, water and energy conservation. Drip irrigation and fertigation has the potential to achieve the crop water productivity to a desired level of 4 t/ha and simultaneously maintain the irrigation efficiency above 80%. It helps in producing high value nutritional crops in open field and protected cultivation. The total coverage of micro irrigation in the Xth Plan was only about 2 million hectare. The task force on micro irrigation (2004) has indicated a potential of 69 million hectare for our country. Hence there is a tremendous potential available and the coverage of drip irrigation has to be increased to cover more crops across newer areas. Drip irrigation and fertigation is one of the most important technology available for increasing the production and productivity of horticultural crops. Drip irrigation and fertigation technology helps in increasing water and nutritional productivity of horticultural crops. Protected cultivation also helps in increasing water and nutritional productivity of horticultural crops .The crop water productivity was found to be 48.5 kg/m^3 and 39.8 kg/m^3 for tomato and cucumber grown in climate controlled greenhouse with drip fertigation. The crop water productivity was found to be 420 stem/m^3

of water for rose soil and 414 stem/m^3 for chrysanthemum grown in climate controlled greenhouse with drip fertigation. The crop water productivity for colored capsicum and green capsicum grown in climate controlled greenhouse was found to be 24.6 and 37 kg/m^3 of water. The crop water productivity of tomato grown in climate controlled greenhouse with drip fertigation was 48.5 kg/m^3 while the same tomato variety grown in naturally ventilated greenhouse with low pressure irrigation was 66.7 kg/m^3 of water. The nutritional water productivity of tomato grown in climate controlled greenhouse with drip fertigation was found to be 8924 Kcal/m^3, protein 410 gm/ m^3, fat 70 gm/ m^3 and calcium 1260mg/ m^3 of water.

ISFS-106

Use of geotextile for tomato (*Lycopersicon esculentum*) production and soil erosion control under red & laterite agroecosystem

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Geotextile a natural product, eco friendly and biodegradable in nature, act as useful ameliorative to climate the soil related constrains towards crop production. Therefore, a field study was conducted at the farmer's field during 2010 and 2011 at the Amlashuli village, Garbeta block II, Paschim Mednipur, West Bengal to investigate the effect of various geotextites on some soil properties and yield of brinjal grown in rainy season. Five treatments combinations viz. T_1- farmers practices (e.g. control) (NPK=80:40:40 kg/ ha), T_2-non woven jute geotextile (5 ton + NPK=80:40:40 kg/ ha), T_3- non woven coco coir geotextile(5 ton + NPK=100:75:75 kg/ ha), T_4- non woven sun hemp fiber geotextile (5 ton + NPK=80:40:40 kg/ ha) and T_5- non woven babui grass geotextile (5 ton + NPK=80:40:40 kg/ ha) were applied in two factor RBD design with 4 replication. The yield of the crop was recorded as 12.8, 17.8, 15.9, 16.6 and 16.3 t/ha respectively under T_1, T_2, T_3, T_4 and T_5 treatments. Crop yield under T_2, T_3, T_4 and T_5 treatments escalated by 39.06, 24.21, 29.68 and 27.34% over T_1 (control). These treatments reduced the degree of soil erosion by 72.44, 71.42, 69.38 and 67.34% over T_1. The four sets of treatments reduced the bulk density by 12.3, 10.9, 9.5 and 8.2% and increased the soil porosity by 6.2, 4.8, 3.2 and 2.1%. Improvement of organic carbon in soil occurred by the application of geotextile, the maximum of which found under jute geotextile with 60 % increase over control**.** Among the various geotextiles, use of jute geotextile were found to be most efficient to keep the soil in friable condition, increase the water and nutrient availability and reduce soil erosion as well as increase productivity.

ISFS-107

Effective water management practices in terms of productivity and water expense efficiency of tuberose

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In national and international flower market tuberose (*Polianthes tuberosa* L.) occupies an important position. This is a perennial crop and propagated by seed bulb planting during spring season (March). Tuberose is well responsive to soil moisture status; however, there is no appropriate irrigation schedule for this crop. Therefore, a field study was carried out during 2001 – 2004 to optimize the irrigation frequency and suitable water application methods for tuberose in terms of higher yield and water expense efficiency (WEE). Water application methods like, flat bed (FB), ridge and furrow (RF) and raised bed furrow (RB) were tested with three irrigation frequencies depending on the attainment of soil matric potential ($_m$) value at 0.2m depth as: −0.03MPa (wet), −0.05MPa (moderately wet) and −0.07MPa (dry). The depths of irrigation for FB, RF and RB were 5, 4 and 3 cm respectively. Crop received 10, 8 and 5 irrigations in wet, moderately wet and dry irrigation regimes during the dry period (December to June 1st week). In winter, irrigation interval for wet regime was 15-20 days and it was 9 -12 days in summer. Stick yield was recorded separately for winter (October - February), summer (March - May) and rainy season (June - September). Rainfall amounting 78.2, 158.0 and 576.5 mm occurred in winter, summer and rainy season respectively. Irrigation regimes caused significant difference in seasonal flower yield. Tuberose stick was harvested at a wider interval (12-15 days) in winter but frequently during rainy season (4-6 days). In summer the interval was of 8 to 10 days. In winter moderately wet ($_{m =}$ -0.05 MPa) irrigation frequency yielded notable amount (155.7 thousands/ha) of flower sticks. But in summer season only wet regime resulted in sufficient (525.5 thousands/ha) flower sticks. Water application methods had differential impact on highest flower production for a particular season. In winter RF was best performer, in summer it was FB and in rainy season RB performed better. Total water expense varied from 232.9 to 268.4 mm in wet regime and 234.0 to 254.3 mm in dry regime. Profile contribution was more (56.0-65.8 mm) under dry regime. In summer season water expense efficiency (stick No./ha/mm) attained highest value (1483) under wet regime clubbed with RB application methods and the same reduced by 39% under the combination of dry regime-RB. In contrast, during winter dry regime-RB combination resulted in highest water expense efficiency (684). Considering the whole year stick production, irrigation at $_{m =}$ -0.03 MPa was found the best and among the methods of water application flat bed was more productive than others.

ISFS-108

Fertigation – a water and nutrient saving technology for banana

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Water is one of the important natural resources towards sustenance of biological system as well as food and livelihood security. In view of the competitive demands from other sectors, water is going to be a scarce commodity in future. With this back ground, the study was carried out to assess the effect of fertigation at soil water status on yield and quality of friuts as well as water use use pattern of banana (cv. Martaman; AAB, Silk). The experiment was laid out in augmented factorial complete block design with four replications. Main factor was irrigation with 3 levels as I_1= 50% CPE, I_2= 60% CPE and I_3= 70% CPE. Fertilizer was sub-factor at 3 levels as F_1=50% RDF, F_2=60% RDF and F_3=80% RDF and a control. Experimental results revealed that there was an improvement on girth of the pseudostem, leaf area, leaf area index (LAI), yield and water use pattern under drip irrigation over the conventional irrigation. Yield attributing characters and yields were significantly influenced by different treatments and were better in plants under fertigation, compared to those under conventional irrigation. Combined application of irrigation at 60% CPE and 80% RDF produced highest bunch weight (19.7 and 17.6 kg for plant crop and ratoon crop respectively) resulting in significantly higher yield (49.2 and 44.1 t/ha for plant crop and ratoon crop respectively). The same treatment combination also facilitated maximum use of irrigation water and saved considerable amount of water (41.7 and 40.4% for plant crop and ratoon crop respectively). Highest yield increase over the conventional irrigation method was obtained for the plant crop (32.5%) and ratoon crop (26.4%) with the same treatment of drip fertigation. Total soluble solid, reducing sugar, total sugar and acidity of fruits were increased significantly under drip fertigation system over conventional method. The shooting to harvest interval as well as crop duration were shortened with frequent irrigation under drip fertigation system.

ISFS-109

Effect of pitcher irrigation with mulching on brinjal (*Solanum melongena*) production in red and laterite soils of West Bengal

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A field study was conducted at the farmer's field during 2010-12 at the Teskona village (22.50' N L and 87.13' E L, with an altitude of 19.9 amsl), Garbeta block II, Paschim Mednipur, West Bengal. Effect of pitcher irrigation under various mulches was assessed on growth and yield and water use pattern of winter brinjal as

well as on physico-chemical properties of the soil. Five treatments combinations viz., T_1-Pitcher pot irrigation + no mulch, T_2- Pitcher pot irrigation + live mulch (black gram), T_3- Pitcher pot irrigation + coco coir mulch, T_4- Pitcher pot irrigation + jute fibre mulch, T_5- Pitcher pot irrigation + babui grass mulch were applied in two factor RBD design with 4 replications. Yield of the crop was recorded as 10.9, 16.7, 14.8, 15.5 and 15.2 ton / ha respectively under T_1, T_2, T_3, T_4 and T_5 treatments. Relative yield increment under T_2 to T_5 over T_1 were 53.21 (T_2), 35.77 (T_3), 42.20 (T_4) and 39.44 (T_5)%. Imposition of treatments T_2 to T_5 resulted in a decrease in bulk density 12.3%, 10.9%, 9.5% and 8.2%, with an increase in porosity by 6.2%, 4.8%, 3.2% and 2.1%. Highest level of water use pattern was recorded T_2 and this was 89.6% higher over control (T_1). Present study highlighted that, pitcher pot irrigation clubbed with live mulch makes the soil friable and improve the yield and water use pattern of brinjil to its highest level.

ISFS-110

Crop water productivity of rice-toria relay cropping in relation to nutrient management under lowland rice ecosystem

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The traditional rice growing areas in rainfed lowland ecosystem remain fallow in winter due to little scope of irrigation water. *Paira or utera* or relay cropping provides great scope to raise a second crop under such situation. *Paira* crops like *Lathyrus,* linseed, lentil, black gram, green gram, rapeseed and field pea are broadcast in standing rice crop 2-3 weeks after flowering. It is a traditional practice of rainfed cultivation after rice to utilize residual moisture without fertilizer. The field experiment with a toria (*Brassica campestris* L.) cultivar B-54 (Agrani), was undertaken to study the effect of organic sources and inorganic fertilizer management on crop water productivity of toria crop in low land ecosystem during winter season of 2009-2010. Experiment consisted 3 levels of NPK nutrition (kg ha^{-1}): 0:0:0, 15:15:15 and 30:30:30; and 4 levels of organics substituting 25% of recommended dose of nitrogen in rice were farm yard manure, vermi-compost, mustard cake and no manure. The toria seed @ 5 kg/ha was broadcast over standing rice at 15 days ahead of harvest. Schedule NPK fertilizers in the form of Suphala (N:P:K::15:15:15 %) were also broadcast in the rice field in the saturated soil 3 days before seed sowing. The results revealed that the maximum seed yield of toria crop was recorded 625.1 kg/ha with NPK@ 30:30:30 kg/ha. The least seed yield (483.6 kg/ha) was noted in control i.e. without fertilizer application. Among the organic manures, farmyard manure had recorded maximum seed yield of 608.8 kg/ha followed by mustard cake (588.2 kg ha^{-1}). The highest water use efficiency value of 4.91 kg/ha/ mm was recorded with the treatment NPK @ 30:30:30 kg/ha + FYM 5.0 t/ ha applied in rice.

Technical Session - 4

Innovative management of fastidious entities, primarily plant viruses

Chairman: SM Paul Khurana
Co-Chairman: PS Nath
Rappoteur : KK Biswas

ISFS-111

Biotechnology in detection and diagnosis of plant viruses for enhanced food production

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To enhance agricultural/horticultural production, we need enough of pathogen-free propagation and planting material. It is essential for worldwide movement of germplasm for plant breeding and effective integrated pest and disease management. To ensure this it requires rapid and sensitive methods to detect, identify and quantify plant diseases. Diseases caused by viruses are contagious, acute either with mosaic, curling or necrosis resulting in chronic taking heavy toll of crop production. Considerable efforts are being continuously made to control these diseases including rapid and accurate diagnosis using both classical and emerging technologies. Plant diseases can be managed effectively by the integrated control measures from as early as seed sowing to crop flowering/fruiting by saving their horizontal spread. Reliance on symptoms is inadequate as the disease may be well underway when symptoms first appear and they may be highly variable. Hence, it warrants the development of highly accurate, efficient and rapid techniques amenable to large-scale rapid, noninvasive robotic application. Attempts to control plant viral diseases without sufficient information about their causal agents their perpetuation and dissemination usually results in inadequate control or many times crop failure. Any attempt to effectively run an effective disease control program for a plant viral disease, precede an accurate and rapid identification of the causative virus and vector.

Serology provides a dependable tool for detecting/monitoring diseases, for routine quarantine testing and in breeding programs for testing the tolerance/resistance. Remarkable advancements in molecular biology techniques have played a significant role in developing new rapid, specific and sensitive sero-moleculardiagnostics.

Numerous serological techniques have been developed for identification and characterization of plant viruses. Advent of the enzyme-linked immunosorbent assay (ELISA) has largely facilitated the virus detection/identification. ELISA is a highly specific and sensitive, quick and economical. It is able to detect viruses in very low concentrations including phloem limited viruses. Although many variants of ELISA have been developed, both direct and the indirect ELISA are the most frequently used for diagnosis of common plant virus diseases e.g. *Papaya ringspot virus* (PRSV-W), *Lettuce mosaic virus* (LMV), *Bean common mosaic virus* (BCMV), *Cowpea aphid-borne mosaic virus* (CABMV), *Soybean mosaic virus* (SoyMV), *Comovirus*: *Cowpea severe mosaic virus* (CPSMV) etc. Triple antibody sandwich (TAS- ELISA), which is similar to the DAS-ELISA, except that an additional antibody produced in another animal is used. Protein A-Sandwich ELISA (PAS- ELISA) variation is based on the property of protein A combining specifically with the Fc portion of the IgG. It proved very useful in the detection of peanut mottle virus (PMV), tomato spotted

wilt virus (TSWV) and Indian peanut clump virus (IPCV). Considering the problems with plant viruses, particles of which are not well adsorbed in the microtiter plate wells, a new technique involving the immunoprecipitation (IP- ELISA) was developed and validated for viruses detection e.g. *Cowpea severe mosaic virus* (CPSMV), *Squash mosaic virus* (SQMV) and *Papaya lethal yellowing virus* (PLYV) etc.

In recent years rapid serological tests using lateral flow immunochromatography have been combined with a novel extraction procedure to allow disease diagnosis in the field or the laboratory within three minutes. Lateral-flow immunochromatography devices for *Potato Y potyvirus* and *Potato X potexvirus* have been demonstrated as being 100% accurate. A technique called immuno capture polymerase chain reaction (IC-PCR) combines the technical advantages of PCR with the practical advantages of serology and has been successfully validated for the detection of Bean yellow mosaic virus (BYMV), Cherry leafroll virus (CLRV), Cucumber mosaic virus(CMV), citrus tristeza virus(CTV), Grapevine fanleaf virus (GFLV), Potato leafroll virus (PLRV), Pepper mild mottle virus (PMMV), and Tomato spotted wilt virus (TSWV), as well as the satellite RNA of Cucumber mosaic virus (CMV) and Potato spindle tuber viroid (PSTVd). A new PCR technology involving virus immunoprecipitation (IP-PCR) is used for identification and molecular characterization of plant viruses from different families and genera. This technique is very practical, highly specific and minimizes the problems of RNA extraction by combining the serological efficiency and the technical advantages of virus nucleic acid amplification, e.g. Papaya lethal yellowing virus (PLYV) and viruses from different families *viz*. Bromoviridae, Comoviridae, Potyviridae and Sobemoviridae.

The virus antigens are applied on to the membranes in methods *viz.* western blot; dot blot or dotimmuno binding assay (DIBA) and tissue blot immunoassay (TIBA). Immuno-specific electron microscopy (ISEM) combines the serological specificity while revealing the morphology of the virus particles. It has the great advantage of requiring only very small amounts of antisera and diluted antigens sample. *Blackeye cowpea mosaic virus* (BlCMV), Potato leaf roll virus, Petunia vein clearing virus (PVCV), etc, are easily detected using ISEM.

New developments in molecular biology have generated exciting possibilities for production of difficult to purify virus coat protein antigens through gene cloning and expression and *in vitro* peptide synthesis for use in serodiagnosis, while nuclear hybridization techniques offer a vastly improved approach to identification of plant viruses/parasites in the tissue specimens of infected hosts as a means of diagnosis. The future serodiagnostic techniques need to be more rapid, sensitive and accurate than the traditional methods, depend on selection of antibody producing (DNA) fragments for production of more efficient antibody. Use of appropriate monoclonal antibodies can meet these requirements for many pathogens. The novel diagnostic methods for early/rapid detection would help to improve our understanding of the spatio-temporal dynamics of any developing epidemic and effective forecasting for management system.

ISFS-112

Threatening and emerging viruses of important vegetable crops in West Bengal

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Diversification, intensification and globalization of agriculture add to emergence of diseases caused by virus, bacteria, and fungal pathogens which causing increase in disease incidence, aggressive in pathogenecity and host range which may be mainly driven by pathogen introduction through germplasm exchange, trade in plant products, seeds, planting materials and live plants. The unusual weather events also have been linked to the global changes in relates to plant diseases. The changing scenario in diseases of major food crops including cereals, vegetables, pulses, fruits, coffee, cacao, cassava, sweetpotato etc. and non-food crops like fibres, forestry, timber, fodder, tobacco is becoming a major threats to global food security specially in the developing nations because they generate income, employment and foreign exchange especially from agricultural commodities. The evolution, re-emerging and co-infection of several plant viruses causing crop losses on a scale that required international intervention to prevent widespread crop losses. The state West Bengal is one of the largest vegetable producers in India with the area about 12.10 lac hectors and contributes a good share of production of several vegetables. Among the biotic constraints white fly transmitted Gemini viruses, viruses under Potyviridae and Tospo group are now causing great damage to the crops every year. A comprehensive study has been initiated to detection, characterization and mapping of the threatening and emerging viruses in different vegetable crops in this state.

The chilli (*Capsicum annum, C. frutescences*), Tomato, Okra (Bhendi) are the major contributing vegetables in West Bengal and leaf curl viruses of tomato (TLCV)and chilli (ChLCV), Bhendi yellow mosaic virus (BYVMV), Bean Yellow Mosaic Virus (BYMV), Sweetpotato Leaf Curl Virus (SPLCV) are the worst viruses causing huge loss of the crops round the year. In the recent survey it was found to cause about100% crop loss if it occurs early or in the middle of the growing season. In the very recent, emergence of Tospo virus in tomato, chilli, watermelon has proven to be widespread and important components for limiting the yield and quality of the produce.

The infected samples from chilli, tomato, Bhendi, Sweetpotato, beans have confirmed by PCR-based method with respective primer pairs. Further, DNA-Hybridization assay confirmed the presence of Gemini virus infection in chilli, tomato, beans and suspected plants. In order to define the genomic structure and the taxonomic status of this chilli leaf curl virus, the nucleotide sequence of partial AV-1 gene (replication

initiator protein) of BCKV isolates (HF548665) of ChLCV confirmed the infection of TLCV in chilli and 91-92% homology with Tomato Leaf Curl Virus of Joydebpur isolates (HF 548665, EU431116, FJ345401, FJ345402, HM007117). It is evident from the primary data that TLCV of Joydebpur isolates are the predominant to infect tomato and chilli in different provinces of India. Similarly, the partial segment of BYVMV Transcription activation protein & Replicase gene of BCKV, Kalyani isolate (HF545019) has the 90% homology with BYVMV of New Delhi (GU112063), Kerala (GU112060), Pandarihalli (GU112079) and 89% of Chelur isolates (GU112059).

The complete genome of Gemini virus infecting sweetpotato (SPLCV) was cloned and sequenced for AV1, AV2, AC1, AC2, AC3 and AC4 genes of 2823nt size confirmed that SPLCV Bengal Isolate (FN432356) is highly similar (90-95%) with the isolates of China, Eastern China, South Korea, Japan and USA which is most significant in epidemiological studies and evolutionary analysis. Among Four iterative elements, three were forward and one was inverted position in the Intergenic Region (IR) and Nucleotides sequence of large intergenic region was found conserved. However, presence of AV2 ORF, arrangement of IR elements surrounding TATATA box revealed that the SPLCV Bengal Isolate is typical to monopartite old world sweetpotato begomoviruses.

The partial sequence data on the polyprotein region of Sweetpotato Feathery Mottle Virus (SPFMV) BCKV isolate (HM035545) showed > 96% identity with the coat protein (CP) region of SPFMV Indian and other isolates from the World. The multiple alignment and phylogenetic analysis revealed that CP gene of SPFMV differs significantly among the isolates of other continent and was separated from the cluster SPFMV RC, EA, O, C strains. The DAG (Aspartic acid-Alanine-Glycine) motif for Helper-Component protein of SPFMV of isolates was conserved and common for aphid-transmitted potyviruses.

Although the infection of Gemini and Poty viruses are very widespread in most of the vegetable crops, infection of Tospo virus has been detected in large number of samples of chilli, tomato, watermelon, ground nut which is becoming a newly threatened virus in this state. The presence of amplicons of ~420 bp and size ~828 bp of N-gene segment confirmed the infection of Tomato Spotted Wilt Virus (TSWV) in chilli and tomato. Characterization of N, Small, Medium and Large genome segments are in progress.

ISFS-113

Genomics, genetic diversity, diagnostics, geographical distribution and biotechnological management of *Citrus tristeza virus* in India

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Citrus tristeza virus (CTV) is one of the major causes of citrus death and decline of 100 millions citrus trees worldwide over the last 70 years. The virus is dispersed by infected propagative materials and by vector brown citrus aphid (*Toxoptera citricida*). CTV, a member of the genus *Closterovirus*, is phloem limited and forms flexuous filamentous particles 2000 X 11 nm in size. The viral genome contains a positive-sense ss RNA of about 20 kb with 12 ORFs encoding 19 proteins. The virus generally induces symptoms including decline, yellowing and growth cessation, and stunting and stem pitting with poor fruit yield and quality. Citrus is cultivated in all the four geographical zones of India; Northeast, Northwest, Central and South, occupying 9.23 lakh ha with 86.08 lakh tones fruit production. CTV occurs in all the important citrus and its relatives all citrus growing regions and killing of more than one million citrus trees has been estimated.

Overall incidence of the disease caused by CTV was found to be 26.3- 60% in the citrus growing geographical zones of India (36.3% in Central, 47-56% in Northeast, 36-50% in South and 16-60% in North-Northwest) by ELISA and RT-PCR. A total of 102 isolates of CTV from India (19 isolates from Central, 51 from Northeast, 24 from South and 17 from North zone) were analyzed using sequence of the 5′ORF1a fragment of partial LPro*I* domain and coat protein (CP) gene and compared with international isolates. Sequence analysis determined that Indian isolates are extensively diverse showing 80-99% identity with nine phylogroups based on 5′ORF1a and 89-99% identity with seven phylogroups based on CP genes. The phylogenetic clustering did not reflect geographical origin of the CTV isolates as isolates originating from different regions fell into the one phylogroup. Intra-farm as well as intra-region diversity of CTV isolates was determined. Several potential recombination events were identified by recombination-detecting program RDP3, indicated recombination phenomenon is important factor for the extensive diversity of CTV in India.

Complete genome (19253 nt) of CTV isolate, Kpg3 (HM 573451), from the Darjeeling hills of NE Himalayan region, was sequenced for the first time in India. This isolate was found to be related to Israel severe CTV isolate VT in phylogenetic analysis. Sequence analysis of 3′ half of the genome(8398 nt) comprising ten important ORFs (ORFs 2-11) of four CTV isolates, one each from Bangalore (isolate B5, HQ912023), Delhi (isolate D1, HQ912022), Assam (isolate G28) and Vidarbha (isolate Katol) showed diversity in the Indian CTVs. For diagnostics, more than 30 pairs of specific and degenerative primers, targeting different region of CTV genome were developed, that could detect all the CTV variants occurring in

India. Disease-free grafted Darjeeling mandarin planting materials against virus was produced after exploitation of ELISA and PCR based diagnostic system and supplied to the farmers of the Darjeeling hills.

Genetic engineering approaches using pathogen derived gene have been proved to be an effective alternate method to develop virus resistant cultivars in many crops. An efficient method for organogenic regeneration of Indian Kagzi lime (*Citrus aurantifolia)* has been developed. The epicotyl segments of about 0.75-1.0 cm in length from central part of *in vitro* grown seedlings of 21 days old were found to be better explants for regeneration of Kagzi lime. The best regeneration efficiency, 84% with five micro shoots/explant was found at concentration of 2.0 mg/l BAP. The efficiency of root formation up to 60% was observed at lower of NAA at 0.5 mg/l, whereas, poor efficiencies of 40% and 30% were at higher of NAA at 1.0 and 1.5 mg/l. Although addition of GA_3 at 0.1-0.2 mg/l to the medium did not show effect on shoot induction, it enhanced shoot elongation. The regeneration protocol developed in the present study will be useful for improvement in efficiency of genetic transformation and recovery of whole transgenic plantlets, as well as, for induction of multiple shoots for mass propagation of certified disease free plant material in citrus cultivars.

For transformation twelve gene constructs targeting complete CP gene of five CTV isolates (K5, K9, K10, K13, P15) in both sense and antisense and two (D10 and Kat7) in antisense direction were developed in pBinAR vector. One RNAi construct (630 nt) targeting suppressor gene and one short sequences (siRNA) (87 nt) targeting CP gene were constructed in pBinAR vector. The constructs were mobilized to *Agrobacterium* cell EHA105. Agrobacterium-mediated transformation protocols of Kagzi lime plant using one ach of antisense and sense CP gene and suppressor gene constructs were developed. *For selecting putative* transformants, a multiplex PCR-based screening method was developed using primers designed from *tetA* (to detect T-DNA) of pBinAR and CTV-CP gene. Amplification of both *tetA* and CTV-CP gene confirmed *Agrobacterium* contamination, whereas, amplification of CP gene only confirmed putative transformants. The regenerated plants showed a high degree of false transformation. Out of 482 plants transformed with one antisense construct (K9) regenerated in Kanamycin medium, 36 plants were tested by PCR and 15 plant showed positive PCR reaction. Of them, three PCR positive plants showed only CP gene amplification and other 12 plants showed amplification of both *tetA* and CP genes indicating *Agrobacterium* contamination. The protocols developed in this study will be useful in producing CTV resistant clones of Kagzi lime.

ISFS-114

First report of natural occurrence of *Cowpea mild mottle Carlavirus* in soybean from India

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Cowpea mild mottle virus (CPMMV), a member of genus *Carlavirus* (*Betaflexiviridae),* is an emerging problem for cultivation soybean in tropical and sub tropical region of Africa and Asia. CPMMV, contains *flexuous virion, 650 x 13 nm, is* transmitted by whitefly, *Bemisia tabaci*. The viral genome consists of positive sense ss RNA, about 8.12 kb. Soybean crops cultivated at experimental field, IARI farm, New Delhi was found to be severely affected by mosaic disease during 2011-12 cropping season. The disease incidence was estimated to be *18.6-71.2%.* Different kinds of symptoms; mosaic, mottling, leaf deformation and stunting were observed in soybean crops. Host range of virus was studied through sap inoculation and it could infect different plants species soybean, French bean, mungbean, urdbean, fenugreek and asparagus bean under the families Leguminosae and Solanaceae. All the 26 soybean and five French bean cultivars tested were found to be infected by CPMMV with percent transmission estimated to be 25-100% depending on the cultivars. Symptoms appeared in the infected plant within 10-14 days after inoculation. Seed transmission was observed in different cultivars of soybean and transmission efficiency ranged from 0.62 to 14.2%. Long flexuous particle measuring 620-650 x 12-15 nm was observed from symptomatic soybean leaves under electron microscopy. This virus was also found to be transmitted to soybean in greenhouse condition through insect vector whitefly with transmission efficiency of 70% and above.

The associated virus was identified as a member of Carlavirus and a strain of CPMMV using several sets of specific primer pairs, which amplified specific sequence of the viral genome. One virus isolate from soybean, designated as CPMMV-D1 (Acc. no. JX524198) was characterised based on sequencing of viral genome. A sequence fragment, ~1.3 kb of CPMMV-D1 from 3′end of viral genome which containing the complete CP gene (867 nt), the complete NABP gene (303 nt) and 3′end UTR (120 nt) was sequenced and analysed. Sequence analysis~1.3 kb showed CPMMV-D1 to be distinct from other isolates showing 68-73% nt identity among them. The amino acids (aa) sequence of CP gene was analysed and found to be different from other isolates by 90-91% aa identity but related with previously reported two Indian groundnut isolate CPMMV-S and –M by 93-94% aa identity. Critical analysis identified a 80 aa length (positioned 1-80 aa of CP gene) sequence was variable, and a 36 aa length (positioned 81-116 aa of CP gene) was conserved; those region could be targeted for differentiation of CPMMV strains and epitope based antibody production, respectively. Earlier, it was presumed that *Soybean mosaic virus* (SMV) is the causal agent of mosaic disease in soybean in Delhi condition, but present study ruled out the SMV-etiology and determined CPMMV-etiology of mosaic disease in soybean under Delhi condition. This is the first report of natural infection and occurrence of disease and molecular characterization of CPMMV in soybean from India.

ISFS-115

Virus disease problem in important horticultural crops of north eastern region of India: improved diagnostics

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The northeast eastern region (NER) of India is one of the richest reservoir of genetic variability and diversity of different horticultural crops. One of the reasons for low productivity of crops is due to attack of varieties of pests and diseases. Disease incidences are generally high in the region due to its high humidity associated with heavy rainfall resulting in appearance viral diseases as well as its insect vector. Thee most important commercial horticultural cros which are commonly attached by viral and virus like pathogens are citrus, chilli and tomatoes.Citrus suffer from Tristeza disease caused bt *Citrus tristeza virus* (CTV) and citrus greening disease caused by fastidious bacteria Candidatus liberibacter specie, chilli from several viral diseases like mosaic and curling, caused by *Cucumovirus*, *Potyvirus*, *Tospovirs* and *Begomoviruses*, and tomato from many viral diseases like various mosaic and leaf curl viruses. The Double antibody sandwiched-ELISA (DAS-ELISA) using specific antisera detected CTV in several orchards in this region and disease incidence was estimated to be 48.06-58.32% depending on the different orchards at different location in this regions. The complete coat protein (CP) gene of several CTV isolates was amplified using RT-PCR and the CP gene was further sequenced and analysed and compared. Sequence analysis determined the occurrence of genetic diversity in CTV isolates. Some CTV isolates were related to with other Indian, (Darjeeling hills and Delhi) and International CTV isolate (Hawaii). The incidence Citrus greening disease (CGD) in Khasi mandarin (*Citrus reticulata*) and Assam lemon (*Citrus limon*) orchards in Assam, Arunachal Pradesh, Meghalaya and Nagaland was estimated. Diagnosis of CGD was carried out using specific primer pairs yielded 703 bp PCR products from CGD infected citrus samples. Samples were further assayed using real time PCR using the Taqman probe targeting the four forms of *C. liberibacter species* like *asiaticus, africanun, americanum* and *solanacearum*. The present result revealed that all the CGD samples from this region were positive to *C. liberibacter asiaticus.* However, samples from Assam, Meghalaya and Nagaland were also positive to *C.liberibacter africanun* too. The results, thus, suggested that citrus orchards of NER were dual infected with *C. liberibacter asiaticus* and *C. liberibacter africanus.* The DAS-ELISA based detection of viral diseases in chilli cv. Bhut Jolokia, an interspecies hybrid between *Capsicum chinense* and *C. frutescens* detected *Tomato spotted wilt virus* tospo(TSWV, 24.24%), *Cucumber mosaic virus* cucomo (CMV, 12.12%) and *Potato virus Y* poty (PVY, 24.24%) infection on infected leaf samples. However, incidence of such diseases on ripe fruit recorded 12.5% (TSWV), 25.0% (PVY) and 37.5% (CMV). Detection of Tomatoto leafcurl virus begomovirus (ToLCV) from Jorhat district of Assam using PCR using specific primers amplifying a 348 bp PCR product. The product was sequenced and sequence similarity of the present ToLCV designated as ToLCV-J (Jorhat) other ToLCV isolates reported from India and abroad.

ISFS-116

Phytoplasma: high risk pathogen to medicinal and aromatic crops

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Phytoplasmas are specialised bacteria that are obligate parasites of plant phloem tissue and insects, over the last 40 years. These bacteria have resisted all attempts of cell-free cultivation. Severe disease epidemics associated with phytoplasma presence have been described worldwide. Little leaf, a lethal disease caused by phytoplasma has been also recorded formerly on various medicinal and aromatic plants (MAPs) including *Catharanthus roseus* (Sadabahar), *Withania somnifera* (Ashwagandha), *Tagetes minuta* (Marigold), *Matricaria chamomile* (German chamomile), *Foeniculum vulgare* (Fennel), *Plantago ovata* (Isabgol/Psyllium), *Oenothera biennis* (Evening primrose), *Trachyspermum ammi* (Ajwain), *Stevia rebiduana* (Stevia), etc. Under transmission electron microscope, the infected leaf tissue revealed numerous pleomorphic bodies in the phloem region with typical ultrastructural details resembling plant pathogenic phytoplasmas. Pleomorphic bodies varied considerably in size (60 – 1100 nm), shape (spherical, oval, some with budding) and electron opacity. Detection and characterization of phytoplasmas infecting different plant species are now possible with molecular methods, based on the study of 16SrDNA polymorphisms. Control of phytoplasma diseases is currently based on prophylactic measures and cultural practices. Certification programs aim to avoid the introduction of new diseased into healthy fields. These approaches however are of limited effectiveness. Additionally, host resistance & genetic engineering approaches to develop pathogen-resistant genotype could be beneficial in near future. The purpose of the present work is to provide useful information and an efficient identification of the phytoplasmas.

ISFS-117

Molecular characterization of *Banana bunchy top virus* based on DNA R segment from Meghalaya: A new member of "Pacific-Indian Oceans" group

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Banana bunchy top virus (BBTV) is an aphid-transmitted, multi-component, circular single stranded DNA virus belonging to the genus *Babuvirus* and family Nanoviridae. The BBTV genome comprises of six DNA components of approximately 1.1 kb in size, referred to as DNA R, DNA U3, DNA S, DNA M, DNA C and

DNA N. To date BBTV isolates are categorized into two groups, namely the "Pacific-Indian Oceans" group (isolates from Australia, India, Myanmar, Srilanka, Pakistan, Egypt, Tonga, Hawaii) and the "Southeast Asian" group (isolates from China, Taiwan, Philippines, Indoneshia, Vietnum, Japan) based on nucleotide sequence identity of DNA R. Though earlier reports from India confirmed the association of Indian isolates of BBTV within "Pacific-Indian Oceans group", but molecular architecture of BBTV from north-east India remains unexplored. In this study, incidence of banana bunchy top disease in Ri-Bhoi district of Meghalaya was identified on the basis of symptom. PCR detection using six genomic component specific primers confirmed the presence of BBTV. Two BBTV isolates (Umsning and Umiam) from Ri-Bhoi, Meghalaya were characterized on the basis of DNA R segment. The 1092 bp long DNA R segment of Umsning (JQ911667) and Umiam (KC119098) isolate shared 99% similarity to each other. A unique deletion of 20 nucleotides in the intergenic region was identified in both the isolates without affecting the relative position and length of TATA box, replicase gene, poly A signal, major common region (CR-M), stem-loop common region (CR-SL). The new isolates from Meghalaya were compared with previously reported DNA R sequences collected from NCBI database. During multiple alignments following CLUSTAL W algorithm, Meghalaya isolates showed 95-96% identity with "Pacific-Indian Oceans" group and only 70-92% similarity with "Southeast Asian" group. The phylogenetic tree constructed following Neighbor-Joining method of MEGA5 software clustered the Meghalaya isolates within the "Pacific-Indian Oceans" group.

ISFS-118

Incidence, occurrence and characterization of begomoviruses associated with cotton leaf curl diseases in Northwest India

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India accounts for about 32% (11.0 million ha) of the global cotton area and about 21% of the global cotton produce having 38% of export value. Northwestern (NW) India covering Punjab, Haryana and Rajasthan contributes 20% of the total cotton produced in India. During the last one and half decade, cotton leaf viral curl diseases (CLCuDs) have been found to one of the major constraint to the production of cotton across NW India. CLCuD is caused by a complex of Cotton leaf curl viruses (CLCuVs) belong to the genus Begomovirus transmitted by the whitefly *Bemisia tabaci*. The virus genome contains monopartite circular ssDNA molecule associated with betasatellite and, frequently, a third component known as alphasatellite DNA molecule. During the last two decades, cotton leaf viral curl disease (CLCuDs) has emerged as a major constraint to the production of cotton across NW India and Pakistan. It has assumed devastating in NW India

since 2009, causing yield losses ranging from 54 to 100% in the cotton belt of Punjab and Rajasthan states. The begomoviruses causing CLCuD are evolving fast resulting in breakdown of resistance in cotton varieties and hybrids. So far two distinct begomoviruses are referred to be associated with CLCuD in Northwest India. Until the year 2004, CLCuRV (Rajasthan) was predominant and in 2005-06, CLCuBuV (Burewala) appeared in a limited area . Recently, CLCuBuV has been found to be the most dominant and a resistance-breaking virus in this area. Since begomoviruses are highly prone to recombination and changes in the Avr and Vir gene(s), leading to the emergence of recombinants. In 2012, an extensive survey was conducted in 10 villages of Sriganganagar District in Rajasthan and seven villages of Sirsa District in Haryana. In addition experimental fields at Indian Agricultural Research Institute, New Delhi were also surveyed. Different kinds of CLCuD symptoms were observed in various fields; upward, downward curling coupled with leaf deformation and stunting were most prominent. CLCuD incidence varied in different cultivars, fields and areas. The incidence varied from 10 to 30% in Sriganganagar, 10-100% in Sirsa and 0-4% in IARI All the varieties of *G. hirsutum*, including Bt cotton were found to be infected, but Desi cotton (*G. herbaceum*) was apparently free for CLCuD. Real-time PCR data suggests the presence of several variants of begomoviruses in CLCuD complex. Major variants collected from Rajasthan, Punjab, Haryana and Delhi have been sequenced and characterized.

ISFS-119

Characterization of *Citrus tristeza virus* and determination of genetic variability in northeast and south India

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Citrus tristeza virus (CTV) is an important plant virus under genus *Closterovirus* causing huge losses of over 100 million citrus trees worldwide including more than one million trees in India. CTV is a longest known, aphid (*Toxoptera citricida*) transmitted flexuous plant virus of 10×2000 nm in length. The viral genome is single stranded RNA of 20 kb with 12 open reading frames. Several biological and sequence variants of CTV have been reported from many countries. Although, occurrence and genetic diversity in CTV has been reported from India, however particular-region based diversity was not known clearly. Northeast region of India is the place of several citrus species including important citrus like Khasi mandarin, Acid lime and Assam lemon, and considered as one of the important centre of origin of citrus. Tirupati region of South India produces important citrus like Sweet orange, Sweet lime, Acid lime. Although occurrence of CTV was reported in these regions but molecular characterization and genetic diversity of CTV were not reported so far. A survey was conducted in citrus growing areas of Assam and Meghalaya of Northeast, and Tirupati in South India. About 5 to 29 citrus samples from each citrus orchard of several areas of Assam, Meghalaya and Tirupati were collected. In the field condition, no characteristic symptoms were observed in citrus hosts

except in Kagzi lime which showed typical vein clearing and flecking symptoms. The virus infection was determined by ELISA and RT-PCR. Percent tree infection (disease incidence) was estimated, which varied in different hosts, orchards, locations and regions. Total number of twenty two CTV isolates; 11 from Tirupati, seven from Assam and four from Meghalaya were selected for molecular characterization. The PCR product of full coat protein gene, 672 nt (CP gene) and 5'ORF1a fragment, 404 nt (5'ORF1a) were cloned, sequenced and analyzed. Nucleotide sequence of CP gene and 5'ORF1a of present, previously reported Indian and international CTV isolates were compared. A range of 88-99% nt identity among Assam and Meghalaya, and 87-98% nt identity among Tirupati isolates were observed. Phylogenetic analyses showed that Assam and Meghalaya isolates fell into four genogroups and Tirupati isolates into five genogroups. For 5'ORF1a, a range of 83-98% nt identity among Assam and Meghalaya and 88-98% identity among Tirupati isolates were found. In phylogenetic analyses, the Assam and Meghalaya isolates formed four genogroups, whereas the Tirupati isolates formed three genogroups. Distribution of CTV sequence was studied in different geographic areas. The phylogenetic clustering did not reflect geographical origin of the CTV isolates as isolates originating from different regions fell into the one phylogroup. For example, the four Assam isolates AR1, AR2, AR16 and AG-18, and two Tirupati isolates TP1 and TP-9 fell in one group. Recombination-detecting program RDP3 identified MB3 isolate of Meghalaya and TP6 isolate of Tirupati based on CP gene and isolates MU6, MB6 and AR1 based on 5'ORF1a were detected as putative recombinants.

ISFS-120

Evidence of *Citrus liberibacter asiaticus* and *Citrus liberibacter africanus* causing Citrus greening diseases in north eastern states of India

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Citrus greening disease (CGG) (syn. *Huanglongbing*) is caused by a fastidious phloem limited, uncultivable gram negative bacterium known as *Candidatus liberibacter* spp. The disease is primarily spread by two species of psyllid, the Asian citrus psyllid (*Diaphorina citri*) and the African citrus psyllid (*Trioza erytreae*). The *C.liberibacter* that reported to occur in worldwide designated as *Candidatus liberibacter asiaticus, C. liberibacter africanus, C. liberibacter americanus* and *C. liberibacter solanacearum*. The CGD in two commerciallly important citrus orchards, Khasi mandarin (*Citrus reticulata*) and Assam lemon (*Citrus. limon*) of North eastern states, Arunachal Pradesh, Assam, Meghalaya and Nagaland was surveyed and CGD was detected based on molecular-based diagnostics using polymerase chain reaction (PCR) and real time PCR assays. Several citrus samples were collected form over all 10 districts of the four North eastern Sates surveyed. The CGD specific PCR primer pair, CGD-A2 and -J5 yielded 703 bp PCR products in all the representative infected samples. The samples were further assayed by h multiplex and real time PCR,

individually, using Taqman probes targeting all the forms of four *Candidatus liberibacter* spp. The specific primers targeting *C. liberibacter asiaticus* and *C .liberibacter africanus* showed evidence the multiplex and real time PCR reaction from infected citrus samples. The CGD samples in the Assam, Meghalaya and Nagaland North eastern states were positive to both the form of diseases, *C. liberibacter asiaticus* and *C. liberibacter africanun*, where as, CGD samples of Arunachal Pradesh showed evidence of only *C. liberibacter asiaticus*. The present study suggested that Citrus orchards in North eastern States are were dual infected by *C. liberibacter asiaticus* and *C. liberibacter africanus*.

ISFS-121

Studies on the incidence and detection of bhendi yellow vein mosaic virus (YVMV) in the Gangetic plains of West Bengal

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Yellow vein mosaic virus is one of the most important diseases of bhendi. The characteristic symptom of YVMV is the yellowing of the entire network of veins in the leaf blade (vein clearing). In severe infections the younger leaves turn yellow, become reduced in size and the plant is highly stunted. Bhendi yellow vein mosaic virus (YVMV) consists of monopartite genome consisting of DNA-A and DNA- β satellite. *DNA-A encodes all viral functions required for replication, gene expression and insect transmission. DNA-β satellite causes symptom expression in the infected hosts of bhendi. Nine promissing cultivars of bhendi were field screened on the incidence of YVMV and yield reduction in the university farm of BCKV, Kalyani during the year of 2011-2012. Among the varieties,* Pusa Sawani was found most susceptible to bhendi yellow vein mosaic virus and percent disease index (PDI) reached up to 81.7% whereas the variety, 09/OKYV RES-1 showed no YVMV symptoms. The highest total yield was obtained from 09/OKVY RES-1 with 83.08 q/ha and the lowest yield was obtained with Pusa Sawani with 22.71 q/ha. The presence of Bhendi yellow vein mosaic virus was detected by PCR-based method using degenerate primers for Begomoviruses. The gene specific primers were designed to amplify DNA-β satellite and DNA-A segment. PCR products from degenerate primers produced a band of ~883 bp, and the specific primers yielded ~1363 bp and ~1022 bp of products respectively. The PCR product (~883 bp) of Bhendi yellow vein mosaic virus was sequenced and found that the fragment was homologous to the AC1 gene of DNA A segment. The analyzed sequence through NCBI and EBI BLAST confirmed the resulted band of YVMV which was found to have high identity to other Indian isolates of BYVMV from a maximum similarity of 94% to a minimum of 91%. Bhendi yellow vein mosaic virus was found to form a cluster with its Indian isolates (FN645917-Haryana isolate, EU589392-Maharashtra isolate and EU482411-Maharashtra isolate) of bhendi from a maximum similarity of 94% to a minimum of 91%. The alignment of the sequences with the present isolate confirmed the existence of begomovirus of India isolate in bhendi.

Technical Session - 5

Soil health and crop productivity *vis-à-vis* pest management

Chairman: SK Sanyal
Co-Chairman: Pradip Dey
Rappoteur: Tapas Biswas

ISFS-122

Soil-test-based site-specific nutrient management for realizing sustainable agricultural productivity

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Site-specific nutrient management (SSNM) is an approach for feeding crops with nutrients as and when needed. The application and management of nutrients are dynamically adjusted to crop needs of the location and season. SSNM can be efficient and profitable where intra field variability can be assessed reliably and economically. It will not be profitable where the diagnostic assessment remains expensive and unreliable and also where high level of uniformity is neither required nor brings about significant yield increase. In most cases, it is not of much interest to small holders with severe financial constraints. However, it is valuable tool for large farms, organized plantations and for the large-scale production of high-value crops. However, since most of the farms in India are one acre or less than one acre, the SSNM could most often be practiced if the inter-farm variability is assessed. Intra-farm variability often would not exist or so less that their determination and use would not be economical or even practicable.The basic concept of SSNM through STCR is that a site represents a unique farmer's field. This is relevant in Indian context since the farm sizes are small. Cropping pattern within a farm is uniform and each farm has a uniform previous fertilization history. Such site-specific nutrient management is also being advocated in India since late 1960s through targeted yield approach. The approach is unique in the sense that it not only prescribes the optimum dose of nutrient based on soil fertility status but also predicts the level of yield that a farmer can expect. The targets can be chosen based on farmers' resources. The approach has been test verified in several follow-up experiments and demonstrated in a large number of farmers' fields. Recommended agronomic practices are to be followed along-with the fertilizer doses. The recommendations for different crops for specified yield targets are available in the voluminous work conducted under AICRP (STCR). Lately, the calibrations are being developed under integrated supply of organics and fertilizers keeping into account the nutrient contribution of organics, soil and fertilizers. The technology of fertilizing the crops based on initial soil test values for the whole cropping system is also being generated. Considerable agronomic and economic benefits were accrued when farmers applied fertilizer nutrient doses based on soil tests. The fertilizer use efficiency calculated in terms of average nutrient (N+P+K) response ratios increased considerably in STCR based applications over farmers' practice. The technology was implemented under Integrated Plant Nutrient Supply (IPNS) systems and was beneficial across the crops and soils. Fertiliser recommendation equations derived from STCR studies require soil nutrient efficiency (Es), fertilizer nutrient efficiency (Ef) and nutrient requirement (NR) of a particular crop. Linking these parameters with soil maps makes it possible to provide

spatial fertilizer recommendation in the form of maps. An Expert System (ES) is a computer programme designed to simulate the problem solving behaviour of an expert in a narrow domain or discipline. Several such expert systems have been developed and successfully used in pests and disease control, farm management, livestock breeding, but more concerted efforts are required to integrate the concept in soil fertility management. AICRP (STCR) has developed a computer aided model that calculates the amount of nutrients required for specific yield targets of crops based on farmers' soil fertility. It is accessible on Internet (http://www.stcr.gov.in/HTML/html/diary_fset.html). This software program reads data, performs calculations and generates graphical and tabular outputs as well as test reports. This system has the ability to input actual soil test values of the farmers' fields to obtain optimum dose of nutrients. The application is a user-friendly tool. It will aid the farmer in arriving at an appropriate dose of fertilizer nutrient for specific crop yield for given soil test values

ISFS-123

Enhancing beneficial rhizosphere interaction through plant breeding for improving soil-health: prospects and challenges

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Plants exude a variety of organic compounds (carboxylate anions, phenolics, carbohydrates, amino acids, enzymes, proteins, etc.) and inorganic ions (protons, phosphate and other nutrients, etc.) into the rhizosphere which can change the rhizosphere dynamics and can influence the adaptation of plant in a particular environment along with its associated microbial community. The functional diversity of microbial community structure and its expression is crucial in nutrient mobilization, availability and subsequent uptake by the plants from the limited available pool of nutrients in soil. As these root exudates are primary substrates for proliferation of different microorganisms in the rhizosphere, it is hypothesized that change in the composition of the root exudates would change the functional diversity of the microorganisms in the rhizosphere and thus, in turn, will influence the mobilization and availability of nutrients.

Unfortunately little is known about the specific roles played by the specific plant genes in structuring the associated community. Contrary to cereal crops where 50% of the 50% photo-assimilated carbon is required for root respiration and biomass and rest 50% meant for root exudation, in legume situation is little different considering the fact that 30% of the 50% photo-assimilated carbon is required for sustaining root nodules and nitrogen fixation. Given that more than 50% of photo-assimilated carbon is required to sustain subterranean system and there is a big drain of energy and resources, thorough understanding of the regulation of the whole

sequence of event leading to exudation of organic compounds in the rhizosphere is required.

Complete understanding of complex interactions governing the relationship of quantity and differential composition of root exudates with soil properties as well as plant genotypes and phenotypes is still in its infancy. The inadequate experimental methods to assess and quantify the spatial and temporal variability of the root exudates in the rhizosphere and their possible impact in influencing the rhizosphere dynamics in terms of functional microbial associations and nutrient mobilization and availability complicates the problem further. Besides, the interaction and exchange of signals between plants and microbes and the molecular trafficking at the soil-root interface add additional dimensions to the already existing complexity.

Thus to accrued benefits out of the association of microbes with plants and improving the soil in qualitative terms, few fundamental questions need to be answered:

1. Do plant genotypes determine the functional microbial diversity structure in the rhizosphere in a given soil environment by differential composition of root exudates quantitatively and qualitatively?
2. Does change in functional microbial diversity affect the nutrient mobilization and availability in the rhizosphere and their uptake subsequently and improve the soil health microbiologically?
3. Is it possible then to shift the functional dynamics of beneficial microbes in the rhizosphere by altering the genetic makeup vis-à-vis root exudates patterns of the plant by plant breeding approaches? If yes, is it possible then to change the nutrient availability in the rhizosphere and uptake patterns of plants by enhancing the number of beneficial microbes in the rhizosphere by altering the plant genotype?

Probably there is as much variability for root as available for shoot traits. Root responses to beneficial soil microorganisms might exist. However, much less is known about such host variability because of limited interest and technical difficulties associated with studying subterranean systems. Breeding for enhancing beneficial interaction in the rhizosphere requires understanding of a complex, dynamic and interdependent systems. For example, the interrelationship between photosynthesis and N_2 fixation is complex because more available N stimulates more photosynthesis which in turn can support more N_2 fixation. In addition to total PS, the coordination of photosynthate production and N_2 fixation with peak demands of the maturing plant are important. Carbohydrates availability to the nodules limits N_2 fixation. Plant type, size and amount of leaf canopy which are influenced by N supply, flowering time, total leaf area, and leaf area duration often affect fixation.

Therefore, there is potential in utilizing the root variability and variability in rhizodeposition to tailoring the plant types in enhancing the rhizosphere outcome for enhancing the transformation, mobilization and availability of nutrients vis-à-vis improve the soil health. It will go a long way in shaping the future crop production strategies in India for harnessing nutrients under sub-optimal cultivation conditions.

ISFS-124

Bioavailability of arsenic in *boro* rice irrigated through arsenic contaminated underground water in West Bengal

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Rice is a potentially important route of human exposure to arsenic (As), especially in populations with rice-based diets. However, As toxicity varies greatly with species. The purpose of the present study was to find accumulation of As species in rice. The WHO standard for As in drinking water of 10 μg /L has been adopted by many countries. Arsenic in water is generally inorganic and can be a mixture of arsenite (As-III) and arsenate (As-V). The risk assessment for exposure to As contaminated drinking water, as postulated by the U.S. Environmental Protection Agency, is based on carcinogenicity risk from inorganic As. No intake of inorganic As from food was considered while setting the drinking water standard, while, it is now evident that significant amounts can be ingested this way. Arsenic in rice is of special concern because of the much higher levels of As in rice grain as compared to other staple cereal crops, coupled with high levels of rice consumption by Asian population. Moreover, knowledge of speciation of As in rice is critical for understanding the potential toxicity of rice to humans. An effort has been made, through the present study, to take an account of species level accumulation of As in rice in the As affected villages of Chakdaha block in Nadia, West Bengal, India. The present study revealed that inorganic arsenic shared maximum arsenic load in rice straw while in grains it is considerably low. Arsenic species recovered from rice straw and grain are principally As-III and As-V with a little share of dimethyl arsenic acid (DMA) and almost non-detectable monomethyl arsenic acid (MMA) and asenobutane (As-B). Rice grain As has been found to be principally As-III while in straw As-V predominated. It is interesting to note that characterization of As source shallow tubewell (STW) and sink (soil) did not show any recoveries of organic As, although *boro* grain and straw also accumulates organic As species. The recoveries of such organic species in rice grain and straw may be due to transformation of inorganic As to organic forms in plant body. Discussion of the health risk of As in rice has largely been based on its inorganic arsenic content because these species have generally been considered to be more toxic than MMA and DMA and can be directly compared to As in drinking water, assuming equal bioavailability of inorganic As in the rice matrix and in water. The maximum dietary risk of exposure to inorganic arsenic through transplanted *boro* paddy in the present experiment was calculated to be almost 1706 % of PTWI (Provisional Tolerable Weekly Intake) for an adult of 60 kg bodyweight.

ISFS-125

Effect of mycorrhizal inoculation, organic and inorganic fertilizers on growth and yield of okra (*Abelmoschus esculentus*)

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Okra (*Abelmoschus esculentus*), a Malvaceous summer vegetable, is also known as 'Power house of valuable nutrients'; but its yield is still low. The yield of okra is influenced by numerous horticultural, ecological and edaphic factors. In the present experiment the influence of Bio-fertilizer, Organic and Inorganic fertilizers individually or in combination on okra (cv. VRO-6), were tested. The experiment was laid out in a Randomized Block Design with 8 treatments and 3 replications during summer-rainy season of 2010. Results revealed that the combined application of mycorrhiza + 75% organic + 25% of standard inorganic fertilizer dose produced the highest yield (136 q/ha) among the treatments. The implication and plausibility of reduced application of inorganic fertilizers to the benefit of micro-climate of the agro-ecosystem cannot be denied.

ISFS-126

Characterization of bacteria sustaining in arsenic contaminated soil matrices, precisely in relation to pollution resistance

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Indiscriminate use of arsenic (As) contaminated groundwater drifted through shallow tube well for irrigation has made a wide area of Gangetic alluvial soils of West Bengal a major sink of this toxic metalloid, which finds its way to human through agricultural produce. Decontamination of such polluted soils through conventional metal removal processes remained quite impracticable in such areas of marginal socio-economic threshold. Low-cost environment friendly bio-resource could be a promising alternative. The present study has been hypothesized to explore such bio-remediating agent for decontamination or mitigation of arsenic hazard. In the present investigation, twenty six As resistant bacterial strains were isolated from As contaminated paddy soil of West Bengal, India. Among them, 10 isolates exhibited higher As resistance capacity and could grow in medium spiked with 12000 mg /L of arsenate (As-V) and 2000 mg/ L of arsenite (AsIII). Maximum growth was observed at 1000 mg/ L and 100 mg/L in case of As-V and As-III respectively. Results of incubation study carried out in basal salt minimal media (BSMY) spiked with either 25 mg/L of As-V or As-III, showed that the isolates could accumulate 1.03 - 6.41 mg/ L of As-V and 2.0 - 7.6

mg/L of As-III from the media. The bacterial isolate AGH-21 showed highest As accumulating capacity both for As-V (25.64%) and As-III (30.4%) under laboratory conditions. The isolates AGH-21 (NCBI accession no: HQ834295) showed highest sequence similarity (98%) with *Bacillus sp* and could be used as a potential bioremediator for decontaminating As polluted soils.

ISFS-127

Accumulation of arsenic in rice; implications of seasonal variations and varietal preferences

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Arsenic (As), a toxic metalloid, is of great environmental concern due to its presence in soil-water-plant-animal-human continuum. The emerging areas of arsenic hazards in agricultural systems through use of contaminated irrigation water and entry of toxin in crops and finally to the agricultural produces have been largely ignored. Although, in recent years, rice-grain arsenic concentrations have received considerable attention, especially in terms of net daily intake by populations that rely on rice as a staple food and are also ingesting high arsenic levels from drinking water. Keeping this in view, the experiment has been undertaken to study arsenic accumulation in rice across seasons and selected popular cultivars, at Farmers' fields in village Nonaghata of Block- Haringhata, Nadia,West Bengal. The arsenic accumulations were estimated following standard protocol through a PerkinElmer Analyst 200 Atomic Absorption Spectrophotometer coupled with FIAS-400. The highest recoveries of arsenic remained always associated with *boro* rice (1.20 – 1.96 mg/kg in grain) preceded by *aus* (0.85 - 1.40 mg/kg in grain) and *aman* (0.53 – 1.06 in grain). Such variations may be associated with varying levels of As contaminations in irrigation water (drifted through shallow tube wells) across seasons (*viz*. 0.31 mg/l during a*us*; 0.16 mg/l during *aman* and 0.25 mg /l during *boro* cultivation). Observations also revealed that As accumulations in different parts of rice plant always appeared in the order of root>stem>leaf>grain over the seasons and cultivars. Varietal preferences to As accumulations were clearly observed when IR-36 showed maximum arsenic accumulation across seasons and the least accumulation was reported in var. Satabdi.

ISFS-128

Effect of integrated management of nutrients in improving fertility of an inceptisol under okra cultivation

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Field experiments were conducted for two consecutive years in an Inceptisol at the Central Research Farm of Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, West Bengal, India with okra (*Abelmoschus esculentus* L. Moench), (cv. F_1- hybrid 152) as test crop. The objective of this study was to assess the efficiency of integrated nutrient management in restoring and or improving fertility of post harvest soils of okra. The experiment was laid out in a Randomized Block Design with seven treatments replicated thrice. Relative efficiencies of selected nutrient management protocols in improving the fertility status in relation to several indices like organic C, N, P, K etc. has been assessed. The improvement of selected soil fertility parameters at the end of second season of cultivation of okra over the initial soil characteristics with regard to organic C, total N, available N, P & K were observed to the tune of 36.67 – 83.33 %, 15.52 – 72.41 %, 3.53 – 15.98 %, 30.69 – 108.49 % and 5.25 – 34.99 %, respectively. Supplementation of chemical fertilizers (N & P) through organic matter (FYM and Vermicompost) always led to substantial improvement of soil fertility while bacterial fertilizers added further dimensions to it.

ISFS-129

Rainwater harvesting and organic amendments - mitigation option to reduce arsenic content in spinach

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Indiscriminate use of arsenic contaminated groundwater for irrigation poses serious threat of arsenic accumulation in crop edibles. Being hyper accumulator the leafy vegetables emerged as serious threat in entry of arsenic through food chain. Indian spinach, better known as palak, Beta vulgaris var. bengalensis, is a very common leafy vegetable and predominantly cultivated in the arsenic endemic area of West Bengal. The present study has been conducted to assess the level of accumulation of the toxin in *palak* and also to explore possible mitigation options through organic amendment and irrigation through harvested rain water. Field experiments were conducted at village Ghentugachi (Latitude $23^0$02N, Longitude $88^0$34E), block Chakdaha, district Nadia, West Bengal, India. *Palak* was irrigated through shallow tube well (STW) and pond (surface)

water. The soil of the experimental plots amended with organic manures like FYM, Vermicompost and Sludge. The experiment was laid out in factorial RBD with three replications to assess the sole and interactive effects of water and organics in offloading arsenic from spinach. The arsenic accumulations were estimated following standard protocol through a PerkinElmer AAnalyst 200 Atomic Absorption Spectrophotometer coupled with FIAS-400. Results shows that arsenic accumulation in palak roots (0.10-0.37 mg/kg @ 30 days and 1.15-1.37 @ 60 days harvest) was higher than the leaves (0.32-0.82 @ 30 days and 0.94-1.24 @ 60 days harvest). *Palak* raised through pond water irrigation accumulated significantly lower arsenic than crops raised with STW. All organic amendments significantly reduced As accumulations in palak leaves as compared to situations where soils were not amended with organics. Vermicompost performed better than other manures in offloading As from *palak* leaves (edibles).

ISFS-130

Evaluation of arsenic oxidizing ability of *Rhizobium* sp. isolated from contaminated area of Deltaic Bengal

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Groundwater contamination of arsenic (As) in a widespread area of gangetic delta of West Bengal and indiscriminate use of shallow tube well drifted water for irrigation of farm land had emerged with the possibilities of human contamination through food. The polluted sinks (agricultural soils) are progressively contaminated with the metalloid (As) which is significantly toxic when exists in inorganic arsenite (As-III) and arsenate (As-V) forms among which the former is more toxic. Oxidizing arsenite to less toxic arsenates may be a modest strategy for management of As toxicity hazards in agricultural soils. Microbial populations are indicators of soil health, influences soil fertility and those who can sustain arsenic contaminated environment may help in As mitigation. The present investigation has been conducted to assess the intrinsic efficiencies of some *Rhizobium* strains isolated from the root nodules of groundnut cultivated in an arsenic endemic area of Nonaghata (Chakdah, Nadia, West Bengal, India). The arsenic resistant ability of 15 bacterial isolates was studied in yeast extract mannitol liquid medium spiked with different concentration of As-V and As-III. Among these 15 bacterial isolates, 5 isolates were shown their arsenic resistant capacity (growth up to 15000 ppm for As-V and 1500 ppm for As-III). The arsenite oxidizing abilities of selected resistant isolates were further assessed through standard methodology and 3 isolated bacterial strains (out of 5 investigated) had clearly shown arsenite oxidizing abilities. These 3 isolates were identified as *Rhizobium* through standard biochemical tests.

ISFS-131

Performance of rhizobium with inoculation of phosphate solubilizing bacteria for improving yield of blackgram

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Combined effect of *Rhizobium* and, Phosphorous solubilizing bacteria (PSB) on nodulation and grain yield of blackgram was studied in field during *kharif* 2009-10. Different strains of PSB in association with *Rhizobium* were tested by inoculation to blackgram seeds. Significant variation was observed with respect to formation of nodules and grain yield. Seed bacterization increased nodulation over uninoculated control as well as recommended dose of fertilizer. 35.40 nodules/plant were observed in seeds treated with *Rhizobium* @25g/kg seed +PSB @25g/ kg seed followed by *Rhizobium* +PSB-1. Least (17.70) nodules/plant were recorded in uninoculated control. Similar trend was noted in respect of nodule dry weight/plant and plant dry weight. Plant dry weight was in the range of 3.89 to 5.25 g/plant. Maximum grain yield 899 Kg/ha was obtained in treatment where *Rhizobium* @25 g/kg seed +PSB-2 @25 g/kg seed. It was found significantly superior to all other treatments. Minimum grain yield was obtained in uninouculated control (714Kg/ha) and PSB alone (760 kg/ ha).

ISFS-132

Pseudomonas mendocina – a promising native bacterial isolate for remediation of arsenic toxicity in polluted soils of West Bengal

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Arsenic pollution in groundwater and its influence on soil-biota-ecosystem in the state of West Bengal, India and Bangladesh adjoining the river Bhagirathi and Padma, is a matter of great concern. Major cereals, legumes and pulses grown in arsenic contaminated fields accumulate substantial amount of the metalloid in their edible parts that may pose serious health hazards. Rice, being the principal crop of the endemic zone, is exposed to arsenic contamination through soil and ground water. But, some of the microbial communities have the capacity to adopt As-contaminated environment by developing resistance ability and capable of transforming it into less toxic forms. In the current investigation, isolation and characterization of efficient As-transforming microorganisms and their remediation potentiality was studied. Twenty arsenic tolerant bacterial strains were isolated from the polluted rice field (total arsenic 7.61 mg/kg and available arsenic 1.69

mg/kg) from Haringhata Block of Nadia district, West Bengal. The growth pattern and arsenic tolerance capacity of those isolates were studied with increasing concentrations of arsenate (As^{V}) and arsenite (As^{III}). Arsenic removal ability of 10 tolerant isolates and that of cell bio-accumulation from As^{V} and As^{III} broth spiked with 50 mg/L of arsenic were studied. Remediation ability of arsenic polluted soils with the selected isolate (TB_{21}) was studied along with FYM @ 0 and 10 t/ha, under green house condition with *kharif* rice. All bacterial isolates did not show same tolerability to arsenic toxicity. The isolate TB_{21} showed the highest tolerance ability towards both the specieses of arsenic. Minimal inhibitory concentration (MIC) of As^{V} and As^{III} for the isolate in nutrient broth after 72 hours incubation was 125 and 5.0 mM respectively. The isolate could remove 8.1 ppm of arsenate (16.2 %) and 9.1 ppm of arsenite (18.2 %) from 50 mg/L of arsenic enriched broth at 21 days incubation. The bio-accumulation of arsenic by the isolate was 7.6 ppm of arsenate (15.2 %) and that of 7.5 ppm of arsenite (15.0 %). The isolate was gram negative, aerobic, non-spore forming rod shaped bacterium. Molecular chraracterization of the isolate based on sequencing of 16S rDNA and subsequent comparison with database in Gene Bank revealed that the isolate was *Pseudomonas mendocina.* Inoculation of *P. mendocina* significantly reduced the accumulation of arsenic in plant bio-mass. Addition of FYM @ 10 ton/ha along with *P. mendocina* further decreased the accumulation of arsenic in root, shoot, leaf and grain of rice and thus reduced the risk of arsenic entry in food chain. The bacterium *P. mendocina,* in future, can be a potential bioremedial agent in arsenic polluted soils.

ISFS-133

Growth and P-nutrition response of lentil (*Lens esculenta* M.) genotypes to arbuscular mycorrhizal fungal inoculation at different P-regimes

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Two lentil genotypes, Asha (with root hairs) and L-249 (without root hairs), were selected for studying their growth, P nutrition and mycorrhizal dependency in low nutrient red laterite soil at five levels of added P (0, 15, 30, 45 and 60 ppm) with or without mycorrhizal inoculation. Results of the experiment revealed that mycorrhizal inoculation (M) and phosphorus levels (P) caused significant improvement of plant height, shoot-, root-, plant-dry weight, P concentration and uptake of both genotypes except the root dry weight parameter of L-249 whereas M x P interaction caused significant enhancement in almost all parameters except root dry weight parameter of the genotype Asha. Mycorrhiza inoculated L-249 was found superior for all growth and P nutrition parameters as compared to mycorrhiza inoculated Asha at zero level of P. The former showed decreasing trend for all parameters with added levels of P but in the latter plant height up to 30

ppm, shoot and plant dry weight upto 15 ppm, P concentration and uptake after 45 ppm and root dry weight after 0 ppm decreased with increased levels of added P. Mycorrhizal L – 249 had higher mycorrhizal inoculation efficiency and dependency, P substitution efficiency, lower root – shoot ratio and phosphorus utilization efficiency than Asha. It can be concluded from the results of the above experiment that lentil genotype L- 249 having no root hairs has greater mycorrhizal dependency, responds better in the growth and nutrition parameters at lower P levels than Asha genotype having high root hair densities.

ISFS-134

Soil covers for sustaining yield and quality of guava

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The experiment was carried out at the Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, during the years 2007-08. The yield and quality parameters were recorded after following different soil covers such as T_1- Cow pea, T_2- Sugarcane trash, T_3- Saw dust, T_4- Dry leaves, T_5- Paddy straw, T_6- Black polythene, T_7- White polythene and T_8- Control. The experiment was laid out in CRD and replicated thrice. The significant variations among yield and quality parameters were observed after the period of 6 months. With respect to fruit set and final fruit retention potentiality of paddy straw was observed maximum. Whereas, maximum number of fruits per plant, fruit yield (kg/plant) and yield (t/ha) were observed in soil covered with black polythene. With regards to physio-chemical parameters of fruits covered soil cover with paddy straw produced optimum results.

ISFS-135

Assessment of balanced nitrogen scheduling in *kharif* rice under mahananda flood plain farming situation

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Indiscriminate use of nitrogenous fertilizers in *kharif* rice results in poor nitrogen use efficiency, poor grain filling, harnessing of more weeds, diseases and insects which ultimately resulted in declining trend in rice productivity under Mahananda Flood Plain farming situation. Keeping in view the present study was conducted during *kharif* seasons of 2010-11 and 2011-12 in On Farm Trial (OFT) mode at the village Chhoto

Sapnikla, (Block : Islampur, Dist. : Uttar Dinajpur, West Bengal) to study the balanced nitrogen scheduling using Soil Test and Leaf Colour Chart (LCC) based recommendation as compared to farmers practice. The experiment was laid out in a randomized block design with three (3) treatments *viz.* T_1 : Farmers practice (50 kg N ha^{-1} as basal and 30 kg N ha^{-1} at active tillering stage); T_2 : Nitrogen Schedule 1 (Soil test based N application, *i.e.*, $^1/_4$ N as basal, $^1/_2$ N at active tillering stage and $^1/_4$ N at panicle initiation stage); T_3 : Nitrogen Schedule 2 (No basal N and N top dressing through LCC with a critical value of 4) with seven (7) replications. Average data of two years revealed that, least amount of N was applied in LCC based approach (65 kg N/ha). Highest number of panicle bearing tillers m^{-2} (251), filled grains $panicle^{-1}$ (101.4), grain (42.2 q /ha) and straw yield (57.3 q ha^{-1}) were associated with LCC based N application with no significant difference between Nitrogen schedule 1 and 2. Regarding grain yield of rice, there was a yield advantage of 10.47% with Nitrogen Schedule 2 and 9.69 % with Nitrogen Schedule 1 over conventional Farmers' practice. As far as Benefit / Cost ratio was concerned, LCC based Nitrogen scheduling (1.71) was found advantageous over both soil test based approach (1.68) and farmers' practice (1.51).

ISFS-136

Effect of organic and inorganic nutrients on karonda (*Carissa carandas*) grown in new alluvial soil of West Bengal

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A field experiment was conducted at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, to study the beneficial effect of organic and inorganic nutrients on three years old grafted karonda plant, comprising of 8(eight) treatments viz., cowdung @2kg/plant/year, cowdung @4kg/plant/year, Mustard cake @ 500g/plant/year, Mustard cake @1kg/plant/year, urea @100g + SSP @160 g + MOP @ 40 g/plant/year, urea @ 200g + SSP @ 320 g + MOP @80g/plant/year and the last one was Control (without any manure and fertilizers). The results revealed that application of cowdung @ 4kg/plant/year could produce 215 number of fruits per plant which was upto 273% and 245% higher than control and application of urea @100g + SSP @160 g + MOP @40 g/plant/year respectively. A maximum plant growth, fruit weight (23.50g), number of fruits per plant (215 per plant) and improved fruit quality was recorded due to this treatment (cowdung @4kg/plant/year). It is therefore concluded that application of cowdung was recommended to obtain the highest yield with better quality of karonda.

ISFS-137

In situ utilization of rice stubble in relation to Nitrogen status *vis-à-vis* performance of wheat crop

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An investigation was conducted in the Bidhan Chandra Krishi Viswavidyalaya (BCKV) Farm at Kalyani to evaluate the change in nitrogen (N) profile in soil through *in situ* utilization of rice stubble and its effect on performance of subsequent wheat crop. Lignocellulolytic fungal inoculated stubble, uninoculated stubble, phosphocompost (PC) blended uninoculated stubble with or without N fertilizer and burnt stubble with or without PC but having N fertilizer were incorporated in soil and their influence on soil fertility vis-à-vis performance of wheat crop was investigated. PC blended stubble resulted in the highest total, ammoniacal (NH_4-N) and nitrate (NO_3-N) nitrogen, biomass carbon (MBC) and nitrogen (MBN), urease activities in wheat rhizosphere soil. Consequently, the uptake of nitrogen, and grain and straw yields of wheat increased. On the other hand, PC blended stubble without N fertilizer effectuated the highest non symbiotic nitrogen fixing bacteria (NFB) and their potential in soil. However, burnt stubble engendered the lowest NO_3-N, non-symbiotic NFB, non- symbiotic nitrogen fixing power, MBC and MBN, in soil. Rice stubble without nitrogen brought down the level of NH_4-N and urease activity in the soil to the lowest extent. Consequently, the wheat grain and straw yields, and N uptake were also the least. On the contrary, the lowest level of total nitrogen was resulted in the inoculated stubble without nitrogen and inoculated stubble. On the whole, phosphocompost blended rice stubble was found to be the best approach for stubble management in wheat field.

ISFS-138

Studies on identification of arbuscular mycorrhizal fungal strains for increased acid soil tolerance

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Acid soil is one of the problematic soils in agricultural production system. The constraints for the crop cultivation in acid soil includes generally low in nutrient availability, low in available P and other micronutrients like Zn, toxicity of Al and Mn. The present investigation was focused on the identification of

efficient arbuscular mycorrhizal strains for increased acid soil tolerance. Acid soil samples (pH 4.4-6.6) were collected from different locations namely National Pulses Research Centre, Vamban in Pudukottai district and Nilgiri forest of Tamil Nadu. All the soil samples were analysed for physico-chemical, AM spore load, total microbial load and infective propagules of AM fungi. A highly negative correlation was noticed between soil available P_2O_5 and AM fungal spore density at 5% level of significance. Host plant infection studies were carried out with maize as trap crop. A negative correlation was observed between soil P and root colonization at 5% level of significance. AM fungal spores were collected and were mounted on glass slides in PVLG + Melzer's reagent. AM species were identified by their spore wall layers, shape and colour of the spore. Twelve AM isolates were identified viz. *Acaulospora scrobiculata, A. laevis, A. foveata, Glomus sinuosum, Glomus multisubstensum, Glomus clarum, Glomus geosporum, Gigaspora gigantea,* Glomus *etunicatum, Glomus microcarpum, Glomus aggregatum, Scutellospora* sp. These were further used for reinfection studies using maize. Based on spore density and AM colonization percentage, two AM isolates *Glomus geosporum* and *Acaulospora scrobiculata* were selected for increased acid soil tolerance.

ISFS-139

Irrigation and sulphur levels in relation to yield attributes, yield, sulphur uptake and quality of Indian mustard (*Brassica juncea*)

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Water and sulphur can play crucial role towards increase in both quantity of yield and oil of mustard. Therefore, the present investigation was planned to optimize irrigation schedule and dose of sulphur. Study was conducted during winter season of 2010-11 at Jaguli Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, West Bengal. The experiment was laid out in split-plot design with three replications. Treatments comprised of three levels of irrigation (I_1: one irrigation at 30 DAS i.e. at flower initiation stage, I_2: one irrigation at 60 DAS i.e. at siliqua development stage and I_3: two irrigations both at 30 DAS and 60 DAS) in main plots and four levels of sulphur (S_0: no sulphur, S_1: 30 kg S/ha, S_2: 45 kg S/ha and S_3: 60 kg S/ha) in sub-plots. Results revealed that yield attributes i.e. number of siliquae / plant, number of seeds / siliqua, seed and stover yield, oil %, oil yield and sulphur uptake in seed and stover increased significantly with successive increase in irrigation levels. Sulphur application also increased yield and quality parameters significantly over control. Application of 60 kg S/ha recorded higher seed and stover yield, oil % and sulphur uptake in seed and stover which did not differ significantly with 45 kg S/ha. Irrespective of irrigation levels, there was no marked influence of sulphur on fatty acid content in mustard oil. A slight increase in sinigrin content with increase in S levels was observed. Therefore, application of 45 kg S/ha along with two irrigations at 30 and 60 DAS will be effective for higher yield and quality of mustard oil under Gangetic alluvial zone of West Bengal.

Technical Session - 6

Corporate participation in producing, marketing and recycling of genetically improved varieties

Chairman: CD Mayee

ISFS-140

A decade of bt- cotton: the way forward for the gm crops in India

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Cotton is unique crop and economically very important in India. It occupies nearly 12 m ha and ranks first in area in the world. Indian cotton encompasses several unique features in terms of production such as; growing of all cultivated species of *Gossypium,* interspecific and intraspecific hybrid cultivation, intercropping, total rained to total irrigated cropping, hand picking and from North to South variation in sowing from April to December. Although these variabilities are sustainable, the productivity fluctuations are large and range from 300 to 900 kg lint per ha with country average of 500-600 kg lint per ha. Among several reasons of low productivity, the dreaded bollworm complex is considered a major one, as the annual losses due to these pests ranges from 25 to 70 % regularly. The management of these pests relied totally on insecticide uses in several cocktail forms which resulted into several times resistance in bollworms to chemicals.

This is where the GM approach through Bt Cotton technology provided an elegent and effective option. The Bt technology was commercially permitted by Government of India in 2002. In the last decade, Bt cotton hybrid occupied nearly 92% of the total 12 m ha. This phenomenal growth of technology adoption is unparallel in the modern history of Indian Agriculture. The Bt cotton technology is highly successful in controlling bollworms, reducing pesticide uses and increasing the cotton yields. There are obviously certain country advantages of this situation. Reduced uses of chemical brought down pollution and health hazards. Enhanced yields changed the status of country from net importer to assured exporter of cotton, stabilised domestic consumption , made up for shortages of vegetable oil by cotton seed oil and made all the cotton related industries vibrant in the country.

Bt Cotton I India is a classical example of how technology can benefit farmers, consumers and users. The multiple benefits are summarized below;

1. Bt cotton halved the usage of insecticide from 46% of the total uses in 2001-02 to 21% in 2010. Prior to 2004, Bt cotton area was less than 5% and the usage of insecticide for 10 preceding years was 1.22 kg per ha. The Bt cotton occupied nearly 92% of total area now and insecticide usage average for 2005-2011 was only 0.6 kg per ha.
2. Total production jumped from 14 million bales of 170 kg each prior to 2002 to 35 million bales in 2011, with increase in productivity from 300 kg lint to 550 kg lint per ha.
3. Multiple uses of cotton as food (edible oil), feed (de oiled cake) and fibre has increased. The cotton seed and its by products, oil and meal enhanced from 0.4 million tones in 2002-03 to 1.11 million tones in 2011-21.
4. The Bt technology assisted domestic seed industry to grow and the vibrancy is seen from the fact that the

biotech seed industry market jumped two-fold from Rs. 1100 million (US $ 25 m) in 2002-03 to Rs. 24800 million (US $ 551 m) in 2010-11.

5. India's share in world cotton increased from 14% to 21%.
6. Bt cotton created vibrant ginning, spinning industry based on domestic market and export increased from 0.1 m bale to 9 m bales.
7. Bt cotton contributed to farm economy, a whopping US $ 9.4 billion during the last 10 years.
8. Based on 12 studies the profitability of cotton farmers increased to 76-250 US $ per ha.

In spite of these clear benefits of the technology, those who have never been in practical farming are advocating the ban on GM- technology either through legal or illegal means. They are bent upon stopping the trials of GM crops either by burning them or raising the issues through supreme court or parliamentary committee. However these actions shall certainly not deter the biotechnologists and government to stall the progress of GM technologies as it is sufficiently realised that for ever growing population of this country, the food security can only be achieved by the use of modern tools of molecular biology coupled with the traditional breeding.

Efforts are being made in Indian Public Research Institutions since early eighties to develop transgenic crops. The Government of India has been very supportive of the efforts to develop transgenic crops and invested liberally through the Department of Biotechnology, Department of Science and Technology and Indian Council of Agricultural Research. As a result many transgenic crops have been developed and are being tested by various public and private institutions. Currently, 7 field crop viz, sorghum, rice, chickpea, sugarcane, castor, groundnut and mustard; 4 vegetables *viz.* brinjal, potato, tomato and watermelon and one fruit crop; papaya have already been genetically modified for various traits like, insect resistance, virus resistance, abiotic stress tolerance, fruit ripening, heterosis, fungal disease resistance etc, from 15 public sector institutions are in field trials in India. Similarly, more than 15 private companies are field testing their GM crops viz., corn, rice, brinjal, tomato, cabbage, cauliflower and okra. Department of Biotechnology, Govt. of India, Indian Council of Agricultural Research (ICAR) and Department of Science and Technology (DST) are already investing huge money in the series of network projects for development of GM – crops. India is therefore, well poised for talking a huge leap forward in GM – technology. The temporary opposition to GM – food crops is being scientifically well challenged and slowly but steadily the commercialization of GM – food crops shall occur.

In spite of the clear benefits of GM – crops, the opposition mainly comes from an unknown risk that the new technology may bring. These concerns of biosafety have been adequately addressed in India by adopting set of internationally accepted procedures. The biosafety testing, risk assessment, evaluation and commercialization of GM crop involve carefully drawn guidelines which are globally accepts.

In India, with the evaluation of Bt Cotton, these guidelines of evaluation, field testing, and commercialization have been well prepared and developed. Standard organizations and bodies such as; IBSC, RCGM and

GEAC (Genetic Engineering Approval Committee) have been created to deal with the regulations of GM – crops. A set of procedures have been made available to all those interest in GM – crop research and commercialization. Post – commercial monitoring has also been very successful. Transparency of the regulatory system, its procedures and guidelines that instil public confidence in the system are vital to the success of GM – crops. With the Indian experience of last 10 years with the first GM product in field, it is well established that the current regulatory framework is fairly robust and works well.

ISFS-141

Importance of Private-Public partnership and genetically improved varieties in Indian Agriculture

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Indian agriculture is still backward in terms of productivity and very marginal in nature. It is more due to lack of application of modern technology and tools rather than the marginal size of land that makes it backward. Any application of novel technology has brought in dramatic changes as was evident in the way the dwarf wheat or rice varieties brought the green revolution in India. The example of Bt cotton shows how a single technology, use of a single gene can make a huge change in raising productivity and profits of farmers. Similarly, use of single cross hybrids is pushing productivity up in corn as it has happened due to hybrids in case of rice in China in the '70s or in Eastern India now. Globally, novel technologies have helped small or marginal farmers with limited resources, mainly in the form of genetically improved varieties as seeds are the primary carriers of technology and the adoption of a better variety needs the minimum amount of investment. But, technologies are not very easy to develop. Earlier huge public funds helped the CIMMYITs, the ICRISATs and the IRRIs to develop the mutant wheat varieties, the sorghum or pearl millet hybrids or the dwarf rice varieties. Now, the resources are shrinking for the public sector institutes globally. On the other hand, corporate sector is leading in development of the novel traits or the new genetically improved varieties. But, in Indian context, it is time for effective Public-Private- Partnership to shape the future. Private or the corporate sector alone can't do it as they lack the huge infrastructure and manpower of the public sector. Technologies developed by the joint effort will have much broader public acceptance, wider social goals and objectives and shorter gestation period. All these things bode well for Indian agriculture which is asking for cutting-edge technologies to overcome problems of flood, draught, salinity, pest and diseases, decreasing fertility, stagnation of productivity etc.

Technical Session -7

Integrated pest management including
non-pesticidal biomanagement

Chairman: MR Ghosh
Co-Chairman: C. Chattopadhyay

ISFS-142

Climatic adaptation in mass - produced biocontrol agents: Global research status and future needs

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Biological pest control has emerged more strongly in the current century, because of the wide-scale negative effects like harmful residues, besides resistance and resurgence in pest populations caused by indiscriminate synthetic insecticide use. The current addition to the requirements for successful deployment of the mass-produced biocontrol agents like parasitoids, predators and entomo-pathogens is their adaptation to harsher climatic regimes, especially to higher temperatures and lower relative humidity, which may feature more prominently in the context of global warming. The identification/development of heat tolerant and drought-hardy strains of entomophagous insects like Trichogramma has been emphasized considerably in the last few decades. In Europe, especially in the former USSR, local climatic adaptation has been given due emphasis in wide-scale deployment and impact by Trichogramma. In Eastern Africa, the author led an inter-country team in GIS-based collection and characterization for climatic stress adaptation among native Trichogrammatid species/strains and their subsequent utilization across lowland to highland ecologies. In India, recent R&D has led to high temperature tolerant strains of T. chilonis and T.japonicum being available for commercial production. The author is currently involved in an inter-state R&D program for mass production and release regime optimization for the heat tolerant T.chilonis strain towards promoting its wide-scale adoption in biocontrol of sugarcane internode borer in South India. The scope for UV-tolerance and drought hardiness has also been explored in species/strains among several microbial biocontrol agents, supplemented with fortification by effective and cost-effective UV protectants, so to stand against extended exposure to sunlight in the tropics. The future thrusts for safe-guarding the sustainability of impact of biocontrol programs are not only to further develop heat-tolerant and drought-adapted strains of promising parasitoids and predators used in augmentative biocontrol, especially in the tropics. Similar improvements are also needed in climatic stress adaptation among microbial biocontrol agents and their formulations for enhancing their field stability/survival. Tri-trophic studies should focus on the potential effects of global warming on the development and survival of the herbivores in relation to crop plants-herbivores-natural enemies' continuum should be undertaken in bench mark locations, so to evolve a model for their relative survival/mortality across the climatic regimes visualized in the target crop ecosystems. There is also good scope to identify compatible cropping system options and ecosystem adaptations that minimize/avoid the exposure of biocontrol agents to the climatic stresses.

ISFS-143

Nano-pesticides - a recent approach for pest control

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The application of synthetic pesticides has caused threat to non-target organisms and the environment due to their overuse. Since the release of xenobiotic results in the increase of environmental risk, the goal should be to use such compounds carefully so that they cause least negative impact on the environment into which they are released. To remove harmful effects on the non-target organisms, encapsulation of the active ingredient with other materials such as a polymer can allow sensitive ingredients to be physically enveloped into a protective matrix in order to protect core materials from adverse reactions due to factors like air or light. Traditional strategies like integrated pest management used in agriculture are insufficient, especially in changed climate scenario and application of persistent older pesticides have adverse effects on animals and human beings apart from the decline in soil fertility. An outcry is exhibited against the use of pesticides due to their hazardous effects on human as well as environment. There is a great concern regarding the nano materials which have potential to exert hazardous effects on human and the environment and when we have a nano-pesticide, it becomes a double edged weapon. Nanomaterials need to be evaluated, so that this novel technology does not meet the same apprehensions and bottleneck as faced by genetically modified crops.

Nanoparticles present possibilities for more efficient and effective control of pests, but our relative lack of information on how they act and how they can be contained are giving regulators pause before allowing their release into the environment. Pesticides containing nanotechnology hold promise for reducing the environmental footprint left by conventional pesticides. As EPA has noted, “these novel products may allow for more effective targeting of pests, use of smaller quantities of a pesticide, and minimizing the frequency of spray-applied surface disinfection. These could contribute to improved human and environmental safety and could lower pest control costs”. Nanotechnology research opens up opportunities of agricultural productivity enhancement involving nanoporous zeolites for slow release and efficient dosage of water and fertilizer, nanocapsules for herbicide delivery and vector and pest management and nanosensors for pest detection. The atom by atom arrangement allows the manipulation of nanoparticles thus influencing their size, shape and orientation for reaction with the targeted tissues.

We prepared nanopesticides of fungicides and insecticides and compared their efficacy with the conventional products. Nano-hexaconazole was characterized by SEM, TEM, and FT-IR etc. and it was found to be less than 100 nm in size. Patent application on Nano-hexaconazole has been filed. Nanohexaconazole is five times more effective in controlling pathogens and nanosulfur is ten times more effective for control of mites as compared is its WDP for formulations. We have to ensure the materials, we introduce in environment, are evaluated before launching.

While using a new technology, safety of the user and its affect on environment has to be considered. We tested nanohexaconazole and initiated work for preparing a protocol to test the safety of nonmaterial to be applied in field. The present study also evaluated the effect of nanohexaconazole on total microbial count, soil enzymes, nitrifying bacteria, blue- green algae and seed germination. Comparing the results of various enzyme activities, like soil dehydrogenase (DHA), fluorescein diacetate (FDA), alkaline phosphatase (Alk P), acidic phosphatase (Acid P) and microbial count after application of a nanomaterial was taken as a criterion for testing, whether such materials are causing adverse effect of soil health or not. The results are encouraging and our nanopesticide, unlike metal nanoparticles, is found to be safe. Therefore, nanotechnology has potential to provide green and efficient alternatives for the management of pests in agriculture without harming the nature.

This review is focused on traditional strategies used for the management of insect pests, limitations of use of chemical pesticides and potential of nanomaterials in insect pest management as modern approaches of nanotechnology. The process of Registration of pesticides will need to be modified and also a protocol for handling them has to be developed specially for nonmaterial. Newer technologies can be adapted with surveillance and social control for sustainable agriculture.

ISFS-144

Thus spoke agro-nanobiotech: "Crops! you never know how much scientists care, until you are under the weather"

Arunava Goswami

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As per FAO, India ranked fifth in 80% of different agricultural produce in the world in 2010 & poultry and meat production in 2011. Should we be satisfied with this excellent performance? The answer is a big `NO', because we are worried about India's burgeoning population and plateau in productivity due several factors like climate change. One of the significant outcomes of climate change is behavioral changes of pests like their sense of olfaction and gustation.

Green revolution was all about intelligent plant breeding. Plant breeders take advantage of the crossing over during first phase of meosis and generate novel genomic landscapes. Agronomists, test the elasticity of the genotype thus produced, by all Indian co-ordinated trial program, to find out which agro-climatic zone (s) could give us highest yield. The job of the entomologists and plant pathologists is to ensure that farmers can take home entire yield avoiding pest attack. Plant breeders again resort to novel genomic landscape generation when the yield plateau is observed in this genotype by introducing genes from other germplasms / varieties / land races etc.

During Green revolution, younger India was in hand-to-mouth situation in terms of import and therefore

polity could convince consumers about the need of introduction of high yielding varieties of cereals. But India is no more a young democracy. We are partially self-reliant in major food grain production. Therefore, consumers' choices have changed and now a certain section is more aware of health security of their own as well as environmental safety. They are raising serious concerns over indiscriminate use of agro-chemicals which leave behind significant amount of pesticide residue in soil and ground water. Indian Council of Agricultural Research (ICAR) made sincere effort to introduce new technology like GM technology. But technologists and companies had to face resistance from a wide spectrum of stakeholders starting from polity to consumers to activists to farmers' organizations. We have learned a lot from this experience and we must take them in a positive note.

I have worked on yet another new technology, called `nanotechnology'. Although, I would showcase a number of promising results of my students, but I would also remind you all about the precautions we must take while generating debate and dissemination of this technology to the different stake holders of the Indian democracy. We worked on different oxide (SiO_2, ZnO etc.) and sulfur nanoparticles their role in controlling pests, for example, *Sitophilus* sp., mustard aphid, *Spodoptera sp.*, *Aspergillus* sp., *Fusarium* sp., *Erysiphe* sp. etc. We have data on the biosafety of these nanoparticles in plant, *Trichoderma* sp., *Drosophila sp.*, mouse (acute toxicity) model systems. One note of caution, all these datasets, have so far been generated in my controlled laboratory conditions and have not been tested in the field conditions due to non-availability of regulatory policy about nanotech crops. In my opinion, we must undertake a field trial of the bio-safety of some nanoparticles involving different stake holders of our society, right at the beginning of the introduction of this technology in India. Otherwise, we are bound to face a GM crop like experience again.

ISFS-145

Bioinoculants with important agricultural traits for increasing productivity and eco friendly disease management

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The crops infected by plant pathogens need immediate protection through the use of chemical pesticides to maintain the productivity in our modern agriculture system but the selective and highly effective chemicals pesticides are not a long-term solution to the crop, human and animal health. Their intensive and indiscriminate use posed many serious problems including development of resistant strains of the pathogen; build up of harmful residues in the edible plants, non-target side effect of beneficial micro flora and environmental pollution etc. To avoid such problems, attentions have been diverted towards the use of bioinoculant for improving yield and the management of pests and diseases. It is well accepted and widely recognized that bioinoculant is a distinct possibility for the future and can be successfully exploited in

modern agriculture without affecting our precious ecosystem. They have been applied to various agricultural and environmental problems with considerable success in recent years. Here, I would present my work on the use of bioinoculant to enhance productivity and disease management of some medicinal and aromatic plants. They are effective only when they are presented with suitable and optimum conditions. The bioinoculant used in the present investigations were all isolated from indigenous sources and were found to be highly antagonistic against the plant pathogens of medicinal and aromatic plants (MAPS) *in vitro* test. Some of them showed growth promotion activity. They were identified as strains of *Bacillus* sp., *Pseudomonas, Streptomyces* and *Trichoderma harzianum.* They *have* been used either alone or in different combinations along with different arbuscular mycorrhizae (*Glomus aggregatum, G. fasciculatum G. intraradices G. mosseae*) as potential bioinoculant for the yield improvement of geranium and pyrethrum and protection from the attack of the diseases caused by fungal pathogens. The results would be presented and discussed.

ISFS-146

Integrated pest management in tea: prospects and future strategies in Bangladesh

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Tea as a perennial crop is grown in single stand on large contiguous areas. Tea plant is attacked by many pests-1034 species of arthropods and 82 species of nematodes are associated with tea world over. Among these 25 species of insects, 4 species of mites and 10 species of nematodes are recorded from Bangladesh. Crop losses enormous due to the attack of these pests and is largely responsible for declining productivity of tea. Extensive use of chemical pesticides began a few decades ago with immediate economic gains but its abuses were not foreseen or were ignored. As a consequence pest resistance to pesticides, pest resurgence and undesirable pesticide residue in the made tea has appeared as major problems. Current trends in eco-friendly insect pest management practices emphasize the host plant resistance, preparation and application of new botanicals and microbial pesticide formulations, mass rearing of biocontrol agents, field evaluation of bio-efficacy and conservation of biological agents, cultural control measures, genetic techniques in pest and vector management, and pheromones, attractants and repellents. In tea husbandry, cultural control measures such as plucking, pruning, shade regulation, field sanitation, fertilizer application, manipulation or destruction of alternate hosts and selection of pest resistant/tolerant varieties and mechanical mechanisms like manual removal, heat treatments, light traps, use of biopesticides, bio-control agents and sex pheromone

trap need to be given more importance in pest management programme. A tentative IPM system for tea cultivation in Bangladesh has been proposed. In the system, both natural enemies and insecticides are used complementarily. The proposed integrated approach for pest control is expected to help tea industry In Bangladesh.

ISFS-147

Identification of antifungal and antiviral potential of *Ganoderma*, the medicinal mushroom for the management of sheath blight of Rice and *groundnut bud necrosis* virus in cowpea

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Eighteen mushrooms, both wild and cultivated types were collected as part of a survey conducted at Yercaud, Salem and Coimbatore Districts in Tamil Nadu and were screened against plant pathogens for the presence of antifungal activity. The antagonistic effect of the mushrooms against each fungus was tested by dual culture technique. Among them, *Ganoderma* sp. exhibited antifungal activity against Rice sheath blight pathogen, *Rhizoctonia solani* Kuhn. Six solvents were tested for their efficacy in extracting the antifungal principle. Diethyl ether was the most efficient one in extracting the antifungal metabolite from the culture filtrate of the mushroom. Poisoned food technique at 20 and 25% concentration of *Ganoderma* diethyl ether extract caused 100% inhibition of mycelial growth from the sclerotia of the pathogen. Thin Layer Chromatography could identify the presence of purple and blue coloured spots when vanillin sulphuric acid and folin ciocalteau spray reagents were used respectively. This reveals the identification of two new compounds from the culture filtrate of the mushroom. Further, characterization of the diethyl ether extract through Gas Chromatography-Mass Spectrometry could identify two molecular ion peaks. The structure of the compound was elucidated. The diethyl ether extract was further used to develop an Emulsifiable Concentrate *viz*., ganosol and the miminum concentration was standardized. A glasshouse experiment was conducted to study the effect of Ganosol 10 EC on sheath blight incidence in rice. Pre inoculation spray of Ganosol 10 EC (0.25 %) caused 63.62 per cent reduction of lesion length produced by sheath blight pathogen. The antiviral effect of the formulation on *Groundnut bud necrosis virus* (GBNV) infection was studied on cowpea (local lesion host cv C-152). Spraying of cowpea plants with the formulation reduced the number of lesions to a significant level when compared to the inoculated control. Simultaneous spray of the formulation and virus inoculation exhibited antiviral property (88.39 %) against GBNV while under micro plot studies.

ISFS-148

Pseudomonas aeruginosa SD12 with important agricultural traits for growth promotion, disease management and bioremediation

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Pseudomonas aeruginosa is one of the most common soil inhabitants which play important roles in promoting plant growth and suppression of soil-born plant pathogens. It survives in soil and colonizes on root surfaces. It produces an array of primary and secondary metabolites having diverse agriculture and industrial importance. A heavy metal resistant strain SD-12 was isolated from tannery effluent polluted soil and was identified as *Pseudomonas aeruginosa* on the basis of phenotypic traits and by comparison of 16S rRNA sequence homology. The present strain of *P. aeruginosa* exhibits a broad-spectrum antifungal activity towards phytopathogenic fungi that infect several medicinal and aromatic plants. Its broad spectrum activity has been demonstrated due to production of secondary metabolite/s one of whose structure has been confirmed as 1-hydroxyphenazine by 2D-NMR spectroscopic analysis. The strain is capable of producing siderophores, HCN and phosphatase solubilizing for inorganic phosphate, and extracellular hydrolytic enzymes such as proteases, pectinases and cellulases with different catalytic properties. The strain was tested as a biocontrol agent against root rot & wilt disease of pyrethrum caused by *R. solani*. Its application under glasshouse condition significantly ($P<0.05$) increase the biomass of *Oscimum basilicum*. It also helped in augmenting Cr uptake and increased the shoot and root biomass of the plant growing under heavy metal contaminated soil. Microscopic studies revealed that the Cr accumulation resulted in dehydration and collapse of anatomical structure. Thus, the strain may be utilized as a biofertilizer, biocontrol agent and for bioremidiation of heavy metal polluted soils.

ISFS-149

Effect of temperatures on infectivity and multiplication of entomopathogenic nematodes against shoot borer (*Conogethes punctiferalis*) infesting ginger (*Zingiber officinale*)

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Infectivity of eight native isolates of entomopathogenic nematodes (EPNs), *Heterorhabditis* sp. (IISR-EPN 01), *Steinernema* sp. (IISR-EPN 02), *S. ramanai* (IISR-EPN 03), *S. carpocapsae* (IISR-EPN 06), *Oscheius* spp. (IISR-EPN 04, 05, and 08) and *O. gingeri* (IISR-EPN 07) against larvae of shoot borer (*Conogethes*

punctiferalis) infesting ginger (*Zingiber officinale*) and their multiplication at different temperatures *viz*., 20, 25, 28, 30 and 35 ^{0}C was studied. The rate of larval mortality and multiplication of nematodes varied among EPNs and temperature regimes. Maximum mortality of larva was found at 30 ^{0}C followed by 25 ^{0}C, whereas the least mortality of larva was recorded both at 20 and 35 ^{0}C. Maximum number of infective juveniles was yielded at 30 ^{0}C followed by 28 ^{0}C; minimum multiplication was recorded at 35 ^{0}C. Among the test EPN isolates, no multiplication of *Heterorhabditis* sp. (IISR-EPN 01), *S. ramanai* (IISR-EPN 03) and *O. gingeri* (IISR-EPN 07) was recorded at 20 ^{0}C, whereas, *Heterorhabditis* sp. (IISR-EPN 01), *Steinernema* sp. (IISR-EPN 02), *Oscheius* sp. (IISR-EPN 04) and *S. carpocapsae* (IISR-EPN 06) did not multiply at 35 ^{0}C. This study indicated that a temperature of 30°C is optimum for multiplication of EPN species and mortality of shoot borer larva and for obtaining the maximum number of IJs to be used for research or field application.

ISFS-150

Weeds as major biotic stress and their chemical management in direct seeded rice

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Weeds are a great menace in direct seeded rice (DSR) during rainy season and their inadequate management often leads to severe loss in grain yield. Field conditions are also more conducive in direct seeded condition for the germination of weeds, which competes with rice for different growth-limiting resources. Among different crop pests, weeds also pose major biotic stress in relation to agricultural productivity. Manual removal of weeds is labour-intensive, tedious, back breaking and does not ensure weed removal at critical stage of crop-weed competition. Although herbicides do well, many times their pre-emergence application is not possible because of sowing pressure and unfavorable climate. Metamifop [(*R*)-2-{4-(6-chloro-1, 3-benzoxazol-2-yloxy) phenoxy}-2′-fluoro-*N*-methyl propionanilide] is a new post-emergence herbicide for controlling mainly annual grasses in rice culture. In this background, a field experiment was conducted during *kharif* season of 2009 and 2010 at the Rice Research Station, Chinsurah, Hooghly, West Bengal to evaluate the bio-efficacy of new chemicals against weeds in DSR. The experiment was laid out in a randomized complete block design with six treatments replicated four times. The treatments comprised of post-emergence (POE) application of metamifop 10 EC (75 and 100 g ha^{-1}) at 12-15 days after sowing (DAS) or 2-3 leaf stage of grasses, cyhalofop butyl 10 EC (100 g ha^{-1}) at 15 DAS (POE), weed free, two hand weedings (20 and 40 DAS) and unweeded check. Results revealed that average yield loss was 35.46% due to

intense crop-weed competition in unweeded plots having prolific weed growth. Though the highest grain yield was recorded under weed free treatment (3.28 t ha^{-1}), it was comparable with two rounds of hand weeding (3.12 t ha^{-1}), metamifop at 100 g ha^{-1} (3.05 t ha^{-1}) and cyhalofop butyl at 100 g ha^{-1} (2.94 t ha^{-1}). Higher yields under these treatments might be due to improvement in yield attributes owing to effective suppression of weeds.

ISFS-151

Investigation on the biology of papaya mealy bug, *Paracoccus marginatus* Williams and Granara de Willink (Pseudococcidae: Hemiptera)

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Papaya mealybug, a polyphagous insect pest is causing serious damage of agricultural and horticultural crops in India ever since it was first reported from Coimbatore in 2007. It has a wide host range of over 60 species of plants. A laboratory investigation was carried out to know the biology of *Paracoccus marginatus* on sprouted potato tubers for five months from September 2011 to May 2012 at ambient temperature and relative humidity. The female nymphs moulted three times to become adult females while the male nymphs moulted four times to become winged adult males. The male and female nymphs took longest period to complete their life stages during February-March 2012 when maximum and minimum temperature and relative humidity ranged from 14^0C-31^0C and 24-95 percent respectively. During September, they took lesser days to complete their development and when maximum and minimum temperature and relative humidity ranged from 24^0C-32^0C and 76-99 percent respectively. The ratio of female to male varied from 1.2:1 to 2.8:1. Males took highest number of days for its development during December-January when temperature ranged between 8^0C-19^0C while for female nymphs the same was during November when temperature ranged between 16^0C-28^0C. The pre-reproductive period of adult female varied from 2-9 (5.42 ± 0.75) days to 7-13 (11.75 ± 0.84) days in different generations of the year. The minimum period was observed in September at 28^0C-29^0C and 87-98 per cent relative humidity. The females laid 135-145 eggs during the longest period of oviposition of 8-11 (11.6±0.50) days at 10^0C-14^0C and 70-97 per cent relative humidity in December-January. September month was most preferred period for oviposition when fecundity rate was 158-295 at 22^0C-30^0C and 85-99 per cent relative humidity.

ISFS-152

Sensitivity of *Alternaria solani* against different fungicides under laboratory and field condition

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Early blight of potato caused by *Alternaria solani* Soraver is a common and widespread foliar disease causing severe crop losses in every cropping season in West Bengal. An experimental trial was conducted to detect the protective and curative action of different fungicides i.e, Indofil M-45 (mancozeb), Indofil Z-78 (Zineb), Ditto (Thiophanate Methyl), Blitox (Copper oxychloride), Kavach (Chlorothalonil), Cabrio (Pyraclostrobin + Metiram), Amister (Aoxystrobin), Ridomil M (Metalaxyl + Mancozeb), Antracol (Propineb) and Bavistin (Carbendazim) against *A. solani* under *in vitro* condition at five different concentrations (50ppm, 100ppm, 150ppm, 200ppm and 250ppm). Among the tested fungicides, Cabrio (Pyraclostrobin + metiram) @ 250ppm was observed to be most effective in inhibiting mycelial growth (83.4%) and conidial germination (81.1%) of *A.solani.* Next to Cabrio was Indofil M-45 @ 250ppm forf mycelial growth inhibition (81.1%) and conidial germination (80.0%). Efficacy of pyraclostrobin + metiram was evident from the result and its projected EC_{50} value was 22.96 µg/ml for mycelial growth and 22.64 µg/ml for spore germination inhibition respectively. Next best efficacy was shown by mancozeb, where, EC_{50} value was 31.18 µg/ml for mycelial growth and 45.39 µg/ml for spore germination inhibition respectively. Under field studies on susceptible potato cultivar i.e, Kufri Chandramukhi, all the tested fungicides were found to be effective to control the development of early blight of potato. Out of ten fungicides, mancozeb @ 0.3% was found to be the most effective by decreasing the disease severity (10.8%), increasing the PEDC (84.8%) and tuber yield (307 q/ha) as compared to control.

ISFS-153

Biodiversity and seasonal activity of arthropod fauna in brassicaceous ecosystems in medium altitude hills of Meghalaya, north east India

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Brassicaceous crops (rapeseed, mustard, toria and sarso) are the major seasonal cash crops in Meghalaya region, used as either green vegetables or oilseeds. Diversity of insect pests and their natural enemies were conducted on brassicaceous crops during 2010-11. Three species of aphids *viz., Lipaphis erysimi*, *Brevicoryne brassicae* and *Myzus persicae* and large white cabbage butterfly (*Pieris brassicae*) were

recorded as major pests of brassicaceous plants pentatomid bugs (*Nazara viridula*), flea beetle (*Phylletreta cruciferae*), leaf beetle (*Monolepta signata*), saw fly (*Athalia lugens proxima*) and small white cabbage butterfly (*Pieris rapae*) were observed to be the minor pests. Natural enemies of this pest recorded brassicaceous include mainly predators of aphid *viz*., coccinellid beetles, syrphids flies and spiders. Parasitoids include nymphal-adult parasitoid of aphids, *Dietiriella repae*, larval parasitoids of cabbage butterfly, *Hyposoter ebeninus* and *Cotesia glomerata.* Besides, several hymenopteran wasps (Ichneomonids, Chalcids and Encyrtids) were also observed during flowering stage. Additionally, four species of syrphid flies and spiders were also recorded. Major predators of aphids were *Coccinella septempuncata* complex, *C. transvarsalis* complex; *Micraspis discolor* complex, *Oenopia kirbyi* and *Oenopia sexareata***.** Information generated by this study would be helpful in documenting the biodiversity of arthropod fauna associated with brassicaceous crops in the region.

ISFS-154

Efficacy of eco-friendly pesticides for control of leaf webber (*Glyphodes pyloalis* Walker) (Lepidoptera : Pyralidae) on mulberry (*Morus alba* L.) of Kalimpong area

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Mulberry (*Morus alba*) the sole food plant of silkworm (*Bombyx mori* L.) is prone to attack by varied pests. Among the insect pests, the leaf webber *Glyphodes pyloalis (Lepidoptera : Pyralidae)* has gained considerable notoriety in sericultural areas of Kalimpong and Sikkim for causing leaf yield loss about 9.05 – 16.75% during July-September. The early stage larvae inhabit the apical part of the mulberry shoot and feed on the tender epidermis of lower surface of mulberry leaves. The grown up larva devours from the edge of the leaves and folds the lamina partially with silken thread, ultimately reducing leaf productivity and quality. As chemical control has already proven hazardous for hilly regions, bioefficacy of eco-friendly pesticides like Pongamia oil, Neem oil and Agro spray oil with three different doses 0.5% ,1% & 1.5% were evaluated for management of the pest. Pongamia oil was found very effective for reducing the pest population up to 15 days after spray followed by Neem oil and Agro spray oil. Bioassay of the three pesticides on bivoltine silkworm race (SK6 x SK7) showed that mortality of silkworm is very low in case of neem oil followed by Agro spray oil and Pongamia oil after 15 days of spray. Bioassay with Neem oil solution revealed that feeding of 1% neem oil treated mulberry leaves resulted 93% ERR (Effective rate of rearing) and 19% S.R. (Silk ratio) which is on par with the control lots. Based on the economics and residual toxicity on silkworm, 1% neem oil (azadirachtin 1500 ppm) was found as effective alternative to chemical pesticide for controlling leaf webber in Mulberry.

ISFS-155

Evaluation of some biopesticides for the management of shoot and fruit borer (*Earias vitella* (Fab.)) of okra

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A field study was conducted to evaluate the efficacy of some biopesticides (Spinetoram, emamectin benzoate, chlorfenapyr, B.t., spinosad and azadirachtin) for the management of shoot and fruit borer of okra, during pre *kharif* season of 2009 and 2010 at the University research farm, Bidhan Chandra Krishi Viswavidyalaya. Results showed that Spinetoram 50 g a.i/ha was superior over other treatments against *Earias vitella* (Fab.) with overall mean shoot and fruit infestation as 4.01%. The next effective treatment was Emamectin benzoate 18 g a.i/ha (5.61% overall mean shoot and fruit infestation in okra) followed by Spinosad 75 g a.i/ha (5.87%), Chlorfenapyr 125 g a.i/ha (7.42%), B.t. (9.47%) and Azadirachtin 1% (10.68%) respectively. The same trend was followed in case of yield also. Spinetoram recorded the highest undamaged fruit yield (71.45 q/ha) followed by Emamectin benzoate, Spinosad, Chlorfenapyr, B.t. and Azadirachtin. Spinetoram (mixture of spinosyn J and L) is a new member of the spinosyn class of insect management tools derived from fermentation of *Saccharopolyspora spinosa* and provide long lasting control of a broad spectrum of insect pests in a variety of crops. It is applied at low rates and has low impact on beneficial insects, it has favourable toxicological and environmental attributes than spinosad and is effective in controlling a variety of lepidopteran pest. From the experiment, it was found that Spinetoram was the best insecticide among the against shoot and fruit borer of okra.

ISFS-156

Study of yeast flora of fruits and their *in vitro* screening for antagonistic property against *Penicillium digitatum*

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One Hundred fifty (150) samples of different types of fruits orange , green grape, fig , dried date and apple were collected from different markets of (N) 24 Parganas of West Bengal, India in sterile biodegradable polyethylene bags. Isolation of different yeasts were done from the washing of the fruit samples by using

dilution plating method on MA medium. From these samples 480 yeast colonies were isolated and were identified by conventional morphological, microscopical and biochemical. These isolets belongs to 13genera and 20 species of yeasts. *Candida* and *Rhodotorula* each yielded four species. All yeast species isolated were screened by dual culture plate method for their antagonistic property against *Penicillium digitatum*, causal pathogen of *Penicillium* rot of citrus. Out of 20 species of yeasts, 15 species are antagonistic to *Penicillium digitatum* . *Candida guilliermondii* gave maximum percent inhibition of growth (75.50) followed by *Candida famata* (70.56) *Rhodotorula mucilaginosa* (68.21), *Debaryomyces hansenii* (58.00 PIRG*)*. These fruits are good habitats of various yeast species and the antagonistic yeasts can be tested and pursued further for biological control of post harvest *Penicillium* rot disease of citrus.

ISFS-157

Morphological variation of some *Alternaria* species infected on different floricultural plants

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Many different species of *Alternaria* are important necrotrophic fungal pathogens of tuberose, marigold, rose, gladiolus and other floricultural crops. Characteristic symptoms of this pathogen group are dark brown to black spots with concentric rings giving a target board effect. The loss due to this pathogen causing disease is widely varied between 10-90% according to host, time of attack and environmental conditions. Variability among isolates of *Alternaria spp.* obtained from different crops was determined based on conidial morphology the isolates. The conidia of *Alternaria* spp. isolated from tuberose, rose, marigold and gladiolus varied in length, breadth, beak size, septation within the host species. The rose isolate showed a varied length of conidia without beak 6.91-29.73µm, varied beak length 0.0-6.16µm, varied length of conidia with beak 7.93-32.30µm, width of conidia varied between 3.71-10.12µm varied number of horizontal septation 1-5, vertical septation varied between 0-1 and oblique septation varied between 0-1. In case of marigold, the length of conidia with beak varied between 21.45-44.42µm, length of conidia without beak varied between 16.41-43.76µm, beak length varied between 0.0-10.26 µm, width of conidia 9.40-17.71µm. Similarly, horizontal septation varied between 2-5, vertical septation varied between 0-3 and oblique septation 0-1. In case of tuberose, length of conidia with beak varied between 17.28-64.30µm, length of conidia without beak varied between 14.44-46.98µm, beak length varied between 0.0-17.32µm, width of conidia varied between 4.68-16.49µm. Horizontal septation varied between 2-7, vertical septation varied between 0-2 and oblique septation varied between 0-1. Similarly, in gladiolus, different morphological characters were showed among the 30 observations taken. Length of conidia with beak varied between 15.96- 41.16µm, length of conidia without beak varied between 13.85-36.02µm, beak length varied between 0.0-9.19µm, width of

conidia varied between 3.23-9.43µm. Horizontal septation varied between 2-8, vertical septation 0-4 and no oblique septation was observed. Cultural characteristics like colony size, colour of substrates, zonation, and growth characteristics wesre also different on different media, this is an important useful characterstic to differentiate among four *Alternaria* spp.

ISFS-158

Rodent pest in India and their management

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Rodents are serious non- insect pests of tropical agriculture causing enormous losses to crops and stored grains. Rodents including rats, mice, bandicoots, gerbils, squirrels, and porcupines are gnawing animals having chisel like teeth. They have highly developed sense of smell, taste and hearing; omnivorous and feed on grains, vegetables, fruits, meat and other products in the houses or in the field. The rodent fauna of the Indian sub-continent is represented by 46 genera and 128 species. The important species causing damage to crops are *Bandicota bengalensis, Rattus meltada, Tatera indica , Milarda meltada, Mus booduga, Hystrix indica, Bandicota indica, Funambla* spp. In India, rodents have been estimated to cause 5 to 10% losses in rice. Rodents do not spare any variety and they attack all stages of the crop during all seasons. Severity varies with season, location and ecosystem. Crop protection specialists usually recommend control programs based on integrated pest management (IPM) technologies involving the use of rodenticides in combination with various techniques of habitat manipulation. Trapping, proofing, bait poison are effective methods for rodent control incorporated with indigenous technical knowledge (ITK). Rodenticides like Aluminum phosphide, Zinc phosphide, Bromodiolone, Coumachlor, Coumatetralyl and Warfarin used at recommended doses is an ideal approach of rodent control.

ISFS-159

Management of rhizome rot of ginger

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Data on disease development recorded at 90th, 120th, 180th and 210th day after planting (DAP). Maximum disease development was recorded at 150th DAP in all the treatments which decreased from 180th day onwards. Highest disease development (28.50 %) was observed in control plots where ginger rhizomes were inoculated with the pathogen (*Pythium myriotylum*) prior to sowing. Copper oxychloride rhizome treatment

effectively reduced disease development (5.16%) at 150th DAP in the field. Neem extract rhizome treatment was least effective in reducing disease development (12.45 % at 15th DAP). Among the growth parameters, maximum plant height of 46.46 cm was recorded in plots with *Trichoderma* spp + neem extract rhizome seed treatment, followed by copper oxychloride rhizome seed treatment (45.28 cm). Lowest plant height (40.22 cm) was recorded in plots with neem extract rhizome seed treatment on the last day of observation. Maximum number of tillers per hill (11.49) was recorded from rhizome treatment with copper oxychloride + neem extract at 180th day of observation. This was followed by rhizome treatment with copper oxychloride (10.54). Minimum (6.56) tillers per hill was recorded in control plots. In respect to yield, even though all the treatments were on par, highest yield (3.55 kg/plot) was observed in plots with copper oxychloride rhizome seed treatment. Projected per hectare highest yield (59.14 qts/ha) was recorded in plots with copper oxychloride rhizome seed treatment followed by copper oxychloride + neem extract (49.30 qts/ha). The lowest projected yield (9.98 qts/ha) was recorded in control plots where rhizomes were inoculated with the pathogen (*Pythium myriotylum*).

ISFS-160

Management of late leaf spot of groundnut by different fungicides

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In vitro experiments were carried out with *Cercospora personata* isolate to determine its sensitivity to different fungicides *viz.,* Tebuconazole at different doses, Folicur (0.10%) and Mancozeb (0.30 %) using poisoned food technique both in solid and liquid medium. There was no significant difference among the fungicides doses in their efficacy against *P. personata*, compared to control in solid medium. However, there was significant difference between the fungicides in per cent inhibition against mycelial growth of the fungus. Tebuconazole 0.4% showed highest inhibition (87.97 per cent) followed by Tebuconazole 0.2% (85.24 per cent) and Tebuconazole 0.15% (83.50 per cent). Application of Tebuconazole (0.15%) in the field gave best result and reduced disease intensity to 52.42 per cent. Area under disease progress curve (AUDPC) greatly varied among different fungicidal treatments and which showed significant differences in yield also. Tebuconazole (0.15%) gave best result and increased yield up to 67 per cent.

ISFS-161

Physiological implications in certain Lepidopteran insects due to nano silver exposure and bioaccumulation

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In recent years, the advent of nanomaterial use has increased exposure rates and raised health concerns. Silver nanoparticles are the most common nanomaterial added to commercially available products, so understanding their influence on certain animals and plant communities is integral to the safe use of these new products. We studied the physiological effects produced in the two major castor (*Ricinus communis* L.) *viz*. insects- castor semilooper (*Achaea janata)* and the Asian armyworm (*Spodoptera litura*) due to the nano-silver exposure. Comparison of developmental progression amongst groups of insects ingesting different concentrations (500-4000 ppm) of silver as nano particles form (Ag NP), as well as silver nitrate ($AgNO_3$) the bulk form of silver, revealed that larval growth rates were affected to some extent. The larval weight was significantly influenced due to the treatments with both the forms of silver, in bulk as well as nano forms. $AgNO_3$ treatments caused reduced larval growth with increase in concentrations to the test insects, *A. janata* and *S. litura*. Larvae had a higher growth rate when fed with untreated leaves compared to AgNP and $AgNO_3$ treated castor leaves, suggesting that silver slows down larval growth in both the species. Between the treatments, developmental rates of larvae were higher in AgNP treated leaves than the $AgNO_3$ treated castor leaves. Caterpillars exposed to different silver treatments regulate their internal silver concentration through excretion of highly metal-concentrated feces which is indicated through Atomic absorption spectroscopy (AAS) and demonstrating that there was negligible absorption in the larval body mass. This research provides evidence that nanoscale silver particles are less toxic to *A. janata* and *S. litura* than silver from silver nitrate.

ISFS-162

Integrated disease management of *Sclerotium oryzae* (Cattanoe) causing stem rot of rice (*Oryza sativa* L.)

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Soil-borne plant pathogenic fungi cause heavy crop losses all over the world. With variable climate from region to region, most crops grown in India are susceptible to diseases caused by soil-borne fungal pathogens. Certain well-studied chemical pesticide management strategies are available for reducing damage by *Sclerotium oryzae*, but increasing awareness about the health hazards and environmental problems due to the use of chemical pesticides resulted in the development of Integrated Disease Management. In an attempt to develop effective biocontrol system for management of stem rot disease in rice, 20 bacterial isolates were evaluated for their antagonistic activity against *Sclerotium oryzae* (Cattanoe). The antagonists were selected based on their ability to inhibit the external growth of *Sclerotium oryzae* from infected rice seedlings. Three bacterial isolates *viz.*, SRR-1, SRR-3 and SRR-6 were identified as potent antagonists of S*clerotium oryyzae* by dual culture technique. The potential bacterial bioagent SRR-1 was found to be most compatible with the systemic fungicide thiophanate methyl (95.70%) and also with insecticide cartap hydrochloride (91.69%).In the present study, integrated management of stem rot disease of rice using a combined application of antagonistic bacteria and fungicides was performed. The potential bacterial bioagent SRR-1 was found to be most compatible with the systemic fungicide thiophanate methyl (95.70%) and also with insecticide cartap hydrochloride (91.69%). The results indicated that the application of these native micro-organisms successfully decreases the stem rot incidence and also increases the plant growth parameters, *viz.* grain yield/hill (29.41 g), straw yield/hill (36.12 g), panicle weight (12.34 g), panicle length (34 cm), filled grain level (88.57%) and grain weight (19.09 g per 1000 grains) of the plants. The plant growth promoting activity and disease control ability of these microbial agents are discussed.

ISFS-163

Integrated weed management in transplanted *kharif* paddy in the inceptisol of West Bengal

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A field experiment was conducted at C-Block Farm of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India, during *kharif* season for two years (2008-10) to study the effect of Integrated Weed Management in transplanted paddy (IET-4786). The experiments were conducted with 8 treatments replicated thrice in RBD. Chemicals used in this experiment was Oxyfluorfen 23.5% EC as pre-emergence at 2 DAS. The treatments were as follows: Oxyfluorfen 23.5% EC @ 100 g ha^{-1}, Oxyfluorfen 23.5% EC @ 200 g ha^{-1}, Oxyfluorfen 23.5% EC @ 300 g ha^{-1}, Oxyfluorfen 23.5% EC @ 400 g ha^{-1}, *Parthenium* extract and *Calotropis* leaf extract @ 5% at 2 DAS + Hand Weeding at 21 DAS, Pretilachlor 30.7% EC at 2 DAS + Hand weeding at 25DAS, Hand weeding 15 DAS + Wheel hoe at 30 DAS and Unweeded control. Among all the treatments, Pretilachlor 30.7% EC at 2 DAS + Hand weeding at 21 DAS recorded minimum weed population as well as biomass. Grain yield was maximum in Pretilachlor 30.7% EC at 2DAS + Hand weeding at 21 DAS (4.371 t ha^{-1}) which is statistically at par with Hand weeding 15 DAS + Wheel hoe at 30 DAS (4.104 t ha^{-1}). No phytotoxicity was recorded in paddy crop.

ISFS-164

Weed management as influenced by Clodinafop-Propargyl 15% WP in wheat

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A field experiment was conducted at Kalyani C-Block Farm of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India, during 2008 and 2009 in *rabi* season to study the bio-efficacy and phytotoxicity of Clodinafop-Propargyl 15% WP on wheat. The experiment was conducted with seven treatments replicated thrice in RBD with the wheat variety PBW–343. Dominant weed flora were *Echinochloa colona, Digitaria sanguinalis and Eleusine indica* (grass)*, Cyperus rotundus (sedge) and Chenopodium álbum, Scoparia dulcis, Melilotus alba, Cirsium arvense, Melilotus alba, Gnaphalium luteoalbum* and *Vicia hirsute* (Broadleaf). Sedge weed, *Cyperus rotundus* was dominant among the all monocot and dicot weeds.

Clodinafop-Propargyl 15% WP @ 120 g a.i./ha showed highest efficacy in controlling the weed flora than its lower doses and the standard Clodinafop-Propargyl (Pyroxofop-Propargyl) (TOPIC) used in this experiment. The same dose also provided higher grain yield (3.274 t/ha) than weedy check. Clodinafop Propargyl 15% WP herbicides at their respective doses did not cause any phytotoxicity.

ISFS-165

Management of late blight of potato through seed treatment with the fungicide Cymoxanil 8% + Mancozeb 64%

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A trial was conducted during 2010 and 2011 at Instructional Farm, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India. The test fungicide was applied as seed dresser at different dose based treatments, viz T_1 Curzate M8 72%WP (Cut tubers), T_2 Curzate M8 72%WP (Cut tubers) T_3 Curzate M8 72%WP(Cut tubers) T_4 Curzate M8 72%WP(whole tubers), T_5 Curzate M8 72%WP (whole tubers), T_6 Curzate M8 72%WP (whole tubers) T_7 Curzate M8 72%WP + Non ionic surfactant (whole tubers), T_8 Curzate M8 72%WP + Non ionic surfactant(whole tubers), T_9 Curzate M8 72%WP + Non ionic surfactant (whole tubers), T_{10} Control (cut tubers) and T_{11} Control(whole tubers). The required amount of seeds of potato were taken in big size earthen pot previously filled with required doses of Curzate M-8 72% WP. In three separate pots Dupont made non ionic surfactant was mixed with Curzate M8 72% WP and the required amount of potato seed tubers immersed for 10 minutes in the mixture of test fungicides after treating the seeds they were kept in shade for 30 minutes for air dry. Then the seeds were sown in 5x4 m plots with a spacing with three replications. All the treatments with different doses were found significantly superior over untreated control. The yield was also higher in treated plots.

ISFS-166

An approach for the management of rhizome rot complex of ginger

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India ranks first in production and second in area of ginger in the world. Major ginger growing states are Meghalaya, Kerala, Arunachal Pradesh, Mizoram, Sikkim and West Bengal. Production of ginger in these states, particularly West Bengal planing is affected due to the attack of rhizome rot complex of ginger caused by *Pythium*, *Fusarium* and *Ralstonia*. An experiment was made to check the disease complex using different treatments. Of the six treatments, seed treatment with *Trichoderma harzianum* (250 g formulation in 10 litre of water for 10 Kg of seed rhizomes) was found to be the best treatment in reducing the disease incidence at different phases of crop growth. This treatment reduced 68.49% disease over control and was closely followed by seed treatment with Metalaxyl (8%) + Mancozeb (64%) @ 1.25 g/litre of water (100 ppm Metalaxyl) which showed 66.07% disease reduction over control. These 2 treatments produced yield of 10.66 t/ha and 9.43 t/ha respectively. Highest Cost: benefit ratio of 1: 2.10 was also found in the best treatment.

ISFS-167

Management of causal agents of chilli leaf curl complex through biofriendly approaches

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Chilli leaf curl complex cances serious crop loss in Sundarban islands and occurs primarily due to attack of thrips and yellow mite followed by invasion of chilli leaf curl virus. Attempts were made towards management of thrips, mite and leaf-curl virus vectors to minimize the loss. Overall seven treatments were taken up for study having two chemical formulations namely Profenophos 50 % EC at 15 days interval and Diafenthiuron 5% WG @ 15 days interval; three biological and botanical approaches comprising of garlic extract @ 20 ml/lt of water, **r**ectified spirit @ 20 ml/lt of water at 15 days interval and alternate spray of garlic extract @ 20 ml/lt of water and rectified spirit @ 20 ml/lt of water at 15 days interval; intrusion through use of predatory insect (*Chrysoperla carnea* grubs @ 2/plant at 15 days interval) and one untreated control.

Lowest population of thrips and yellow mite was recorded with application of Diafenthiuron 5% WG at 15 days interval from seedling stage to early fruiting stage. Amongst the botanicals, combination of garlic extract and rectified spirit performed better than solitary application. From economical point of view, both Diafenthiuron as well as combination of garlic extract plus rectified spirit proved effective and may be suggested for field application.

ISFS-168

Efficacy of bioagents and neem products for management of root knot nematode (*Meloidogyne incognita*) in tuberose

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A field experiment was conducted on Central Research Farm at Gayespur of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India to determine the efficacy of bioagents and neem products for control of root knot nematode (*Meloidogyne incognita*) in tuberose. Tuberose cultivar, Calcutta single was grown in a sick-plots (1.8m × 1.2m) and each plot was transplanted with 42 infested bulbs with spacing between the plants as 30cm×30cm. Total eight treatments were taken in this experiment and the treatments are T_1 - Neem cake @ 1.0t/ha, T_2 - *Paecilomyces lilacinus* @ 5kg mixed with FYM 5t/ha, T_3 - *Trichoderma harzianum* @ 5kg mixed with FYM 5t/ha, T_4 - *Pseudomonas fluorescens* @ 5kg mixed with FYM 5t/ha, T_5 - *Pochonia chlamydosporia* @ 5kg mixed with FYM 5t/ha, T_6 - Carbofuran @ 1 kg a.i./ha, T_7- Neem seed powder @ 5g/ plant and T_8 - Untreated control. All the treatments were observed superior over control. Among the treatments, T_2 exhibited significantly superiority in reduction of nematode population (149.60 J_2 per 5g root) and reducing root galling (gall index ~2.00) which was on par with T_3 (168 J_2 per 5g root and gall index~ 2.07). This was followed by T_6 (228 J_2 per 5g and gall index ~ 2.13) and T_1 (238 J_2 per 5g gall index~ 2.20). Relatively low soil nematode population (616 J_2 per 200cc soil) and maximum yield (2742.28 kg/ha) of cut flower was recorded in T_2 which was followed by T_3 (1130 J_2 per 200cc soil and yield- 2406.28 kg/ ha) and T_6 (1069 J_2 per 200cc soil and yield- 2239.19 kg/ha). Further, total stalk length (66.08±4.81), inflorescence length (27.26±1.73) and total number of florets (25.48±1.57) were also highest in T_2.

ISFS-169

Study on plant growth promoting activity of some local *Trichoderma* isolates and their field performance against sheath blight of rice in old alluvial zone of North Bengal

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Five *Trichoderma* isolates were isolated from old alluvial zone soil of North Bengal, India and their biocontrol activity was tested in dual culture against four soilborne plant pathogens, namely, *Fusarium oxysporum*, *Macrophomina phaseolina*, *Rhizoctonia solani* and *Sclerotium rolfsii*. Efficacy of all the isolates for plant growth promoting activity was also tested with culture filtrate of the isolates. The isolates had varied effect on seed germination, plant growth and vigour, where, the isolate, *Trichoderma* B18 showed negative results. A field experiment was conducted to evaluate their field performance against sheath blight of rice caused by *Rhizoctonia solani*. A talc based bioformulation for each of *Trichoderma* spp. was prepared with $3x10^8$ cfu. Two commonly used fungicides, namely, Hexaconazole 5EC @2.0ml/l and Carbendazim 50WP @1g/l were taken for comparison with the biocontrol agents. All *Trichoderma* isolates were found effective to increase yield (12.50% to 23.14%) significantly over check plots and the isolate, *Trichoderma* B18 gave the highest yield. Efficacy of the biocontrol agents was significantly higher in the blocks with green manure than blocks without green manure. Incidence of disease was significantly reduced with 46.32% to 70.54% on application of bioagents and two fungicides. All the biocontrol agents were found significantly superior to the fungicides, where *Trichoderma* B18 and *Trichoderma* B16 performed better than others.

ISFS-170

Bioefficacy of *Metarrhizium anisopliae* against red spider mite of tea in West Bengal

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Among the different biotic stresses red spider mite (RSM) *Oligonychus coffeae* (Nietner) (Fam. : Tetranychidae) is one of the key constraints of tea plantations particularly in North East India. The estimated yield loss due to RSM varies between 6-11%. Numbers of synthetic chemical acaricides are in use for the management of the mite. Excessive and injudicious use of chemical acaricides leaves chemical residues in made tea posing health hazard and limiting export potentiality. Chemical acaricides are not also used in the

organically managed garden producing world class organic tea. *Metarrhizium anisopliae* var. *anisopliae* is an entomopathogenic fungus known to attack over 200 species of insects covering seven orders. A commercial formulation of *Metarrhizium anisopliae* (MeT-52) was evaluated for its efficacy against RSM of tea. Effect of the product on the common natural enemies of RSM was also recorded. The experiment was laid out during June-July, 2011 at the Mogolkata Tea Estate at the Dooars region of West Bengal following Randomized Block Design with six treatments and four replications. Treatments were applied twice at fifteen days interval starting at the ETL (5 mites/leaf) along with a sticker. Observations were recorded using a 10X hand glass before spray and at different days after treatment from ten random leaves chosen from ten random bushes of each plot leaving the border row. Observations on the incidence of predators were recorded at 7 days after spraying. *M. anisopliae* was found to be highly effective against RSM of tea. The formulation MeT-52 @ 5 ml/l of water proved to be significantly the best treatment in reducing the population of the phytophagous mite. The lower dose of the formulation MeT-52 @ 4 ml/l was the second best treatment. Over 90% of the RSM population was reduced by 10 days in both these two treatments. *M. anisopliae* was found to be safe to the natural enemy complex of RSM which consisted of predatory mites *viz., Amblyseius* sp., *Agistemus* sp. and predatory the insect *Chrysoperla* sp.

ISFS-171

Evaluation of fungicides and botanicals against *Alternaria* leaf blight of mustard

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A field study was carried out during 2008-09 and 2009-10 to evaluate six botanicals [Neem leaf extract (10%), Onion bulb extract (5%), Garlic bulb extract (5%), Ginger rhizome extract (5%), *Pongamia labra* oil (2%) and Neem oil(2%)] and seven fungicides [Iprodion (0.25%), Dithane M 45 (0.3%), Bavistin (0.2%), Ridomil MZ (0.25%), Tilt25%EC (0.2%), Blitox50 (0.2%) and Saaf (0.1%)] at respective recomended doses against *Alternaria* blight of mustard. The botanicals and fungicides were sprayed separately after disease appearance (40 days after sowing) at 10 days intervals. Two years pooled mean showed that all the six botanicals and seven fungicides significantly reduced the disease and increased yield in comparison to untreated control. Among the thirteen treatments spraying of Iprodion@ 0.25% a.i. resulted in lowest disease severity on leaves (17.37%), siliqua (11.49%) and increased the yield (1363 kg/ha^{-1} and 85.17 siliqua/plant) followed by Garlic bulb extract @ 5% (21.06%; siliqua infection 13.08%) and 7.52 number of spots/siliqua) and increased yield (1272kg/ha^{-1} and 85.28 number of siliqua/plant). Garlic bulb extract can be used as a substitute for chemical fungicides for management of *Alternaria* leaf blight of mustard.

ISFS-172

Studies on invitro compatibility of *Trichoderma viride* with agrochemicals in oil palm production system

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A laboratory experiment was carried out to know the compatibility of some pesticides with *Trichoderma viride*, a bio-agent used widely for the management of Basal stem rot of oil palm, *Elaeis guineensis*. A total of 17 agrochemicals including 14 insecticides (Monocrotophos, Phorate, Quinolphos, Chlorpyriphos, L-cyhalothrin, Imidachloprid, Buprofezin, Fipronil, Triazophos, Cypermethrin, Deltamethrin, Thiamethoxam, Acetamiprid, Profenophos), 2 fungicides (Carbendazim, Dithane M-45) and one herbicide (Glyphosate) were tested at their recommended, double the recommended and half the recommended doses. A control was also maintained and 'poisoned food technique' was used to study the effects of the pesticides. The insecticides, Phorate, Imidacloprid, Fipronil were highly compatible with *T.viride* at all the concentrations tested. Though cypermethrin also was found compatible at the recommended dose but it inhibited growth at double the recommended dose. At half the recommended dose, monocrotophos, dithane M-45, glyphosate were also highly compatible. Carbendazim was found to be highly toxic to the bio agent and caused complete inhibition at all concentrations tested. Dithane M-45, Quinolphos, Profenophos, Chlorpyriphos, L-Cyhalothrin, Acetamiprid and Thiomethoxam inhibited more than fifty per cent mycelial growth of the bio agent. Application of the bioagent with agrochemicals has to be assessed carefully prior to any field applocation.

ISFS-173

Biofumigation effects of brassicaceous plants on root knot nematode(*Meloidogyne incognita*) infesting cucumber

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Experiment on biofumigation effects of brassicaceous plants on root knot nematode (*Meloidogyne incognita*) infesting cucumber was conducted during 2010-11 and 2011-12 at the Central Research Farm**,** Bidhan Chandra Krishi Viswavidyalaya located in the New Alluvial Zone of West Bengal, India. Comparative biofumigation effect of brassicaceous crops - detopped mustard root amendment, chopped & mixed mustard root and shoot amendment @ 1 kg/m^2, detopped radish root amendment, chopped & mixed

radish root and shoot amendment @ 1 kg/m^2, cabbage green biomass amendment @ 1 kg/m^2, cauliflower green biomass amended @ 1 kg/m^2, carbofuran treatment @ 0.1g a.i./m^2 as check and untreated control on *M. incognita* populations were studied in fixed plots of 3.5mx2m. Two consecutive years results indicate incorporation of brassicaceous crop biomass in different forms in the crop sequence had suppressive effect on *M. incognita.* Soil amendments with detopped mustard showed highest reduction of root galling (less than 2.0 Gall Index on a 1-5 scale). This was followed by amending with chopping and mixing of mustard biomass, incorporation of cabbage residues, in situ chopping-mixing of radish and incorporation of cauliflower residue. The final nematode population (second stage juvenile-J2) in soil was also reduced to the extent of 50% to 76% over untreated control. All these plants release volatile glucosinolate hydrolysis product isothiocyanates probably for which cause gradual reduction of soil nematode population.

ISFS-174

An integration of weed management practices in potato under new alluvial soil

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To identify and enlist the important weed flora of potato; study the effect of different weed control measures on the yield of this crop; to measure the uptake of nutrients by the crop and weeds; and analyse the cost effectiveness of different weed control measures, a field experiment was carried out with potato crop (var. K-Jyoti) for two consecutive years (2009-10, 2010-11) at 'C' Block farm of Bidhan Chandra Krishi Viswavidyalaya ($22^0$5' N latitude and 89^0 E longitude with an altitude of 9.75 meters above the mean sea level), Kalyani, Nadia, West Bengal. The soil of the experimental field was typically of Gangetic alluvium (Entisol) type with sandy clay loam in texture having total 0.055% N, 26.29 kg ha^{-1} available P_2O_5 and 148.72 kg ha^{-1} available K_2O. The experiment was laid out in RBD with nine treatments (T_1: Unweeded check, T_2: HW at 20 DAS, T_3: T_2 + mulching, T_4: Metribuzin @0.60 kg a.i. ha^{-1}, T_5: Quizalfop ethyl @1 kg a.i. ha^{-1}, T_6: Pendimithalin @1 kg a.i. ha^{-1}, T_7: T_4 +mulching, T_8: T_5 +mulching, T_9: T_6+ mulching) replicated thrice. The predominant weed flora in the experimental field of potato was *Cyperus rotundas, Chenopodium album, Anagallis arvensis and Fumaria purviflora*. The results revealed that the maximum pod yield and return per rupee invested *vis-à-vis* the maximum N, P, K uptake by potato and the minimum uptake of N, P and K by weeds emerged in the potato field were recorded under the treatment T_3 which was closely followed by the

treatment T_9. This treatment (T_3) showed the lowest value of total weed biomass in the crop and the highest value of weed control efficiency at all the growth stages. So, the findings of the experiment provide us with a great opportunity of using herbicides along with mulching to manage the labour crisis and minimize the cost of cultivation, therefore, maximizing benefit cost ratio. At the same time mulching can also help in conserving soil moisture and nutrient as an important tool of resource conservation technology.

ISFS-175

Integration of weed management practices in rice-potato-groundnut cropping sequence

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Crop diversification in a cropping sequence on the same piece of land may be a very important tool in increasing per ha net production from that very land. But in the era of global environmental perspective we cannot emphasize on our production need alone; we must consider the soil health to keep the sustainability of our production unaffected. But, it is also important that to get some profitable return from a given cropping system, it is vital to keep the damage of the crop by various "harmful agents" below the economic threshold level (ETL). Among these agents weeds contribute a significant interference to the normal crop growth and yield. With the increase of global temperature the weeds, which are mostly of C_4 types will sustain in a better way due to increased rate of photosynthesis with decreasing photorespiration. On the other hand the agricultural crops which are mostly of C_3 types will not be able to sustain properly due to decreased rate of photosynthesis with increasing photorespiration. As a result, the weeds gaining a competitive advantage dominate in the crop field. Keeping all these facts in background an experiment was carried out at the University Research Farm of BCKV, Kalyani, Nadia (22°5′ N latitude, 89° E longitude, 9.75 m above the mean sea level) during 2009 -10 and 2010-11 under new alluvial soil (pH 6.74, organic C 0.57%, total N 0.05%, available P 25.29 kg ha^{-1} and available K 145.72 kg ha^{-1}) to study the integrated weed management in Rice- Potato-Groundnut cropping sequence. The data on gross return (Rs ha^{-1}) and weed control efficiency (%) of all the treatments used in rice, potato and groundnut crops revealed that irrespective of all the three stages (30,60 DAT/DAP/DAS and at harvest) the maximum values were obtained when two hand weedings were applied at 20 and 40 DAT in case of rice and in case of potato and groundnut one hand weeding was applied at 20 DAT/DAS along with mulching.

ISFS-176

Managing root knot nematode (*Meloidogyne incognita*) problem by *Paecilomyces lilacinus* in pointed gourd (*Trichosanthes dioica*) – a success story

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An investigation was carried out during 2011-12 in the farmer's field at the Chandamari in Nadia district of West Bengal where infestation of root knot nematode (*Meloidogyne incognita*) is one of the major concerns for growing vegetables particularly pointed gourd (*Trichosanthes dioica*). Field performance of *Paecilomyces lilacinus* (commercial product YORKER, $2x10^8$spore/g) against root knot nematode (*Meloidogyne incognita*) infesting pointed gourd at the farmers' field was tested. Ten farmers of small land holding size varied from 10 cottah (~0.07 ha) to 20 cottah (~0.13ha) of pointed gourd fields were selected for testing this study. PL-formulation was advocated at 15kg/ha. This formulation was mixed with well decomposed organic matter (OM) at 25kg for each kg of *P. lilacinus* (PL) and incubated for 7 days. PL-enriched decomposed OM was applied in each pit at the time of planting. About 20% of each field was maintained as untreated area for comparison. Results revealed that PL- treated area had less nematode infestation and relatively better crop health with enhanced fruit yield over untreated areas. Observation of root galling caused by root knot nematode showed gall index (on a 1-5 scale) ranging between 2 to 3 in the treated areas and 3-5 in the untreated areas. Soil population (second stage juvenile-J2) of root knot nematode was also reduced substantially (up to 72%) towards harvesting. The overall performance of this bioagent at the farmer's field was realized through comparison of total fruit yields. The field areas received treatments showed fruit yield ranged between 40 to 52 ton/ha and 37 to 45 ton/ha in the untreated areas. Thus the farmers perceived increased yield (6 to 22%) and the incremental cost benefit ratio (ICBR) of this technology for management of RKN in pointed gourd was estimated to be 1:2 to 1:8.

ISFS-177

Disease free seed potato production through seed plot technique at farmers' level in Bangladesh

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Seed plot technique was found to be very effective in producing quality seed tubers of potato at farmers' level in Bangladesh. Incidence of virus, bacterial wilt, common scab and late blight were very low compared to farmers practice at neighboring plots. Results showed that although, in farmers' practice, the yield was comparatively higher (31.9t/ha) than seed plot technique (31.7t/ha) but the quality of seed was better in seed plot technique. In seed plot technique, the wilt infestation was not observed whereas, in farmer's practices the infestation percentage was 1.9; the virus affected plant in seed plot technique was 0.3% and it was 5.9% in farmers' practices. Mean percent virus infection was found very low (0.89%)in all observed locations was irrespective of varieties. It was also observed that average scab infection was 7.36% whereas average late blight infection was 2.13%. Average percent cutworm infection was also very low (1.60%). The variety Diamant produced highest average tuber yield (28.16 t/ha), while Asterix produced 27.66 t/h. Average tuber yield of Granola, Cardinal and Provento were 26.59, 25.45 and 23.21 t/ha respectively. Most of the farmers including participating farmers showed very positive reaction to introduce potato seed production programme under seed plot technique in order to produce quality seed tuber in their field in the next seasons.

ISFS-178

Farmers field school for potato integrated crop management with women participation vs farmers' practices

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Integrated Crop Management (ICM) study was done in 16 locations of 4 districts of Bangladesh with different potato varieties during 2010-2011 potato growing season to find out the profitability level of ICM practice with farmers' practice. A study plot was set up in each location where, Integrated Crop Management (ICM) practices that recommended by the Tuber Crops Research Centre (TCRC) of BARI was followed in half of the plot and in the other half, Farmers' conventional practices (FP) were followed. It was found in all locations that there were distinct differences between the ICM practice and the FP in respect of yield. In all locations except those of Bogra, farmers used fertilizers in higher doses than the recommended doses. Insecticides are not used even in the seed production plots in most of the studied areas but fungicides are used

in more than the recommended quantity resulting in misuse and environmental hazard. All farmers obtained lower yields in their practices than the ICM method. Incidences of different diseases were found to be higher in the FP plots than those of the ICM. Boric acid and bleaching powder had a positive effect in controlling scab and wilt respectively. The farmers of Bogra and Comilla are likely to be benefited more by practicing ICM than those of the other districts. Benefit-cost ratio was higher in Munshiganj for ICM practice (2.77) on full cost basis and in Bogra for farmers' practice (4.63) on cash cost basis. Moreover, participating women members of FFS became economically benefited by making and selling potato chips that might leads them towards empowerment and social dignity.

ISFS-179

Study on insect-disease incidence and their organic management in indigenous aromatic rice of West Bengal, India

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A field experiment was conducted to find out the comparative insect-disease tolerance and weather-pest relationship of two scented rice cultivars (*viz*. Gobindabhog and Kalojira) as well as evaluation of organic pest-disease management (control, neem extract @ 50 g litre^{-1} of water, garlic extract @ 50 g/litre of water and karanja extract @ 50 g/litre of water) at 'C' Block Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, India during *kharif* season of 2008 and 2009. The incidence of leaf folder (*Cnaphalocrocis medinalis*) decreased with the advancement of crop growth, while that of yellow stem borer (*Scirpophaga incertulus*), gundhi bug (*Leptocorisa acuta*) and brown spot disease (*Drechslera oryzae*) increased during respective infestation periods in unprotected control plots. The correlation studies between meteorological parameters and insect disease incidence in the control plot revealed that minimum temperature and minimum relative humidity had negative influence ($P < 0.05$ or 0.01) on yellow stem borer (i.e. dead hearts or white earheads) and brown spot disease, while rainfall and bright sunshine hour showed negative and positive effect, respectively on yellow stem borer in both cultivars of the study. Kalojira showed greater tolerance or resistance to leaf folder, yellow stem borer, gundhi bug and brown spot disease as well as produced higher grain yield (2.73 t/ha) than Gobindabhog (2.62 t/ha) during both the years of experimentation. All three bio-pesticides (viz. neem, garlic and karanja extracts) were found effective in controlling the insects and diseases at different growth stages and their efficacy could be summarized as: neem (*Azadirachta indica*) extract > garlic (*Allium sativa*) extract > karanja (*Pongamia pinnata*) extract > unprotected check.

ISFS-180

Bioantagonist mediated approach for management of guava wilt disease

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Wilt of guava is the most destructive disease under Indian condition and losses due to this disease are substantial. In West Bengal guava is commercially cultivated mainly in Baruipur Subdivision of South 24 Pargana district with an average yield of 15- 18t / hectare per year. Surveys were conducted during 2007 - 2008 in guava growing belts of Baruipur (South 24 Pargana district), red and lateritic regions of Jhargram (Paschim Medinipur district) and Raghunathpur Subdivision (Purulia district) of West Bengal to record the intensity of guava wilt. Incidence of the disease was recorded from 3.33 to 60.0 %. Wilt is predominantly caused by three fungi namely *Fusarium solan*i, *Fusarium oxysporum* f. sp *psidii* and *Macrophomina phaseolina,* either alone or in combination under West Bengal conditions. Bioantagonists viz. *Trichoderma viride, Aspergillus niger* and *Pseudomonas fluorescens* were used in wilt conducive soil at farmer's field of Baruipur during 2007-2011. The treatments were applied just after on set of monsoon in each year (2007-11) on 5-6 years old plantation (var. Baruipur local) after multiplying the bioantagonist in FYM (5 kg/plant). Five years (2007-2011) pooled data revealed that all the bioagents reduced the wilt intensity over control. Wilt intensity was minimum (2.25%) in *Trichoderma viride* treated plots in comparison to *P. florescens* (9.91%), *A. niger* (12.40 %) treated and untreated control (27.88 %) plots. Application of *T. viride* was substantially delayed the appearance of wilt symptoms up to 251 days and protect the infected plants for maximum period of 236.80 days to complete the wilting than other treatments viz. *A. niger* (64 & 37.6 days), *P. florescens* (58.20 & 39.6 days) . Hence, present findings could be useful through application of eco-friendly bio antagonists for sustainable crop health management in guava.

ISFS-181

Screening of some improved germplasms against major pests of groundnut (*Arachis hypogaea* L.) in new alluvial zone of West Bengal

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A field experiment was conducted at District Seed Farm Bidhan Chandra Krishi Viswavidyalaya, West Bengal (India) during summer and *kharif* seasons of 2010 to screen out some improved groundnut germplasms against major pests in new alluvial zone of West Bengal. A total of 94 groundnut germplasms,

among 53 germplasms during summer season and 41 germplasms during Kharif seasons were evaluated against major pests viz. *Helicoverpa, Spodoptera,* thrips (mixed population of *Scirtothrips* and *Caliothrips*) and jassids (*Empoasca* spp.). Results revealed that none of the germplasms were tolerant/resistant to the candidate insect pests. Only four germplasms (ISK-I-2009-20, IVK-I-2009-2, AIS-2009-8 and INS-I-2009-18) out of 94 germplasms were found less susceptible and rests were either moderately susceptible (51 germplasms) or highly susceptible (39 germplasms). Among the four promising lines, INS-I-2009-18 recorded the lowest Helicoverpa damage i.e. 6.11% whereas AIS-2009-8 showed the minimum pest infestation of 8.56% and 4.24% due to *Spodoptera* and thrips, respectively and in case of jassids it was 2.8 (mean number of jassids/three top leaves of a plant). This study indicated that the extent of damage by *Spodoptera* was more prominent (8.5% - 26.3%) followed by *Helicoverpa* (4.3% - 16.2%) and thrips (3.2% - 22.1%) during both the seasons of the crop irrespective of the germplasms used. This study also further revealed that the nature of pest infestation was more during kharif as compared to summer growing groundnut and that might be due to excessive rainfall including prolonged drought spell, common phenomenon of this season, leads to excessive vegetative growth which invites the pests more abundantly.

ISFS-182

Weed management in sisal nursery

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A field experiment was conducted for two years during 2009-2010 at Sisal Research Station (23.05° N, 84.23° E, and 256.03 m MSL) at Bamra located in the northern part of Sambalpur district of Odisha to study the effects of different herbicides and other methods for managing the weeds of Sisal (*Agave sisalana* Perrine ex Engelm., Family: Agavaceae) and their effect on the growth of sisal bulbils in primary nursery. Pre-emergence herbicide, Trifluralin (0.75 kg a.i./ha) was applied in the soil as pre-plant soil incorporation at 3 days before planting (DBP) of sisal bulbils; whereas, other pre-emergence herbicides namely S-Metolachlor (0.50 kg a.i./ha) and Pretilachlor (0.05 kg a.i./ha) were applied 1 DBP. Post-emergence herbicide, Quizalofop ethyl (0.050 kg a.i./ha) was applied two times at 3 and 5 weeks after planting (WAP). The 1st and the 2nd hand weeding were done at 3 and 5 WAP. At 2 WAP, the highest weed control efficiency (WCE) was observed with S-Metolachlor (90.1%), followed by Pretilachlor (62.5%) and Trifluralin (46.2%). At 5 WAP, the lowest weed dry weight was recorded with hand weeding (5.3 to 8.4 g m^{-2}), followed by S-Metolachlor (9.9 g m^{-2}). The highest WCE was 89-93% in case of hand weeding followed by S-Metolachlor (87%). However, at 7 WAP, only two hand weeding proved effective with lowest weed dry weight (7.4 g m^{-2}), followed by one hand weeding (62 g m^{-2}) and S-Metolachlor (64.6 g m^{-2}). Likewise, the WCE was the highest (92.3%) in two hand weeding treatment. Quizalofop ethyl controlled the grasses (98%) which in turn encouraged the growth of

sedge weeds (2.3 times). Sisal leaf waste could not control the weeds, whereas, it supported weed growth (as well as growth of sisal bulbils) might be due to its benefit as mulching material conserving soil moisture which is a scare input in such dry situation. The effect of herbicides on sisal bulbils were compared by the number of leaves and the dry weight of sisal plantlets. It was observed that after 6 months after planting, hand weeding twice produced the highest number of leaves (7.6 per plant) followed by the number of leaves produced in Trifluralin (7.4 per plant) and Pretilachlor (7.2 per plant) treated plots; whereas, no weeding produced lowest number of leaves (5.3 per plant). Hand weeding twice produced the most robust type of sisal plants (13.9 g per plant) followed by the plant dry weight obtained with sisal waste (13.27g per plant). All the tested herbicides reduced the biomass production by sisal plants as compared to hand weeding in the order of Trifluralin (15%) > Pretilachlor (22%) > S-Metolachlor (36%) > Quizalofop ethyl (39%). From the results of the field experiment it may be concluded that only hand weeding twice (3 and 5 WAP) was effective in controlling weeds in the primary nursery of sisal (92%) beyond 7 WAP. However, among the herbicides tested, S-Metolachlor was effective up to 5 WAP (87% WCE) after which it requires one hand weeding for managing the weeds in sisal nursery.

ISFS-183

Studies on predatory coccinellid beetle for taxonomy and species composition in rice ecosystems of Tripura

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A study was conducted during 2009-2011 to collect and identify predatory coccinellid beetle associated with rice ecosystem of Tripura. The rice ecosystem surveyed included lowland, upland and jhum land of four different district of Tripura (North Tripura, South Tripura, West Tripura and Dhalai), India. The collected beetles were dried, mounted, labelled and dissected in the laboratory for studying genitalia and mouthpart structures and unique features of mouth parts, antennae, pronotum, hind leg and genetalia parts micromerically studied. Based on such features identification key along with illustrations was prepared. The result revealed that Coccinellid species belonging to ten genera, under four tribes of the family Coccinellidae. They were *Brumoides suturalis* (Fabricius), *Chilocorus nigritus* (Fabricius) *Coccinella septempunctata* Linnaeus, *Coccinella transversalis* Fabricius, *Harmonia octomaculata* (Fabricius), *Illeis cincta* (Fabricius), *Micraspis crocea* (Fabricius), *Propylea* sp. nr. *japonica* (Thunberg), *Cryptolaemus montrouzieri* Mulsant and *Scymnus* (Scymnus) *nubilus* Mulsant. Out of ten coccinellid *Harmonia octomaculata* (Fabricius)

(22.9%), *Micraspis crocea* (Fabricius) (18.5%), *Brumoides suturalis* (Fabricius) (12.36%) and *Chilocorus nigritus* (Fabricius) (9.06%) were major beetle in rice ecosystems of Tripura. Study also revealed that population of *Harmonia octomaculata* (Fabricius) and *Micraspis crocea* (Fabricius) were higher in lowland rice ecosystem, *Brumoides suturalis* (Fabricius) and *Micraspis crocea* (Fabricius) were higher in upland ecosystem of rice and *Chilocorus nigritus* (Fabricius), *Coccinella transversalis* Fabricius and *Harmonia octomaculata* (Fabricius) were higher in *jhum* ecosystem of rice in Tripura.

ISFS-184

Biology and control strategies of papaya mealybug, *Paracoccus marginatus* Williams & Willink (Hemiptera : Pseudococcidae) attacking major vegetable crops in Bangladesh

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Papaya mealybug, *Paracoccus marginatus* William & Willink is a small hemipteran insect belonging to the Family Pseudococcidae was recorded from immature, mature papaya fruits and foliages from BCSIR Vegetable Garden during March, 2011. *P. marginatus* passes through egg and three nymphal stages to become adult. Generally, three and four nymphal instars occur in case of female and male mealybugs respectively. The adults are most active in warm, dry and humid weather. The male adult mealybugs possess two pairs of wings. Female have no wings and move by crawling short distances or by being blown in by air currents. Egg laying is continued up to 2 weeks and 150-200 eggs are deposited. The life cycle is completed within 29 days at an average room temperature of 25 ± 1ºC and 67 ± 5 % RH in female and that of 27 days in male mealybug. Active ingredients in registered pesticide formulations for chemical control include acephate, carboryl, chlorpyrifos, diazinon, dimethoate, malathion, and white mineral oils. Chemical controls are only partially effective and require multiple applications. Five genera of encyrtid endoparasitoid wasps specific to mealybug biological control agents i.e., *Acerophagus papayae* (Noyes and Schauff), *Anagyrus loecki*(Noyes and Menezes). *Anagyrus californicus* Compere and *Pseudaphycus* sp and *Pseudleptomastix mexicana* have been so far reported. During present study two encyrtid and two braconid endoparasitoid wasps have been recorded parasitizing different nymphal instars of *P. marginatus* which are awaiting identification.

ISFS-185

Role of the ectoparasitoid, *Choetospila elegans* Westwood (Hymenoptera: Pteromalidae) in suppression of *Sitophilus oryzae*

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Control of insect pests by biocontrol agents like beneficial insects, parasitoids, predators, pathogens etc. are essential elements of biological control. Success of using this parasitoid in biocontrol programme usually depends not only on the availability of their insect hosts but sometimes on a complex system of other factors such as additional food sources, alternate hosts and shelter. Ability of *Choetospila elegans* to reach the host insect in rice kernels kept at different depths in grain columns in the laboratory conditions was evaluated. Total numbers of 30 males and 50 females were released at the top of the grain column of 30 cm and time required for penetration was 3.8 hrs. In a column depth of 60 cm with the same number of male and female parasitoids it took 25 hrs for penetration. Evaluation of the effectiveness of *C. elegans* for suppression of *Sitophilus oryzae* population in sterilized room revealed that per cent suppression was highest at the introduction level of 15 parasitoid females, i.e. (56.6 ± 1.17 %). The next average per cent suppression of host population was lower, i.e. 17.6 ± 1.12 %. It is apparent that introduction levels with 5-15 female parasites always exhibited greater suppression. The more the parasitoid released, the number of host progeny was lower. Highest parasitoid progeny was produced when a single parasitoid female was released and it was 35.3 ± 3.2. When the mated female parasitoids were released at 1, 5, 10 and 15 and 50 hosts to each of 200 individual hosts, the parasitoids restricted the growth of *S. oryzae* population. More progeny per parasitoid female were produced at the lower levels of introduction than those of at higher ones. Biological control of *S. oryzae* infesting rice (husked) and wheat kernels by the pteromalid wasp *C. elegans* may thus be considered as satisfactory.

ISFS-186

Integrated management of bacterial blight of rice in Odisha

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Bacterial Blight (BB) of rice caused by *Xanthomonas oryzae* pv. *oryzae* is a major disease of rice in Odisha. Crop loss assessment studies have revealed that this disease reduces grain yield to varying levels, which may range from 50 - 80%. Increased use of nitrogenous fertilizer favours disease development and causes greater yield loss. A combination of more than one major strategy is required to alleviate this problem. Keeping this

in view, the present experiment was carried out with two types of disease management practices other than chemicals i.e. varietal resistance and nitrogen management. The experiment was conducted in Split plot design with four replications. Four rice varieties as Susceptible (TN-1), Moderately Resistant (Swarna), Resistant (Pratikshya) and Local hybrid (Ajay) in main plots and two Nitrogen levels as 80kg/ha and 120kg/ha in sub plots were used. Least disease severity (9.9%) was noticed in local hybrid Ajay with 80kg N/ha followed by resistant variety Pratikshya (18.5%) with 80kg N/ha and susceptible variety TN-1 showed highest disease severity (50.7%) with 120kg N/ha.

ISFS-187

A new record of a native predator, *Scymnus pallidicolli* (Mulsant) on pink mealybug, *Maconellicoccus hirsutus* (Green) causing TUKRA in mulberry

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Pink mealy bug, *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) is reported to infest 28 plant species in India. It is one of the major pests of mulberry, *Morus alba*, L. mostly during summer and pre-monsoon seasons. Mealy bug infestation shows symptoms like curling and crinkling of leaves at the growing tips, thickening and twisting of the apical portion of the affected shoot, shortening of internodal distance with bushy top and leaves turn pale yellow and fall off pre-maturely. All these symptoms are together called "Tukra" leading to considerable loss of leaf yield in feeding silkworm with tukra affected leaves causes significant decline in economic characters of silkworm rearing like larval weight, cocoon weight, shell weight, silk ratio and effective rate of rearing . A coccinellid beetle, *Scymnus pallidicolli* (Mulsant) was found to be a potent predator of *M.hirsutus* in the tukra affected mulberry fields of CSR&TI , Berhampore ,West Bengal, India and duely identified by Zoological Survey of India. Prelimnary studies on the biology of *Scymnus pallidicolli* revealed that the life cycle completes in 23 days. Feeding efficacy of grub was found to be 1,379 eggs or 61 nymphs and 13 adults of mealy bug. This is potential to explore the possibility of using this predator in biological control of the pest causing Tukra in mulberry.

ISFS-188

Late blight incidence of tomato as influenced by inorganic fertilizer, organic manure and biofertilizer in terai zone of West Bengal, India

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An investigation was conducted to study the impact of organic manure and biofertilizer inoculation along with inorganic fertilizers on natural infestation of late blight of tomato cv. Pusa Ruby. The treatments were selected for sole and combined application of varied levels of vermicompost and farmyard manure along with 100% and 75% of recommended dose of inorganic fertilizers (RDF-100:60:60 kg N P K /ha) in presence and absence of *Azotobacter* and PSB containing biofertilizer (Azophos) thus 14 treatment combinations were laid out in Randomized Block Design (RBD) with three replications. The experiment was conducted during the years 2005-06 and 2006-07 at UBKV, Pundibari, Cooch Behar, West Bengal, India. The result revealed none of the treatments were found completely free from late blight incidence, however the incidence varied in different treatments. Higher levels of organic manures augmented with biofertilizer along with 75% RDF significantly reduced the late blight incidence and produced higher amount of tomato yield. Application of 75% RDF along with 4 tonnes of vermicompost per hectare inoculated with Azophos recorded significantly lowest percent disease index (PDI-13.84%) and produced highest marketable yield compared to highest PDI of 31.62% and lowest fruit yield (15.42 t/ha) by the treatment containing 100% sole inorganic fertilizers. This may be practiced for sustainable tomato production in terai zone of West Bengal.

ISFS-189

Comparative performance of different nutrient sources on white fly infestation of tomato (*Lycopersicon esculentum* Mill.)

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Field performance of different nutrient sources on white fly infestation of tomato was studied during 2005-06 and 2006-07 at UBKV, Pundibari, Coochbehar, West Bengal, India. Fourteen different treatment combinations comprising two organic manures (farmyard manure and vermicompost), inorganic fertilizers and *Azotobacter* and PSB containing biofertilizer (Azophos) in different levels were laid out in RBD with three replications. The infestation was recorded at 30 and 45 days after planting after enumerating number of flies per plant basis. The findings indicated that the infestation varied from treatment to treatment. A

significant difference in white fly population was observed between sole inorganic fertilizers and the treatment containing higher amount of FYM or vermicompost. However higher amount of vermicompost emerged superior in minimizing the white fly population compared to farmyard manure. Considering the magnitude of white fly attack and economic yield, the treatment containing 75% RDF of inorganic fertilizers along with 4 tonnes vermicompost per hectare inoculated with Azophos may be recommended for successful tomato cultivation in terai zone of West Bengal.

ISFS-190

Mechanism of resistance of wild jute to bihar hairy caterpillar, *Spilosoma obliqua* Walker (Lepidoptera: Arctiidae)

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Bihar hairy caterpillar (BHC), *Spilosoma obliqua* is a polyphagous pest attacking several crops including jute. Nowadays' it has become a major pest on jute. Possible sources of resistance in jute against BHC was determined on the basis of antibiosis effect on the pest. Larval growth rate in terms of weekly weight gain was significantly impaired on the wild species particularly *Corchorus tridens* and *C.aestuans*. In case of the later, the growth rate was reversed. Growth of 5-day old larvae on different jute species indicates maximum antibiosis effect of *C. aestuans* on BHC. After feeding for 4 days the larval weight of BHC in *C.olitorius* (Cv.JRO-204) was 9.9 mg which was 0.9-8.8 mg in wild species. The antibiosis effect was more prominent in 13-days old larvae during which the larval weight in the wild species was in the range of 18.1-40.8 mg which was less as compared to the *C. olitorius* (58.7 mg), while the growth on *C.aestuans* was reversed. There was no pupation on *C. tridens* and *C.aestuans* because of high larval mortality. The pupation on *C. pseudo-olitorius, C. tricularis* and *C. fascicularis* was to the extent of 37.50%, 22.50% and 15.00% respectively as compared to 62.50% on the cultivated species i.e. *C. olitorius*. The pupation was significantly less in wild hosts compared to cultivated species i.e. *C. olitorius* indicating strong antibiosis effect of wild species. Among the wild species *C. pseudo-olitorius* only supported adult emergence (27%). The effect of wild jute species as host, manifested adversely on larval development, growth, survival and pupation which clearly indicates the antibiosis mechanism of resistance of wild species on BHC.

ISFS-191

Diversity of soil fungi of north 24-Parganas and their antagonism against fruit and shoot borer (*Leucinodes orbonalis* Guen) of brinjal

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Soil is the most common habitat of many microflora and they can easily be isolated from the soil, thus while we collect soil sample from various agricultural field and garden area from various subdivitional region of 24-Parganas (North) West Bengal, India. Isolation of soil mycoflora was done by soil dilution plate technique. The isolated fungi were identified with the help of published fungal key. Diversity of various fungi in two types of soil was calculated by Simpson's diversity formula. Entomopathogenic capacity of the fungi isolated were tested *in-vitro* condition against fruit and shoot borer of brinjal (*Leucinodes orbonalis* Guen) which is the main insect pest of brinjal cause damage to the plant by boring shoot and fruit. Various fungi were isolated from soil and treated against *Leucinodes orbonalis.* Among them *Beauveria bassiana*, *Penicillium* sp. and *Aspergillius* sp. show antagonist to *L. orbonalis* and their LD_{50} were 10^5 spore/ml, 10^{10} spore/ml and 10^7 spore/ml respectively. Their LT_{50} were analyzed and were 8.5 days, 12.5 days and 14.5 days, respectively.

ISFS-192

Seed-borne fungal infection in conserved seed samples of jute (*Corchorus* sp.) and mesta (*Hibiscus* sp.) germplasm

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Sixty seed samples of jute and mesta comprising 15 each of *Corchours olitorius, C. capsularis, Hibiscus cannabinus* and *H. sabdariffa* germplasms obtained from National Gene Bank, New Delhi were subjected for seed health test. Standard seed health testing methods were employed. Germination of jute seed varied from 0% to 75% while in case of mesta it was 15% to 100%. A total of nine plant pathogenic fungi were recorded on seeds viz. *Alternaria alternata* (infection 10%), *Bipolaris oryzae* (3%), *Curvularia lunata* (3%), *Macrophomina phaseolina* (3%) *Phoma exigua* (33%) on jute, *Fusarium moniliforme* (15%) and *Sclerotium rolfsii* (3%) on mesta. *Aspergilli* (21% and 33% on jute and mesta, respectively) and *Penicillium notatum* (3% on mesta) were the saprophytic fungi detected.

ISFS-193

Evaluation of rhizobacterial isolates for growth promotion and disease suppression against bacterial wilt in ginger

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Bacterial wilt disease, caused by *Ralstonia solanacearum* is a very serious threat in most of the ginger growing areas. A group of beneficial bacteria popularly termed as plant growth prompting rhizobacteria (PGPR) are ideal for use as biocontrol agents, as they can provide first hand defense for plant roots against the attack by various plant pathogens, can improve plant growth and vigour and can induce systemic resistance in the host plant. An attempt was made to identify the useful rhizobacterial isolates which can improve growth as well as induce systemic resistance in ginger against bacterial wilt disease. Rhizosphere microflora of ginger from different locations of Thrissur, Wayanad and Palakkad districts were isolated. Out of 163 isolates only 45 showed antagonistic properties. Study of these antagonists based on zone of inhibition resulted in selection of 20 isolates. Effect of these 20 isolates in promoting growth of ginger was studied in pot culture against three reference cultures of *Pseudomonous fluorescens* and *Bacillus subtilis*. Only 11 isolates including the two reference cultures of *P. fluorescens* had growth promoting effect as evidenced in terms of yield and yield attributing characters of ginger. Factors which commonly impart plant growth promotion were assessed by estimating the inhibition zone, vigour index, hydrogen cyanide, indole acetic acid, ammonia production and 'P' solubilzation by these isolates and based on that, PGPR index of the isolates was worked out. In addition to that, production of salicylic acid, antibiotics and siderophore were also assessed. The isolates varied in their ability to produce salicylic acid. Isolates RB-22 followed by RB-11, RB-144 and RB-66 produced more number of antibiotics which include pyoluteorin, pyrrolnitrin, 2,4DAPG etc. Similarly, isolate RB-22 and RB-11 produced highest siderophores. The promising six rhizobacteria isolates were identified based on cultural, morphological and biochemical characters and also in comparison with that of reference culture of *P. fluorescens*. They were tentatively identified as *P. aeruginosa* (RB-22), *P. fluorescens* (RB-82, RB-66, RB-11) and the remaining two, RB-144 and RB-77, as non-fluorescent Pseudomonads.

ISFS-194

Oviposition and feeding preference of *Helicoverpa armigera* Hub. to some Indo -African cross derivatives of pigeon pea

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Helicoverpa armigera Hub. is one of the major pest of pigeonpea. It causes direct damage to bud, flower and pods. Development of resistant line is one of the important eco friendly approaches of pest management, Oviposition and feeding preference stage is very important to identify lines resistant to the insect. Field study during *kharif* season revealed that determinate plant type was highly preferred for oviposition than non-determinate plant type. White colour flowered genotypes were less preferred for oviposition (0.01 eggs/plant) as compared to yellow colour flowered (0.05 eggs/plant) followed by red coloured flower derivatives (0.03 eggs/plant). Similarly, derivatives having yellow coloured buds were highly preferred for oviposition (0.54 eggs/plant) followed by red colour (0.53 eggs/plant) and white colour (0.30 eggs/plant). Maximum eggs were layed on bud of plants having green coloured pods (0.63 eggs/plant) as compared to green pods with purple streaks (0.47 eggs/plant). Eggs were laid less on flowers of plants having green pods (0.03 eggs/plant), while, plants having purple coloured pods were highly preferred for oviposition on flowers (0.08 eggs/plant). So far as feeding preference is concerned, non determinate genotypes (NDT) had less larva population (0.32 larvae/plant) as compared to DT genotypes (0.58 larvae/plant). Genotypes having red coloured flowers and red bud harboured more larvae (0.49 larvae/plant). While, genotypes having yellow (0.33 larvae/plant) and white coloured buds (0.29 larvae/plant) had less number of larvae. Genotypes having green pods with purple streaks recorded maximum larvae (0.40 larvae/plant), than purple pods (0.28 larvae/plant). Intermediate incidence of larvae was recorded on genotypes having green pods with brown streaks (0.31 larvae/plant) and genotypes with green pods (0.31 larvae/plant). Pod damage in green pods with purple streaks was highest (6.85 %), having green pods (2.67 %). Lowest pod damage percentage was recorded in genotypes having purple pods (1.33 %) followed by genotypes having green pods with brown streaks (2.44 %).

Technical Session - 8

Novel and nuclear approaches to
post harvest plant protection and food security

Chairman: SK Mitra
Co-Chairman: SF D'Souza

ISFS-195

Radiation technology for enhancing food security

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Bhabha Atomic Research Centre (BARC) is playing an important role in addressing various national needs through the peaceful applications of radiations and radioisotopes aiming towards better life for our large population, in terms of energy production, health and food security. Use of radio-isotopes in agriculture for increasing crop yields and minimizing post-harvest losses is one of the most important fields of peaceful applications of atomic energy for societal benefit. Availability of wide range of genetic variability is the main stay of plant improvement. Improvement of economically important plants can be achieved by cross breeding, somaclonal variation, recombinant DNA technology or mutation breeding. Mutation breeding is one of the important tools for creating the genetic variability in a short period of time. The novel genes identified through induced mutations can play a significant role for preserving and upgrading biodiversity. Mutations may alter one or more of the yield contributing factors leading to higher yields and / or impart resistance to biotic and abiotic stresses Radiation induced genetic variability in crop plants is a valuable resource from which plant breeder can select and combine different desired characteristics to produce better crop varieties. Crop improvement programmes at BARC, envisage radiation based induced mutagenesis along with recombination breeding in oilseeds (groundnut, mustard, soybean and sunflower), pulses (urdbean, mungbean, pigeonpea and cowpea), cereals (rice and wheat) and other crops (banana and sugarcane). With an effective blend of these approaches, 40 new crop varieties developed at BARC have been released and Gazette notified by the Ministry of Agriculture, Government of India for commercial cultivation. Some of the desirable traits which have been bred through induced mutations in these crops include higher yield, improved quality traits, early maturity and resistance to biotic and abiotic stress. Several of these varieties have high patronage from the farming community and are extensively grown across the country.

Though India is the leading producer of food in the world, ironically it also registers high post-harvest losses. Thus' strategies to increase food production must be complemented with appropriate post-harvest practices and value addition. Issues related to shelf-life, quality and quarantine are the major stumbling blocks to trade, both national and international. Radiation technology offers multidimensional solutions to these problems. The technology can complement and supplement existing and emerging techniques of value addition. The country has the necessary know-how and expertise with the department of Atomic Energy to build and operate radiation-processing plants. Food preservation using radiation involves controlled application of energy of radiations such as gamma rays, X-rays, and accelerated electrons to food and agricultural commodities. It provides an effective alternative to fumigants, which are being banned and phased out due to their deleterious effects on human health and environment. The wholesomeness, nutritional adequacy and

safety of radiation-processed foods was endorsed by world bodies including, WHO, FAO, IAEA and Codex Alimenatrius Commission. In our country, Directorate General of Health Services has accorded approval for processing of a number of commodities under the Prevention of Food Adulteration Act rules. This technology can thus complement and sustain agricultural productivity and boost exports of agriculture produce.

Other applications of radiations and radioisotopes in agriculture are in the development of sterile insect technique (SIT) for the control of insect pests, radioisotope tracers to study the nutritional requirements of plants thus enabling optimization of fertilizer inputs, to understand fate and persistence of pesticides and for the preservation of food. Some of the notable contributions of BARC in the area of use of radiation technology for enhancing crop productivity, crop protection and plant nutrition and food preservation will be delineated.

ISFS-196

Current status of irradiation in protecting fruits and vegetables from postharvest losses

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Irradiation has been given due attention recently as a method of preservation. In the present scenario both ionizing and non-ionizing radiation are used for insect disinfestations, reduce microbial load, induce resistance and control diseases caused by microorganisms in harvested fruits and vegetables. Gamma rays from Cobalt-60 are almost exclusively used for ionizing irradiation. Irradiation has emerged as effective alternative to harmful fumigants like methyl bromide, ethylene dibromide and ethylene oxide. It has been demonstrated that low doses of ionizing radiation between 0.15 to 0.3 kGy effectively controls fruit fly, mango seed weevil, naval orange worms and other insects of quarantine significance. A very low radiation dose of 0.05 to 0.15 kGy can inhibit sprouting in bulb and tuber crops. It leaves no residues and allows storage at higher temperature. Gamma irradiation dose of 0.45 kGy controls postharvest mango rot caused by *Fusicoccum*. Irradiation at a dose of 1.5 and 3 kGy is effective in protecting Golden Delicious apples against brown rot disease caused by *Monilinia fructigena*. In mango fruit, 3 minute exposure to short wave infra-red (IR) non-ionizing radiation after harvest was effective in controlling anthracnose rot caused by *Colletotrichum gloeosporioides* and soft brown rot caused by *Nattrassia mangiferae*. Pretreatment with low Ultra Violet-C (UV-C) dose followed by artificial inoculation with *Botrytis cinerea* reduced postharvest grey mould of table grapes, suggesting induced resistance to the disease. The application of UV-C reduced postharvest decay which included: brown rot (*Monilinia fructicola*) of peaches; Alternaria rot (*Alternaria* spp.), bitter rot (*Colletotrichum gloeosporioides*) of apples and brown rot (*Monilinia* spp.) of apples; green

mould rot (Penicillium digitatum) of grapefruits and tangerines; and stem end rot (*A. citri*) and sour rot (*Geotrichum candidum*) of tangerines. UV-C can also control natural infections and induced resistance to fungal decay caused by *Botrytis cinerea* in bell peppers stored at both13 or 20 °C. Irradiation delays ripening, senescence and also affects the quality of many tropical fruits. In India due to lack of suitable postharvest technologies 25-30% of total production is wasted every year. Irradiation technology has a great scope of protecting fruits and vegetables from postharvest deterioration, extend shelf-life and ensure food security by minimizing postharvest losses.

ISFS-197

Restructuring of plant types for improved seed yield, oil content and quality through induced mutation in sesame (*Sesamum indicum* L.)

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The present investigation is oriented towards development of high yielding genotypes with good oil content and quality through induced mutation. Twenty three genotypes of sesame representing different parts of India were evaluated for agro-morphological and biochemical traits. Three genotypes chosen on the basis of phenotypic and seed storage protein diversity through SDS-PAGE were treated with γ-rays and ethyl methane sulphonate, (EMS), individually. Three doses of γ-rays namely 200 Gy, 400 Gy and 600 Gy and four concentrations of EMS (0.5%, 1.0%, 1.5% and 2.0%) were used to induce mutation. Simultaneously these three genotypes were hybridized to produce F_1s and the F_1s were further treated with EMS. Mutants from genotypes as well from hybrids were advanced upto F_4 generation. Nineteen superior M_4 lines and seven promising F_4M_4 lines based on seed yield, oil content and fatty acid composition were selected for multilocation trials to assess the stability of desirable mutants. The newly developed 26 elite lines were evaluated in seven locations over four consecutive years. Out of twenty six, three M_8 lines viz. CUMS-09, CUMS-11 and CUMS-17 professed their stability for seed yield and yield components. Apart from higher seed yield these three superior mutant lines also possessed high oil percentage with relatively more PUFA content than the control. The developed mutant lines have already been enlisted in ICAR trials for evaluation as new mutant varieties of sesame. Hopefully, these promising and stable mutant lines having higher seed yield, oil yield and improved oil quality would ameliorate sesame production and productivity.

ISFS-198

Biocides hindered the postharvest stress in cut flowers

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With certain exception harvesting of flowers is commercially practiced at bud stage. And for proper flower opening, as flower open in intact plants, considerable amounts of soluble carbohydrate foods are needed as substrate for respiration and cell wall synthesis. When considerable sugar reserves are consumed for this purpose, no or very less sugar remains available for further growth which leads to termination in vase life. The best option to cope up with this unavoidable situation is exogenous application of readily available sugars which also aggravate the unavoidable condition of increased microbial population hindering the uptake of solution by the cut flower necessitates the use of some biocides in vase preservative. There are a number of chemicals available to be used as biocides, is quite effective for extension of vase life of flowers in general, including roses and carnation. In vase preservatives, use of biocides and its continuous application enhanced vase life of flowers due to its biocidal action. Moreover, it may improve water relations of cut flowers and also to inhibit foliage transpiration and thereby maintain the quality of cut flowers under postharvest condition.

ISFS-199

Drying: an age-old practice to control microbes

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Like food items, preservation of flowers by drying has been practiced for centuries. Most flowers contain enough moisture to permit action by their own enzymes and by micro organisms, so that to preserve them by drying, removal or binding (by solutes) of moisture is necessary. A laboratory experiment was conducted to investigate the storage life of loose chrysanthemum flowers after drying by embedding in river bed sand (silver) and self indicating silica gel at $45\pm2\ ^{0}C$. Stage of harvesting the flower was taken at 80-100% mature of the same size. Dried flowers were stored in two different storage condition i.e. in desiccators and in air tight plastic jar. Weight loss, moisture content, brittleness and brightness of the flower were directly related to the storage conditions and type of media used for drying. The storage life of the dried chrysanthemum flowers were more than one year when stored in desiccators and left undisturbed, while that in an air tight plastic jar was up to 3 months. The chrysanthemum flowers stored in desiccators showed higher brightness and moderate brittleness. While flowers stored in air tight plastic jar were least brittle (soft) and dull in colour. However, no pathological growth was observed during the storage interval, under any treatment. It is obvious that by drying, the available moisture content (a_w) of flowers were lowered to such a level that created an uncongenial atmosphere for microbes to grow, which resulted into increased storage life.

ISFS-200

Storage quality of spray-dried powder prepared from aonla juice blended with pigment rich vegetable juice

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Aonla juice is a rich source of natural ascorbic acid and polyphenols, while vegetables are good source of pigments. The present investigation aims at providing better nutritional quality of spray-dried aonla powder by enriching it with carotenoids and anthocyanins. Spray-dried powder was prepared either from pure aonla juice or its blend with 10 per cent carrot and/or beet juice and stored in laminated aluminium foil pouches up to 6 months under ambient conditions (18-34^{0}C, 40-90% RH). Blended powder of aonla and beet showed a significant increase in anthocyanins content from 0.47 to 14.25 mg/100g, while that of aonla and carrot showed an increase in total carotenoids from 0.27 to 4.69 mg/100g. The contents of total carotenoids and anthocyanins were found to be 5.09 and 12.97 mg/100g, respectively, in powder prepared from blended juice of aonla, carrot and beet. During storage, an increase in anthocyanin and non-enzymatic browning (NEB) values were recorded in all the spray-dried powders, while the contents of total carotenoids decreased. Maximum retention of ascorbic acid (2540.3 mg/100g) was observed in powder obtained from the blended aonla and carrot juice after 6 months of storage. The content of polyphenols did not change significantly either in pure aonla powder or powder obtained from blended juices during storage. The critical and danger points in terms of equilibrium moisture content (EMC) for spray-dried aonla powder were observed to be 1.96% and 1.86%, respectively. At 50% RH colour of the powder changed from white to brown and lump formation started. The liquefaction of powder started and mould growth appeared at 80% RH. It could be concluded from the study that carotenoids and anthocyanins enriched spray-dried aonla powder could be prepared and stored in sealed packaging up to 6 months under ambient conditions.

Technical Session - 9

Distribution, pricing and marketing issues
relevant to crop health and food security

Chairman: Sudin K Mukhopadhyay
Co-Chairman: Manas Mohan Adhikary
Rappoteur: Sanjib Mukherjee

ISFS-201

Energy metabolism and social ecology in technology socialization process: the dictum and kinetics of food security

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The developing countries across the world are reeling under not only with economic poverty but also with serious ecological disaster and impoverishment to add more misery to global warming. Continuous rejection of and resentment on non remunerative and defile farm technology by the farmers in post green revolution villages in India are amounting to social entropy and fragile social metabolism. While 43 per cent of ground water reserve in Punjab, once the pioneering green revolution state, is perniciously contaminated with heavy metals like Cd, Pb and Hg amounting to humongous problem of cancer in human being and in cattle Diaspora and contributes to conceiving deformed embryos by the mothers. The present paper highlights the interrelationships between social entropy and factors of farm modernisation through regression coefficient, path coefficients and canonical discriminant function(CDF) to elicit much needed policies on management of motivation and social energy towards attaining an a social equilibrium. The variables, cropping intensity, fuel consumption level, exposure to multiple sources of information, perception on rejection, have been found strongly intrigued into social entropy and metabolism. While global warming poses increasing threats to social ecology and bio-physical ecosystem, this social research shall go a long way in motivation management and social chaos, what may be conceived as mitigation social warming. This is simply because society is turning warmer and chaotic at a much faster rate than the nature herself.

ISFS-202

Using orange-fleshed sweet potato as an alternative to carrot in Chhattisgarh for salad preparations

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Sweet potato [*Ipomoea batatas* (L.*)* Lam.] is a largely tropical root crop that has started playing an important role in the food security and nutrition of Chhattisgarh and many other tropical sub-tropical countries. Tuberous roots of two improved orange fleshed sweet potato (OFSP) genotypes (Indira Madhur and IGSP-C-15) were assessed as alternative vegetables to the carotene rich carrot roots in the preparation of carrot based vegetable salads (fresh and parboiled). The results shown that the fresh largely tropical OFSP roots like carrot have sweet taste, fairly long shape and minimum gummy flesh latex. The carotenoid content of the fresh

carrot was 5.09 mg/100 g while that of the OFSP roots was 3.87-5.97 mg/100 g. The deep yellow or orange-fleshed roots and the leaves and tips are rich sources of beta-carotene and other biologically active carotenoids and would be valuable as one means in a multiple approach to prevention of vitamin A deficiency. The sensory evaluation result of the salad samples shown that the fresh OFSP samples were liked much and compared favourably with that of fresh carrot sample. However, only OFSP var. Indira Madhur compared favourably with carrot in the preparation of parboiled vegetable salad. The potential of these OFSP genotypes grown in Chhattisgarh as very good dietary sources of pro-vitamin A in local food industries and human nutrition was also observed. Repositioning sweet potato production and its potential for value-added products will contribute substantially to utilizing its benefits and many uses in human food systems.

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ISFS-203

Unlocking the healing potential of tulsi

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Tulsi is both a miracle healer and an ingredient in gourmet cooking. Tulsi or Basil is catching the attention of medical research derived from the Greek word 'Basileus' meaning Majestic, Basil or Tulsi has great restorative qualities and has been hailed as the queen of all the curative herbs. The generous amounts of the phyto-chemical compounds present in the plant posse's powerful antioxidant and antiviral qualities. Another important compound present in it is called ursolic acid, which is an essential oil. All these compound work

together to form a support to the body's natural immune system and guards against stress by balancing the mind, nerves and emotions. Tulsi is a storehouse of flavonoids which help protect cells and chromosomes from oxidation and damage. Tulsi cures a host of physical ailments as it is an outstanding source of iron, calcium, potassium and Vitamin-A and Vitamin-C which in particular is beneficial in curing cough and cold. It has a strong presence of magnesium that keeps arteries healthy thereby improving blood and oxygen is the body. The herb excellent digestive qualities and chewing a few leaves after a meal is very beneficial. This not just works as an anti acid as it helps the body absorb food but also prevents reflux and the formation of ulcers. The herb is also an environmentalist's delight as it rids the surroundings of all kinds of pollution due to its absorptive qualities. It also releases a high amount of oxygen that enhances the cleansing process. It is commonly used in the preparation of a concoction wherein, Tulsi and tea leaves are boiled for a refreshing beverage. The flavonoids in Tulsi leaves are believed to reduce the risk of platelets forming clots on the arterial wall preventing coronary heart disease and heart also relieves stress and helps fight many debilitating diseases by neutralizing free radicals that can damage tissues, cells and genes. Whether, for perking up pastes and curries or for as an herb that provides miracle cures for an array of physical ailments or even as nature's own weapon against pollution, Tulsi is a wonder plant that is a divine gift to humankind and has been used for centuries as a miracle herb.

ISFS-204

Bamboo shoots as nutritive source of food

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The emerging fresh young bamboo shoots are harvested and used as vegetables. They are used in numerous Asian dishes and are available in markets in various sliced forms, fresh, fermented and canned version. Its consumption increase world wide expanding from oriental to western world. The bamboo shoot in its fermented state forms an important ingredient in cuisines across the Himalayas. In Assam as *khorisa,* Nepal (*alu tama)* and *p*ickled bamboo are used as a condiment in Sikkim and in Sambalpur as *kardi*. In Indonesia, sliced thin bamboo make a dish named *gulai rebung.* In the north eastern state of India, Manipur, the fresh succulent bamboo shoots and the fermented preparation of bamboo shoot slices, locally called "soibum / soidon" are highly prized vegetable item. The present work is undertaken to assess the nutritive content of fresh and fermented succulent bamboo shoots and its medicinal properties so as to stimulate new uses of bamboo shoots in the existing markets. The young fresh bamboo shoots contain various ingredient of nutritional significance like carbohydrate (2.5 to 5.2 %), protein (2.0 to 3.2 %), amino acids, minerals, ascorbic acid (0.02 to 2.0 %), flavonoids (0.5 to 2.3 %), tannins (0.01 to 0.05 %), total phenols (0.01 to 0.33

%) and a good source of natural antioxidants. They also have high dietary fiber content and low fat content. Bamboo shoot slices contain high level of phytosterols (0.08 to 0.19% dry wt. in fresh shoot slices). Bamboo shoots contain cyanogenic glycoside (0.24%) which decreases during the fermentation process below the toxic level. Further works on its anti-microbial activities is still in progress. In this paper the traditional fermentation technique and its importance is highlighted.

ISFS-205

Stress tolerant tuber crops for food security under changing climate

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The threat of food insecurity under changing climate is haunting everyone. To resolve the issue agrihorticultural research is now taking a paradigm shift to develop climate proof crops with valued traits. The tropical tuber crops viz. cassava, sweet potato, taro and yams are the staple food of people live in Islands and fragile environment. These crops are gaining importance for their high productivity (20-50 t/ha), nutrition and ability to thrive on harsh climate. The climatic resilience of sweet potato and taro as life support species was evident during super cyclone in 1999 in Orissa, Tsunami in 2004 in costal Andhra and Tamil Nadu in India and other countries. Such fact revalued the potential of these third world crops for livelihood security under awakening threats of global warming. About ten thousand tuber crops accessions are conserved at Central Tuber Crops Research Institute (CTCRI) of ICAR and its AICRP Centres. These crops mostly conserved *ex-situ* in field and also *in-vitro*. Conservation, progressive screening and evaluation of genetic resource of tuber crops at CTCRI resulted in identifying sweet potato genotypes tolerant to biotic (weevil) and abiotic (salt) stress having high yield, starch (18-20%), ß-carotene(6-12 mg/100g) and anthocyanin (85 mg/100g). Similarly local land races of taro are found to be tolerant to biotic leaf blight and abiotic submergence, drought and salt stresses. Likewise improved varieties of elephant foot yam and other tuber crops have also been developed. Developed and developing countries have shown greater concern about the loss of genetic diversity of such climatic resilient valued tuber crops genotypes. Conservation of gene source with valued traits is essential. Diverse collection need to be evaluated for biotic and abiotic stress tolerance. Moreover, improved varieties for the future should be adapted to low inputs (water, fertilizers) but 'highly responsive to organics' so that they can be used by resource-poor farmers. In this context, low input high energy nutrient rich tropical tuber crops responsive to organics hold great promise. The NBA-PPVFRA based system in India supports the conservation and resolve the various issues related to biodiversity. Awareness on conservation especially community based conservation starting from grass root level is the demand of the day. Farmers–researcher participatory evaluation of genetic resources for valued traits can unearth the paradox to realize the potential of tuber crops for achieving food and nutrition security against adverse climatic conditions.

ISFS-206

A study on effect of change in prices of inputs on food security of agricultural households in coastal saline zone of West Bengal

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The term 'food security' means availability of food materials to all the people at all times in adequate quantity for active and healthy life. Food and Agriculture Organization (1983) defined food security as ensuring that all people at all times have both physical and economic access to basic food they need. World Development Report (1986) defined food security as access by all people at all times to enough food for an active, healthy life. Basic problem of food security originates from shortage of food for consumption requirement of people in a geographical area. The agricultural households are not self-sufficient for producing all sorts of food commodities needed for consumption for healthy and active life. A Lion share of their family earning is accrued from crop production in which various types of inputs applied to fixed factors get transformed into output. So prices of Inputs and outputs are strongly related to the earnings of the agricultural households. The study attempted to find capabilities of agricultural households in maintaining food security with their income earned from crop production at two points in time.The study was conducted in Kakdwip block of South 24 Parganas district. The reference years of the study are 2001-02 and 2011 – 2012 agricultural years. The study is based on primary as well as secondary data . Requirement of food commodities was estimated on the basis of prescription for balanced diet for people made by National Institute of Nutrition working under the aegis of Indian Council of Medical Research. The study revealed that prices of input materials used by the farmers and the outputs produced by them went up to a large extent in the concerned period. But it was found that increase in prices of input materials was higher than that of outputs. Consequently real income of the agricultural households earned from crop production declined in this period. A higher portion of this income was necessitated to be spent for purchasing food commodities in maintaining food securities in 2011-12 as compared in 2001–02. This study calls for shifting a portion of people from crop production to other earning activities.

ISFS-207

G x E interaction for yield and important yield components in Indian mustard (*Brassica juncea* L. Czern and Coss) under valley conditions of Manipur

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To cope with the changing climate,a study was undertaken during *rabi* season 2009-10 and 2010-11 in Indian mustard (*Brassica juncea* L. Czern and Coss) so as to find out a suitable variety for valley conditions of Manipur .The stability on yield and its important attributes of twelve genotypes under eight environments was studied. Environment analysis of variance revealed highly significant variance due to genotypes for all the characters under study. The environment (linear) was significant for all the characters under study, while the GxE interaction (linear) was found to be significant for the characters, *viz*., number of secondary branches per plant, number of siliquae per plant, siliqua length, seed yield per plot and 1000- seed weight. Analysing the stability parameters for individual genotypes, GM-2, JD-6 and Pusa Bold were found to be stable for wide adaptation. Genotypes, Kranti, NDRE-7, NDRE-22 and Sej-2 could be recommended for cultivation under favourable environments. On the otherhand, Urvashi could be recommended for cultivation under poor environments.

ISFS-208

Identification of elite resistant genotypes in potato (*Solanum tuberosum* L.)

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Eleven potato genotypes were evaluated for yield, storability and resistance to major disease and pests by growing them in two years and harvesting tubers in two different dates. Genotypes showed above average yield over all the year and date of harvesting and three of them like J/95-378,K.Ahoka and K.Pukhraj performed consistently well in all the year with high tuber yield for early as well as late harvesting. Dry matter content in tuber were found to be comparatively stable in other two genotypes like J/96-80,J/96-84.Least loss due to storage in ambient condition was noticed in J/96-238 and J/96-149 as well as J/95-378.J

and 96-238 followed by J/97-243 were found to be consistently east susceptible to biotic stresses due to attack by major pests and diseases like against aphids, whitefly, epilachna beetle, viral diseases, late blight and other fungal diseases. Genotypes J/96-238, J/97-243 were found to be highly resistant to late blight diseases as well as other fungal diseases. So these types of resistant genotypes can be employed to obtain high yielding resistant genotypes with maximum storage capacity under ambient environments.

ISFS-209

Altitude extension: the differential knowledge management in hill ecosystem of north-east India

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Extension education, by becoming both system and function for technology socialization, can't go without geographical references. With a change of altitude and slope, the panorama of biology and sociology keeps transforming and hence, the altitude of a hill becomes a major character itself in deciding on strategy of extension for a synergy of geography with sociology. What is happening since past and till today is a kind of blanket extension recommendations is being made to cover all geographical variations and social scores, along and across the slope or terrains in a given hill ecosystem. This can neither be flexible, nor be as précised in redressing the geography specific technological problem or sociology specific institutional issues. The North East Hill eco system of India is blessed with bounty of nature and is one of the hot spots of the World. Altitude extension, the first of its kind in extension domain, has attempted to include the geographical variations along with the altitude of a hill ecosystem in designing the extension approach with social, technological, and cultural variants. In this paper and with this innovative approach, an empirical study has been conducted to estimate the factors of variations with the change of altitude, for ultimately designing a both gross and subtle extension plan for desired changes in the agriculture *vis-à-vis* social ecology of hill ecosystem. The altitude variances here are being associated with change in farming system, options of indigenous technology, the text of culture, the value and praxis, the income and livelihood generating from a micro farming system.The altitude extension thus will add a new dimension of hill development by encompassing micro-micro interventions, oriented to and based on, what we may term, is the neo altitude extension.

ISFS-210

High density planting systems in mango – an approach for food and nutritional security

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The experiment was carried out at Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya , Nadia, West Bengal to study the effect of different high density planting systems (hedge row: 167 plants/ha, double hedge row: 222 plants/ha, paired: 133 plants/ha and cluster: 178 plants/ha) and conventional system (square: 100 plants/ha) on 10 years old mango cv. Himsagar for three consecutive years (2010-12) with an objective of getting higher production from a unit area to meet the food and nutritional prosperity of the ever increasing human population. Yield and fruit quality along with the incidence of three important diseases *viz.* powdery mildew, anthracnose and bacterial canker were recorded. Among 5 different planting systems, double hedge row with highest plant density resulted maximum yield per unit area (8.10 t/ha) though maximum number of fruits (280 fruits/plant) and yield per plant (56.7 kg/plant) were obtained by square planting system with lowest plant density. Fruit weight and fruit quality in terms of total soluble solids, acidity and ascorbic acid varied insignificantly among different planting systems. Double hedge row planting system can be adopted well in mango cv. Himsagar with proper management for yield increase from a unit area without deteriorating fruit quality.

ISFS-211

Management and development of bee colonies, *Apis mellifera* through *Haldi* during dearth period

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For the management of mites, moths, diseases and development of bee colonies, the experiment was done in *Apis mellifera* bee colonies of Bihar Agricultural University, Sabour, Bhagalpur during 2010-11 and 2011-12. *Haldi* contains curcuminoids (Plant based powerful antioxidant and anti-inflammatory nutrient). It improves digestion and it also act as antibiotics in bee colonies. One litre of sugar syrup contains half gram of haldi powder is given as food in bee colonies in dearth period. The bee colonies performance was good as compare to sugar syrup done. Sulphur powder 500 gm was mixed with 200 gm haldi powder. After cleaning the boxes, the mixture was spread @ 10 gram per box in bee boxes. It prevents the varroa mites, other mites, moths and diseases which were found in bee colonies.

ISFS-212

Assessment of nutrition level of school going children (primary) in terms of agro-economic and psychological variables

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Across the world, the problem of malnutrition has been perceived as the most dangerous and menacing factors towards ensuring a decent and secure livelihood. The situation has gone further worse for some African and South East Asian countries. The problem of malnutrition has got social, political, technical and motivational dimensions as well. Education being the basic driving force for any economic and social process per se, the school going children need to be focussed and attended comprehensively so that they can grow up themselves as the healthy citizens having belligerent mind and body. But unfortunately, almost 80% of the school going children in India are suffering from delirictous impact of malnutrition leading to poor performance, malfunctioning, stunted growth, vulnerable to diseases and morbidity and so on. Malnutrition is not only a biological phenomena, it is a synergy of biophysical as well as social process. Access to food, sufficient and nutritionally rich is also one of the discerning factors that impacts heavily on the nutritional aspects on the school children. The analysis of malnutrition thus needs a complex framework gridding all the cognate factors like size of holding, parental education, food intake volume, energy intake, chronological age, ill behaviour of agriculture, information seeking behaviour, medical and health care and so on.The entire exercise over the research text of child nutrition has proved that the nutrition is basically a complex phenomena and cannot be managed in the single intervention, it's not been a single chance factor either. In this study, the nutrition has been conceived as a composite configuration of food intake, calorie intake, high value food intake, sanitation and total calorie intake. It depicts that the predictor variables like age, training, family size, subsidiary income, parents education, crop yield, etc. have become predominant factors in making a discernable difference between high and low level of nutrition status among the respondents.

ISFS-213

Innovative technologies to enhance the production and productivity of jute and allied fibre crops

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The Central Research Institute for Jute and Allied Fibres (CRIJAF), one of the premiere institutes of Indian Council of Agricultural Research (ICAR) is the sole institute shouldering the responsibility to sustain and improve the jute and allied fibre farming through economically viable, ecologically sustainable and farmers' friendly production and post-harvest technologies. In order to enable the farmers to get highest possible economic yield per unit of arable land CRIJAF has developed 14 varieties of tossa jute (*Corchorus olitorius* L.), 11 varieties of white jute (*C. capsularis* L.). Apart from the development of improved jute varieties CRIJAF has taken initiatives to produce quality jute seeds of newly released varieties for favour of sale under the trademark "CRIJAF SEED" (Regn. No. 1893231). "An improved seed sowing machine" (vide patent application no. 1367/KOL/2006, dated 18.12.2006) has been designed and fabricated to encourage line sowing and thereby to increase fibre yield and to reduce seed rate and cost of cultivation and to facilitate intercultural operations. For weed management in line sown field crops (jute, mesta, cereals, pulses, vegetables), horticultural crops and kitchen garden CRIJAF has developed "An improved herbicide applicator" (vide patent application no. 319/KOL/2010, dated 26.03.2010) to deliver non-selective herbicides and "Nail weeder" (vide patent application no. 386/KOL/2010, dated 05.04.2010) to weed out young composite weed flora including germinating ones. These three technologies have been commercialized. CRIJAF has developed "A microbial consortium used in faster retting of jute and mesta" (vide application No. 418/KOL/2011, dated 30.03.2011) through ribbon and whole plant retting. CRIJAF has also developed a novel, eco-friendly, cost-effective and energy-saving technology for large-scale degumming of ramie fibres and filed a patent application in the name of "An improved process of large scale degumming of ramie fibre" (vide application no. 1036/KOL/2008, dated 16.06.2008). These production-cum-post-harvest technologies contributed a lot to achieve the landmark production of raw jute and make jute cultivation a viable and competitive one.

ISFS-214

Scenario of mango production under changing climatic conditions

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Irregular cropping is the biggest problem in mango production. Inconsistent run of cool nights and relatively warm winter has adversely affected flowering in mango during the year 2009-11. Among the factors responsible for flowering in mango, suitable environmental conditions namely low night temperature (< 12^0C) and soil moisture stress (-75 kpa or even less) before flowering are the main flowering trigger in mango. However, moisture stress can supplement the low temperature requirement to a great extent depending on varieties and induce flowering in mango. Mango grown in light soils (which have the capacity to loss moisture quickly) produced better flowering in spite of experiencing warm winter prior to flowering. Flowering in Himsagar (Khirsapati) had been worst affected during the years even in more moisture stressed situation grown in light soils. Intensification of flower induction under such prevailing warm winter could be supplemented by using growth retardants along with imposition of moisture stress prior to flowering (4 months dry period). In general, the erratic /low/ no flowering in late and vigorous varieties like Aswina, Fazli etc. grown in heavy soils were because of low soil moisture stress due to delaying monsoon upto first fortnight of October as well as lack of cool winters. If the situation (global warming and climatic change) prevails in the coming years, the mango production in the state will be at stake.

ISFS-215

Pre-flowering pruning to ensure regular cropping and sustainable yield in litchi

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The experiment was conducted in Horticultural Research Station Mondouri, Bidhan Chandra Krishi Viswavidyalaya during 2009-11 to induce flowering in late autumn flush and to ensure regular cropping and sustainable yield in litchi cv. Bombai by pre-flowering pruning shoots in different months. The experiment comprised 9 (nine) treatments with three replications, laid out in completely randomised design; [T_1: Pruning of current season shoots in the 1st fortnight of October; T_2: Pruning of current season shoots in the 2nd fortnight of October; T_3: Pruning of current season shoots in the 1st fortnight of November; T_4: Pruning of current season shoots in the 2nd fortnight of November; T_5: Pruning of current season shoots in the 1st fortnight of

December; T_6: Pruning of current season shoots in the 2nd fortnight of December; T_7: Pruning of current season shoots in the 1st fortnight of January; T_8: Pruning of current season shoots in the 2nd fortnight of January;T_9: control]. The per cent flowering shoots was recorded maximum 65.52 per cent with pruning shoots in the 2nd fortnight of November. Emergence of panicle was earlier nearly by 3-4 days by pruning shoots in the month of October and November. The better fruit set and the retention of fruits per panicle was observed in pruning of current season shoots in the 1st fortnight of November compared to control. The number of fruits per tree was recorded highest (3061.53) from trees pruned in 2nd fortnight of November. The highest yield (74.07 kg/tree) recorded in the trees pruned in 2nd fortnight of November. The pruning shoots in first fortnight of November caused maximum fruit weight 24.22 g, fruit length of 3.94 cm and pulp weight of 18.33 g. The highest total soluble solids content 17.33 ^{o} brix with trees pruned during 1st fortnight of November and the highest total sugar content of 14.44 per cent was recorded with pruning at 2nd fortnight of October followed by pruning at 1st fortnight of November with 14.04 per cent. The lowest acidity content 0.33 per cent and highest TSS/acidity ratio (50.45) with pruning in 2nd fortnight of November. The pruning of current season shoots in 2nd fortnight of November showed highest vitamin-C content of 67.98 mg per 100g of pulp. It appears from the results that pruning current season shoots in 1st fortnight of November could be suggested to induce flowering in the unproductive late autumn flush to ensure regular cropping and sustainable yield of litchi cv. Bombai.

ISFS-216

Conversion of agricultural land to construction of residential buildings: a threat to the food security

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The observation was made in the dense populated district head quarter Sandhikharkha, Arghakhanchi District of Nepal. The land is under good irrigated from the local stream named *Bangi Khola* and considered as one of the productive field of the District, where most of the agricultural crops namely Rice, Wheat, Maize, vegetables crops grown which feeds the huge population of the district. The area from the *Bihara* to *Fudbang* is a highly agricultural belt from where even from a single rice crop cultivation the land owner can feed their family for whole year. Unfortunately due to High demand for residential and commercial properties in higher price and construction of new roads is posing a threat to the agricultural production. As individuals and big investors take advantage of the expansion of infrastructure and selling them, the sudden shift in uncultivated barren and un-irrigated land use could result in the disappearance of productive agricultural lands which could in turn affect food security and economic growth. Unless the effective government policy on it where to

start construction, farmers will be unable to enhance food security. The government needs to issue guidelines on infrastructure development, especially on agricultural land areas adjacent to urban areas. For food security conceptually, four different components- Availability, access, utilization and vulnerability should be fulfilled, due to destruction of cultivable land the availability of the production is getting low. So, from the root of it if consequence disturbed, would be seen the great food insecurity in a near future.

ISFS-217

Environmental impact and social dynamics in tea garden ecology in India : the issues of food security

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The social ecology of tea gardens in north-eastern part of India has been characterized with polymorphic interactions amongst and between three sets of sub- ecological cybernetics *viz* physical ecology(x),biological ecology(y) and social ecology(z).Each of these sub- ecosystems is being comprised of sets of constituent characters. The present study has envisaged polyhedral interactions amongst and between the constituent characters of these three sub-ecological characters. Accordingly, the above mentioned sub-ecologies (x,y,z) have been conceived to have sub-systems. The variables pertaining to all these sub-ecologies again have been articulated into the set of socio-economic characters(X) of respondents. All these have been done to establish and estimate the pattern, direction and intensity of interaction to ultimately estimate the ecological behaviour of that tea garden setup. The respondents have been selected through both purposive and random sampling approaches to ultimately derive and elicit their behavioural traits in the changing meteorology, biological and physical setup.The results depict that a change in physical ecology, like, a change in rainfall pattern conspicuously enters the social echelon by impacting on income, market behavior and strategic interactions. The biological components like declining fish species and local weed species have entered the social echelon, by setting its livelihood generation to a new direction. So, the interdependent and mutually synchronized relationship amongst and between the physical, biological and social echelons have been the prime mover for ushering a social change *vis-a-vis* an ecological transformation as well. All these analytical outcomes can be networked to formulate a policy echelon to make clandestine intervention to protect the ecological health of that tea garden based mega-ecological setup from both decadence and destruction. The study would go a long way to make a series of interventions here in this area or can be replicated elsewhere .

ISFS-218

The climate change perception in Sikkim hill ecosystem of India : A perceptual analysis towards achieving food safety

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The brunt of climate change on hill ecosystem is very much conspicuous and discernible across the world. The melting of snowline, the rise of mean winter temperature, the loss of biodiversity etc, all are enough indicative to estimate the imminent losses and deleterious impact on agriculture, human life, biodiversity or summative; which may be elicited as social ecology. The present study has selected the Hill ecosystem of North Sikkim as a research locale to estimate the people's perception on the impact of climate change on this fragile ecosystem. The variables Y_1 (Climate change perception), Y_2 (Yield change perception), Y_3 (Water bodies perception), Y_4 (Health problem perception), Y_5 (Species decline perception), Y_6 (Perception indicator change), Y_7 (Landslide perception), Y_8 (Distance perception), Y (Comprehensive climate change perception) the following variables has been selected and customised as core of predict ants, against which the following variables X_1 (Age), X_2 (Education), X_3 (Family size), X_4 (Media interaction), X_5 (Per capita holding size), X_6 (Cropping intensity), X_7 (Technology socialization status), X_8 (Family income), X_9 (Expenditure after health), X_{10} (Animal health mentoring), X_{11} (Location of the market), has been selected as to have causal impact on the above stated perceptual variables. It has been found that the variable X_2 (Education) has got decisive impacts on climate change perception. While path analysis has been carried out the variable X_3 (Family size) has exerted the HIDE (Highest Indirect Effect) on climate change perception. The correlation analysis has evinced that the variables X_2 (Education), X_6 (Cropping intensity), X_8 (Family income), have been significantly correlated with climate change perception. The Principle Component Analysis depicted that the following key factors are characterizing climate change perception : Farm capacity, Health Ecosystem, Geo- Diversity, Media Complex, Socialization Dynamics, Resource based climate change perception, Landslide perception.

ISFS-219

Conservation of icthiofaunal diversity through participatory learning action : an action research for securing food security

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The brunt of climate change is strongly discernible through the erosion of Icthiofaunal biodiversity. The present paper has been the outcome of a rigorous research work to identify the factors attributing to the fast reduction of local fish biodiversities. The indigenous fish goners are the most important bio-ecological indicators to measure the intensity of changes disturbing ecological balances of any micro-farming system both in intrinsic and extrinsic manner. Some local and innovative measuring devices, elicited by the stakeholders themselves, were applied to calculate the FMV and fish landing in different local markets. This would ultimately make the researchers draw conclusion that the factors like chemical loads in agriculture, occupational change of the rural people, destruction of local bodies, indiscriminate use of pesticides in agricultural field and adjoining water bodies are all responsible for ushering a faster decline of these local fish species. The decline of species has been measured in terms of loss of decadal score down the years and declining availability of these fishes across the spatial distribution had been statistically intercepted to get the most expected estimation of species count and the factors contributing to them. Other PRA tools had been administered and subsequently been quantified for facilitating the objective analysis and drawing thereby a logical conclusion.

ISFS-220

Role of growth analysis studies and their possible use in selection work in safflower (*Carthamus tinctorius*)

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An intensive investigation showed that some physiological growth parametrers were determined for efficient selection work at early stages of crop growth in safflower (*Carthamus tinctorius* L.). Plant samples were taken three times at 15 days interval starting from 38 days of seeding. Results revealed significant genotypic differences in respect of Crop Growth Rate (CGR) and Leaf area Index (LAI) between 38 and 53 days of seeding, whereas Net Assimilation Rate (NAR), Relative Growth Rate (RGR) and Specific Leaf Weight

(SLW) gained in importance in the interval between 53 and 68 days. The magnitude of total correlation among and of direct effects of most of these growth parameters on seed yield were low and insignificant suggesting that dry matter accumulation at earliest stages of crop growth (before anthesis) would have little impact on seed yield. The object of the present investigation was found that the growth analysis indicate that leaf area was more effective in dry matter accumulation at the earliest stage of crop development while in the later stage both leaf area and leaf mass (SLW) played significant role in crop growth.

ISFS-221

Estimation of dissonance in transforming farm ecology: a system approach to measure social entropy in rural India

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Farm technologies are being innovated and being diffused among the farmers in rural areas in India has become very frequent. Therefore, it is likely that some of the innovation conflicts in rural social system. Small and marginal farmers in search for alternatives to improve their livelihood often confront with the prescribed and impository farm technologies which in turn generates discomforts. This sort of discomfort is mostly cognitive in nature and is felt by the Indian farmers which can be otherwise called dissonance. In the state of dissonance farmers feel surprise, dreed, guilt, anger or embarrassment and often seek motivational drive to reduce dissonance by allowing existing cognitions adding new one to create a consistent belief system or alternatively by reducing the importance of any of the dissonant elements. Therefore it is important in the process of technology socialization to estimate the dissonance which can prove to be important factor to measure social entropy in metamorphosing farm ecology. An Ex-post facto research method was carried out in two villages namely Ghoragacha in West Bengal and Chiroura in Bihar. Coefficient of correlation, Stepwise regression, and path coefficient were used to find out the reasons for dissonance. It was found that Market orientation (x26), Urbanization index (x7), Information seeking behaviour (x29), Family Education status (x3), Irrigation index (x16), Farm size (x10), Adoption leadership (x17) and Innovation proneness (x20) were the significant predictors to cause dissonance among the farmers. We need productive farm ecology to sustain livelihood among the farmers by mitigating their dissonant elements.

ISFS-222

Socialization of rubber Enterprise: a multi factorial study on livelihood security

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Technology socialisation is a alternative process over technology transfer approach to estimate the level and degree of characterisation of technology in a given social echelon. Rubber is one of the major plantation crops for smallholders which generates continuous cash flow and provides livelihood to millions of people. Keeping this in view, the present research was carried out with objective to assess the level of socialization of rubber enterprise among the growers. The study was conducted in the some selected village of Manu Block in Dhalai District of Tripura. The data was collected through personal interview with the help of a structured schedule and questionnaire was administrated to a randomly selected sample of 77 households. The correlation analysis reveals that predictor variable education (X_2) is significant and positively correlated on socialization level (Y), whereas the variables Age (X_1), homestead land (X_6) and area under rubber (X_8) have been found negatively significant with socialization level (Y), the consequent variable. The regression analysis also reveals socialization has been decisively influenced by area under rubber. Again, the path analysis presents that antecedent variable; area under rubber (X_8) has come up as the most significant variable in the entire study. Resource entrepreneurship has also been found to be important causal factor to characterize the dictum and direction of socialization of plantation crop. Contemplating these factors are crucial in modelling socialization in any given agro-socio-eco system at both micro and macro level.

ISFS-223

The change dynamics of rural livelihood : the chronicle of food security

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The national economy of India is heading for an “inclusive growth” and, in making this progress a reality through livelihood generation process, the agricultural and rural sector must have to go all out in attaining a sustainable, persistent rural sector growth with a clear focus on peripheral economy. The livelihood generation, mentoring, customization and value addition have got both intrinsic dynamism and extrinsic

disposition in both ecological and economic echelons. The present study has been undertaken to throw some light on 'The change dynamics of rural livelihood" and intricacies associated with the social chemistry of "Rural livelihood generation along the pipeline of technology flow and socialisation therewith". The objectives of the study was (i) to estimate change dynamics of livelihood over decades as the consequent character of the respondents perceived have as "Y", (ii) to study the personal, socio-economic characteristics of the respondents eking out rural livelihood from selected areas of Nalanda District, (iii) to customize as estimate a set of variables (16 by count) as predictor character deemed to have impact on livelihood dynamics, (iv) to estimate the interaction and relationship among and between the between the dependent and independent variable both at inter and intra level and (v) to elicit some policy implication for a subsequent application in area under study or elsewhere having similarity of system characters to usher sustainable livelihood for respondent or the population having homogeneous trait within that of respondents.

The work was conducted with 3 dependent and 16 dependent variables. Purposive as well as simple random techniques were adopted for the study. For selection of district , block, village, purposive sampling techniques was employed for selection of respondent. There are 325 families only 75 farmers have been randomly selected respondents. The main findings of the study on the change dynamics of rural livelihood in correlation coefficient analysis the variables like X_5 (distance matrix), X_{13} (yield), X_{14} (adoption level), X_{15} (annual income), X_{16} (Expenditure) come as important variables. These entire variableshave important effect on dynamics of livelihood in village. However, enterprise factor for change dynamics of livelihood among the respondents which enhancing the productivity and generating the sustainable livelihood through utilization resources.

ISFS-224

Integrated technology for sustainability of food security and food safety

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Being multidimensional in nature, food security includes food access, availability, food use and stability. Food safety is an integral part and important component of food security when populations have access to sufficient and healthy food. It is directly related to the method of food production, postharvest handling, processing, storage, distribution, marketing and consumption. Food safety is the assurance of food supply that does not pose health risk of food borne diseases or harmful levels of toxic substances to human health. It is, now a globally recognized major public health issue which has become a priority concern in many

countries. Improving food safety issues can also promote the food security due to reduction in loss of food and medical cost. However, reducing food risk is the challenge issue since food hazards vary among climatic condition, food habit, income level, and public infrastructure. Some hazards are closely linked with sanitation, water supply, food preparation and its marketing. Thus, food safety issues cannot be addressed separately from health, nutrition, food production and marketing issues. So, enhancing food safety is an alternative perspective to the improved health and nutrition. New regulations in the developed countries have also implication for food producers and processors of developing countries. The authority organization should assist the exporters of developing country to maintain global market access. In this paper, an attempt has, therefore, been made to discuss the integrated technology including GAP, GMP, HACCP, SSOP etc. for food security and food safety with an objective to consider food not only as an agricultural and/or trade commodity but also a public health issue to boost the consumers' confidence in food safety. Among various strategies at community level, good agricultural practices (GAP) can limit the mycotoxin formation in crops before harvest, and good manufacturing practices (GMP) from harvest to table can reduce food quality and safety concern.

ISFS-225

Studies on effect of bunch cover in banana to combat climatic vulnerability in teesta flood plains of terai region

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Hot humid weather is a typical characteristic of Teesta flood plains of Terai region prevailing from April to October. Banana bunches emerging during this period are highly infested by scarring beetle (*Basilepta subcostatum*). In order to cope with this problem of scarring beetle and improve banana yield and quality the following study was conducted at Khagribari village of Cooch Behar district, West Bengal, India during the year 2011-12 to assess effect of bunch cover in banana (*Musa* AAA, cv. Dwarf Cavendish). 14 innovative and receptive farmers were selected from the village for conducting the trial ensuring their active participation. Each farmer had one plot of 150 plants. Two treatments were taken (i) bunch cover with non woven poly propylene skirt bag (ii) Control of existing practice having no bunch cover. Observations were taken on bunch weight, fruit weight, shooting-harvest interval, scarring beetle infestation on fruit, visual appearance and net profit. Two independent sample t-test were performed to compare two treatment for all parameters. Experimental results indicated the superiority of using bunch cover (49.50 t/ha) over conventional method of no bunch cover (47.62/ha). Higher bunch weight (19.97 kg) and fruit weight (125.70g) were recorded with bunch cover showing significant increase of 4.50% and 7.84% respectively over control. Whereas shooting-

harvest interval was reduced by 8 days under cover as compared to control. Significantly lower scarring beetle infestation (1.8%) was noted under bunch cover as compared to fruits of uncovered bunches (98.5%). Banana fruits grown under cover had minimal bruises (2-5%) and were significantly cleaner from dust, spider web and bird drops at harvest over control (50%), which made the covered bunch fruits more attractive to the consumers. The bunch covering method also registered significantly higher net profit (Rs. 3,74,543.21/ha) against conventional practice.

ISFS-226

Sweet potato- its past, present, and future role in human nutrition in Chhattisgarh

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The sweet potato meal after drying and slicing is useful as a feed for dairy, beef cattle and sheep. The chipped tubers can be ensiled. The peel of tubers and spent pulp after the extraction of starch from tubers may also be used as a feed for livestock. Sweet potato is used as a good source of starch in Japan, U.S.A. and India. Sweet potato starch is also useful in laundry work where it imparts a cleaner colour, greater smoothness and stiffness to fabrics treated. It can also be used for coating in dry batteries, insulating fabrics, postage stamps and dextrin's and adhesive. Sweet potato starch is useful as an ingredient in the products of confectionary and baking industries. Bactericidal and fungicidal substances have been isolated from the vines and tubers of sweet potato. The overall objective of this chapter is to assess past, present, and future role of sweet potato in human nutrition and tribal people of Chhattisgarh. Specifically, the chapter describes the role of the sweet potato in human diets; outlines the biochemical and nutritional composition of the sweet potato with emphasis on its beta-carotene and anthocyanin contents; highlights sweet potato utilization, and its potential as value-added products in human food systems; and demonstrates the potential of the sweet potato in the Chhattisgarh context. Early records have indicated that the sweet potato is a staple food source for many indigenous populations in Chhattisgarh district like Bastar, Kanker, Raipur, Dhamtari and Mahasamund. Protein contents of sweet potato leaves and roots range from 4.0% to 27.0% and 1.0% to 9.0%, respectively. The sweet potato could be considered as an excellent novel source of natural health-promoting compounds, such as beta-carotene and anthocyanins, for the functional food market. Also, the high concentration of anthocyanin and beta-carotene in sweet potato, combined with the high stability of the color extract make it a promising and healthier alternative to synthetic coloring agents in food systems. Starch and flour processing from sweet potato can create new economic and employment activities for farmers and rural households, and can add nutritional value to food systems. Repositioning sweet potato production and its potential for value-

added products will contribute substantially to utilizing its benefits and many uses in human food systems. Multidisciplinary, integrated research and sustainability livelihood and development activities aimed at improving production, storage, postharvest and processing technologies, carotene rich varieties and quality of the sweet potato and its potential value-added products are critical issues, which should be addressed globally.

ISFS-227

Studies on yield and yield attributing characters in some recombinant inbred lines of photo-insensitive Basmati derivative

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The present investigation consisted eighteen recombinant inbred lines (RILs) of Basmati derivative and two check varieties of rice was evaluated during *kharif* 2010 to study yield and yield attributing characters. Seven RILs *viz.*, Bidhan Moti 11, 30, 15, 6, 10, 23 respectively surpassed the check varieties i.e., Satabdi (IET 4786) and Khitish (IET 4094) in respect of grain yield and some yield related traits. The maximum range of variation in mean was observed for floret number panicle^{-1} followed by number of grains panicle^{-1}, plant height and fertility percentage. The highest estimate of phenotypic and genotypic variances was observed for florets number panicle^{-1} followed by number of grains panicle^{-1} and plant height. High estimates of GCV and PCV were obtained for grain yield plant^{-1}, number of grains panicle^{-1}, panicle weight and floret number panicle $^{-1}$. High heritability was observed for most of the characters studied *viz;* florets number per panicle, fertility percentage, kernel length, panicle weight, grain length, number of panicles plant^{-1}, kernel L/B ratio, grain breadth and days to maturity. Grain yield showed positive and significant correlation with fertility percentage at genotypic level and number of panicles plant^{-1}, number of grains panicle^{-1} both at genotypic and phenotypic levels. Path coefficient analysis revealed that seven characters *viz.* plant height, days to 50% flowering, number of panicles plant^{-1}, panicle length, number of grains panicle^{-1}, grain length and kernel breadth had positive direct effect on grain yield while nine characters namely days to maturity, panicle weight, florets number panicle^{-1}, fertility percentage, grain breadth, L/B ratio, kernel length, kernel L/B ratio and 1000 grain weight incurred negative direct effect on grain yield. Number of grains panicle^{-1} and panicle number plant^{-1} showed highly significant positive correlation simultaneous with high amount of yield.

ISFS-228

Evaluation of responses of cowpea (*Vigna unguiculata*) genotypes and varieties to infestation of legume pod borer (*Maruca vitrata* Fabricius)

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For present investigation five local varieties, twenty genotypes obtained from Indian Institute of Vegetable Research, Uttar Pradesh and three varieties from Indian Institute of Horticultural Research, Andhra Pradesh, India were sown on Agricultural Research Farm of Banaras Hindu University, Varanasi, Uttar Pradesh, India during two consecutive cropping seasons. Among twenty eight cowpea genotypes and varieties tested for its levels of resistance against legume pod borer (*Maruca vitrata* Fabricius), EC 394828, ET 116932, Kashi Shyamal, Arka Suman and Arka Sumurudhi were found more resistant than others. All the other genotypes and varieties showed tolerant to highly susceptible reactions to natural infestation of legume pod borer. The correlation coefficient values revealed that amount of phenol in flowers and immature pods affects adversely the infestation of legume pod borer. However, the concentrations of carbohydrate and protein affect it favorably. The peduncle and pod length did not play any significant role in natural buildup of legume pod borer population in cowpea agroecosystem.

ISFS-229

Effect of biopriming of radish (*Raphanus sativus*) seed with some antagonistic isolates of *Trichoderma*

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Two antagonistic *Trichoderma* species *T. viride* and *T. harzianum* isolated from soils of new alluvial zone were used for bioprimng of radish seeds. Seed priming with bio agents was done for protection of seeds and their subsequent effects on seed germination, plant biomass, leaf area and cholorophyll content and some other parameters both under laboratory and field conditions.

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