2017-18

Annual Report

भाकृअनुप
ICAR

ISO 9001: 2015

ICAR-Central Institute for Subtropical Horticulture
Rehmankhera, Lucknow - 226 101
(An ISO 9001: 2015 Certified Institute)

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Annual Report
2017-18

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Preface

We are delighted to present the annual report of 2017-18 of ICAR-Central Institute for Subtropical Horticulture, Lucknow. Horticulture led farming system has potential to double farm income on sustainable basis. Institute is actively engaged in developing technologies to augment income of farmers. Pink pulp coloured guava variety CISH-Lalit has gradually changed the guava cultivation landscape of country and emerged as most sought after variety due to its suitability for table and processing purposes and it has spread over 4700 hectare in the country. This variety is helping growers and nurserymen raise their income. Revenue of Rs. 7.43 crore was generated through sale of grafted plants of CISH-Lalit by different stakeholders and around Rs. 24 crore by sale of its fruits. Nurserymen are now targeting production of planting material of CISH-Lalit worth Rs. 40-80 lakh in ensuing year. Similarly, CISH-Shweta is replacing other varieties in Punjab, Haryana and Western Uttar Pradesh. Rejuvenation technology, canopy management, intercropping in mango, HDP in guava, wedge grafting in subtropical fruit crops, poly house cultivation of off season vegetables are some of the technologies which have made horticulture more profitable in subtropics. Institute has commercialized eleven post harvest technologies to three entrepreneurs. Institute has developed management schedules for mango wilt, shoot gall psylla and work is going on to manage thrips in mango which has become a bane for farmers. Institute in collaboration with ICAR-CSSRI, Lucknow identified banana wilt caused by *Fusarium oxysporum* (Race TR 4) endemic areas in UP and Bihar and management practices were developed and extended to farmers. In order to augment income of farm families, institute developed orchard based integrated farming system. Mango based poultry farming coupled with intercropping has been demonstrated successfully in four villages of Malihabad, Lucknow. Integrated farming system modules encompassing fish, poultry and pigs in orchard ecosystem are being demonstrated in Malda, West Bengal. Institute has promoted GAP and GI for Malihabadi Dashehari and linked mango growers to Bengaluru and Hyderabad market this year through help of Mandi Parishad. Under Mera Gaon Mera Gaurav programme, 18 farmer-scientist interactions, 12 kisan gosthies and 5 demonstrations were organized in 45 villages in Malihabad and Kakori. A number of training, exhibitions, demonstrations were organized through Skill Council of India/ PFDC/FFP/NEH/TSP. Two Horti-Entrepreneurship seminars were organized to develop entrepreneurship among youth. Two apps and 5 whatsapp groups were developed to have better connectivity with stakeholders. Institute participated in cleaning drive and created awareness about cleanliness under Swachcha Bharat Abhiyan.

I am extremely grateful to Dr. T. Mohapatra, Hon'ble Secretary & Director General, Indian Council of Agriculture Research, New Delhi and Dr. A.K. Singh, Deputy Director General (Horticulture Science Division), New Delhi for their guidance and support. My sincere thanks to all the scientists and publication committee for their contribution in compiling this report.

Place : Lucknow

Date: 30-06-2018

(Shailendra Rajan)

Director

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1 Executive Summary

Crop Improvement and Biotechnology

Eleven mango germplasm/varieties from Jammu and Kashmir, Pune (Maharasthra), BAU, Sabour and Bhagalpur (Bihar) and Malihabad, Lucknow (U.P.) were collected for their attractive colour, adaptability and better shelf life. Total of 772 mango accessions are being maintained in field gene bank. Pulp of thirty mango hybrids was analyzed for total antioxidants, total phenols, total flavonoids and total carotenoids. Evaluation data of 138 accessions indicated wide variability for fruit pulp, peel and stone weight. During 2018, using 10 cross combinations, 57314 flowers were crossed on 15125 panicles. A total of 226 seeds of mango hybrid were obtained from the crosses made during 2016-2017 and 201 stones germinated. The six hybrid seedlings raised from hybrid combinations attempted in 2015-16 were planted in field for evaluation of F_1 progeny of mango hybrid with a view to improve various fruit and quality parameters. During the year, 629 hybrids were evaluated for fruit physical parameters. The hybrids exhibited wide variability for fruit weight, pulp weight, pulp percentage, TSS and fruit colour. Among the hybrids evaluated, around 57 per cent hybrids exhibited fruit weight more than 200g, indicating scope for selection of hybrids with better fruit weight. Transcriptome data for floral buds of cv. Dashehari was mined for SSR containing coding sequences. Among 40,068 sequences examined, 2286 SSR containing sequences with di, tri, tetra, penta and hexa nucleotide repeat motifs were located, corresponding to genomic annotations were identified. This data set is important for development of functional markers. Ten key transcription factor gene families *viz*., *LFY, AGAMOUS-like 26*, *SAP*, *AP2*, *CO-like*, *FAR1*, *C2H2*, *TALE, M-type MADS box* and *Trihelix* were shortlisted for the computational analysis based on earlier described flowering models. A total of 48 coding sequences (CDS) representing these transcription factors were analyzed for their exonic segments which was reconfirmed by BLAST analysis with top hits matching with gene orthologs of either *Citrus sinensis* or *C. clementina*. Subcellular localization of these proteins identified that they have different sorting signals which diverted them to cytoplasm, chloroplast, mitochondria, golgi bodies and endoplasmic reticulum. The members of a specific gene family of transcription factors exhibited diversity which was also evident from domain analysis and phylogenetic groupings. For examples, the diversity and relationship among MADS box gene family retrieved from the transcriptome data is evident in the phylogenetic tree. Leaf transcriptome datasets of Amrapali and Chausa were mined for CDS encoding genes involved in carotenoid biosynthetic pathway and used for real time validation. Computational and bioinformatic analysis of these CDS and protein sequences of genes indicated that no alternate splice variants could be identified in the transcriptome datasets. The expression levels of 3 key genes *viz*., phytoene synthase (*MiPS*), Lycopene b-cyclase (*MiLBC*) and lycopene e cyclase (*MiLEC*) were high in orange pulp coloured variety Amrapali in comparison with yellow pulp coloured Chausa. Similar results were obtained with Mallika and Lucknow Safeda. GC-MS analysis of pulp of these mango varieties showed distinct differential expression of metabolites belonging to isoprenoids, terpenoids and flavonoids groups. From the available RNA-seq data a total of 60 families of transcription factors were identified, many of these being relevant to flowering in other crop plants. Differential gene expression analysis was carried using DESeq package based on common hit accession of the CDS. Comparative transcriptome profiling of floral and vegetative buds in mango cv. Dashehari has revealed a clear cut pattern of the same. DEGs significantly up regulated in FBD were down regulated in VBD (423) and *vice versa* (301). The DEGs identified to be significantly up-regulated included genes *viz*., CRY2 (blue light photoreceptor), GRP4 (Giberellin regulated protein), Transcription factors (AGL8, WD, RF2), ARF, some stress related proteins. DEGs that were significantly down regulated encoded for genes such as ABC transporters and exportins, transcription factors (AP2, ERF, WRKY). miRNA sequencing generated 37600826 reads in same tissues FBD and 18012498 reads in VBD samples, of which 29140659 and 17820435 reads, respectively, were retained following 3′ adapter trimming and size selection to read length greater than 17bp. Following

the discovery of known and novel miRNA, analysis was done for differentially expressed miRNA between VBD and FBD. Following the differential analysis, the targets were predicted for known and novel miRNA against *Citrus clementina* transcripts. A total of 7171 targets were predicted against 1576 known miRNAs out of 1641 known miRNAs and 16 targets against 6 novel miRNA out of 8 novel miRNA from VBD sample. Six key genes *viz*., *STPK*, *MAPK6*, *ERF2*, *MYC2, MDH*, and *TPS* related to salinity stress responses were mined from leaf transcriptomes. Gene expression profiling of these genes were carried out through RT-PCR assays in salinity tolerant Nekkare and salinity susceptible Vellai Colomban under stressed and control conditions. *STPK* gene encoding serine threonine protein kinase, *MAPK6* encoding mitogen activated protein kinases, *MYC2* a transcription factor and *TPS* encoding trehalose phosphate synthase were typically up-regulated under stress conditions in Nekkare which proved the activation of salinity stress response signal transduction pathway and alternate carbohydrate metabolism. *MYC2* and *TPS* genes were uniquely up-regulated in Nekkare while *STPK* and *MAPK6* genes were up-regulated under stress in both susceptible cv. Vellai Colomban and tolerant cv. Nekkare. Illumina Transcriptome paired end cDNA libraries were prepared for 13-1 (leaf and root tissues, control and salt treated) and sequenced annotation was also performed using Malvids protein sequences downloaded from Uniprot database. Differentially expressed genes and their pattern of relative abundance among the two tissues under control and stress conditions implicated role of transporter proteins like aquaporins, transcription factors, osmotin like proteins and LEA in salt stress responses in 13-1. RNA seq analysis of mango jelly seed pulp generated 2.4 GB data, 36,909 transcripts with an N_{50} scaffold length of 1,053 bp. A total of 17,000 CDS were predicted. KOG classes transcription, translation, post translational modification, protein turnover, chaperones and signal transduction dominant category. Overall data suggests a molecular basis for the biochemical consequences of the jelly seed formation. The GC-MS analysis of mango jelly seed pulp shows the presence of a wide range of fatty acids, heterocyclic and aromatic compound *i.e.* Pentadecanoic acid, Hexadecanoic acid, 7,9-Di-tert-butyl-1-oxaspiro(4,5) deca-6,9-diene-2,8-dione which are intermediates of many secondary metabolites and involve in flavouring and colour development .

Expression analysis (RT-PCR) of Ethylene Responsive TFs genes under salt stress (200mM NaCl, 2 hour) in mango revealed up-regulation of ERF 61, ERF21, ERF 39, ERF RAP2-4 like and ERF RAP2-12-like Mango *cv.* Vellai Colomban.

Twenty one guava germplasm/varieties including indigenous collections from IIHR, Bangalore, Madhya Pradesh and exotic collection from Taiwan were made for their quality and wider adaptability. The germplasm exhibited maximum variability for fruit weight, while, the minimum variability was recorded for seed hardiness and TSS. *In vitro* regeneration system in wilt resistant rootstock using leaf callus is being attempted. Minimum time taken for callus induction from *in vitro* leaf was observed to be 10 days in MS medium containing 2 iP 0.5mg/l + NAA 1.0 mg/l+ Glutamine 100+PVP 50. The entire leaf converted into callus in 3 weeks. The callus was proliferated in the same media after 3-4 weeks. Green friable callus transformed into shoot like structures which are being maintained under *in vitro* condition. Micropropagation through enhanced axillary branching was also worked out. The explants collected during April to June were most responsive in terms of explant survival and bud burst. Maximum of 40.11 per cent aseptic explants survived and 21 per cent explants induced bud. Maximum number of shoots (2.6 mean shoots) could be induced under *in vitro* conditions by fortification of BAP at 4 mg/l. Maximum *in vitro* rhizogenesis (3.6 roots/explants) was observed in MS+IBA 2 mg/l. The length of primary root was 3.94 cm whereas the fresh weight of root was 50 mg. This treatment also reduced the time taken for root induction (6.47 days). Rewa and adjoining areas of Madhya Pradesh were explored for collection of superior aonla genotypes. A total of 21 accessions were collected and on the basis of overall assessment four accessions *i.e.*, T_6, T_7, T_8 and T_{21} were considered promising. Thirteen accessions of bael collected and marked and passport data were recorded in and around Jaunpur district. On the basis of overall assessment, four bael accessions T_5, T_9, T_{10} and T_{13} appeared most promising. Tree height of jamun accessions/varieties varied significantly (6.80-10.60 m) with minimum tree height in Konkan Bahadoli. Pruning was performed with open and palmate system of canopy and flowering was recorded on one year old shoots. The maximum number of fruit set was recorded on 4 month old shoots.

Crop Production

Research work on canopy modifications in young and canopy re-orientation in overcrowded and unproductive orchards of mango cv. Dashehari was carried out. Significantly higher light availability beneath the canopy, for diffused, direct and total solar radiation has been recorded. Maximum light availability (47.70%) was recorded in rejuvenated orchard and minimum (5.69 %) in overcrowded and unproductive orchards. Evaluation of various filler crops in rejuvenated mango orchards, e.g. guava cv. CISH Shweta, bael cv. NB-5, custard apple cv. Atemoya × Balanagar, ber cv. Gola, Apple ber and pomegranate cv. Bhagwa was also done. Soil nutrients and enzymatic activities were estimated across 284 mango orchards of cvs. Dashehari and Langra in Kakori and Malihabad blocks of Lucknow district and majority of orchards were found in low category of soil physico-chemical and biological properties. Guava cv. CISH-Lalit was planted on Espalier architecture during 2016 and after one year, trees developed complete canopy and yielded 35-40 fruits/tree (7-8 kg). Guava variety CISH-Lalit when planted on raised beds, covered with 100 micron black polythene mulch and drip irrigation at 80 per cent PE and fertigation with 75 per cent RDF, performed best over control. The effect of zinc and boron spray on yield and quality of guava fruits was also determined. Highest yield was recorded in 2 sprays of 0.4 per cent $ZnSO_4$+0.2 per cent Borax during fruit growth at monthly interval as compared to other treatments including control. Jamun cv. CISH-J-37 plants were grown in three training systems *viz.*, control, open and palmate and differences in availability of diffused and direct light, gas exchange parameters, stomatal conductance and transpiration rate were recorded. The yield and fruit quality traits were recorded best in open system. The banana cv. Grand Naine imposed to different nutrient dose and schedule for better yield and quality. The results of first year crop indicated that maximum leaf area and yield was recorded in the application of 100 per cent N:K (40:25, 30:35, 30:25, 0.15) at critical stages of crop. Efforts have also been initiated for development of techniques for off season vegetable production in peri urban areas and CISH-P-5 and CISH-P-3 cultivars of pointed gourd performed well over the check variety Kashi Alankar under Malda (West Bengal) conditions.

PFDC organized five training programmes in four districts of Uttar Pradesh, *viz.*, Faizabad, Lakhimpur Kheri, Banda and Lucknow on drip irrigation, polythene mulching and protected cultivation of high value vegetables. About two hundred twenty farmers, orchardists and state government officers were trained. Apart from these trainings, 26 on-farm trainings and field visits were also conducted.

Crop Protection

Real time dynamics of insect-pests, diseases and parasitic nematodes of mandate fruit crops was recorded throughout the year. The peak fruit fly population in methyl eugenol based para pheromone traps was recorded in the 20th SMW on mango (211.2/trap/week) and in the 33rd SMW (331.2/trap/week on guava). Mango hopper population was observed throughout the year in mango orchards with peak (13.4/sweep) during 48th SMW. The infestation of mango leaf webber was observed during 28th to 52nd SMW. Peak infestation was recorded during 43rd and 45th SMW with 8.1 and 7.55 fresh webs formed during the week/tree. Severe incidence (100%) with severity up to 74.5 PDI of shoulder browning was recorded during end of July on cv. Mallika. Peak powdery mildew disease severity (0.98 PDI) was recorded during 13th SMW in fixed plots and incidence was recorded up to 90 per cent with severity up to 58.5 PDI during 12th SMW in roving survey. Blossom blight disease incidence was rarely observed on panicles and almost no damage was caused during 2018 flowering season. Leaf anthracnose incidence fluctuated between 28.0-33.6 per cent and severity ranged between 17.66 to 27.53 PDI during 2017-18 in fixed plots. Severe incidence of wilt and decline disease of mango was observed at Sahilamau, Malihabad and near Dhyodhi Bazar, Sohawal (Faizabad) and in a 75 year old Chausa orchard near Sitapur. Besides, few wilted trees were also observed at several locations in Unnao, Lucknow, Sitapur, Barabanki and Pratapgarh districts. Severe infestation of root-knot nematode and *Fusarium oxysporum* was observed in guava nurseries and orchards located in Uttar Pradesh, Rajasthan and Madhya Pradesh. Mango powder based artificial diet was standardized for mango fruit borers. Base line susceptibility for mango leaf webber against insecticides was studied by leaf dip bio-assay. Field efficacy of newer insecticides was tested against mango hopper at panicle development stages and Imidacloprid, Fipronil and neem were found best. Field efficacy of insecticides was also tested against mango thrips and neem oil, Fipronil

and Thiamethoxam were found best. An organic bio-pesticide formulation was prepared with *Trichoderma harzianum,* compost, plant product and carbohydrate. Culture filtrate of *T. harzianum* CISH-12 strain completely suppressed the growth of *C. fimbriata* in culture. *T. harzianum* suppressive fungal colonizers of compost were isolated for incorporation in bio-pesticide development against *C. fimbriata.* Multi-location trials for the management of mango wilt/decline were also carried out in disease hot spot orchards. The species of root-knot nematode infecting guava was identified as *Meloidogyne enterolobii* on the basis of molecular characterization. Conclusive evidences were gathered to prove role of guava nurseries in spread of root-knot nematode and management efforts were also initiated in guava nurseries. Successful efforts were also made for the development and testing of computer software for fast and automatic measurement of leaf length, width and aspect ratio.

Post Harvest Management

The solar dehydrator (1 × 2 m, covered with UV stabilized polythene) was developed and tested for hygienic drying of mango slices. Mango fruits, treated with methyl jasmonate at 0.01 per cent for 5 minutes, could be stored up to 10 days with better firmness. Mango cv. Mallika fruits were treated with *Lactobacillus* culture @ 10^8 cells/ml for 10 minutes and stored for 10 days without quality deterioration. Estimation of mangiferin, lupeol and β-carotene was done and maximum amount of mangiferin was recorded in Ambika (35.1 µg/g) and minimum in Totapuri (1.00 µg/g), whereas, Arunika contained maximum amount of lupeol (135.1 µg/g) and Janardan Pasand, the minimum (2.99 µg/g) lupeol. Out of six varieties, β-carotene was found maximum (8.45 µg/g) in pulp of Langra followed by Neelam (8.01 µg/g) and minimum (3.34 µg/g) in pulp of Janardan Pasand. Characterization of phenolic compounds in peel and pulp was done during ripening of mango fruits. Gallic acid, chlorogenic acid, catechin, epicatechin, caffeic acid and ellagic acid were quantified in unripe and ripe peel and pulp of five mango cultivars (Dashehari, Langra, Amrapali, Mallika and Chausa). Caffeic acid was not detected in Dashehari peel and pulp. Unripe peel of Amrapali contained maximum amount of phenolic compounds and ripe pulp of Mallika the minimum. Pesticide degrading microbes were isolated from mango orchards. Out of seven bacterial isolates, three isolates namely, CISH Bac-2, CISH Bac-5 and CISH Bac-7 exhibited higher pesticide degrading ability. These bacteria also possessed strong PGPR activity. *Lactobacillus* sp. was found suppressive against *Aspergillus* sp., *Fusarium* sp., *Colletotrichum gloeosporioides* and *Pestalotia* sp. isolated from fruit crops. Eight month storage study of aonla juice with different anti-browning agents at room temperature revealed the maximum retention of vitamin C was achieved with L-cysteine and that of polyphenols (2.33%) with ascorbic acid. Stevia based aonla-fennel, aonla-coriander and aonla-dill drinks were developed. A low calorie aonla-fennel drink was also standardized using a combination of natural and artificial sweetener. Sugarcane aonla drink was prepared and successfully preserved for 6 months. Acceptable quality RTS and jam were prepared from aonla murrabba residue syrup. Aonla, bael, guava based laxatives were developed and evaluated for their laxative properties. Technology was standardized for preparation of sugarcane-aonla blended cider vinegar and honey cider vinegar using alcoholic and acetic acid fermentation technologies with laboratory microbial cultures. Bael powder was prepared from ripe fruits by three different drying methods namely solar, cabinet and sun drying.

Meetings

The 22nd Research Advisory committee meeting of the ICAR-Central Institute for Subtropical Horticulture, Lucknow was organized under the chairmanship of Dr. B.S. Chundawat, Ex-Vice Chancellor, Sardarkrushinagar Dantiwada Agricultural University, Gujarat on 28th Novemeber, 2017 at Rehmankhera, Lucknow. The 40th Institute Research Committee meeting of ICAR-Central Institute for Subtropical Horticulture, Lucknow was held on April 29, May 1, 3 & 4 and June 8, 2017 to review the work carried out under different projects.

Awards and Recognitions

Dr. Shailendra Rajan, Dr. Neelima Garg and Dr. V.K. Singh acted as Judge during Pradeshik Aam Mahotsav for evaluation of mango exhibition stalls at Indira Gandhi Pratisthan, Lucknow on June 24, 2017. Dr. A.K. Singh appointed as a member of selection committee of CSIR-CIMAP, Lucknow on August 24, 2017 and for Associate/Assistant Professor of Fruit Science at BUAT, Banda, UP on September 14, 2017. Dr. A.K. Trivedi received Eminent Scientist Award from Samagra Vikas Welfare Society during National

seminar on Transforming agriculture to doubling of farmers income held at BBAU, Lucknow from February 10-11, 2018. Gundappa was recognized as the external evaluator for the DST projects. Dr. K.K. Srivastava awarded Fellow of Horticultural Sciences by U P Academy of Agricultural Sciences, Lucknow on June 14, 2017, and was conferred Horticulture Society of India Fellowship on December 16, 2017 at ICAR-NRC Biotechnology, New Delhi. Dr. Maneesh Mishra acted as DBT Nominee, IBSC, ICAR-IISR, Lucknow for 2017-18 and also acted as Expert member in Selection Committee for appointment of Associate Professor (Hort.) and Subject Matter Specialist (Hort.) at BUAT, Banda from August 16-22, 2017. Dr. Maneesh Mishra acted as Member, Expert Committee on Agriculture & Allied Sector, UPCST, Govt. of Uttar Pradesh. Dr. P.N. Barman awarded with "Mahima Young Scientist Award" in Horticulture during International conference on Agricultural, allied sciences & biotechnology for sustainability of agriculture, nutrition & food security held at Banaras Hindu University, Varanasi on November 25-26, 2017.

Linkages and Collaborations

The Institute had linkages with various National and International organizations such as DAC-NCPAH, Ministry of Agriculture, DBT, DST, PPV & FRA, UPCST, UPCAR, AMAAS and RKVY. Institute is having MoUs with Integral University, Lucknow; Sam Higginbottom University of Agriculture, Technology and Science, Allahabad; Amity University Uttar Pradesh, Lucknow Campus, Lucknow; Banda University of Agriculture & Technology, Banda, Uttar Banga Krishi Vishwavidyalaya Pundibari, Cooch Behar (W.B.) and University of Gour Banga, (UGB), Mokdumpur, Malda (W.B.) for pursuing research as part of M.Sc. and Ph.D. degrees of their students.

Mera Gaon Mera Gaurav

A total of fourty five villages of Malihabad and Kakori blocks of Lucknow adopted under Mera Gaon Mera Gaurav (MGMG) programme were visited frequently by the Institute's coordination team. During the period, two trainings were organized on aonla products for additional income generation of rural women community at Institute and on Mango wilt disease management at Sahilamau under the MGMG programme. In these trainings, 38 women, school going children and 7 farmers participated. Twelve gosthis were also organized in various villages of Malihabad and Kakori area under MGMG programme. During the organization of these gosthies, more than 316 farmers interacted with the scientists of the Institute. Eighteen Scientists-Farmers Interactions meets and sensitization programmes were conducted in the selected villages of Malihabad and Kakori blocks under this programme wherein 405 farmers were apprised about the developed technological interventions. During the interactions, 826 farmers came in contact and more than 2200 improved variety seedlings of bitter gourd var. Jhalar, bottle gourd var. Aditi and pumpkin var. Sadabahar and starwberry var. Chandler, and seeds of French bean were distributed to motivate the farmers for kitchen gardening. Five demonstrations were laid out on bagging technology for Langra variety, crop production and protection technologies, uniform ripening of Dashehari mango using ethrel, demonstration of fruit fly trap, safe and effective use of insecticide and training and pruning in tomato. A total of 1100 farm families in Malihabad were demonstrated different interventions for augmenting income under Farmer FIRST Project.

Other activities

Dr. Shailendra Rajan delivered a lecture in TEDx SRMU on January 20, 2018. Activities undertaking in adopted villages for enhancing farmer's income under Farmer FIRST project at ICAR-CISH, Lucknow was covered by DD Kisan Channel on June 06 and 07, 2017. A farmer–scientist interaction based on mango orchard planting, management, plant protection, safe harvesting, ripening, packaging, marketing, value addition of raw and ripe mango and poultry was conducted under "Kisan Prashn Manch" Television programme, later on it was telecasted on National DD Kisan channel.

ICAR-CISH observed the Vigilance Awareness Week during October 30 to November 4, 2017. A three day's training programme was conducted on various technologies for subtropical fruit production at ICAR-CISH for 30 farmers from eastern districts of Uttar Pradesh during October 9-11, 2017. Fifty students of 9th and 12th standard along with 5 teachers and Principal of the school visited ICAR-CISH, Lucknow as a part of their educational tour on December 16, 2017. A scientist-farmers interactions meet was organized at Belgarha village, Malihabad, Lucknow under the ICAR networking project on "Micronutrient management in Horticultural Crops for Enhancing Yield and Quality" on August 29, 2017.

Five farmers of Farmer FIRST Project were invited to tell their success story at National workshop on Let's Listen to Farmers at ICAR-NAARM, Hyderabad during 22-23 December, 2017.

The mango and tourism festival was organized during July 8-9, 2017 in Malda district of West Bengal where ICAR-CISH put up stall and diversity of mango (115 varieties) was displayed. RRS, Malda received appreciation for Best Mango Diversity Stall in the Festival. RRS, Malda organized Mahila Kishan Diwas on October 15, 2017. One year course of Diploma in Agricultural Extension Services for Input Dealers (DAESI) was inaugurated at ICAR-CISH, KVK, Malda on October 25, 2017.

Dealers and progressive farmers' training programme organized on November 03, 2017 at CISH RRS and KVK, Malda by Fertilizers Association of India Eastern Region in collaboration with IFFCO (Indian Farmers Fertilizers Cooperative Company Limited), CISH Krishi Vigyan Kendra and CISH Regional Research Station, Malda West Bengal. A refresher course of ATMA functionaries was held at ICAR-CISH KVK, Malda during January 31 to February 02, 2018.

The scientists of CISH RRS, Malda interacted with the tribal farmers of Kheribari village on March 15, 2018.

Revenue Generation

A total of Rupees 45.69 lakhs was generated by the Institute during the financial year 2017-18.

2 Institute

The ICAR-Central Institute for Subtropical Horticulture (CISH) was started as Central Mango Research Station on September 4, 1972 under the aegis of the ICAR-Indian Institute of Horticultural Research, Bengaluru. The Research Station was subsequently upgraded to a full-fledged Institute as Central Institute of Horticulture for Northern Plains on June 1, 1984. The Institute was later renamed as Central Institute for Subtropical Horticulture on June 14, 1995. It is serving the nation on different aspects of research and development on mandated subtropical fruit crops and associated cropping systems aimed at developing integrated farming systems. The Institute has two experimental farms, one located at Rehmankhera, approximately 25 km away from the city and another at Raebareli (R.B.) Road right in the Lucknow city. The experimental farm at Rehmankhera has an area of 132.5 hectare comprising of 4 blocks (block I – 15.5 ha, block II – 35.5 ha, block III – 37.42 ha and block IV – 44.08 ha). The Institute was shifted to its present laboratory-cum-administrative building at block-II at Rehmankhera during May, 1999. The Project Coordinator Cell of AICRP on Subtropical Fruits was situated in CISH during 1972 to 2014, which later merged into AICRP (Fruits). The Institute has modern nursery facilities, well established experimental orchards and equipped laboratories to meet the emerging challenges in the niche areas of research on subtropical fruit crops. The well established modern scientific nursery unit of the Institute is producing quality planting materials of mango, guava, aonla and bael at large scale and that of jamun, litchi, strawberry and vegetable crops at limited scale with traceability incorporated for supply of core/genuine planting materials to the farming communities and backstopping of Krishi Vigyan Kendras for establishing mother blocks. Simultaneously, concerted endeavors for human resource development through capacity building were also put in place under Skill India programme. Recognizing the importance of capacity building and in harmony with ICAR focus *Student Ready*, the Institute has in place MOUs with Amity University Uttar Pradesh, Lucknow, Integral University, Lucknow, Sam Higginbottom University of Agriculture, Technology and Science, Allahabad, Dr. Babasaheb Bhimrao Ambedkar University, Lucknow, Bundelkhand University, Jhansi and Lucknow University, Lucknow for pursuing research at the Institute leading to the award of M.Sc. and Ph.D. degrees to their students. The Institute has also been recognized by IGNOU, New Delhi as one of its study centers for offering one year Diploma course on value added products from fruits and vegetables and a Certificate course on organic farming. The National Horticulture Mission has also identified the Institute as a nodal center for imparting training on rejuvenation of old and unproductive mango orchards and high density planting system in guava. Institute is keenly pursuing the programmes towards doubling farmer's income. Mango based farming system technologies have been transferred in three villages of Malihabad block of Lucknow district to enhance profitability of farmers under Farmer FIRST project. The Institute has also contributed significantly in research and extension to resolve farmers' issues in fruit crops under National Initiative for Climate Resilient Agriculture (NICRA), Precision Farming Development Centre (PFDC) and other projects. The Institute also renders other quality services to the growers, *viz.*, responding to queries on orchard related problems through Kisan Call Centre No. 1800-180-1551 and 09415751200 each day from 10.00 am to 4.00 pm and phone-in-live programme (0522- 2841082) every Friday from 10.30 am to 4.00 pm services on soil and nutrient constraints, pest and disease problems, on-farm visits, production and supply of bio-control agents, hand holding of KVKs and other agriculture/horticulture universities including the one in Nagaland and taking care of other multi-stakeholders. The Institute continues to be an active partner with the National Horticulture Mission and National Horticulture Board units for its outreach activities of promoting integrated development of horticulture. The ICAR-CISH Regional Research Station along with KVK at Makdumpur, Malda (West Bengal) are catering to subtropical horticulture for Eastern India.

Vision

Augment the share of agriculture sector in general and horticulture in particular in the GDP of the country and its export basket.

Mission

Conduct basic and strategic research to develop cost effective and viable technologies for production of subtropical fruit culture as a component of integrated farming strategy.

Mandate

- Basic, strategic and applied research to enhance sustainable productivity, quality and utilization of subtropical horticultural crops.
- Repository of subtropical horticultural crop genetic resources and scientific information.
- Transfer of technology, capacity building and impact assessment of technologies.

Objectives

- Management of genetic resources of mandate fruit crops.
- Crop improvement through breeding and genetic engineering.
- Enhancing productivity through improving quality of planting materials using modern propagation techniques and rootstocks, good horticultural practices including mechanization and management of biotic and abiotic stresses.
- Reduction in post-harvest losses and enhancement of profitability through integrated pre- and post-harvest management practices, value addition and product diversification.
- Human resource development, transfer of technology, capacity building and evaluation of its socio-economic impact.

Significant Achievements

Crop Improvement and Biotechnology

- The Institute is conserving the world's largest germplasm collection of mango numbering 775 accessions.
- CISH-Ambika (Amrapali × Janardhan Pasand) and CISH-Arunika (Amrapali × Vanraj), two regular bearing hybrids, have been advanced for multi-location testing through AICRP network and at progressive farmer fields.
- Morphological and molecular characterization of 250 mango cultivars indicated that the germplasm accessions could be categorized into 3 broad groups, *viz*. northern, eastern and other representing both northern and eastern regions.
- Institute is conserving one hundred fifty-one accessions of guava and six species of *Psidium* in its field gene bank.
- CISH-Lalit and CISH-Shweta were released for commercial cultivation and have become favourite varieties of farmers in diffrent parts of the country. Fruits of CISH-Lalit are attractive, saffron yellow with red blush, medium size and firm with pink pulp. CISH-Shweta, especially has found favor with the Punjab and Haryana growers and is getting popularized there. Fruit of CISH- Shweta has attractive pink blush, white pulp, few soft seeds, high TSS (14 °B) with good yield potential.
- Institute has released two more guava varieties, *viz*. CISH-Dhawal which is a heavy bearer (20% higher than Allahabad Safeda) with round, smooth, medium to large fruits (200-250 g) and has been developed from half-sib selection from Allahabad Safeda seedling population. CISH-Lalima, which is a selection from half-sib population from Apple guava having crimson colored fruits and good yield with higher shelf life (fruit weight 190 g and TSS 13.7 °B).
- Wilt resistant hybrid rootstock of guava (*P. molle* × *P. guajava* L.) developed by the institute earlier was advanced for field evaluation by grafting on commercial scions in wilt endemic areas / multi-location testing through AICRP (STF) network and KVKs.
- Genetic transformation system has been developed in guava using *endochitinase* gene and *Agrobacterium* mediated genetic transformation system was developed in papaya using hp-tr-cp gene of PRSV.
- In aonla, CISH A-31 seedling selection with red coloured fruit and CISH A-33 seedling selection with bigger size fruit and higher yield were identified.
- Two bael selections, CISH-B-1 and CISH-B-2 having good table and processing qualities are being popularized through multiplication and supply of quality planting materials to the growers.
- Two promising jamun accessions CISH J-37 (mean fruit weight 24.05 g) and CISH J-42 (seedless) have also been identified and are under advance stage of evaluation.
- Institute continues to conserve germplasm accessions (36 accessions of bael, 7 accessions of banana, 32 accessions of papaya, 35 accessions of litchi, 22 accessions of aonla, 30 accessions of karonda, 35 accessions of jamun, 38 accessions of khirnee, 24 accessions of tamarind, 30 accessions of mahua, 8 accessions of chironji, 17 accessions of wood apple, 10 accessions of mulberry, 3 accessions of cape gooseberry, 8 accessions of custard apple, 2 accessions of carambola, 3 accessions of lasora, 2 accessions of rose apple, 36 accessions of jackfruit and 20 accessions of strawberry) in the field gene bank.

Crop Production

- Medium density planting system (400 plants/ha) in Dashehari mango led to three fold increase in the yields (15-18 tonnes/ha) over conventional planting (100 plants/ha) of 6.0 tonnes/ha.

- Crown thinning in mango resulted in higher yield (80 kg/plant) in Mallika in the following year as compared to 55 kg in control.
- Techniques for high density planting system and canopy management in guava were developed and popularized.
- Rejuvenation techniques for old and unproductive mango and guava trees continued to be demonstrated at farmers' fields.
- Soil application of paclobutrazol @ 4 g/tree (3.2 ml/m canopy diameter) was found to manage the problem of irregular bearing in mango cv. Dashehari resulting in increased flowering and fruiting during the expected 'off' year. Mulching along with application of paclobutrazol (1.6 ml/m canopy diameter) was found effective in improving yields.
- Soil application of one kg each of N, P and K/tree/year to 10 year old Dashehari mango trees increased the yields. Trench application of fertilizers around the tree in July was found efficient in nutrient use.

Crop Protection

- Cost effective IPM modules based on crop phenology and weather for mango insect pests and diseases have been developed, refined and standardized.
- Entomogenous fungus *Verticillium lecanii*, egg parasites *Agrostocetus* sp., *Gomatocerus* sp., *Polynema* sp. and predators *Chrysopa lacciperda*, *Mallada boninensis* and *Coccinella septumpunctata* were found potential bio-control agents against mango hoppers.
- Critical limits of weather parameters (temperature and relative humidity) for forecasting the epidemics of mango hoppers and powdery mildew were profiled.
- *Ceratocystis fimbriata* was identified as the cause of mango wilt and decline. The decline was managed by trunk injection @ 10 per cent and soil drench @ 0.1 per cent of thiophanate methyl and spray with 0.1 per cent propiconazole. Zero tillage is advocated in affected orchards to avoid damage to roots and further infection.
- Bagging of fruits or spray of tree oil 1.0 per cent or difenoconazole 0.1 per cent were found effective in management of shoulder browning disease of mango fruits.
- Post-harvest diseases of mango, *viz.* anthracnose and stem end rot could be controlled by dipping of the fruits in 0.05 per cent carbendazim in hot water (52±1 °C) for 10 minutes.
- *Gliocladium roseum* was found frequently associated with guava wilt disease. However, *Fusarium oxysporum* f. sp. *psidii* was more potent in inciting the epidemics. Association of root-knot nematode (*Meloidogyne interolobii*) was frequently found with wilt problems in Uttar Pradesh, Madhya Pradesh, Rajasthan and Himachal Pradesh, which is being critically investigated.

Post Harvest Management

- Maturity indices for commercial mango cvs. Dashehari, Langra, Mallika, Amrapali and Chausa were optimized.
- Three temperature gradients for storage, *viz*. 12, 15 and 10 °C, were worked out to enhance the shelf life of Dashehari, Langra and Chausa fruits up to 3, 2 and 3 weeks, respectively.
- Guava fruits cv. Allahabad Safeda could be stored for 28 days at 10 °C in 0.25 per cent ventilated LDPE bags.
- Pre-harvest sprays of calcium chloride di-hydrate (2%) at 10 days interval were found effective to reduce the jelly seed formation in mango.
- Methodologies for preparation of raw mango squash (panna) and instant mango panna powder have been optimized, demonstrated and popularized.
- Protocols for freeze drying of mango and aonla slices, osmo-freeze drying of mango slices and spray drying of aonla juice were developed.
- The techniques for preparation of sweetened and brined (salted) aonla segments were optimized.
- Protocols for the preparation of mahua, mango and mulberry wine were developed.
- Protocols for the preparation of aonla, guava, bael and raw mango cider were developed.
- Mango peel could be utilized to produce compost, fiber, pectin, vinegar, and pectinase and cellulase enzymes.
- The Institute has developed vinegars from mango, aonla, bael, grape and jamun through acetic acid fermentation using immobilization technique.
- Low cost mango, guava and bael harvesters have been fabricated and the old mango harvester developed by the Institute was revisited, refined and parameterized. Destoning machine has been fabricated and evaluated for aonla.
- A low cost foldable ripening chamber has been designed and developed. Evaluation for different parameters is under progress.
- Corrugated fiber board (CFB) boxes of 2 and 4 kg capacities were fabricated and found to be effective for packaging and transport of mango and guava fruits.

- Successful commercialization of two technologies, *viz*. *Aonla Tea* and *Aonla Biscuit* to the Centre for Technology and Entrepreneurship Development (CTED), Amethi, U.P has been accomplished.
- Food safety advisories on insecticide and fungicide residues are being provided to the mango growers.

Agriculture Knowledge Management Unit

The Institute has developed its own software for tracking the documents in the office. The system works through barcode readers and has the facility to have input of the barcodes manually. This on-line file tracking system not only allows the indenters to know the status of process but also location of the document by mere a click. This software also gives details that for how long the document was lying with staff member dealing with it in the chain. Several modules have been developed to get tailor made reports related with the outstanding documents with individual document processed and submitted by outstanding and disposed ones. It has been hosted on the web server and being utilized by all the staff members. This software is handy for the persons who are not able to type fast on computers and they can easily use barcode reader for log in the information which includes receiving/sending of documents.

The Institute has developed its own barcode label printing system as well as other requirements have been customized for this tracking system. It took about six months for developing this software and customizing it as per the document flow in the ICAR system. The Institute is also complying with MISFMS system which monitors all employees' data like pay roll, leave processing stage/records, e-service book/record, establishment records and as such there is utter transparency in recording system. The Institute staff is now regularly using it even for applying leave.

Library

The Institute has a well established Library and Information Centre which caters the requirements of Scientists, traders, entrepreneurs, extension functionaries and Reserach Scholars registered in different State/ Central Universities as per MOU. The Institute Library and Information Centre is well equipped with books, research journals, periodicals, reports, reprints and CD ROMs pertaining to different aspects of Horticultural Science along with computer, internet and reprographic facilities. All the library reading materials have been automated through LSEASE software and search through OPAC (Online Public Access Catalogues). At present our Institute's library existing collection is 3887 of scientific and technical books which was further enriched. Library and Information Centre is also maintaining the bibliography of Institute's Scientists published in various Scientific Journals (1972-2017) and have been collected in hard and soft copies, also uploaded on Krishi Kosh (ICAR). The Institute Library and Information Centre is grid of e-pamphlets, e-newsletters, e-newspapers clippings and other reading materials. More than 121 annual reports and other magazines are being received from ICAR Institutes, State Agricultural Universities and Foreign Institutes on exchange information basis. Institute Library and Information Centre in also supplying reprints of research papers to indenting Scientists/Officers as well as entrepreneurs through CeRA platform.

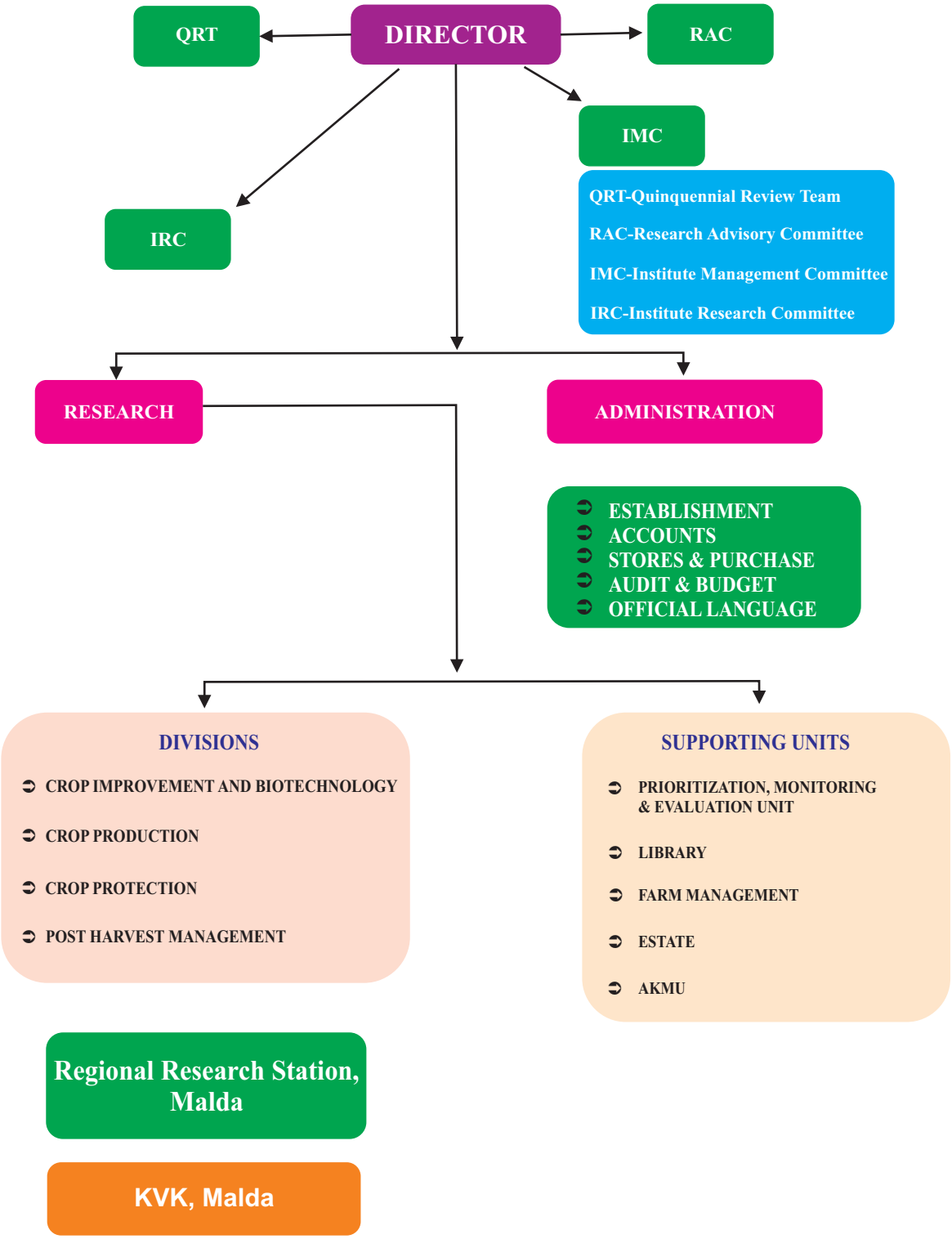
Organizational Set-up

The Institute's functioning is organized through three Divisions (Crop Improvement and Biotechnology, Crop Protection and Post Harvest Management) at headquarters Lucknow and one Regional Research Station and one KVK at Malda (W.B.). A proposal for creation of new Division of Crop Production is under consideration at Council. A Precision Farming Development Centre (PFDC) for promoting aspects of hi-tech horticulture is also located at the Institute. Set-up of the Institute is as below.

Cadre Strength

S.No.	Category/Services	Sanctioned Post	In Position	Vacant
1	RMP (Director)	01	01	Nil
2	Scientists	48	38	10
3	Administrative	24	18	6
4	Technical	44	26	18
5	Skilled Support Staff	44	32	12

Organogram


QRT
DIRECTOR
RAC
IMC
IRC
QRT-Quinquennial Review Team
RAC-Research Advisory Committee
IMC-Institute Management Committee
IRC-Institute Research Committee
RESEARCH
ADMINISTRATION
ESTABLISHMENT
ACCOUNTS
STORES & PURCHASE
AUDIT & BUDGET
OFFICIAL LANGUAGE
DIVISIONS
CROP IMPROVEMENT AND BIOTECHNOLOGY
CROP PRODUCTION
CROP PROTECTION
POST HARVEST MANAGEMENT
SUPPORTING UNITS
PRIORITIZATION, MONITORING & EVALUATION UNIT
LIBRARY
FARM MANAGEMENT
ESTATE
AKMU
Regional Research Station, Malda
KVK, Malda

ICAR-CENTRAL INSTITUTE FOR SUBTROPICAL HORTICULTURE, LUCKNOW

Sl. No.	Name of the Head	Grant (Rs. in lakhs)	
		BE / RE 2017-18	Progressive expenditure
	Capital		
1	Works		
	(A) Land	0.00	0.00
	(B) Building		
	i. Office building	0.00	0.00
	ii. Residential Building	0.00	0.00
	iii. Minor Works	0.00	0.00
2	Equipments *	2.00	1.96
3	Information Technology	2.00	1.84
4	Library Books and Journals	0.00	0.00
5	Vehicles & Vessels	0.00	0.00
6	Livestock	0.00	0.00
7	Furniture & Fixture	3.00	2.99
8	Others	0.00	0.00
A	**Total Capital Expenditure**	**7.00**	**6.79**
	Grant-in-Aid Salaries (REVENUE)		
1	Establishment Expenses		
	(A) Salaries		
	i. Establishment Charges	1490.00	1490.00
	ii. Wages	50.00	49.98
	iii. Overtime Allowance	0.00	0.00
	Total Establishment Expenses	**1540.00**	**1539.98**
	Grant-in-Aid General (REVENUE)		
1	**Pension & Retirement Benefits**	592.50	592.49
2	Travelling Allowance		
	(A) Domestic TA/Transfer TA	20.00	20.00
	(B) Foreign TA	0.00	0.00
	Total-Travelling Allowance	**20.00**	**20.00**
3	Research & Operational Expenses		
	(A) Research Expenses	31.25	31.24
	(B) Operational Expenses	69.00	69.00
	Total Research & Operational Expenses	**100.25**	**100.24**
4	Administrative Expenses		
	(A) Infrastructure	147.11	147.11
	(B) Communication	1.50	1.50
	(C) Repairs & Maintenance		
	i. Equipments, Vehicles & Others	17.82	17.82
	ii. Office building	5.18	5.18
	iii. Residential Building	2.00	2.00
	iv. Minor Works	0.00	0.00
	(D) others (excluding TA)	77.64	77.63
	Total Administrative Expenses	**251.25**	**251.24**
5	Miscellaneous Expenses		
	A. HRD	1.50	1.50
	B. Other items (Fellowships, Scholarships etc.	0.00	0.00
	C. Publicity & exhibitions	1.00	1.00
	D. Guest House-maintenance	1.50	1.49
	E. Other Miscellaneous	4.50	4.47
	Total Miscellaneous Expenses	**8.50**	**8.46**
B	**Total Grant-in-Aid General**	**972.50**	**972.43**
	Total Revenue (Salaries + General)	**2512.50**	**2512.41**
	Grand Total (Capital + Revenue)	**2519.50**	**2519.20**
*	**Tribal Sub-Plan Expenditure**		
	A) Works	0.00	0.00
	B) TA		
	C) Research Expenses	5.00	5.00
	D) Operational Expenses		
	E) R&M. Equipments, Vehicles & Others		
	F) Others (excluding TA)		
	Total Exp.	**5.00**	**5.00**
**	**NEH Expenditure**		
	A) Works	0.00	0.00
	B) TA		
	C) Research Expenses	2.00	2.00
	D) Operational Expenses		
	E) R & M. Equipments, Vehicles & Others		
	F) Others (excluding TA)		
	Total Exp.	**2.00**	**2.00**
	TOTAL EXPENSES	**2526.50**	**2526.20**
	Loans & Advances	0.50	0.50
	Realization of Revenue Receipts	Target	Achievement
	(i) Income from sales/ services	0.00	45.17

	(ii) Income from Fees/ Subs.	0.00	0.00
	(iii) Income from Royalty/ Publicat.	0.00	0.52
	Total	0.00	**45.69**
		2017-18	
S. N.	**Head**	**Plan Scheme**	
		Total No. of project	Expenditure
1	Grant in Aid – Capital	**22**	2.79
2	Grant in Aid – Salary		0.00
3	Grant in Aid – General		82.77
	Total		**85.56**
S. N.	**Head**	**Deposit Schemes**	
		Total No. of project	Expenditure
1	Grant in Aid – Capital	**27**	86.74
2	Grant in Aid – Salary		0.00
3	Grant in Aid – General		138.54
	Total		**225.28**

Joining

Scientist

1. Er. Gopal Carpenter, Scientist (Farm Machinery & Power) joined on 15.04.2017 at the Institute.
2. Dr. Ashok Yadav, Scientist (Fruit Science) joined CISH, Lucknow on 16.10.2017 and on 28.02.2018 at RRS, Malda

Administrative

1. Sri R.N. Mallik, Senior Administrative Officer joined Institute on 03.04.2017.
2. Sri Sulabh Singh Sengar joined the Institute on 22.03.2018 as Assistant.

Transfer

Scientist

1. Dr. Atul Singha, Scientist was transferred to ICAR-National Institute of Research on Jute and Allied Fibers, Kolkata on 24.06.2017.
2. Dr. M. Balaji Rajkumar, Scientist was transferred to ICAR-IISR, Calicut, Kerala on 24.06.2017

Promotion

Scientist

1. Dr. Abha Singh, Senior Scientist was promoted to Principal Scientist (Food & Nutrition) on 22.11.2016.
2. Dr. Ashok Kumar, Senior Scientist was promoted to Principal Scientist (Environmental Science) on 11.11.2017.

Technical

1. Sri Chandra Bhal was promoted to Assistant Chief Technical Officer from 01.01.2015 on the basis of five years evaluation.
2. Sri Shiv Kumar Arun was promoted to Chief Technical Officer from 01.07.2015 on the basis of seven years evaluation.
3. Dr. Vinod Kumar Singh was promoted to Chief Technical Officer from 01.07.2016 on the basis of seven years evaluation.
4. Dr. S.K.S. Raghav was promoted to Chief Technical Officer and granted an advance increment from 01.07.2016 on the basis of five years evaluation.
5. Sri Naresh Chandra Verma was promoted to Senior Technical Assistant from 02.08.2015 on the basis of five years evaluation.

Administrative

1. Sri Vijendra Singh, Senior Clerk was promoted to third MACP after completing 30 years of service on 28.01.2017.
2. Sri Mahendra Kumar, Junior Clerk was promoted to second MACP after completing 20 years of service on 26.06.2017.

Skilled Support Staff

Sri Chandrika, SS Staff was granted first MACP from 09.08.1999.

Probation completion

Scientist

Ms. Swosti Suvdarshini Das completed her probation on 31.12.2015.

Retirement

Scientist

Dr. Ram Kumar, Principal Scientist (Horticulture) retired on 31.01.2018.

Technical

1. Sri Mishrilal, Senior Technical Officer retired on 30.06.2017.
2. Sri Sanjeevan Lal, Senior Technical Officer retired on 31.08.2017.
3. Sri Swayamwar Dutt, Technical Officer retired on 30.09.2017.
4. Sri Shiv Kumar Arun, Chief Technical Officer retired on 31.12.2017.
5. Sri Bramhpal, Technical Officer retired on 31.01.2018 .

Administrative

Sri Parmeshwar Deen, Senior Clerk retired on 31.07.2017.

Skilled Support Staff

1. Sri Shiv Dayal, SSS retired on 31.05.2017.
2. Sri Chedalal, s/o Sri Shivdayal, SSS retired on 30.06.2017.
3. Sri Shankar Lal, SSS retired on 30.06.2017.
4. Sri Babu Lal, SSS retired on 30.06.2017.
5. Sri Karile Prasad, SSS retired on 31.08.2017.
6. Sri Parshuram, SSS retired on 31.08.2017.
7. Sri Gangaram, s/o Sri Rajju, SSS retired on 31.08.2017 (voluntary).
8. Smt. Nankai, SSS retired on 30.09.2017.
9. Sri Balram, SSS retired on 30.11.2017.
10. Sri Rajaram, s/o Sri Zurakhan, SSS retired on 30.11.2017 (voluntary).
11. Sri Amrit Lal, SSS retired on 28.12.2017.
12. Sri Ram Chander, s/o Sri Ramcharan, SSS retired on 31.12.2017.
13. Sri Sriram, s/o sri Fatte, SSS retired on 28.02.2018
14. Sri Kallu, s/o Sri Chandrika, SSS retired on 28.02.2018.
15. Sri Shiv Das, SSS retired on 31.03.2018.

3 Research Achievements
Crop Improvement and Biotechnology

MANGO (*Mangifera indica* L.)

Collection

During the year 2017-18, eleven mango germplasm/ varieties from Jammu and Kashmir, Pune, (Maharashtra), BAU, Sabour, Bhagalpur (Bihar) and Malihabad, Lucknow (U.P) were collected for their attractive colour, adaptability and better shelf life.

Field gene bank planting

Total of 772 mango accessions are being maintained in field gene bank. Gaps in field gene bank were filled. Twenty eight accessions multiplied for planting.

Profiling of major nutraceuticals in mango

Pulp of thirty mango hybrids was analyzed for total antioxidants, total phenols, total flavonoids and total carotenoids. The total antioxidant content was 0.35-1.14 µmol Trolox/100g, total phenols 23.05-92.08 mg gallic acid equivalent/100g, total flavonoids 11.00-32.0 mg quercetin equivalent/100g and total carotenoids 1.76-15.56 mg/100g. The lowest carotenoids (1.78 mg/100g) content was recorded in H-707 while hybrid H-4509 recorded highest carotenoids (15.56 mg/100g) content indicating its potential as carotenoids rich hybrid.

Evaluation

Evaluation data of 138 accessions indicated wide variability for fruit, pulp, peel and stone weight. The evaluation revealed the average fruit weight of 258.68g and an appreciable proportion (58.69%) of accessions exhibited fruit weight more than 200g, whereas, 13.04 per cent accessions recorded fruit weight in the range of 400-600g. The pulp weight ranged from 8.33g (Angoordana) to 785.33g (Rogni Zarda) with a mean of 180.53g. The pulp percentage was an important parameter ranged from 36.84 to 82.09 with an average pulp of 66.81%. TSS ranged from 11.40 to 24.0°B. Dashehari clone T.No. 6 recorded maximum TSS of 24°B. The CIE L*, a* and b* values measured for fruit pulp using CIE L,a*,b* coordinates indicated the wide variation among the different varieties for colour as indicated by their varied colour differences.

Hybridization and establishment

During 2018, using 10 cross combinations, 57314 flowers were crossed on 15125 panicles (Table 1). A total of 226 seeds of mango hybrid were obtained from the crosses made during 2016-2017 and 201 stones germinated. However, fruits could not be obtained from one cross combination (Table 2). The six hybrid seedlings raised from hybrid combinations attempted in 2015-16 were planted in field for evaluation of F_1 progeny of mango hybrid with a view to improve various fruit and quality parameters (Tables 1-3).

Table 1. Hybridization carried out during 2017-18

S.N.	Cross combination	Panicles used for hybridization	Number of flowers
1	Ambika × Tommy Atkins	650	2049
2	Amrapali × Tommy Atkins	3050	11927
3	Amrapali × Vanraj	400	1586
4	Amrapali × Sensation	1400	5509
5	Arunika × Tommy Atkins	700	2453
6	Dashehari × Sensation	2400	8596
7	Dashehari × Tommy Atkins	3000	11288
8	Dashehari × Vanraj	2250	9516
9	Neelum × Tommy Atkins	1200	4270
10	13-1 × ML-2	75	120
	Total	**15125**	**57314**

Table 2. Hybrid seedlings from hybridization during 2016-17

S.N.	Cross combination	Panicles used for hybridization	Number of flowers	No. of fruits harvested	No. of stone germinated
1	13-1 × ML-2	50	96	-	-
2	13-1 × ML-6	50	113	02	02
3	Ambika × Sensation	350	875	02	01
4	Ambika × Tommy Atkins	300	1259	03	02
5	Amrapali × Bride of Russia	650	2401	21	20
6	Amrapali × Sensation	2250	8153	49	45
7	Amrapali × Sharda Bhog	1100	4092	82	72
8	Amrapali × Tommy Atkins	3750	13029	63	56
9	Arunika × Sensation	150	372	03	02
10	Arunika × Tommy Atkins	200	556	01	01
	Total	**8850**	**30946**	**226**	**201**

Table 3. Basis for selection of cross combinations during 2017-18

S.N.	Cross combination	Q+C	RB	WA	AB
1	Ambika × Tommy Atkins	+	+	+	
2	Amrapali × Tommy Atkins	+	+	+	
3	Amrapali × Vanraj	+	+	+	
4	Amrapali × Sensation	+	+	+	
5	Arunika × Tommy Atkins	+	+	+	
6	Dashehari × Sensation	+	+	+	
7	Dashehari × Tommy Atkins	+	+	+	
8	Dashehari × Vanraj	+	+	+	
9	Neelum × Tommy Atkins	+	+	+	
10	13-1 × ML-2			+	+

Q+C = Quality and colour of fruits, RB = Regular bearing, AB = Abiotic stress, WA = Wider adaptability

Evaluation of hybrids

During the year, 629 hybrids were evaluated for fruit physical parameters *viz*., fruit weight, fruit length, peel weight, stone weight, pulp weight, stone length, stone width and stone thickness. The hybrids exhibited wide variability for fruit weight, pulp weight, pulp (%), TSS and fruit colour as indicated by wide L*,a*,b* values (Fig. 1). The pulp weight and pulp percentage ranged from 19.67 to 739 g and 31.09 to 93.09 respectively. TSS varied between 11°B to 28°B (H-1960). Among the hybrids evaluated around 57 per cent hybrids exhibited fruit weight more than 200g, while maximum hybrids (50%) exhibited fruit weight in the range of 200-400g indicating scope for selection of hybrids with better fruit weight (Fig. 2).

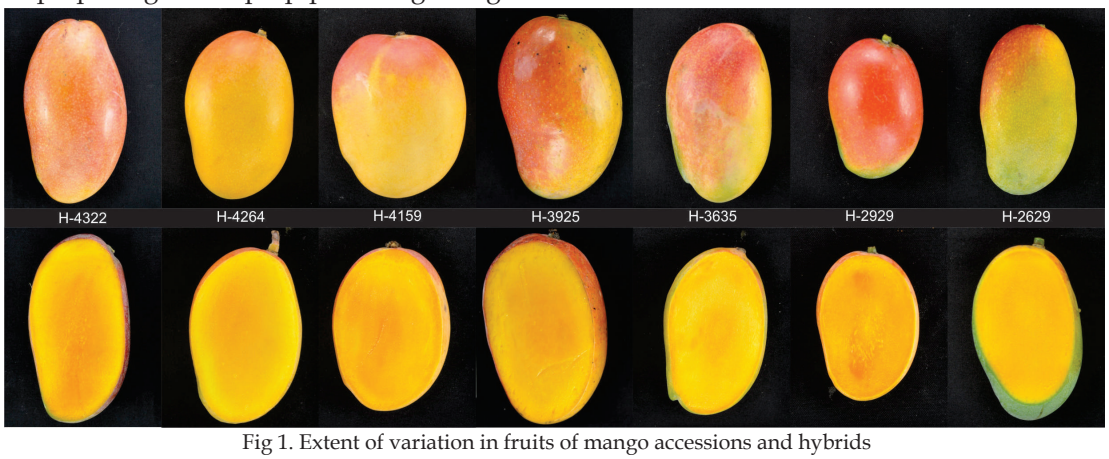


Fig 1. Extent of variation in fruits of mango accessions and hybrids

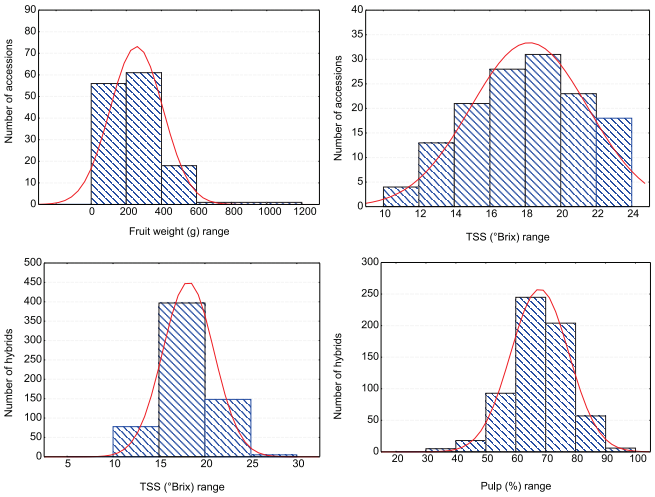


Fig.2. Extent of variation in mango accessions and hybrids for fruit weight, TSS and pulp (%) range

Development of genomic resources

Transcriptome data for floral buds of cv. Dashehari was mined for SSR containing coding sequences. Among 40,068 sequences examined, 2286 SSR containing sequences with di, tri, tetra, penta and hexa nucleotide repeat motifs were located, corresponding to genomic annotations were identified (Fig. 3). This data set is important for development of functional markers.

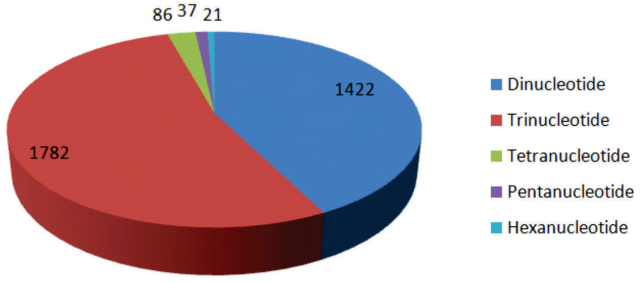


Fig. 3. Distribution of different categories of SSR in FBD library

Bioinformatics and computational analysis of genomics data

Identification of transcription factor (TF) families represented in FBD sample was done by searching against all the transcription factor protein sequences at plant transcription factor database Ten key transcription factor gene families *viz*., *LFY, AGAMOUS-like 26, SAP, AP2, CO-like, FAR1, C2H2, TALE, M-type MADS box* and *Trihelix* were shortlisted for the computational analysis based on earlier described flowering models. A total of 48 coding sequences (CDS) representing these transcription factors were analyzed for their exonic segments which was reconfirmed by BLAST analysis with top hits matching with gene orthologs of either *Citrus sinensis* or *C. clementina*. Subcellular localization of these proteins identified that they have different sorting signals which diverted them to cytoplasm, chloroplast, mitochondria, golgi bodies and endoplasmic reticulum. The members of a specific gene family of transcription factors exhibited diversity which was also evident from domain analysis and phylogenetic groupings. For examples, the diversity and relationship among MADS box gene family retrieved from the transcriptome data is evident in the phylogenetic tree (Fig. 4).

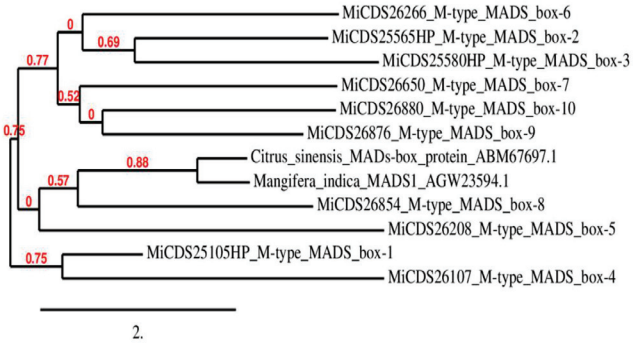
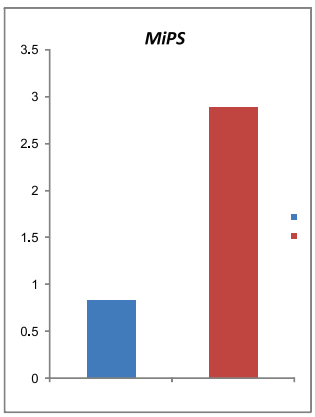


Fig. 4. Phylogenetic tree of M-type MADS box transcription factors in FBD

Molecular basis of pulp colour in mango

Leaf transcriptome datasets of Amrapali and Chausa were mined for CDS encoding genes involved in carotenoid biosynthetic pathway and used for real time validation. Computational and bioinformatic analysis of these CDS and protein sequences of genes indicated that no alternate splice variants could be identified in the transcriptome datasets. Most of the proteins of the carotenoid pathway in were predicted to be targeted into the plastids/chromoplasts. The expression levels of 3 key genes *viz*., phytoene synthase (*MiPS*), Lycopene b-cyclase (*MiLBC*) and lycopene e cyclase (*MiLEC*) were high in orange pulp coloured variety Amrapali in comparison with yellow pulp coloured Chausa (Fig. 4). Similar results were obtained with Mallika and Lucknow Safeda. GC-MS analysis of pulp of these mango varieties showed distinct differential expression of metabolites belonging to isoprenoids, terpenoids and flavonoids groups (Fig. 5).



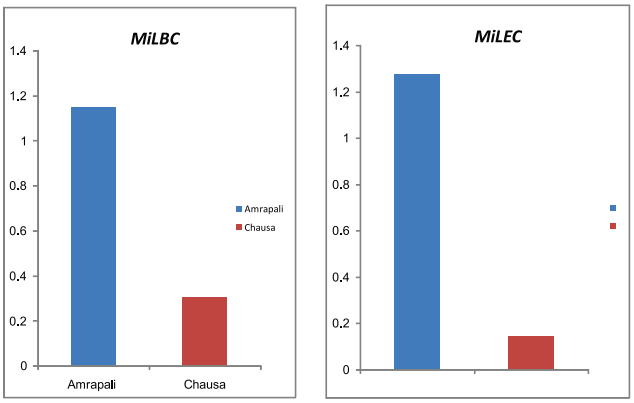


Fig. 5. Gene expression profile of key enzymes of carotenoid biosynthesis through qRT-PCR

Transcriptome profiling of floral and vegetative buds (VBD) in mango cv. Dashehari for alternate bearing

A total of ~1.92 and ~3.39 Gb data was generated in Illumina platform for the sample VBD and FBD respectively. For sample FBD, out of 27345 CDS, hits were obtained for 26641 and no hits were found for 704 CDS. Top hit species distribution shows a close homology with *Citrus sinensis* followed by *Citrus climentia*. Thus, from the available RNA-seq data a total of 60 families of transcription factors were identified, many of these being relevant to flowering in other crop plants. Differential gene expression analysis was carried using DESeq package based on common hit accession of the CDS. A total of 11,220 CDS were identified out of which 5606 were up regulated and 5613 were down regulated based on log 2 fold change. Again, based on p-value, 423 were significantly up regulated and 301 significantly down regulated. Comparative transcriptome profiling of floral and vegetative buds in mango cv. Dashehari has revealed a clear cut pattern of the same DEGs significantly up regulated in FBD were down regulated in VBD (423) and vice versa (301). The DEGs identified to be significantly up-regulated included genes *viz*., CRY2 (blue light photoreceptor), GRP4 (Giberellin regulated protein), Transcription factors (AGL8, WD, RF2), ARF, some stress related proteins. DEGs that were significantly down regulated encoded for genes such as ABC transporters and exportins, transcription factors (AP2, ERF, WRKY).

Nature of DEGs		Differentially expressed genes (DEGs)		
FBD	VBD	Total No	Significant	Non Significant
Up regulated	Down regulated	5608	423	5185
Down regulated	Up regulated	5613	301	5312
		11221	724	10497
		Log_2FC, p value=0.05		
		% DEGs Significant	6.45	

Small RNA sequencing for identification of regulators of flowering

miRNA sequencing generated 37600826 reads in same tissues FBD and 18012498 reads in VBD samples, of which 29140659 and 17820435 reads, respectively, were retained following 3′ adapter trimming and size selection to read length greater than 17bp. Following the discovery of known and novel miRNA, analysis was done for differentially expressed miRNA between VBD and FBD (Fig. 6). Following the differential analysis, the target were predicted for known and novel miRNA against *Citrus clementina transcripts*. A total of 7171 targets were predicted against 1576 known miRNAs out of 1641 known miRNAs and 16 targets against 6 novel miRNA out of 8 novel miRNA from VBD sample.

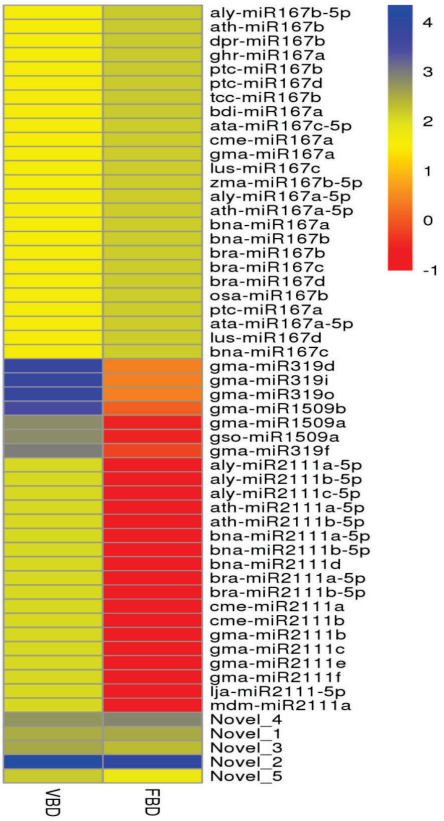


Fig. 6. Heatmap of known and novel miRNA for VBD and FBD

Genome analysis for mango malformation

Malformed gDNA sample was used for sequencing 18S rDNA on Illumina platform using 2x 250 chemistry, which resulted in generation of 755,054 PE reads which was further analyzed and based on UNITE database QIIME analysis using stitched reads as input showed that *Ascomycota* and *Basidiomycota* are most abundant at phylum level. At species level, gDNA sample is highly enriched with *Capnobotryella renispora*. Further analysis is underway with correlation with metabolite studies. Alpha diversity in terms of shannon index was 2.87 and observed species as 251 in the malformed tissue (Fig. 7).

Consensus linkage	gDNA	#OTU ID
k_Fungi;p_Ascomycota;c_Eurotiomycetes;o_Chaetothyriales;f_unidentified;g_unidentified	301	denovo3
k_Fungi;p_Ascomycota;c_Eurotiomycetes;o_Onygenales;f_Anthrodermataceae;g_Trichophyton	4799	denovo50
k_Fungi;p_Ascomycota;c_Dothideomycetes;o_Pleosporales	207	denovo63
k_Fungi;p_Ascomycota	131	denovo76
k_Fungi;p_Ascomycota;c_Incertae_sedis;o_Incertae_sedis;f_Incertae_sedis;g_Ochroconis	120	denovo92
k_Fungi;p_Basidiomycota	314	denovo136
k_Fungi;p_Basidiomycota	1538	denovo137
k_Fungi;p_Ascomycota	39489	denovo192
k_Fungi;p_Ascomycota;c_Dothideomycetes;o_Capnodiales;f_Incertae_sedis;g_Capnobotryella;s_Capnobotryella_renipsora	23601	denovo193
k_Fungi;p_Ascomycota;c_Incertae_sedis;o_Incertae_sedis;f_Incertae_sedis;g_Ochroconis	6088	denovo195
k_Fungi;p_Basidiomycota;c_Tremellomycetes;o_Tremellales;f_Tremellaceae	304	denovo197
k_Fungi;p_Ascomycota;c_Dothideomycetes;o_Capnodiales;f_Incertae_sedis;g_Capnobotryella	4919	denovo198
k_Fungi;p_Basidiomycota;c_unidentified;o_unidentified;f_unidentified;g_unidentified;s_unculturedBasidiomycota	110	denovo219
k_Fungi;p_Ascomycota	253	denovo223
k_Fungi;p_Ascomycota;c_Eurotiomycetes;o_Chaetothyriales;f_Herpotrichiellaceae	1324	denovo239
k_Fungi;p_Ascomycota;c_unidentified;o_unidentified;f_unidentified;g_unidentified;s_unculturedAscomycota	102	denovo261
k_Fungi;p_Ascomycota;c_unidentified;o_unidentified;f_unidentified;g_unidentified	237	denovo274
k_Fungi;p_Ascomycota;c_unidentified;o_unidentified;f_unidentified;g_unidentified;s_unculturedAscomycota	168	denovo283
k_Fungi;p_Ascomycota;c_Incertae_sedis;o_Incertae_sedis;f_Incertae_sedis;g_Ochroconis	754	denovo298
k_Fungi;p_Ascomycota;c_unidentified;o_unidentified;f_unidentified;g_unidentified;s_unculturedAscomycota	235	denovo305
k_Fungi;p_Ascomycota	566	denovo312
k_Fungi;p_Ascomycota;c_Eurotiomycetes	162	denovo315

Fig. 7. OTU identification through QIME analysis based on UNITE

Expression analysis of salinity stress related genes in polyembryonic mango

Six key genes *viz*., *STPK*, *MAPK6*, *ERF2*, *MYC2*, *MDH*, and *TPS* related to salinity stress responses were mined from leaf transcriptomes (SRA Nos. SRP070908, SRP072727). Gene expression profiling of these genes were carried out through RT-PCR assays in salinity tolerant Nekkare and salinity susceptible Vellai Colomban under stressed and control conditions. *STPK* gene encoding serine threonine protein kinase, *MAPK6* encoding mitogen activated protein kinases, *MYC2* a transc ription factor and *TPS* encoding trehalose phosphate synthase were typically up-regulated under stress conditions in Nekkare which proved the activation of salinity stress response signal transduction pathway and alternate carbohydrate metabolism. *MYC2* and *TPS* genes were uniquely up-regulated in Nekkare while *STPK* and *MAPK6* genes were up-regulated under stress

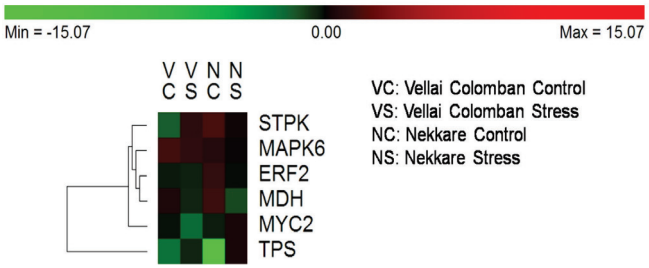


Fig. 8. Heat map of real time analysis of salinity stress response (Green: down-regulated, Red: up-regulated genes)

in both susceptible cv. Vellai Colomban and tolerant cv. Nekkare (Fig. 8). Further studies are underway to elucidate the molecular mechanism of salinity stress tolerance in Nekkare.

Transcriptome sequencing of 13-1 (control and salinity stress) of leaf and root tissues

Illumina Transcriptome paired end cDNA libraries were prepared for 13-1 (leaf and root tissues, control and salt treated) and sequenced annotation was also performed using Malvids protein sequences downloaded from Uniprot database. Differentially expressed genes and their pattern of relative abundance among the two tissues under control and stress conditions implicated role of transporter proteins like aquaporins, transcription factors, osmotin like proteins and LEA in salt stress responses in 13-1 (Fig. 9). These are being validated in different polyembryonic germplasm.

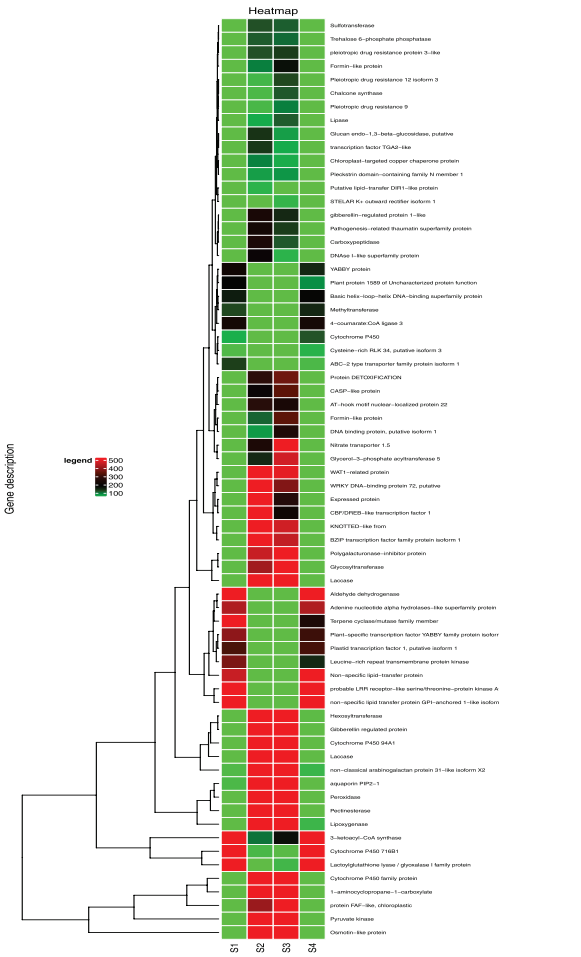


Fig. 9. Heat map of RNA seq for salinity stress 13-1: S1-control leaf, S2- control root, S3-Salt stressed leaf, S4-Salt stressed root

Genomic analysis of mango jelly seed pulp

RNA seq analysis of mango jelly seed pulp generated 2.4 GB data, 36,909 transcripts with an N_{50} scaffold length of 1,053 bp. A total of 17,000 CDS were predicted. KOG

classes Transcription, translation, post translational modification, protein turnover, chaperones and signal transduction dominant category. Overall data suggests a molecular basis for the biochemical consequences of the jelly seed formation (Fig. 10).

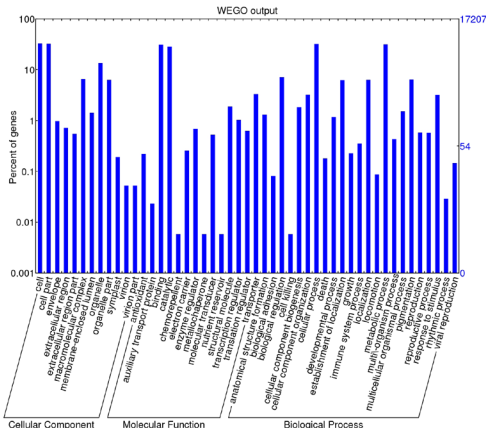


Fig. 10. Genomic analysis of mango jelly seed pulp

Metabolic profiling of mango jelly seed pulp

The GC-MS analysis of mango jelly seed pulp shows the presence of a wide range of fatty acids, heterocyclic and aromatic compound *i.e.* Pentadecanoic acid, Hexadecanoic acid, 7,9-Di-tert-butyl-1-oxaspiro(4,5) deca-6,9-diene-2,8-dione which are intermediates of many secondary metabolites and involve in flavouring and colour development.

Expression analysis (RT-PCR) of Ethylene Responsive TFs genes under salt stress (200mM NaCl, 2 hour) in mango revealed up-regulation of ERF 61, ERF21, ERF 39, ERF RAP2-4 like and ERF RAP2-12-like Mango *cv.* Vellaicolumban (Fig. 11).

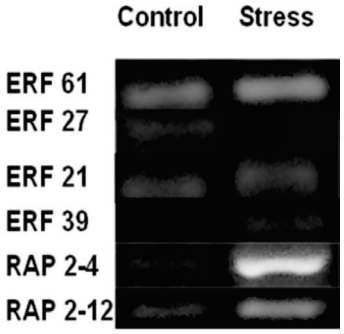


Fig. 11. Expression analysis of ethylene responsive TFs gene

GUAVA (*Psidium guajava* L.)

Collection

During the year 2017-18 Twenty one guava germplasm/ varieties including indigenous collections from IIHR, Bangalore, Madhya Pradesh and exotic collection from Taiwan were made for their quality and wider adaptability.

Evaluation

Evaluation of guava germplasm for fruit characteristics indicated wide variability for fruit weight, fruit length, fruit width, seed hardiness and TSS. The germplasm exhibited maximum variability for fruit weight, while, the minimum variability was recorded for seed hardiness followed by TSS. The TSS and ascorbic acid content ranged from 8°B to 15.40°B and 184.80 to 200 mg/100g. The fruit weight ranged from 53.33 g to 463.50 g (VNR-B-1) with average of 167.32g.

Evaluation of guava hybrids and half-sib population

Evaluation of hybrid seedlings fruit characteristics revealed that highest variability was recorded for fruit weight followed by TSS and seed hardiness. The appreciable number of hybrids recorded fruit weight more than 200g which ranged from 102-287.50g, while TSS varied between 7-13.2°B. Wide variability was observed for fruit weight, seed hardiness and TSS gave scope for identifying the superior soft seeded hybrid (Fig. 12).

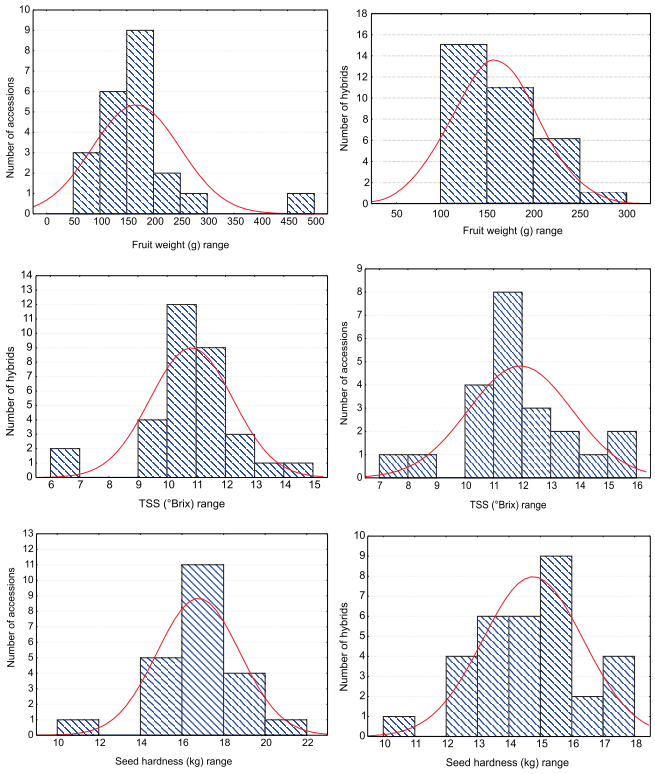


Fig. 12. Extent of variation in guava accessions and hybrids for fruit weight, TSS and range seed hardiness

Callus mediated regeneration of wilt resistant rootstock of guava

Minimum time taken for callus induction from *in vitro* leaf was observed to be 10 days in MS medium containing 2 iP 0.5mg/l + NAA 1.0mg/l+ Glutamine

100+PVP 50. Initially, the callus was observed at the cut end of the leaf. It was predominant at midrib on abaxial surface of leaf. The entire leaf converted into callus in 3 weeks. The callus was proliferated in the same media after 3-4 weeks. Green friable callus transformed into shoot like structures which are being maintained under in vitro condition. Different nutrients formulations have been worked out for induction of callus from *in vitro* leaf.

In vitro regeneration through shoot bud

The explants were inoculated throughout the year and it was observed that explants collected during April to June were most responsive for enhanced axillary branching in hybrid rootstock. Explant survival as well as per cent explants that induced shoots were much higher during April to June viz. 43.33 per cent and 21 per cent, respectively. It is evident data that out of three different sterilant combinations used, pre wash with Carbendazim 0.1 per cent + Metalaxyl 0.05 per cent followed by surface sterilization with $HgCl_2$ 0.1per cent was found to to be most effective in producing aseptic cultures. Maximum of 40.11% aseptic explants survived under this treatment and 21% explants induced bud. Maximum number of shoots (2.6 mean shoots) could be induced under *in vitro* conditions by fortification of BAP at 4mg/L. The days taken for bud induction was reduced to 7 days compared to other treatments. Maximum *in vitro* rhizogenesis (3.6 roots/explants) was observed in MS+IBA 2mg/L. The length of primary root was 3.94 cm whereas the fresh weight of root was 50 mg. This treatment also reduced the time taken for root induction (6.47 days).

AONLA (*Emblica officinalis* Gaertn.)

Collection

Rewa and adjoining areas of Madhya Pradesh were explored for collection of superior aonla genotypes in terms of fruit size, high yield, high vitamin C and phenol. A total of 21 accessions were collected where in fruit weight ranged from 9.93-40.27 g, fruit length 2.37-3.52 cm, fruit width 2.67-4.37 cm and stone weight 0.63-1.84 g. The ascorbic acid content ranged from 403.29-516.62 mg/100g pulp and total phenol content 1.02-2.65 per cent among the different accessions collected. On the basis of overall assessment four accessions *i.e.*, T_6, T_7, T_8 and T_{21} were found most promising . Grafted plants of these accessions will be field planted during coming monsoon.

Evaluation

Twenty one accessions of aonla collected from different parts of Madhya Pradesh were field planted along with four commercial checks (NA-6, NA-7, Kanchan and Krishna) for evaluation during the year 2007. Maximum fruit yield (28.27 kg/tree) was recorded in accession CISH A-33 followed by CISH A-31 (26.61 kg/tree) and CISH A-3 (25.84 kg/tree). The vitamin C content ranged from 357.96 to 391.34 mg/100 g pulp among the different accessions evaluated. However, maximum Vitamin C (391.34 mg/100g) was recorded in accession CISH A-33. Similarly, the polyphenol content ranged from (1.61 to 2.92 TAE g/100g) among the different accessions evaluated, being maximum (2.92 TAE g/100g) in accession CISH A-33 followed by CISH A-31. On the basis of overall assessment, two accessions *viz.*, CISH A-31 and CISH A-33 was found promising with high nutraceutical values.

Seasonal changes in biochemical attributes during different stage of fruit maturity

Biochemical characters like vitamin C, total phenol, acidity, total sugar and TSS content were estimated in seven aonla cultivars *viz.*, NA-6, NA-7, NA-10, Laxmi-52, Krishna, Kanchan and Chakaiya during 1st week of October, 2017 to 2nd week of February, 2018 to establish the optimum time of harvesting with maximum nutraceutical contents. Maximum ascorbic acid content was recorded in NA-6 (484.68 mg/100g pulp), Krishna (420.15 mg/100g pulp) and Laxmi-52 (404.25 mg/100g pulp) when fruits were harvested in 1st week of October, NA-7 (403.67 mg/100g pulp) it was in last week of October, NA-10 (398.17 mg/100g pulp) in 1st week of November, Chakaiya (403.56 mg/100g pulp) in 1st week of December and Kanchan (397.21 mg/100g) in 1st week of January. Similarly, maximum phenol content in NA-7 (1.63%) in last week of December, NA-6 (1.81%) in 1st week of January, NA-10 (1.92%) in last week of January, Krishna (2.09%) and Kanchan (1.51%) in last week of February while, Chakaiya (1.92%) in 1st week of February was recorded.

BAEL (*Aegle marmelos* Correa.)

Collection

Surveys in Jaunpur district and in adjoining areas of Uttar Pradesh were carried out and 13 accessions were marked and passport data were recorded. Fruit samples were analyzed for various physical and biochemical parameters. Fruit weight varied from 0.67 to 3.56 kg, fruit length from 10.25 to 19.15 cm, fruit circumference from 35.50 to 63.50 cm, number of seeds/fruit ranged between 19.50 to 117.00, seed weight ranged between 1.57 to 11.99 g, shell weight from 0.11 to 0.37 kg, shell thickness from 2.20 to 3.38 mm, number of seed sac from 7.00 to 21.00 and pulp weight between 0.61 to 3.13 kg. TSS (30.25 to 40.75°B), acidity (0.36 to 0.45 %), ascorbic acid (8.55 to 15.88 mg/100 g pulp), total sugars (17.01 to 20.77%), reducing sugars (8.03 to 11.03%), non-reducing sugars (6.60 to 10.94%) and tannin (2.25 to 3.42%) among the different accessions varied significantly. On the basis of overall assessment, four bael accessions T_5, T_9, T_{10} and T_{13} appeared most promising.

Evaluation

Clonally multiplied germplasm

Thirty six vegetatively multiplied bael accessions were planted in the field gene bank for evaluation.

Fifteen accessions were analyzed for physico-chemical parameters. The fruit weight (0.57-2.55 kg), fruit length (10.50-17.74cm), fruit circumference (34.50-56.50cm), shape (round to oblong), fruit yield (22.29 to 45.42 kg/plant), number of seeds/fruit (71.50-117.00), number of seed sac (11.00-16.00), seed weight (7.40-14.99g), shell weight (0.22-0.60 kg), shell thickness (2.11-3.67mm). TSS (33.3-42.0^{0}B), acidity (0.36-0.49%), ascorbic acid (9.33-17.20mg/100g pulp), total sugar (15.24-21.95%) and tannin (2.59-3.61%) among the different accessions evaluated. On the basis of three year data, accession number-37 (CISH B-3) found most promising with high yield (35.09 kg/tree), TSS content (38.50^{0}B), less seed weight (9.37g) and less shell thickness (2.60 mm).

Seedling germplasm

A total number of 145 seedlings raised from promising bael accession were planted during the year 2003. The plant height varied from 3.87 to 10.05 m, girth from 16.47 to 68.52 cm, plant spread 2.31 to 8.61m (E-W) and 1.91 to 8.10 m (N-S) and fruit yield varied from 37.50 to 88.50 kg/plant. Fruit weight (0.880-2.740 kg), length (7.00-15.20 cm) and circumference (25.00-44.00 cm) varied significantly. The biochemical parameters also varied *i.e.*, TSS (31.50-38.50°B), acidity (0.36- 0.49%), ascorbic acid (14.29-17.16 mg/100g pulp), total sugar (14.29-20.52%), reducing sugar (7.22-10.35%) and phenol (2.22-3.32%) among the different germplasm. On the basis of three year evaluation data, accession number-34 (CISH-B-4) was found most promising with high yield (47.12 kg/tree), TSS content (39.0^{0}B) with less shell thickness (2.15 mm).

JAMUN (*Syzygium cuminii* Skeels)

Evaluation

Significant variations were recorded for tree height among different identified accessions/varieties. Tree height varied from 6.80-10.60 m. Minimum tree height was observed in Konkan Bahadoli (6.80 m). Fruit weight varied from 5.00 to 22.43 g. Significantly higher weight was registered in CISH J–37 (22.43 g). The pulp content varied from 45.30 to 96.47 per cent. Maximum fruit yield was recorded in CISH J–37 and CISH J-15 (96.74 and 52.34 kg/plant) on 10th year of age.

Flowering and fruiting behaviour in relation to shoot maturity after pruning.

Pruning was performed during October 2017 with open and palmate system of canopy. Flowering was observed in the 2nd week of February 2018 on current season and one year old shoots. The maximum number of fruit set was found in open and palmate system (46 and 35) on current year shoots (4 month old) however, minimum number of fruit set was recorded in open and palmate system on one year old shoot (25 and 23). The data on average light availability (percentage) was recorded in open and palmate system of canopy. The maximum defused light availability was recorded in open system of canopy (33.38%) followed by palmate system (29.66%) and was minimum in control (27.64%). The maximum direct light availability was recorded in open system of canopy (28.67%) followed by palmate system (25.59%) and minimum in control (23.33%). The accession, CISH J-37 was evaluated for its photosynthesis, transpiration and stomatal conductance in both methods of canopy development *i.e.* open centre and palmate system. The net photosynthesis rate ranged from 5.62 to 11.78 mmol CO_2, vapour pressure deficit ranged from 1.08 to 3.76 mbars, and transpiration from 1.22 to 2.28 mmol H_2O $m^{-2}s^{-1}$ and stomatal conductance ranged from 43 to 81 mol H_2O $m^{-2}s^{-1}$. Thirty per cent flower bud opening was recorded in open system of canopy, while only 10 per cent flower bud opening was observed in palmate system during end of March.

Nutrients analysis in irrigated and un-irrigated trees

Soil organic carbon in jamun orchard ranged from 0.23 to 0.43 per cent with average of 0.34 per cent which is below critical level of <0.5 per cent, indicating need for improvement in soil organic matter through organic sources. Soil P and K ranged from 15.1 to 26.7 mg kg^{-1} and 59.65 to 84.7 mg kg^{-1}, respectively. In case of micronutrients, Zn content varied 0.28 to 1.12 mg kg^{-1} and Cu, Mn and Fe was in optimum level. Undisturbed core soil samples (0-10, 10-20 and 20-30 cm depth) were also collected from the experiments having irrigated and un-irrigated jamun trees. Bulk density (BD) was estimated between 1.37-1.42 and 1.42-1.45 g/cm^3, A range of PD was between 2.22-2.34 and 2.41-2.44 g/cm^3, water holding capacity (%) varied between 20.21-20.52 and 19.18-19.72 per cent while porosity had a range of 36.06-41.18 and 40.07-41.82 per cent in irrigated and non-irrigated, respectively. Foliar nutrient status was also determined and it was recorded that P and K varied from 0.18-0.22 and 2.24-2.76 mg kg^{-1}, respectively. Micronutrients like Zn, Cu, Mn and Fe ranged between 0.18-0.37, 0.13-0.25, 0.47-0.72 and 2.24-4.61 mg kg^{-1}, respectively. Nutrient analysis indicated need for micronutrient spray at critical fruit developmental stages along with Zn nutrition in soil. Energy components were also estimated at BBCH scale of critical phenological stages in jamun following flowering (611), end of flowering (619), fruit set (711) and fruit maturity (719). Ambient maximum temperature ranged between 17 to 43.5 °C, minimum temperature between 9 to 26°C, evaporation rates were recorded between 3.6 to 11.2 mm/day during flowering to fruit set periods.

Use of GA_3 for increasing fruit size of CISH J-42

Fruit bunches dipped in different concentration of GA_3 after fruit set revealed that maximum fruit weight and TSS was recorded (8.9g and 12.3° Brix) with GA_3 60 ppm application compared to control fruit weight (6.8g) and TSS (6.8°B).

Crop Production

Mango (*Mangifera indica* L)

Canopy architecture management in newly planted mango orchard

The effect of canopy modifications in mango cv. Dashehari was initiated right from planting stage. Significantly higher light availability beneath the canopy (51.44, 52.20 and 56.87%, for diffused, direct and total solar radiation, respectively) was recorded in plant trained to 3 primary and 2 secondary which was at par with plant trained to 3 primary and 3 secondary branches (54.21%) for total solar radiation after 3 year. Plant trained to 3 primary and 2 secondary branches had significantly high leaf photosynthetic rate, stomatal conductance and water use efficiency (7.88 µmol CO_2 $m^{-2}s^{-1}$, 117.67 mmol H_2O $m^{-2}s^{-1}$ and 3.42 mmol CO_2 mol^{-1} H_2O, respectively), as compared to control. Leaf chlorophyll (a, b and total) was significantly high in plants having 3 primary and 2 secondary branches (1.41, 0.33 and 1.73 mg/g, respectively).

Canopy re-orientation under overcrowded and unproductive trees of mango cv. Dashehari under HDP

Canopy volume was significantly increased by 61.37 per cent in trees provided with organic mulches compared to control. Carbohydrate content in leaves were higher in flowering trees (0.83-1.62 mg/100 g), than non flowering trees (0.33-1.35 mg/100 g) (Fig. 12). Pruning height had significant effects on flowering, maximum trees experienced flowering (71.31%) at 2.5 m height pruning (Fig. 13 & 14). Combined effect of organic mulch, pruning height (2.5 m) and spacing (2.5×5.0 m) had great effects on flowering per cent (76.33) and fruit set (59.50 fruits/tree) recorded in 2nd year of pruning (Fig. 13). In soil microbial enzymatic activities *viz.*, DHA varied from 0.54 to 1.57 µg TPF g^{-1} h^{-1} while FDA ranged between 159.3 to 265.3 µg fluorescin kg^{-1} h^{-1}. The micronutrients contents like Zn (0.53 to 1.05 mg kg^{-1}), Cu (4.17 to 8.75 mg kg^{-1}), Mn (9.33 to 15.33 mg kg^{-1}) and Fe (6.73 to 11.67 mg kg^{-1}), respectively were recorded across twelve treatments. Soil P and K varied between 9.6 to 19.47 and 88.47 to 155.43 mg kg^{-1}, respectively. Soil analysis suggested for better soil management through integrated nutrient approach to improve the soil health status.

Fig. 13. A-Low flowering in mango pruned at 1.5 m pruning height (2.5×2.5 m (2nd year), B- More than 70% trees attained flowering at 2.5 m pruning height, C- Bearing in mango in 2nd year

Light relations and gas exchange studies in mango

Crowded canopy in mango orchards increases light interception which in turn affects gas exchange, fruiting and productivity. In rejuvenated orchard, maximum

direct light availability (47.70%) was recorded during the month of August while in non-rejuvenated mango orchard only 5.69 per cent diffused light was available at ground level. However, 33.36 per cent more diffused light was available at the inter space of rejuvenated orchard as compared to diffused light availability beneath the rejuvenated tree. Similarly, only 3.49 per cent more direct light was available at ground level at the midpoint in the inter space of non rejuvenated mango orchard as compared to direct light availability beneath the tree, where as 20.65 per cent more direct light was available in the inter space of rejuvenated mango orchard as compared to light availability beneath the tree.

Six commercially important mango cultivars (Langra, Lucknow Safeda, Bombay Green, Dashehari, Mallika and Amrapali) planted at row to row and plant to plant distance of 10 m exhibited significant variation in light relations and gas exchange parameters at 30 years age. Maximum availability of light (28.75%) and minimum leaf area index (1.44) was found in Mallika indicating sparse canopy. During flowering stage, net assimilation rate of different cultivars varied from 4.84 to 8.62 µmol CO_2/m^2s^{-1}, stomatal conductance was found to vary from 52 – 109 mol H_2O $m^{-2}s^{-1}$ and vapour pressure deficit from 0.92 – 2.23 kPa.

Evaluation of various filler crops for enhancing profitability of rejuvenated orchard of mango cv. Dashehari

To study the suitability of filler crops under rejuvenated mango orchards, different crops e.g. guava cv. CISH Shweta, bael cv. NB-5, custard apple cv. Atemoya × Balanagar, ber cv. Gola, Apple Ber and pomegranate cv. Bhagwa were grown. Plant height of different filler crops varied from 0.50 to 1.41 m, while plant spread in east-west and north-south direction ranged from 0.21 to 1.48 m and 0.46 to 1.47 m. Plant height and spread were maximum in bael while it was minimum in pomegranate. Among the rejuvenated trees, 24.2 per cent trees produced flowers 2 years after heading back. Mortality of 10.15 per cent of total number of trees headed back was recorded due to various reasons including severe infestation of trunk borer. Increase in growth of mango tree canopy varied from 3.0-4.5 m in spread and 2.5-5 m in height. Soil samples revealed that soil organic carbon, P and K varied between 0.319-0.377 per cent, 15.9-26.0 and 57.1-76.8 mg kg^{-1} respectively. Micronutrients (Zn, Cu, Mn and Fe) ranged from 0.313-0.487, 0.513-0.940, 5.19-6.33 and 3.47-4.09 mg kg^{-1} respectively. Microbial activities i.e. DHA varied between 0.014 to 0.518 µg TPF g^{-1} h^{-1} and FDA ranged from 95.9 to 253.6 mg fluorescin kg^{-1} h^{-1}.

Assessment of soil quality indicators in mango

Undisturbed core soil samples (84) were collected from 0-10, 10-20 and 20-30 cm soil depths in Dashehari and Langra orchards located in Mall and Malihabad blocks of Lucknow district for estimating the physical, chemical and biological indicators in soil. The range was 0.96-1.90 and 0.16-1.14 µg TPF g^{-1} hr $^{-1}$ DHA in Dashehari and Langra respectively. The range for FDA was 391.29-564.95 and 161.11-386.89 mg fluorescein kg^{-1} hr $^{-1}$ FDA, respectively. The bulk density (BD) varied between 1.23-1.47 gcm^{-3} (Dashehari) and 1.28-1.43 g cm^{-3} (Langra) while particle density ranged between 2.29-2.99 and 2.43-2.66 gcm^{-3} across these orchards. Water holding capacity of 20.91-24.39 and 21.34-23.21 per cent and porosity of 39.5-57.2 and 42.6-51.0 per cent in Dashehari and Langra orchards were estimated across three depths. It was observed that majority of the orchards had low soil organic carbon content (0.42-0.55 and 0.34-0.45% in Dashehari and Langra orchards, respectively. Available K varied between 132.99 to 173.51 and 76.62-116.95 mg kg^{-1}, P ranged from 12.08-26.05 and 10.77-27.97 mg kg^{-1}. Among the micronutrients, Zn content (0.64-1.32, 0.89-3.32 mg kg^{-1}), Cu (0.80-1.16, 1.81-3.29 mg kg^{-1}), Mn (2.48-3.56, 3.90-23.88 mg kg^{-1}) and Fe contents of 5.16-8.92, 7.57-24.54 mg kg^{-1} was recorded in Dashehari and Langra orchards, respectively. The data indicated that the majority of orchards are in low category of soil physico-chemical and biological properties and at this status satisfactory productivity cannot be achieved in Dashehari and Langra orchards. Therefore, proper nutrient management is urgently needed for enhancing the productivity.

Assessment of soil properties at Farmers' field

Soil nutrients and enzymatic activities were estimated across 200 mango orchards in Kakori and Malihabad blocks of Lucknow district in order to determine the nutrient status. A range of 0.26 to 1.22, 0.46 to 3.34, 3.62 to 19.82 and 4.46 to 19.36 mg kg^{-1} Zn, Cu, Mn and Fe, respectively was recorded in the selected orchards. Wide spread variations in soil organic carbon content between 0.02 to 0.99 per cent, 12.0 to 35.70 and 60.45 to 213.10 mg kg^{-1} of P and K contents were estimated (Fig. 15). A range of 0.01-2.71 µgTPFg^{-1} hr^{-1} DHA and 146.55-388.36 mg fluorescein kg^{-1} hr^{-1} FDA were estimated across these orchards. Maximum (51.5%) mango orchards had low DHA (0-0.500 µgTPFg^{-1} hr^{-1}). Similarly, maximum (56.0%) mango orchards had lower FDA in the range between 0 to 200 mg fluorescein kg^{-1} hr^{-1} FDA. In case of Zn content, 55.5 per cent mango orchards fall under critical limit of 0.50 mg kg^{-1}. In case of soil organic carbon content, 39.5, 32.5 and 28.0 per cent falls under low, medium and high categories respectively. Lower biological activities

are responsible for low yields in these mango orchards (4 to 6 t/ha) therefore proper organic as well as nutrient application (macro and micro nutrient) is required in order to obtain higher yield (Fig. 14).

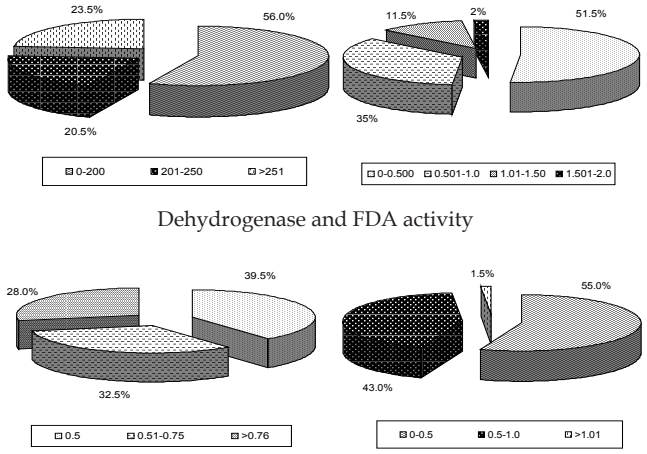


Fig. 14. Zn content (mg kg^{-1}) and per cent soil organic content

GUAVA (*Psidium guajava)*

Growing guava on espalier architecture

Guava cv. CISH-Lalit was planted on Espalier architecture during 2016 and after one year, trees developed complete canopy with 35-40 fruits/tree (7-8 kg). The largest fruits were 370-480 g with projected yield of 14.89 t/ha. Fruit weight varied from 62-470 g/fruit, with average weight of 218 g/fruit and TSS 12.87 °Brix, nearly 60-70 per cent fruits were 'A' grade with attractive red blush (Fig. 15).

Fig. 15. Bearing in one year old espalier architecture of guava

Input use efficiency in HDP guava for yield and quality

Guava variety CISH-Lalit, planted on raised bed, covered with 100 micron black polythene mulch and drip irrigation at 80 per cent PE and fertigation with 75 per cent RDF (T1) performed best over control. Maximum average fruit weight (282.38 g) was recorded in T1 on 2 years old plantation.

Assessment of soil quality indicators in guava orchards

To determine the effect of zinc and boron spray on yield and quality of fruits, experiment was carried out at Rehmankhera farm in Guava cv. CISH Shewta 12 year old orchard. Highest yield was recorded in 2 sprays of 0.4 per cent $ZnSO_4$+0.2 per cent Borax during fruit growth at monthly interval as compared to other treatments including control. The same treatment had highest TSS (14.2 °B), acidity (0.67%) and ascorbic acid (273.3 mg/100 g) content in fruits. Analysis of soil indicated mean water holding capacity and bulk density were 23.5 per cent and 1.3 g/cc, dehydrogenase of 0.53 µg TPF/g/h and FDA of 172.98 µg/g/h. Low organic carbon and Zn content of 0.39 per cent and 0.48 mg kg^{-1}, Cu content of 0.43, Mn of 2.48 and Fe 2.0 mg kg^{-1}, P (18.6 mg kg^{-1}) and K (52.18 mg kg^{-1}). Results revealed that zinc and boron spray has beneficial effect on fruit yield and quality.

JAMUN (*Syzyjium cuminii* Skeel)

CISH J-37 plants grown in three training systems *viz.*, control, open and palmate, availability of diffused and direct light varied significantly *viz.*, 27.64, 33.38, 29.66 per cent and 23.33, 28.67, 25.59 per cent, respectively, considerable variations in gas exchange parameters *viz.*, net assimilation rate (5.62-11.78 µmol $CO_2.m^{-2}s^{-1}$), stomatal conductance (43-81 mol H_2O $m^{-2}s^{-1}$), vapour pressure deficit (1.08-3.76 kPa) and transpiration rate (1.22-2.28 H_2O $m^{-2}s^{-1}$) was found in accordance with this substantial variability in yield and fruit quality traits was recorded.

OTHER FRUITS

Standardization of nutrient requirement through fertigation in banana

Banana cv. Grand Naine was imposed to different nutrient dose and schedule for better yield and quality. The results of first year crop indicated that maximum leaf area and yield (7.55 m^2/tree and 52.71 t/ha) was found in the treatment of 100 per cent N:K (40:25, 30:35, 30:25,

Fig. 16. Field view of banana experiment (a) and bunch development in cv. Grand Naine (b)

0:15) and it was closely followed by (7.25 m^2 and 51.79 t/ha) in the treatment of 80 per cent N:K (40:25, 30:35, 30:25, 0:15) and (7.52 m^2 and 51.09 t/ha) in the treatment of 100 per cent N:K (30:20, 20:30, 20:30, 30:20) applied at vegetative growth, pre flowering, flowering and bunch development stages (Fig. 16).

Phenological manipulation through planting time for higher yield and better quality in banana

The experiment was initiated during June 2017 with an objective to standardize the optimum planting time for better yield and quality of banana cv. Grand Naine. The planting in experimental field was done at monthly intervals (starting from 15th June, 15th July 15th August, 15th September, 15th October, 15th November, 15th December, 2017; 15th January, 15th February, 15th March, 15th April and 15th May 2018). Preliminary observations indicated that the banana planted in June performed better in respect to pseudostem height (108.04 cm), circumference (39.18 cm) and number of leaves (5.16).

Improving fruit size and quality of peach under subtropical conditions

Phenological growth stages and BBCH identification keys in peach revealed that earliest bud swelling, start of flowering and full bloom registered in Pant Peach-1 and Flordaprince, end of flowering observed first in Pratap (Fig. 17). Among early maturing cultivars, Flordaprince had maximum yield and production efficiency (196.67 fruits/plant and 3.97 fruits/cm^2 TCSA, respectively). TSS content varied from 12 to 16 °Brix, fruit weight varied from 35 to 85 g/fruit in different cultivars, correlation matrix showed positive correlation between canopy volume with production efficiency and fruit set pattern (Table 4). Earliest maturity recorded in Sarbati Surkha and Flordaprince (28 April-07 May), while it was very late in Pant Peach-1 (13-17 May)

Table 4. Yield and quality of peach cultivars 2017-18

Varieties	Maturity DAFB (days)	Fruit weight (g)	Pulp weight (g)	Fruit Length (mm)	Fruit Dia (mm)	Stone weight (g)	TSS (°Brix)	Fruit shape	Stone separation
Flordaprince	70.71	64.71	61.00	46.00	46.43	3.85	14.43	Round	Free stone
Saharanpur Prabhat	72.71	48.00	45.28	43.00	43.00	3.71	15.14	Slightly conical	Free stone
Sarbati Surkha	69.00	34.85	31.43	40.14	40.43	5.14	14.57	Conical	Free stone
Pant Peach 1	93.71	80.57	77.00	48.91	50.14	4.57	12.57	Round	Clinging stone
Sarbati	74.14	45.43	42.00	45.00	46.71	4.28	13.71	Conical	Free stone
Shan-e-Punjab	81.14	59.85	56.85	40.00	43.85	3.85	14.42	Slightly conical	Free stone
SE(m)	0.91	3.26	3.24	1.31	1.64	0.30	0.43	-	-
C.D. at 5%	2.65	9.41	9.40	3.80	4.77	0.88	1.26	-	-
C.V. (%)	3.14	17.18	16.40	7.79	9.95	19.03	8.13	-	-

Fig. 17. Florda Prince bears attractive red coloured fruits, matures in last week of April

Effect of flower regulation on runner production in strawberry var. Chandler under row cover in subtropics

Modified row cover was designed for strawberry production. Covering of plants was done during April to June with 50 per cent shade net followed by side ventilated polythene row cover from July to September at a height of 3.5-4 meters above ground level. Early runner production during first week of April was observed in strawberry var. Chandler. Higher temperature favours early runner formation in var. Chandler. Non removal of flower throughout fruiting season resulted in less (32)

number of runner formation while complete removal of the flowers resulted in maximum number (250) number of runner formation in modified row cover.

Effect of modified growing conditions on sunrival of young plants of strawberry var. Chandler

Effect of variations in modified growing conditions on survival of strawberry was determined. Modified row cover (cover with 75 per cent net from April-June followed by cover with ventilated plastic row cover from July-September) exhibited maximum survival, whereas, complete mortality of plants was observed under open conditions in the first week of May followed by first week of July under 75 per cent shade net row cover. Modified row cover protected plants from intense sunlight from April-June and ventilated plastic cover from direct impact of rainfall on plants.

Evaluation of pepino (*Solanum muricatum Aiton*) under open subtropical conditions for principal growth stages

Four germplasm accessions were maintained at ICAR-CISH since 2015-16 and evaluated for its BBCH principal growth stages during 2017-18. Three accessions (CISH-P-1, CISH-P-2 and CISH-P-3 were collected from North East (Sikkim) while CISH-P-4 was collected from Ooty (Tamil Nadu). Vegetative growth started from the first week of October in the accessions from North East, whereas, Ooty accession exhibited advanced vegetative growth starting from last week of September. Advanced flowering, fruit set and ripening were observed in the Ooty collection followed by North Eastern accession. Early senescence (3rd week of May) were observed in the Ooty occesion whereas, North Eastern accessions in the 3rd week of June under open conditions.

Fruit yield and quality variations in pepino germplasm

Variation in the collected germplasm was observed under subtropical conditions. Maximum TSS (10.5 °Brix) was recorded in CISH-P-2 followed by CISH-P-3 (9.5 °Brix). CISH-P-4 was short duration crop among the accessions with maximum fruit weight (400 g). Fruit yield was recorded maximum (35.2 t/ha) in CISH-P-2 followed by CISH-P-3 (31.0 t/ha)

Best season variation and growing conditions on principal growth stage (vegetative propagation) of pepino

Semi hardwood cuttings of pepino were subjected to different growing conditions from the month of August onwards under subtropical conditions. It was observed that open and 75 per cent shade net row cover was not effective during the month of August and September because of rainfall, whereas, it exhibited maximum 75 per cent survival under 75 per cent shade net row cover followed by open conditions (80%) during the month of October.

Development of techniques for off season vegetable production in peri urban areas

Among the six high value crops *viz*. tomato, cucumber, capsicum, lettuce, pointed gourd and dolichos bean, two crops pointed gourd and dolichos bean were evaluated for off season production.

Pointed gourd

Twelve genotype/varieties of pointed gourd were evaluated to find out suitable one for the region as well as for Malda area of West Bengal. CISH-P-5 and CISH-P- 3 were found high yielder (3.54 kg and 3.49 kg/plant, respectively). The highest average fruit size was recorded with CISH-P- 4 (65 g) followed by CISH-P- 5 (56 g). Both the genotypes have striped fruit with oval shape green color fruits. Theses genotypes have higher yield over the check variety Kashi Alankar (3.35 kg/plant)

Hybridization

The best consumer preference for pointed gourd is green uniform fruit color with soft and lower seeds, white creamy flesh and regular node bearing habit. The genotype Lucknow-local bears fruit at node but smaller in size. Kashi Alankar and CISH-P-9 have uniform fruit color but lower in yield. Keeping in view the above facts the hybridization work started to find out ideal type of F_1 following crosses have been made to see the heterosis. Seeds of hybrids were extracted and sown in nursery for germination. More than 500 F_1 have been produced and planted for further evalution.

Kashi Alankar	Lucknow Local	Faizabad local	Male
CISH-P-1	CISH-P-2	CISH-P- 3	(Female)
CISH-P-4	CISH-P-5	CISH-P-6	
CISH-P-7	CISH-P-9	CISH-P-11	

Dolichos bean

Twelve genotypes collected from different locations were evaluated to find out the suitability for the region. Among the evaluated genotypes maximum plant height was recorded with CISH-DC-16 and CISH- DC-17 (6 meter). The maximum fruit set percentage with genotype CISH-DC-12 (87.61%). The number of flower/cluster and highest number of pods /cluster was observed with genotype CISH DC-6. Highest pod yield/plant was recorded with CISH-DC-12 (9595 g) followed by CISH-DC-15 (9450 g) and CISH-DC-7 (918 g).

Precision Farming Development Centre (PFDC)

The main activities of the centre include hi-tech horticulture and plasticulture technology development, validation, refinement and technology, dissemination *viz*., micro-irrigation, plastic mulching, greenhouse technology publication of extension literature and organizing workshop and trainings for state government officials and farmers.

Greenhouse production of tomato

Yield and quality of six varieties of tomato *viz*. Himsona, Himshikhar, Cherry tomato (KSP 1113), NS 5007 (1218), Pant-1 and Pant-2 were assessed in polyhouse. Planting was done at a spacing of 60 cm × 45 cm after 4 weeks of sowing.

The recommended cultural practices along with drip irrigation with 2 litres per hour (LPH) discharge on alternate days to provide irrigation 1-2 liter/plant/day was adopted. The plants being indeterminate type were regularly trellised and trained to two stem by removing all side shoots/sucker developing. Application of 250:150:350 kg NPK per hectare in the form of water soluble fertilizers through fertigation at weekly intervals was done.

The temperature and RH per cent inside polyhouse were maintained and remained at optimum levels. The number of fruit/bunch varied from 10-20 and average fruit weight ranged from 90-142 g. The maximum total fruit weight per plant was in Himsona (11.25 kg/plant). Tomato grown inside polyhouse hastened first flowering, fruiting and maturity by about 20 days as compared to open field. Himsona showed the maximum marketable storage period (13 days). The per cent loss of weight (PLW) was maximum in KSP-1113 (15.39%) and lowest in NS-1218 (7.17%) and Himsona (8.52%). Based on different attributes it can be concluded that the variety Himsona, performed better in terms of yield, quality with high lycopene content (3.79-4.09 mg/g FW) even under higher temperature (Fig. 18).

The cultivars Himsona exhibited maximum shelf life (14-17 days) and KSP-1113 showed minimum shelf life (4-6 days) based on visual appearance with low and high PLW in Himsona (8.52%) and KSP-1113 (15.39%) after 20 days of storage at ambient condition. On the other hand, fruits harvested in second week of April had reduced shelf life up to 5-7 days. The lower value of these parameters may be due to high temperature and age of plants. Thus Himsona having optimum quality and maximum marketable shelf life can be recommended for protected cultivation.

The TSS and acidity ratio contributed strongly to the tomato shelf life and consistency. It ranged from 4.1 °Brix in Himsona to maximum (8.1 °Brix) in KSP-1113 (cherry tomato) and the acidity in cultivars ranged between 0.48-0.64 which is desirable traits for shelf life and processing cultivars of tomato. TSS/acidity ratio was in the range of 6.56 to 16.87 being maximum in KSP-1113 and minimum in NS-1218.

The pectin content in red ripe tomato fruit was estimated. The recovery of water soluble and ammonium oxalate soluble pectin was maximum in Himsona (9.02 and 15.76 g/100 g AIS), however, NS-1218 contained maximum amount of alkali soluble pectin (4.72 g/100 g AIS). Interestingly, the pulp of KSP-1113 contains maximum level of alcohol insoluble solids (2.36%) and minimum in NS-1218 (1.35%). Thus, Himsona is better in terms of high amount of water soluble pectin (Table 5).

Table 5. Pectin content in different varieties of tomato

Variety	WE	AOE	AE	AIS(%)
NS 1218	3.85	9.77	4.72	1.35
KSP 1113	4.76	2.70	1.63	2.36
Himshikhar	5.51	12.35	2.94	2.11
Himsona	9.02	15.76	3.91	1.77

Unit for AE, AOE and WE are g/100 g AIS
WE = Water soluble, AOE = Ammonium oxalate soluble, AE = Alkali soluble, AIS = Alcohol insoluble solids

Fig. 18. Tomato crop in polyhouse

Performance of parthenocarpic cucumber under net-house condition

Parthenocarpic cucumber cv. Infinity was grown at a planting distance of 60×45 cm under 50 per cent green shade net house condition and black mulch (100 µ thick) with drip irrigation during December to March. Fruiting started after 30 days of transplantation. Water and nutrients inputs were administered through drip fertigation. The black plastic mulch effectively improves water and fertilizer use efficiency, control weeds and reduces incidence of fruit rot. Yield increment per plant of 8.0-10.0 kg/plant was obtained under mulch as compared to 4-5 kg/plant as compared to control. Weight of individual fruits was in the range of 200-250 g and maximum weight was obtained up to 450 g. Fruit length was in the range of 10-20 cm (Fig. 19).

Fig. 19. Parthenocarpic cucumber cv *Infinity* under nethouse condition

Inter cropping of turmeric in aonla orchard

Tturmeric cv. Rajendra Sonia was grown as intercrop in aonla orchard to evaluate the effects of black polyethylene mulching (100 µ) on the growth, yield and recovery of curcumin content and compared with control (unmulched). Both the main as well as inter crops with and without mulch were maintained under uniform cultural practices including irrigation and fertigation. Perusal of data revealed that the plant height increased significantly with black mulching but number of leaves and tillers did not respond clearly with the mulching. Turmeric yield were the highest (1.0 kg/plant) with mulching and its value was recorded lowest in control. The recovery of the curcumin content was more (5.9%) in those plants which were grown under mulching condition. Its recovery was low in control (without mulch). This indicates that black polyethylene mulching provides conducive environment and proper uptake of nutrient to enhance the quality and yield of turmeric (Fig. 20).

Fig. 20. Intercropping of turmeric in Aonla

Vegetable cultivation under drip irrigation and colour mulching

Cultivation of cauliflower cv. Girija, cabbage cv. Green flash (NS-22), red cabbage, broccoli cv. Festival, parthenocarpic cucumber cv. Infinity was undertaken to evaluate the efficacy of different irrigation schedule (1.0, 0.8, 0.6, 0.4 OPE) with black polyethylene mulching on their yield performance. The furrow irrigation with and without mulching was taken as control. An increased yield of cauliflower in the tune of 60 ton ha^{-1} with average individual curd weight 1.60 kg/plant was recorded at 60 per cent OPE + mulching as compared to minimum yield 50 ton ha^{-1} with minimum individual curd weight (1.0 kg/plant) in furrow irrigation without mulching. On the other hand cabbage (green and red) and broccoli performed better at 80 per cent OPE with black polyethylene mulching as indicated by 50.0 and 40.5 t/ha yield with maximum head weight of 2.2-2.5 kg/plant and 0.67-0.75 kg/plant respectively. Reduced yield (45.3 and 38.5 t/ha) with low quality in term of average head weight (1.0 and 0.25 kg/plant) were recorded in furrow irrigation without mulch in corresponding crops. On the contrary, reduced yield with comparatively low quality in case of unmulched control *viz.* 48.3, 45.5, 50.4 & 40.5 t/ha in corresponding crops, were recorded (Fig. 21).

Broccoli Cabbage Cauliflower

Fig. 21. Vegetable production under drip irrigation and coloured mulching

Performance of high density guava under different irrigation regimes

In guava cv. CISH-Lalit under high density plantation (3×6 m spacing), the shoots were pruned at 50 per cent of their length in the month of May and concurrent pruning was practiced in the month of October. The trees were exposed with different irrigation schedule *viz.*, 1.0 volume of water to 0.6 volume of water with and without mulch and control was taken as conventional irrigation with and without mulch. The flower bud differentiation and flowering pattern was monitored. Maximum flowering percent to the tune of 87 per cent were observed with the application of 0.8 volume of water. The minimum flowering was recorded in conventional basin irrigation without mulch. The maximum yield (22.5 kg/plant) was recorded in 0.8 volume of water with mulch and minimum in control without mulch. The average individual fruit weight was in the range of 150-200 g/fruit. The quality attributes in terms of TSS (13.4 °Brix) and TSS/acidity ratio (55.8 %) were also recorded maximum in the same treatment. Thus application of appropriate irrigation with black polyethylene mulch can enhance the yield and quality of guava (Fig. 22).

Fig. 22. Performance of guava cv. CISH-Lalit under 3×6 spacing

Performance of mango cv. Dashehari under different canopy shape

Performance of mango cv. Dashehari under different canopy shape was evaluated for flowering and fruiting pattern besides change in light distribution pattern, leaf area index and variation in gas exchange parameters at different phenological stages. Drip irrigation system with four drippers of 4 LPH along with recommended dose of fertilizer was given. On perusal of the data, the yield under different canopy shapes viz. centre open (55 kg/tree), flat top (48.5 kg/tree), conical (39.4 kg/tree), control (32.6 kg/tree) was recorded. The TSS 20.9-24.7 °Brix and acidity in range of 2.0-2.4 per cent was observed in different canopy shapes at maturity stage. This is record increase in TSS during this year of crop over previous years. There were significant changes in light distribution pattern among different shapes with maximum LAI in flat top followed by conical shape and center open system. Maximum flowering with 'A' grade fruits (31.0%) were observed in center open + 80% recommended dose of irrigation followed by flat top (26.0%) and conical shapes (22.0%). The data also revealed that increased flowering (30-35%) was recorded in drip irrigation with mulching as compared to control plants. Interestingly among the different shape of canopy the flat top shape exhibited maximum (80%) vegetative flushing resulted low flowering during this year.

Crop Protection

MANGO (*Mangifera indica* L.)

Population dynamics of fruit flies

Mango fruit fly population was observed throughout the year by using methyl eugenol based para pheromone trap. The peak fruit fly population in trap was recorded in the 19th SMW (Second fortnight of May 2017) with 211.2 fruit flies/trap/week (Fig. 23). The trap catch of mango fruit fly was positively influenced by minimum temperature (r = 0.77**) and evaporation (r = 0.72**). All the weather parameters together had explained 77 per cent variation in the trap catches. Whereas minimum temperature and evaporation had explained 66 per cent variation in the fruit fly catches. Based on the significant weather factors influencing the trap catches, weather based regression model was developed as y = 3.33 (Tmin) + 5.83 (Evp) – 51.43 (R^2=0.66**) to predict the trap catches of mango fruit fly.

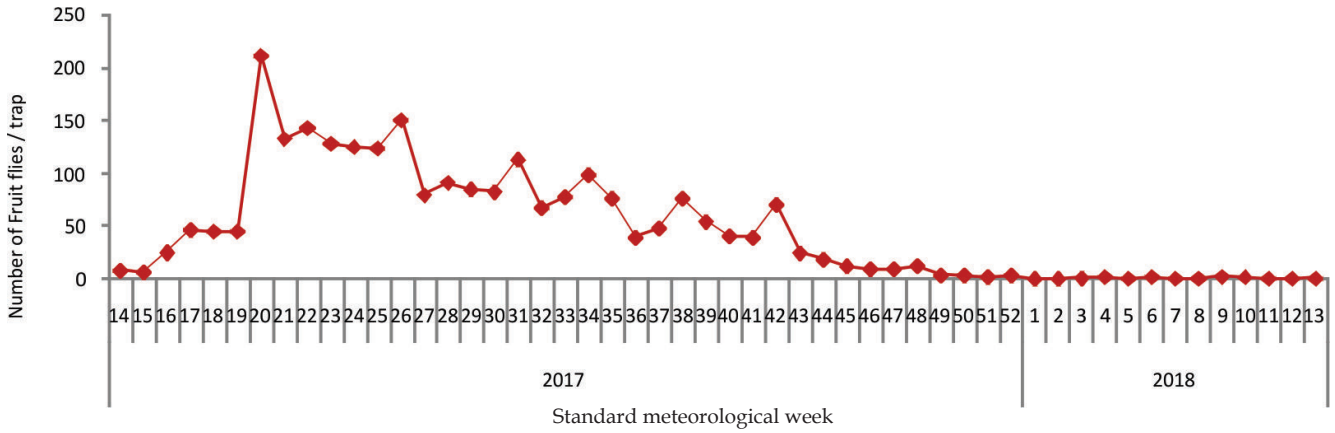


Fig. 23. Mean number of fruit flies caught/trap/week in mango orchards

Population dynamics of hopper

Mango hopper population was observed throughout the year in the CISH Rehmankhera farm. During panicle emergence and flowering period peak hopper population (7.3 hoppers/ panicle) was recorded during 20th SMW (Fig. 24). *Idioscopus nitidulus* was the major hopper species observed. During the off season peak hopper population (13.4 hoppers/sweep) was recorded during 48th SMW and the species observed was *Amritodus atkinsoni*.

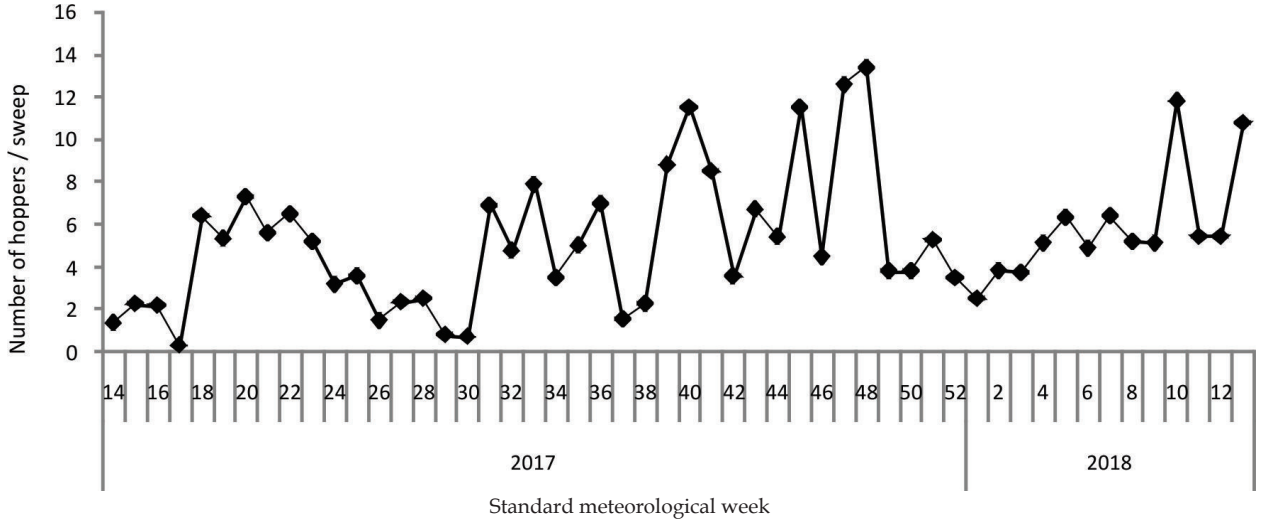


Fig. 24. Mean number of hoppers/panicle or sweep in mango orchards

Population dynamics of leaf webber

The infestation of mango leaf webber was observed during 28th to 52nd SMW. Peak infestation was recorded during 43rd and 45th SMW with 8.1 and 7.55 fresh webs formed during the week/tree (Fig. 25). The leaf webber incidence was negatively influenced by the minimum temperature (r = -0.435) and wind speed (r = - 0.564).

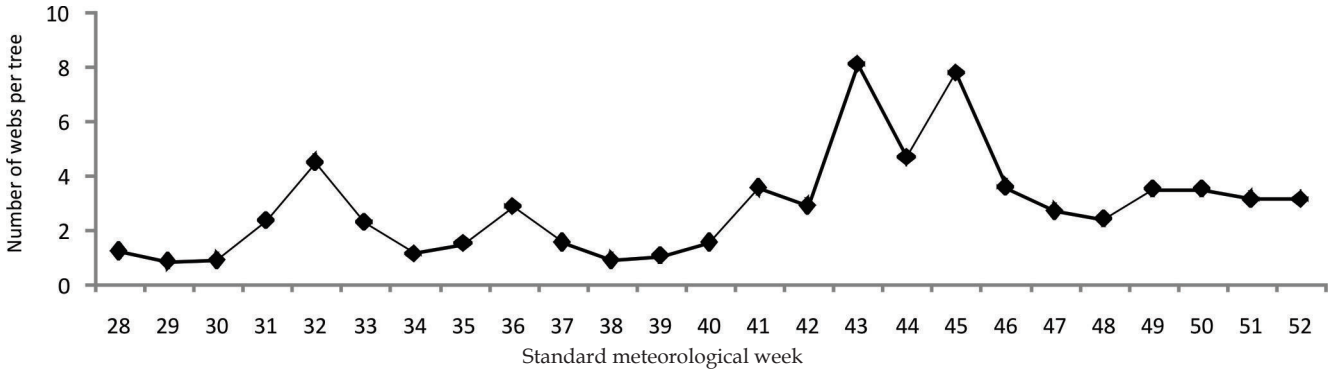


Fig. 25. Mean number of webs formed during the week /tree in mango orchards

Standardization of artificial diet for fruit borer

Mango powder based artificial diet was standardized for mango fruit borers. On this diet fruit borer completed its lifecycle in 22 days with 13.2 days of larval period and 8 days of pupal period. Adults were alive for 2-3 days.

Base line susceptibility of insecticides for leaf webber

Base line susceptibility for mango leaf webber against insecticides was studied by leaf dip bio-assay. The LD_{50} for quinalphos, profenophos and indoxacarb was 25.59, 34.40 and 8.46 ppm, respectively.

Management of mango hopper with insecticides

Field efficacy of newer insecticides was tested against mango hopper at panicle development stages. The significant difference was observed among the treatments with respect the reduction in the hopper population at 3 days after spraying (DAS) ($F_{7, 112} = 20.78$; $p<0.00$) and 7 DAS ($F_{7, 112} = 5.27$); $p<0.00$). Among all the treatments Imidacloprid 17.6 SL, Fipronil 5 SC and neem oil has reduced the hopper population up to 89.4, 78.21 and 86.2 per cent respectively (Table 6). Spraying of these insecticides at the panicle emergence stage of the crop will help in effective management of the hopper population.

Table 6. Field efficacy of insecticides against mango hopper during the year 2017

Treatments	Mango hopper population (number/panicle)			Yield (kg/tree)
	Pre	3 DAS	7 DAS	
Imidacloprid 17.6 SL	13.47 (4.14)	10.00^{b} (3.6)	5.73^{a} (2.86)	88.00^{c}
Thiamethoxam 25 WG	12.27 (3.98)	8.8^{ab} (3.35)	6.53^{ab} (3.00)	39.73^{a}
Thiacloprid	15.07 (4.35)	9.53^{b} (3.53)	10.46^{c} (3.67)	47.8^{ab}
Quinalphos 25 EC	13.00 (4.08)	6.6^{ab} (2.43)	10.20^{bc} (3.62)	47.30^{ab}
Fipronil 5SC	13.13 (4.11)	8.6^{ab} (3.07)	6.06^{a} (2.89)	87.9^{c}
Neem oil	12.93 (4.08)	3.60^{a} (1.97)	5.80^{a} (2.63)	72.8^{bc}
Profenophos 50 EC	11.07 (3.79)	4.73^{ab} (2.59)	8.33^{abc} (3.19)	43.53^{a}
Control	11.80 (3.90)	28.86^{c} (5.28)	10.80^{c} (3.73)	30.33^{a}
F (7, 112)	NS	20.78**	5.27**	
LSD (0.01)	NS	1.50	1.07	

DAS-days after spray; Values in the parenthesis represents square root transformed values $\sqrt{x+0.5}$

Evaluation of newer insecticides against mango thrips

Field efficacy of newer insecticides was tested against mango thrips during April, 2017. The significant difference was observed among the treatments with respect the reduction in the thrips population at 3 days after spraying (DAS) (F5, 84 = 36.00; p<0.00), 7 DAS (F7, 84 = 21.85); p<0.00) and 14 DAS (F7, 84 = 15.86); p<0.00). Among all the treatments neem oil was found superior followed by Fipronil 5 SC and Thiomethoxam 25WG. Spraying of neem oil, Fipronil and Thiomethoxam reduced the thrips incidence up to 90.0, 82.2 and 72.9 per cent, respectively. Minimum per cent fruit damage by the thrips was found in neem spray (Table 7).

Table 7. Efficacy of newer insecticides against mango thrips during the year 2017

Treatments	Thrips population (number/tap)				Fruit damage (%)	Yield (kg/tree)
	Pre count	3 DAS	7 DAS	14 DAS		
Imidacloprid 17.6% SL	35.06 (6.19)	24.4^{c} (5.24)	13.53^{ab} (4.11)	6.00^{cd} (2.86)	33.30^{bc}	50.00^{ab}
Thiamethoxam 25% WG	30.93 (5.85)	15.46^{bc} (4.36)	18.93^{b} (4.77)	2.33^{ab} (1.69)	23.00^{ab}	73.06^{bc}
Thiacloprid	38.6 (6.52)	12.53^{ab} (3.86)	15^{ab} (4.32)	4.26^{bc} (2.25)	38.00^{bc}	32.8^{ab}
Fipronil 5% SC	34.4 (6.24)	3.26^{a} (2.13)	9.93^{a} (3.56)	1.53^{ab} (1.37)	34.33^{bc}	86.4^{c}
Neem oil (0.3%)	47.2 (7.10)	26.73^{c} (5.42)	8.46^{a} (3.32)	0.86^{a} (1.05)	12.00^{a}	32.8^{ab}
Control	41.06 (6.77)	53.06^{d} (7.71)	35.93^{c} (6.33)	8.6^{d} (3.36)	43.30^{c}	25.2^{a}
F (5, 84)	NS	36.00**	21.85**	15.86**	6.60**	6.84**
LSD (0.01)	NS	3.28	2.45	0.85	5.05	4.85

DAS-days after spray; Values in the parenthesis represents square root transformed values √x+0.5

Diseases

Prevalence and severity of shoulder browning

Surveys were conducted in and around Lucknow during June to August, 2017 and severe incidence of shoulder browning was recorded in most of the districts (Fig. 26). Disease incidence was recorded between 45 to 75 per cent with the severity between 9.5 to 32.8 PDI in Lucknow, Sitapur, Barabanki and Unnao districts during first fortnight of July. Highest incidence of shoulder browning was recorded as 100 per cent with severity up to 74.5 PDI during end of July at CISH, Rehmankhera on cv. Mallika. Development of disease was observed to be directly proportional to cumulative rainfall and number of rainy days (Fig. 27).

Fig. 26. Symptoms of shoulder browning on mango fruit

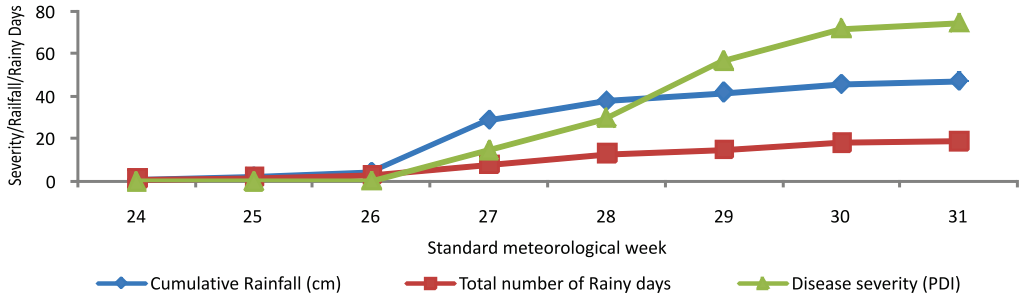


Fig. 27. Severity of shoulder browning in relation to rain during July and August 2017

Prevalence and severity of powdery mildew

Incidence of powdery mildew disease of mango was recorded in different districts around Lucknow and in fixed orchards located in Kakori, Malihabad, Mall blocks and CISH Farm at Rehmankhera. Peak average disease severity (PDI 0.98) was recorded during 13th SMW in fixed plots. In roving survey, incidence was recorded up to 90 per cent and severity up to 58.5 PDI in Unnao district during 12th SMW (Fig. 28). Dry weather and sudden fluctuations in temperature during the month of March adversely affected the crop as well as the disease. Overall decreased incidence and severity of powdery mildew have been recorded for two consecutive years as compared to previous years.

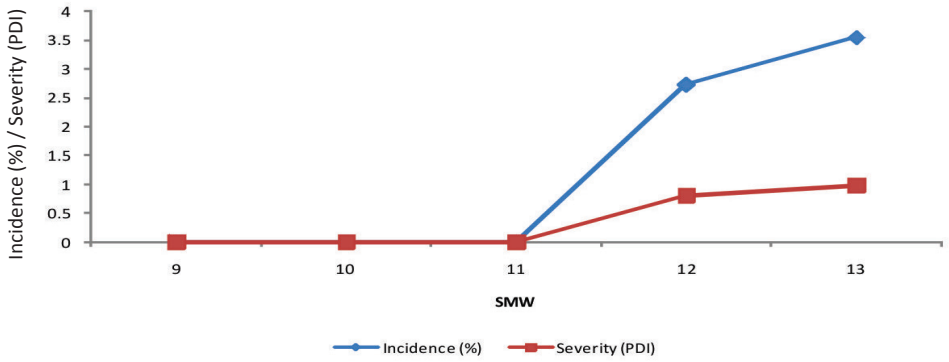


Fig. 28. Incidence and severity of powdery mildew during 2018

Prevalence and severity of blossom blight

Initial symptoms of blossom blight were observed on emerging panicles during 5th and 6th SMW. However, its incidence was rarely observed on panicles and almost no damage was caused during 2018 flowering season (Fig. 29). No rain was recorded during February and March 2018, which resulted in dry weather conditions with bright sunshine, so severity of the disease remained at negligible level (<1%).

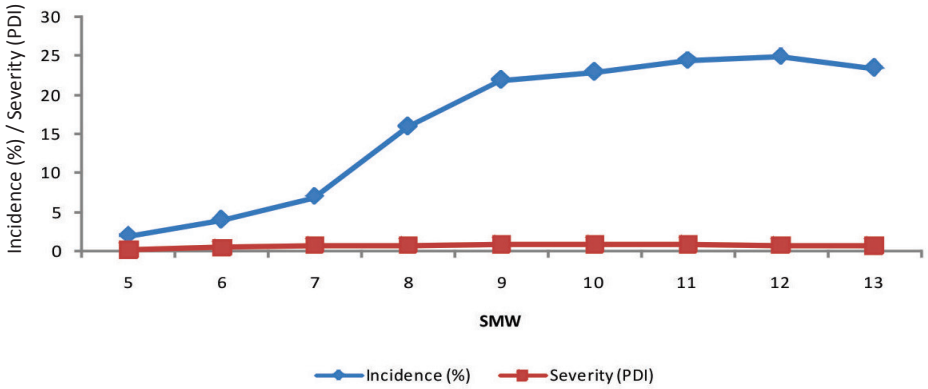


Fig. 29. Incidence and severity of blossom blight during 2018

Prevalence and severity of anthracnose

Leaf anthracnose incidence fluctuated between 28.0-33.6 per cent and severity ranged between 17.66 to 27.53 PDI during 2017-18 in fixed plots (Fig. 30). Much higher variations were recorded in orchards during roving survey. Some of the orchards were very well managed and had severity below 10 PDI and the other uncared had over 40.0 PDI. Anthracnose development continued during July to November 2017 on new flushes and later during the months of February and March 2018. Decrease in disease during March was due to shedding of severely infected leaves.

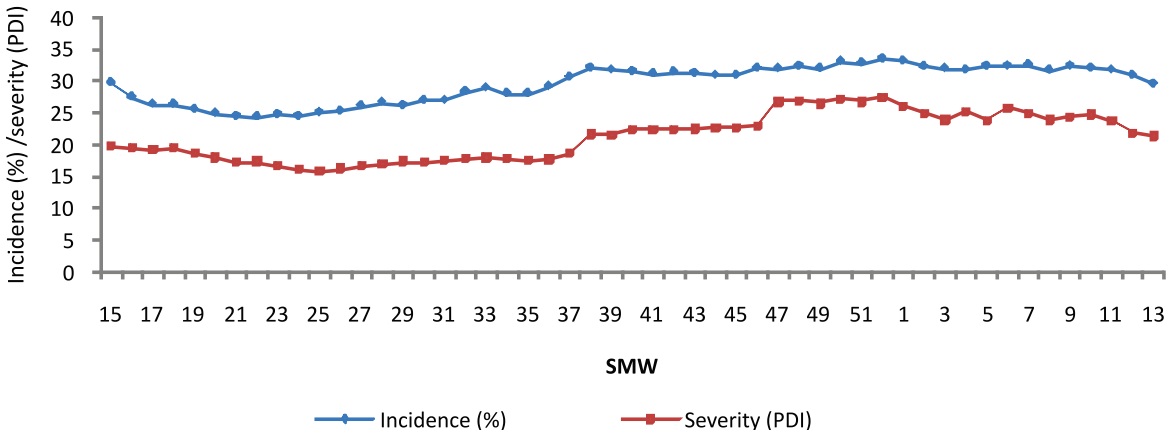


Fig. 30. Incidence and severity of anthracnose during 2017-18

Prevalence and severity of wilt/decline

Survey for assessment of incidence of wilt and decline disease of mango was carried out in and around Lucknow and it was found in severe form in 26 year old Dashehari orchards at Shailamau, Malihabad, Lucknow and near Dhyodhi Bazar, Sohawal (Faizabad) and in a 75 year old Chausa orchard near Sitapur (Fig. 31). Besides, few wilted trees were also observed at several locations in Unnao, Lucknow, Sitapur, Barabanki and Pratapgarh districts.

Fig. 31. Incidence of decline and wilt of mango

Development of bio-pesticides formulation

Organic bio-pesticide formulation containing CISH-*Trichoderma* spore count above standard ($10^6 g^{-1}$) was developed. Its composition was finalized after evaluation of different ratios of compost, plant product and carbohydrate. The mixture was prepared, moistened, sterilized and inoculated with CISH-*Trichoderma*. On the basis of fastest growth, earliest sporulation and highest spore count, one composition was finalized for production of bio-pesticide formulation which is under testing prior its commercial production.

Laboratory evaluation of bio-pesticides against *Ceratocystis fimbriata*

Since, no bio-control options are available for the management of mango wilt, efforts were initiated in this direction. Culture filtrate of *Trichoderma harzianum* ICAR-CISH-12 strain completely suppressed the growth of *C. fimbriata*. Work regarding standardization of protocol and concentration is in progress. Neem, tobacco and mango leaf extracts were also evaluated against *C. fimbriata* but none was found effective after sterilization. However, fungi associated with those leaves, came in extract, completely suppressed growth of *C. fimbriata* in cultures (Fig. 32, Table 8). Such fungi are purified for utilization in further bio-control research.

Table 8. Effect of treatments on radial growth of *Ceratocystis fimbriata* at 3rd and 15th day after inoculation.

S. No.	Treatments	Growth of C.f. (15th day)
1	Control	61.0
2	Neem leaf extract sterilized	66.6
3	Neem cake extract sterilized	66.2
4	Mango leaf extract sterilized	74.6
5	Tobacco leaf extract sterilized	66.8
6	Trichoderma culture filtrate sterilized	0.0
7	Thiophanate methyl	0.0
8	Neem leaf extract unsterilized	Invisible
9	Neem cake extract unsterilized	Invisible
10	Mango leaf extract unsterilized	52.8
11	Tobacco leaf extract unsterilized	Invisible
12	Trichoderma culture filtrate unsterilized	Invisible

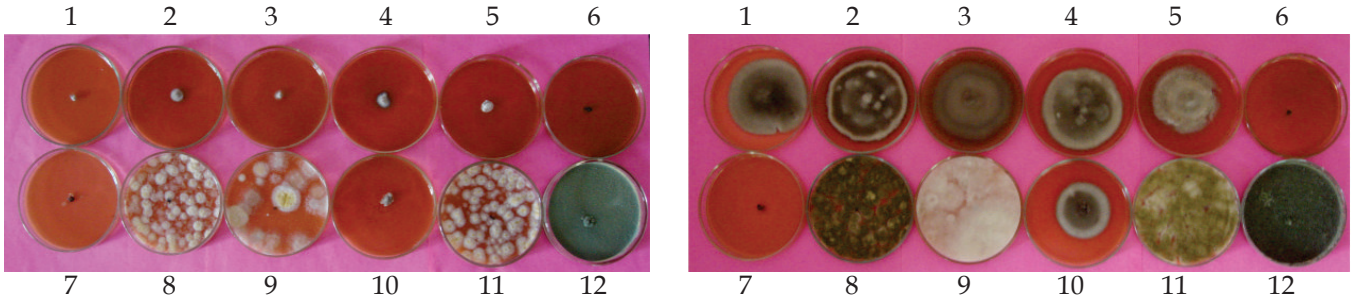


Fig. 32. Laboratory evaluation of bio-pesticides against *C. fimbriata* (Treatment Numbers are as in Table 8)

Evaluation of colonization by CISH *Trichoderma* in compost

General recommendation of application of bio-agent-enriched compost including farm yard manure for the management of soil borne pathogens, particularly guava wilt was revisited. Keeping in view that any organic matter decomposed under natural process is colonized by some fungi and bacteria. If we introduce any bio-agent to it, there is poor chance of colonization by the introduced one. The same was tested under laboratory conditions under unsterilized and sterilized conditions of compost samples collected from four different villages of Lucknow and Unnao districts. Complete colonization of sterilized compost by CISH-*Trichoderma* was observed within 62 to 70 hours and sporulation within 6-7 days (Fig. 33). Fungal growth was also observed in unsterilized compost but there was no sporulation of CISH-*Trichoderma,* which indicated that CISH-*Trichoderma* could not colonize it. Fungi grown in unsterilized compost were isolated, pure cultures of two of them were developed. Further test of interaction of compost fungi with CISH-*Trichoderma* indicated suppression of CISH-*Trichoderma* (Fig. 34).

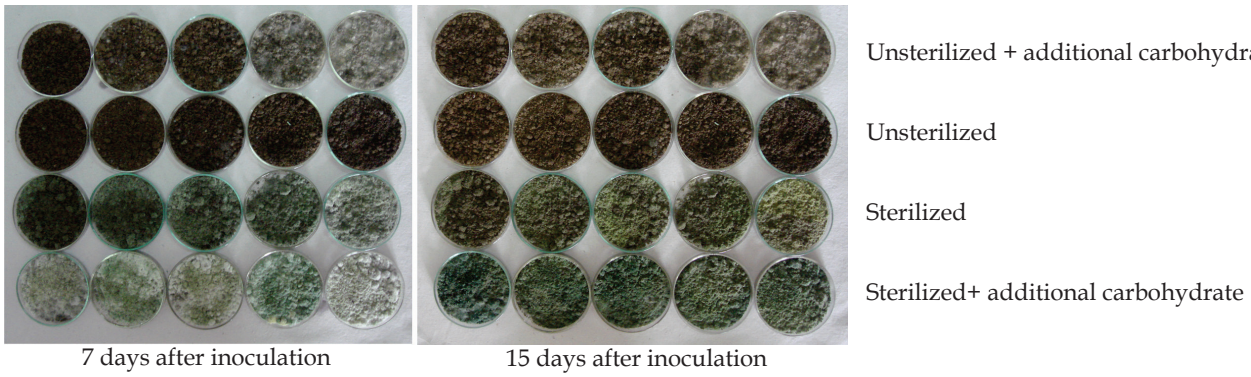


Fig. 33. Colonization of CISH-*Trichoderma* in five compost samples

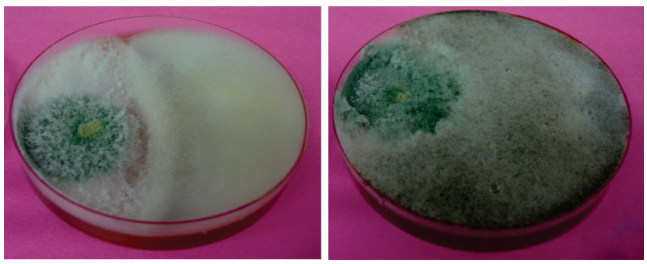


Fig. 34. Suppression of CISH-*Trichoderma* by the fungi isolated from compost

Multi-location trials for the management of mango wilt/decline

Trees exhibiting typical initial symptoms of *Ceratocystis* wilt or decline were treated with suitable management schedules during 2015 to 2017 (Table 9) and sensitization programmes were also organized at different locations (Fig. 35).

Management schedules applied were-

1. Thiophanate methyl as soil drench @ 150g/tree and spray with propiconazole @ 0.1%.
2. Thiophanate methyl as soil drench @ 150g/tree and spray with carbendazim @ 0.1%.
3. Carbendazim as soil drench @ 150g/tree and spray with propiconazole @ 0.1%.
4. Trunk injection @ 5 g thiophanate methyl dissolved in 20 ml of water/hole along with soil drench @ 150g/tree and spray with carbendazim @ 0.1%.
5. Treatment schedule repeated as such after 1 year.
6. Soil drench treatment of thiophanate methyl @ 50 g repeated after 1 year.

Table 9. Multi-location trials for the management of mango wilt/Decline

Location	Age of orchard (Year)	Management schedule applied	Year of application	No. of treated trees	No. of recovered trees
Rehmankhera, Lucknow	30	1 and 5	2015	6	4
Pipari, Lucknow	25	1 and 5	2016	9	4
Bilauna, Aligarh	26	1, 2, 3 and 5	2015	30	28
Patarsa, Kanpur nagar	27	1 and 5	2014	3	3
Unchagaon, Bulandshahar	64	4 and 6	2015	3	3
Sitapur	80	1	2017	1	1
Sohawal, Faizabad	35	1	2017	50	46
Sahilamau, Lucknow	28	2	2017	2	1
Total				104	90

Fig. 35. Sensitization programmes at Bulandshahar and Aligarh for management of *C. fimbriata*

GUAVA (*Psidium guajava* L.)

Population dynamics of fruit flies

Guava fruit fly population was observed throughout the year by using methyl eugenol based para pheromone trap. The peak fruit fly population was recorded in the 33rd SMW (Second fortnight of August 2017) with 331.2 fruit flies/trap/week (Fig. 36). The trap catch of guava fruit fly was positively influenced by minimum temperature (r = 0.64**) and minimum relative humidity (r = 0.55**). All the weather parameters together explained 60 per cent variation in the trap catches. Whereas minimum temperature and minimum relative humidity had explained 55 per cent variation in the fruit fly catches. Based on the significant weather factors influencing the trap catches weather based regression model was developed as y = 5.55 (Tmin) + 2.36 (RHmin) - 144.3 (R^2=0.55**) to predict the trap catches of guava fruit fly.

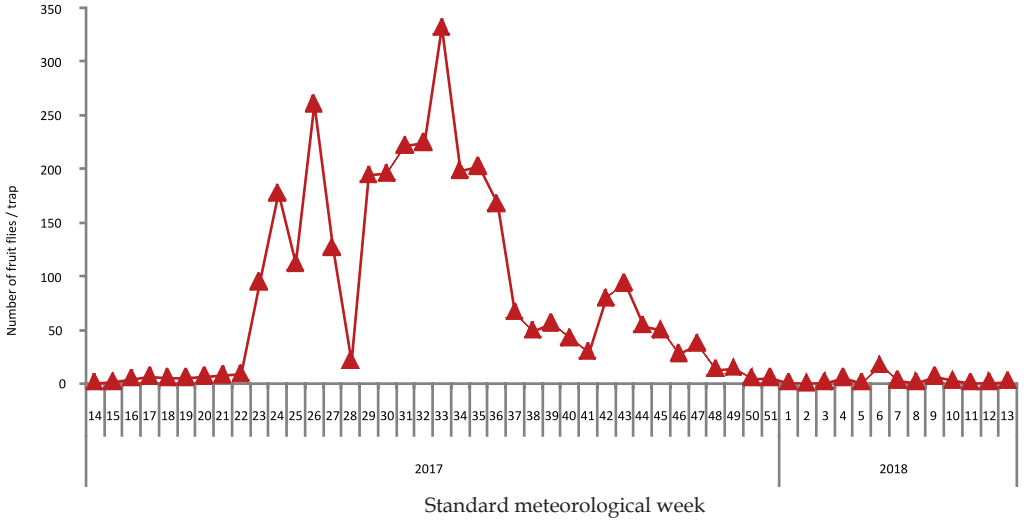


Fig. 36. Population dynamics of guava fruit flies at Rehmankhera, Lucknow during the year 2017-18.

Molecular identification of nematode

Primer designed to amplify conserved regions of mitochondrial repeats, were tested for their potential to identify *Meloidogyne* spp. isolated from roots of wilt affected guava plant. We got a single band of 322 bp with 63 VNL-VTH gene, sequencing and BLASTn analysis of which identified as *Meloidogyne enterolobii* with 90 per cent query coverage and 96 per cent identity (Fig. 37). The nucleotide sequences were submitted in NCBI Gene bank with their accession numbers are MG839108, MG839109, MG839110, MG839111. Based on the molecular characterization population of root-knot nematode collected from guava orchards / nurseries located in Badaun, Farrukhabad, Etah (U.P.) and Sawai Madhopur was confirmed as *M. enterolobii*.

Fig. 37. Gel picture depicting amplicon produced with primer 63 VNL-VTH(322 bp).

Occurrence of root-knot nematode and *Fusarium oxysporum* in nurseries/orchards and role of nurseries in spread of root-knot nematode

Survey conducted across the guava cultivation belt covering three states including Rajasthan, Madhya Pradesh and Gujrat brought to fore an interesting dynamics of prevalence of root-knot nematode in the old and new orchards involving the infested nurseries and supply of infested grafts coupled with gradual realization amongst the orchardist about the impending dangers of rather fast spread of its infestation in new orchards only. Infection of *Fusarium oxysporum* in roots of guava plants was recorded in 75-95 per cent orchards at various locations.

Occurrence of root-knot nematode in nursery and orchards of Rajasthan

Comparative analysis of the data revealed that out of 20 orchards surveyed in seven district of Rajasthan *viz.*, Bharatpur, Gangapur City, Swai Madhopur, Dosa, Tonk, Kota, Chittorgarh, Pratapgarh and Banswara, newly established four orchards were found infested in Bharatpur, Dosa, Tonk and Kota only. Problem of severity of nemic infestation was found further exacerbated in Bharatpur district where the orchard interspaces were used for intercropping of vegetables like tomato and brinjal which also displayed severe galling. Incidentally the chickpea and wheat crop grown in the field did not display infestation of root-knot nematode. Orchards located in Tonk district were raised on reclaimed land without any past history of nematode infestation. All the guava varieties planted in Tonk were found infected with nematode at varying degree of extent. The planting material for the orchards was acquired from different nurseries located at Lucknow, Udaipur and Hissar. Old and established orchards (5-20 year old) located in Bharatpur and Chittorgarh districts were found free from infestation of root-knot nematode despite cultivation of vegetables. One nursery and a 12 years old orchard located at KVK farm, Banswara also had root-knot nematode infestation. On the other hand one orchard at Thakerea (Banswara) did not displayed the root- knot infestation.

Occurrence of root-knot nematode in nursery and orchards located in Madhya Pradesh

Six districts *viz.* Neemuch, Dhar, Seohar, Bhopal, Vidisha and Sagar were surveyed. Three orchards (2-8 years old) located in Neemuch district were found free from infestation of root-knot nematode. By and large the orchards were found healthy displaying only marginal infestation of bark eating caterpillar and negligible incidence of typical fungus induced wilt. Out of three orchards surveyed in Dhar district (Bagh, Tirla, Gunawad), only one orchard of seven years age in Bagh locality exhibited root-knot nematode infestation on the main plants as well as slips. Intercrops including tomato and okra also exhibited knots on the roots. Planting material used for the raising the orchard was acquired district nursery which too seems to have been infested.

Samples collected from Sehore district revealed the root-knot nematode infestation irrespective of varieties. Incidentally the plants for the orchard were also acquired over a period of spanning 4-5 years from one private nursery located in Varanasi and the other one located in Lucknow which of late has emerged as the major hub of guava nursery. Samples collected from the orchards located in the other to district *viz.*, Vidisha and Sagar did not exhibit the infestation of root-knot nematode. Guava plants grown in kitchen garden, homestead located Santrampur were found free from the infestation of root-knot nematode.

Integrated Management of root-knot nematode

Influence of carbofuran (25 g), Thiophanate methyl (25 g), CISH *Trichoderma harzianum* formulation (25 g) and neem cake (250 g) alone and in combinations on infection of *Fusarium oxysporum* in roots, nematode population build-up and growth of grafts planted in infested field was studied in nurseries at Malihabad. Data recorded on initial population revealed a very low population density of nematode in the field. Soil population (g^{-1}) of *Meloidogyne* sp., *Hoplolaimus* sp., *Helicotylenchus dihystera*, *Rotylenchulus reniformis*, *Pratylenchus* sp.,

Tylenchorhynchus sp. other Tylenchids and Dorylaimids ranged between 0-2, 1-2, 0-1, 5-6, 0, 1-2, 0-1 and 0-2, respectively in one plot. The corresponding figures in the second plot were 1-2, 0-1, 0-2, 1-2, 0-1, 0-2, 0 and 0-3, respectively. Roots of 65 per cent grafts were free of fungal infection.

Data on the soil population recorded after seven months revealed a relatively low population of nematode genera in general and *Meloidogyne* sp. in particular, both in treated and untreated plots. Population of second stage juveniles was high (12 per 50 g soil) in untreated. Maximum population reduction was noticed in the plants treated with Carbofuron, Thiophanate methyl, *T. harzianum* and neem cake for only one second stage juvenile was recorded from the soil. All the plants subjected to various treatment schedule by and large had relatively low population of all nematode but it was particularly very low (3 only) in the plants treated with Carbofuron, Thiophanate methyl, *T. harzianum* and neem cake in comparison to untreated ones (22).

Spread of root-knot nematode in the nursery on account of non adoption of good nursery practices

Investigation based on the comparative data and empirical observations revealed that certain nurseries following good nursery practices had prevalence (g^{-1} soil) of ecto parasitic nematode including *Helicotylenchus dihystera* (0-2), *Hoplolaimus indicus* (4-6), *Tylenchorhynchus* sp., *Pratylenchus* sp. (0-1) and *Rotylenchulus reniformis* (3-8) but were found free from root-knot nematode infestation. On the other hand, small land holders supplying planting material to the nurseries had higher incidence (3-4 RKI) of root-knot nematode (Fig. 38). Population of larvae was also retrieved from the channels (2-5 juveniles) supplying irrigation water to bed, polybags stacked under the tree (1-3 Juveniles), beds having plants (0-1), water pipes (0-1) and the water stagnating other around stacks of grafts or bed (0-1)

A B C D E

Fig. 38. (A) Good Nursery Practices (GNP) followed (B to E) GNP not followed

Development and testing of computer software for fast and automatic measurement of leaf length, width and aspect ratio.

A software-'**QuickLeaf_LW**' has been developed in Matlab for quick and automatic measurement of the length, width and aspect ratio of leaves using scanned images (Fig. 39). The software is modified for batch processing of the images, so it works fast & processes several images in batch mode. During execution, it needs minimum user interaction; thereby it is very fast and work in automatic mode. It can be used to measure length, width and aspect ratio (ratio of length to width). It is further modified to produce the output result in MS Excel file, which further make compilation and/or presentation of result more convenient.

The software was tested for accuracy of measurement using green leaves of mango, guava, *Hibiscus* and jamun (Fig. 40). The test result revealed that RMSE for measurement of length, width and aspect ratio are 0.421, 0.19 and 0.122, respectively. Similarly, R^2 value for measurement of length, width and aspect ratio were 0.991, 0.992 and 0.982, respectively.

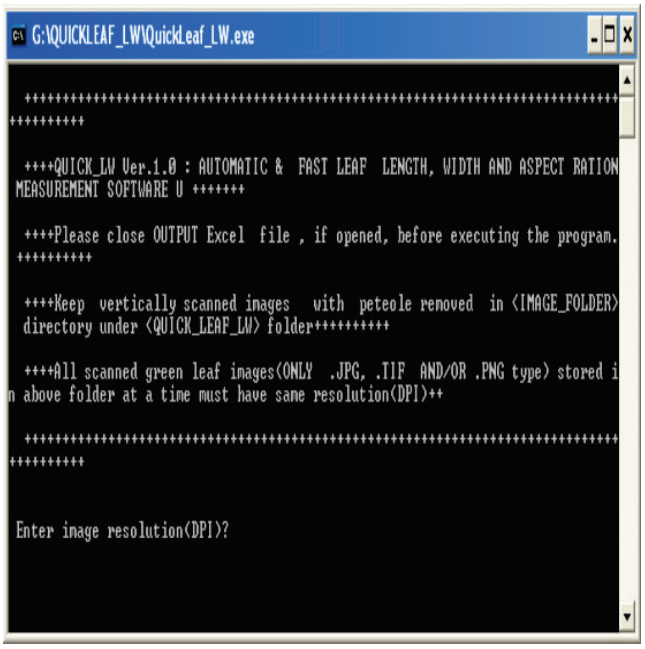


Fig. 39. Snapshot of QuickLeaf_LW software for automatic leaf length, width and aspect ratio measurement

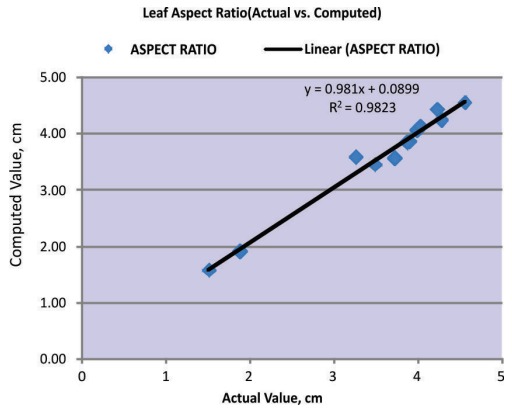


Fig. 40. Scatter plot of actual vs. computed values of Aspect Ratio of leaves

Refinement and testing of software for measurement of leaf area

The leaf area measurement software 'QuickLeafArea' developed during last year has been refined and tested. Testing of leaves of different colors, it was found that the area measured was less than actual area for red coloured leaves. In order to correct this problem, the software code was revised and image filtering was introduced. Furthermore, edge detection was also adjusted to improve the image segmentation so that after segmenting the leaf, the pixels of whole leaf region becomes 'ON'. The software was tested using 18 different types of leaves and it was found that the error rate in leaf area is 0.786 and R^2 is 0.999. Therefore, the error rate is less than 1.0 and Pearson Correlation coefficient is around 1.0 (Fig. 41).

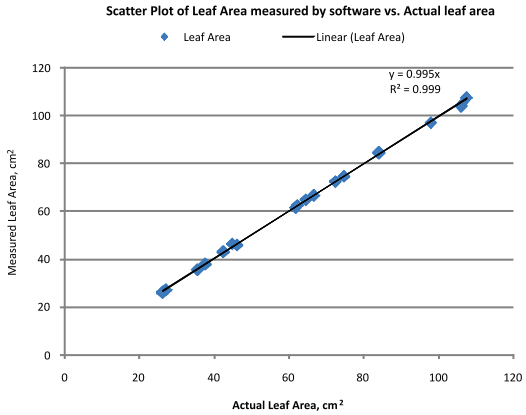


Fig. 41. Scatter plot of leaf area measured by software vs. actual leaf area

Refinement and testing the software for quantitative assessment of damage caused by leaf spot diseases

The software was refined to increase the accuracy of measurement. Linear filter was included for smoothen the damaged image in order to increase the measurement accuracy**.** It is seen that generally the sharpness of the leaf portion damaged by the diseases is not very even/ smooth, which may affect the accuracy of damaged area measurement. Hence, the software is refined to increase the sharpness of leaf. The software was further refined to take the input leaves images in batch mode, calculate the output and then export the output in MS Excel® file

National Innovations in Climate Resilient Agriculture (NICRA) project *"Understanding the changes in host pest interactions and dynamics in mango under climate change scenario"*

Real time pest surveillance of insect pests and diseases was done in 20 selected orchards in Lucknow district and two protected and unprotected orchards at CISH, Rehmankhera. Roving survey in 8 orchards every week was also carried out in Lucknow, Barabanki, Unnao, Sitapur, Faizabad, Raebarelly, Kanpur and Pratapgarh districts of Uttar Pradesh; Bharatpur, Sawai Madhopur, Kota and Bansawara districts of Rajasthan; Godhara in Gujarat and in Raisen district of Madhya Pradesh. In Bharatpur and Sawai Madhopur districts hopper, mealybug, thrips, webber, shoot borer, red ants and shoot gall psylla were not found, whereas, in Kota district of Rajasthan hopper population was recorded up to 2.2 per sweep.

Incidence (8-18%) and severity (1.5-11.5 PDI) of powdery mildew was recorded in Kota, Godhara and Raisen districts during first week of February. Its peak incidence around Lucknow was observed in a range between 2-82 per cent, averaging 52 per cent and severity was recorded up to 58.5 PDI, with average 31.5 PDI during 13th SMW.

In and around Lucknow, hopper was not enough suppressed during winter as the minimum temperature was never recorded <5 ºC this year. Hopper population ranged between 0.4 to 1.0 per sweep during January 2018, as a result of which its population build up during February and March was high and despite management efforts it could cause economic losses to crop.

Maximum incidence of anthracnose was recorded 62.0 per cent with severity up to 44.6 PDI. In general, incidence of bacterial blight was recorded moderate but maximum incidence of was recorded up to 52.0 per cent with severity up to 19.5 PDI. Maximum incidence of sooty moulds was recorded up to 74.4 per cent with severity up to 48.5 PDI and it has been commonly high in about 50 per cent orchards surveyed.

Mango thrips incidence was observed severe during 40th to 46th SMW (2017) and during 11th to 13nd SMW (2018). The peak incidence of the pest was recorded during 11th and 12th SMW (2018) with average population 1.15 thrips/tap in fixed plots and 10.33 thrips/tap in roving survey. Thrips population was found positively correlated with the maximum temperature (r = 0.510), sunshine hour (r = 0.716), wind speed (r = 0.921) evaporation (r = 0.828) and negatively correlated with minimum relative humidity (r = -0.856). Its population was low in least protected orchards and high in protected ones.

Post Harvest Management

MANGO (*Mangifera indica* L.)

Development of improved solar dehydrator

The solar dehydrator (1 x 2 m, covered with UV stabilized polythene) enhanced 8-10 °C temperature over ambient temperature which helped in hygienic drying of mango slices. The solar dried slices contained 8.44 per cent moisture, whereas sun dried slices had 10.45 per cent moisture after 24 hours of sun drying. The solar dehydrator was tested among 30 farmers of Mohammadnagar Talukedari and Nabi Panah villages under Farmer FIRST project.

Bagging of fruits for enhancing shelf life and quality

Mango fruits (cvs Dashehari and Amrapali) were bagged, harvested and stored under ambient conditions to assess their quality. The bagged fruits had firmness of 5.4 kg/cm^2, TSS 12.3 °B, titratable acidity 0.52 per cent, while control fruits had firmness of 3.2 kg/cm^2, TSS 13.5 °B, titratable acidity 0.55 per cent on the 10th day of storage.

Use of methyl jasmonate for enhancing shelf life

Mango (cv. Dashehari) fruits, treated with methyl jasmonate at 0.01 per cent for 5 minutes, could be stored up to 10 days with firmness of 4.3 kg/cm^2, TSS of 12.1 °B, acidity of 0.20 per cent compared to control fruits with firmness of 3.2 kg/cm^2, TSS of 13.5 °B, acidity of 0.22 per cent.

Optimization of bio-agents for enhancing shelf life

Mango cv. Mallika fruits were treated with *Lactobacillus* culture @ 10^8 cells/ml for 10 minutes and stored under ambient conditions. The treated fruits had firmness of 10.5 kg/cm^2, TSS of 12.7 °B, titratable acidity of 0.59 per cent while the control fruits had firmness of 8.7 of kg/cm^2, TSS of 12.5 °B, titratable acidity of 0.46 per cent on the 10th day of storage.

Estimation of antioxidants

Antioxidants estimated by FRAP method was maximum in Mango cv. Mallika (8.73 mg TE/g) followed by Amrapali (6.14 mg TE/g) and Chausa (4.82 mg TE/g). Antioxidants estimated by DPPH method was maximum in Chausa (18.64 mg TE/g) followed by Amrapali (18.01 mg TE/g) and Mallika (15.39 mg TE/g).

Estimation of mangiferin, lupeol and β-carotene

Maximum amount of mangiferin was recorded in Mango cv. Ambika (35.1 µg/g) and minimum in Totapuri (1.00 µg/g) among the pulp of six varieties whereas, Arunika contained maximum amount of lupeol (135.1 µg/g) and Janardan Pasand, the minimum (2.99 µg/g). Out of six varieties, β-carotene was found maximum (8.45 µg/g) in pulp of Langra followed by Neelam (8.01 µg/g) and minimum (3.34 µg/g) in pulp of Janardan Pasand.

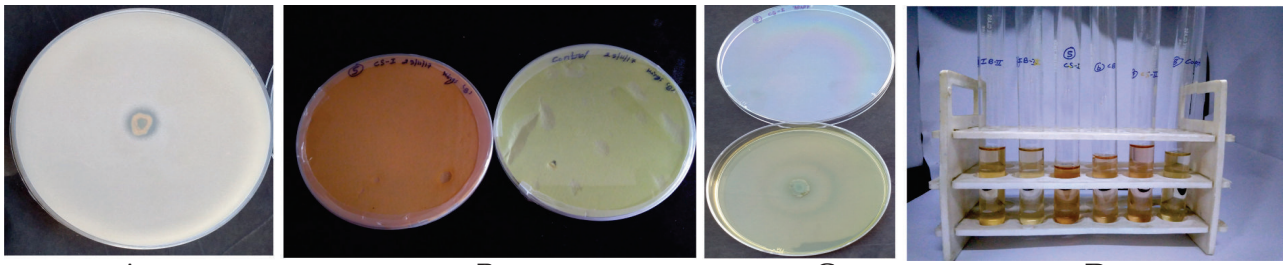
Characterization of phenolic compounds in peel and pulp during ripening

Gallic acid, chlorogenic acid, catechin, epicatechin, caffeic acid and ellagic acid were quantified in unripe and ripe peel and pulp of five mango cultivars (Dashehari, Langra, Amrapali, Mallika and Chausa). Caffeic acid was not detected in Dashehari peel and pulp. Unripe peel of Amrapali contained maximum amount of phenolic compounds and ripe pulp of Mallika the minimum.

Isolation and identification of pesticide degrading microbes from mango orchard soil

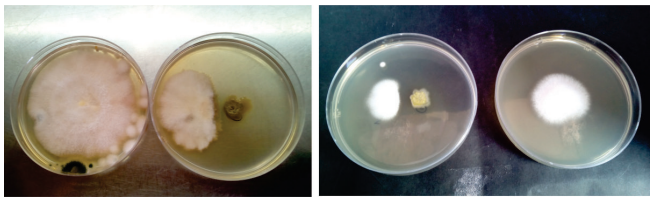
Out of seven bacterial isolates, three isolates namely CISH Bac-2, CISH Bac-5 and CISH Bac-7 exhibited higher pesticide degrading ability. All three bacteria were characterized as gram negative, rod shaped bacteria. CISH Bac-5 and CISH Bac-7 were catalase positive bacteria while CISH Bac-2 was catalase negative. The optimum pH for growth of CISH Bac-2 and CISH Bac-5 was 7.0, while for CISH Bac-7 it was 6.0. The optimum temperature was 35 °C for all the three bacteria. The culture CISH Bac-2 was also possessed high pectinase (0.735 unit/ml) activity.

These bacteria were found to have strong PGPR activity. The PGPR activity of CISH Bac-5, identified as *Pseudomonas aeruginosa* strain MTRI1, was found to be the highest in terms of phosphate solubilization efficiency (164.7%), siderophore production efficiency (128.12%), Indole Acetic Acid and HCN production efficiency as indicated by dark pink and dark brown colour development, respectively (Fig. 42). CISH Bac-5 also exhibited high bio-control activity against *Colletotrichum gloeosporioides* and *Fusarium* sp. (Fig. 43).



A B C D

Fig. 42. PGPR activities of CISH Bac-5 (A: phosphate solubilization, B: HCN production, C: siderophore production, and D: Indole acetic acid production)



A B

Fig. 43. Bio-control activity of CISH Bac-5 against *Colletotrichum gloeosporioides* (A) and *Fusarium* sp. (B)

Survey for packaging materials

A survey was conducted in Delhi, Saharanpur, Muzaffarnagar, Meerut, Sandila and Lucknow fruit markets during June-July, 2017. The major packaging material was CFB boxes (59.5%) followed by plastic crates (38%) and wooden box (2%). The post harvest losses in crates were 5-6 per cent, in wodden and CFB boxes with three and four layers were 9-12 per cent and in single layered CFB boxes were 2-3 per cent due to absence of overloading and minimum pressure on the fruits during transportation.

GUAVA (*Psidium guajava* L.)

Low temperature storage of fruits

Guava (cv. CISH-Shweta) fruits were treated with sodium benzoate and shrink wrapped and without shrink wrap and packed in CFB boxes. Control fruits were packed in brown paper bag and stored at low temperature (8 ^{o}C and 85-90% R.H). Fruits were withdrawn from cold storage after 21 and 28 days and simulated for shelf life for 3 days under room conditions. On the 28th day and 28+3 days the shrink wrapped fruits packed in CFB had firmness of 9.37 and 7.13 kg/cm^2 and CPLW 4.79 and 6.94 per cent, respectively, under low temperature storage.

Use of preservatives for shelf-life enhancement

Guava (cv. Allahabad Safeda) fruits were treated with potassium metabisulphite, sodium benzoate and untreated served as control, packed and stored under ambient conditions. Fruits were withdrawn at regular intervals of 0, 5, 7 and 9 days and analyzed for physic-chemical attributes. The fruits, treated with 2 per cent potassium metabisulphite and 2 per cent sodium benzoate, could be stored up to 9 days under ambient conditions. These fruits had 10.12 and 11.66 per cent CPLW compared to control (14.55%) on the 9th day of storage.

Effect of *Lactobacillus* dip treatment on quality of fruits

Fruits of guava cv. CISH-Lalit were treated with *Lactobacillus* @ 10^8 cells/ml, *Lactobacillus* plus guar gum @ 2 per cent along with control and stored under ambient conditions. Physico-chemical parameters were assessed at regular intervals of 0, 5, 7 and 9 days. Fruits treated with *Lactobacillus* and *Lactobacillus* + guar gum 2 per cent exhibited CPLW of 5.77 and 6.27 per cent, respectively, compared to control (CPLW 7.86%) on 9th day of storage. The firmness of treated and control fruits was 3.8, 2.75 and 2.2 kg/cm^2, respectively, on 9th day of storage.

Use of packages containing ethylene absorbent

Guava (cv. CISH-Shweta) fruits were treated with growth regulators at two concentrations, potassium metabisulphite @ 2 per cent and control treated with water followed by storage under ambient conditions for enhancing shelf life. Fruits treated with growth regulators were exhibiting high firmness 6.5 and 7.2 kg/cm^2 and low CPLW 7.15 and 7.53 per cent, respectively, on the 9th day of storage. The fruits treated with KMS @ 2 per cent had firmness of 5.4 kg/cm^2 while control had firmness of 4.2 kg/cm^2. The fruits were also assessed for TSS, acidity, and ascorbic acid content.

Study of antagonistic activity of *Lactobacillus* against indigenous microflora

Lactobacillus sp. exhibited strong inhibitory activity against *Aspergillus* sp., *Fusarium* sp., *Colletotrichum gloeosporioides* and *Pestalotia* sp. The tested fungi were not allowed to grow on culture plate inoculated with *Lactobacillus* sp.

AONLA (*Emblica officinalis* Gaertn.)

Use of anti-browning agents in aonla juice during storage

Eight month storage study of aonla juice with different anti-browning agents at room temperature revealed the maximum retention of vitamin C (539 mg/100 ml) with L-cysteine and that of polyphenols (2.33%) with ascorbic acid, while the lowest NEB (0.153 OD) was recorded with oxalic acid. HPLC analysis of different phenolic compounds confirmed the role of gallic acid in browning of aonla juice as it increased significantly during storage period. Minimum increase of gallic acid was noticed in juice containing L-cysteine as anti-browning agent. Oxalic acid was also found effective to marginally check browning in aonla juice. In case of organic acids, the content of ascorbic acid decreased during storage and that of citric acid increased.

Development of stevia based aonla-fennel, aonla-coriander and aonla-dill drinks

Stevia based aonla-fennel, aonla-coriander and aonla-dill drinks were developed. The vitamin C content of the drinks varied from 70 to 78 mg/100 ml, while total phenolics from 217 to 223 mg/100 ml.

Development of low calorie aonla-fennel drink

A low calorie aonla-fennel drink was standardized using a combination of natural and artificial sweetener. Calorie value of the drink was worked out to be 21/100 ml. The total anti-oxidant content was found to be 222 mg/100ml (as vitamin C + phenolics). The product could be stored for 6 month under ambient conditions.

Storage study of sugarcane aonla drink

Sugarcane aonla drink was preserved for 6 months. The ascorbic acid content was 63 mg/100 ml while, phenolics were 234 mg/100 ml after 6 months of storage.

Use of aonla murrabba residue for developing RTS and jam

Acceptable quality RTS (vitamin C content 15 mg/100 ml and total phenolic 121 mg/100 ml) and jam were prepared from aonla murrabba residue (left over dark colored) syrup.

Development and characterization of fruit based (aonla, guava and bael) laxatives

Aonla, bael, guava based laxatives were developed and evaluated for their laxative properties. Bael powder was found to have maximum swelling volume factor of 4.7, followed by aonla pomace (3.7) and guava powder (3.5). Aonla pomace was found to contain maximum phenolic content (3.52%), while guava powder possessed maximum vitamin C (295 mg/100 g).

Development of sugarcane-aonla and honey cider vinegars

A technology was standardized for preparation of sugarcane-aonla blended cider vinegar and honey cider vinegar using alcoholic and acetic acid fermentation technologies with lab microbial cultures. The sugarcane-aonla vinegar contained 5.4 per cent acetic acid while honey vinegar had 4.2 per cent acetic acid.

Storage study of kinnow-aonla blended squash and preparation of kinnow peel bar

Aonla and kinnow juices were blended in different proportions for standardizing a recipe for an organoleptically acceptable blended squash. Room temperature storage study up to 6 months revealed that up to 50 per cent kinnow juice could be added to aonla juice to obtain acceptable quality of blended squash. Aonla juice was found to enrich vitamin C and phenolic contents, while kinnow juice provided colour, aroma and taste to the drink. After extraction of juice, kinnow peel was utilized to develop an organoleptically acceptable kinnow peel bar by applying microbial inputs. The bar possessed characteristically pleasant aroma of kinnow and had 60 °B TSS, 0.52 per cent acidity, 39 mg/100 ml vitamin C and 149 mg/100 g phenolics.

BAEL (*Aegle marmelos* Correa)

Nutracenticals analysis in fruits

Profiling of vitamins and coumarins at harvesting stage Four vitamins (vitamin B_1 or thiamine, vitamin B_2 or riboflavin, vitamin B_3 or niacin and vitamin C or ascorbic acid) and three coumarins (marmelosin, psoralen and aurapten) were estimated in two selections (CISH B-1 and CISH B-2) and seven cultivars of bael (Pant Shivani, Pant Sujata, Pant Aparna, NB-5, NB-9, NB-16 and NB-17) at the time of harvesting (315 days after fruit set). In case of vitamins, Pant Aparna possessed maximum amount of riboflavin (423 µg/g), Pant Shivani had maximum amounts of thiamine (331 µg/g) and ascorbic acid (169 µg/g), and CISH B-1 contained maximum amount of niacin (1340 µg/g). For coumarins, maximum amount of marmelosin (596.57 µg/g) was in CISH B-1, while that of psoralen (179.25 µg/g) was in Pant Shivani and aurapten (145.42 µg/g) in Pant Aparna (Table 10). The chemical structures of vitamins and coumarins are provided in figure 45. Selection CISH B-1 and cultivars Pant Shivani and Pant Aparna were found nutraceutically rich.

Table 10. The content of different vitamins and coumarins in various bael selections/cultivars

Bael selections / cultivars	Ascorbic acid (µg/g)	Riboflavin (µg/g)	Thiamine (µg/g)	Niacin (µg/g)	Marmelosin (µg/g)	Psoralen (µg/g)	Aurapten (µg/g)
CISH B-1	79	158	233	1340	596.57	102.02	53.23
CISH B-2	93	182	165	717	170.08	9.20	9.16
Pant Shivani	169	376	331	1142	364.51	179.25	43.94
Pant Sujata	160	214	107	1019	75.40	106.81	15.85
Pant Aparna	153	423	212	918	220.91	163.23	145.42
NB-5	78	76	269	1041	256.71	34.20	55.43
NB-9	81	99	59	471	84.79	62.83	19.32
NB-16	74	54	260	351	86.70	130.32	25.95
NB-17	69	328	37	1212	318.29	36.20	25.72
LSD at $p<0.05$	7.239	23.897	24.428	25.345	19.369	16.892	7.855

Standardization of protocol for preparation of bael powder and its storage

Bael powder was prepared from ripe fruits by three different drying methods namely solar, cabinet and sun drying. Maximum (18.73%) powder yield was found in cabinet dryer followed by solar dryer (16.11%) and sun drying (14.60%). The sun dried powder stored in food grade HDPE, LDPE polythene pouches and laminated aluminium pouches for 180 days at ambient temperature was analyzed for physical and biochemical parameters. The laminated aluminium pouches were found effective for storage of powder with low moisture content (9.20%) and NEB (0.50 OD) as compared to HDPE and LDPE polythene pouches.

Development of raw fruit powder for preparation of instant bael drink

A low cost protocol for raw bael fruit powder preparation through sun drying has been standardized. Powder prepared from fruits harvested at various stages of growth and development was analyzed for physical and biochemical parameters. Ash content (0.67%), total titrable acidity (0.039%), total phenol (17.20 mg GA equivalent/100 g), reducing sugar (6.26%), total sugar (10.43%) and total antioxidants in terms of FRAP 4.18 x 10^4 millimol/kg were estimated. Sun dried bael powder is hydrophobic in nature and so is not dissolved easily in water.

Others

Extraction and characterization of biopigment of microbial origin

A red coloured pigment from *Fusarium solani* was optimally produced at 30 °C, pH 4.0 and under low light condition up to 28 days and was composed of 3,8–bis (dimethylhydroxymethyl) -2,3,7,8–tetraazatetracyclododeca-2, 7–diene; 4-methyl-6 -(1-hydroxyl -2, 2, 2-trifluoroethyl) pyrimidine and a-azido-o-xylene.

4 Technology Assessment and Transfer

Enhancing livelihood and profitability of mango farmers of Malihabad

In order to augment income of 1100 farmers in 4 villages of Malihabad *viz*., Mohammad Nagar Talukedari, Meethenagar, Nabi Panah and Kasmandi Kalan few proven technologies were transferred to farmers based on the results obtained through PRA analysis, focussed group meetings with farmers and feedback from line departments under Farmer FIRST project.

Mango based poultry farming

ICAR-CISH, Lucknow and ICAR-CARI, Bareilly developed guava based poultry farming in Uttar Pradesh successfully under NAIP project. This technology was demonstrated in three villages *i.e.* Nabi Panah, Kasmandi Kalan and Mohammed Nagar Talukedari in Malihabad, Lucknow. One hundred farmers adopted mango based poultry farming. ICAR-CARI, Bareilly extended technical support. Poultry breeds suitable for orchard eco-system such as CARI-Devendra, Upkari, Shyama, Hitkari, Nirbheek and Kadaknath were demonstrated to farmers. An attempt has been made to develop low input- high profit mango system for improvement in annual income and nutritional security of the farmers. Integration of rural poultry in mango farming starts giving income to farmers after three months. Maximum improvement in income (51%) was recorded with farmers having 1-2 acre, followed by farmers having <1 acre. Farmers having more than 2.5 acre realized comparatively less income. This farming approach is highly useful for small farmers. This intervention reduced population of mango pests and enhanced soil fertility. Mango mealy bug and trunk borer were significantly reduced in orchards with rural poultry.

On farm value addition of mango

Farmer FIRST introduced and demonstrated an innovative method of raw mango powder production to 30 farm women in Mohammad Nagar Talukedari village for production of hygienic and good quality dried slices from dropped and cracked raw fruits and then grinding them in a pulverizer to produce good quality Amchur. A low cost solar drier have been developed and distributed in village for fast drying of slices. This intervention help in hygienically and quick drying of mango slices which enhance productivity and income of the farmer 60-80 per cent by selling mango powder.

Farmer category	Improved method (n = 30)			Traditional method (n = 30)			Mean difference	% increase in income over traditional method	t value
	Gross income (Rs)	Gross cost (Rs)	Net Income (Rs)	Gross income (Rs)	Gross cost (Rs)	Net Income (Rs)			
Land less	44460	20748	23712	35126	19068.4	16057.6	7654.40	47.67%	9.68**
Marginal	26730	12474	14256	20706	11240.4	9465.6	4790.60	50.61%	16.54**
Small	18045	7619	10426	15102.5	8198.5	6904	3520	50.98%	8.30**

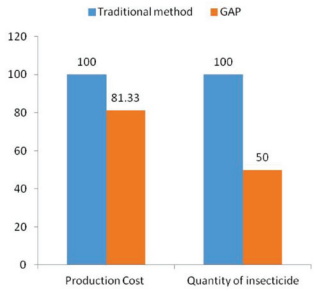
Intercropping in mango orchard

The livelihood of majority of mango growers in Malihabad depends solely on sale of mango fruits. In order to generate sustainable income, shade loving crop turmeric var. Narendra Dev Turmeric-1 (20 quintals seed) was distributed as critical input to 40 farmers for planting in mango orchards as inter crop with a view to multiplying the seed and spread it in wider area. From 100 kg seed, each farmer harvested around 400 kg of turmeric which they are using it as seed material to expand turmeric cultivation in mango


orchards. Twenty quintals Elephant yam seed has also been given to another set of 30 farmers. Turmeric Field Day was organized to create awareness about turmeric processing. Efforts are on to convert these villages as seed hub for turmeric and yam.

Promoting GAP in mango, branding GI and linking growers to market

Mango growers used to harvest fruits by shaking of branches and by locally made hook attached on wooden stick. Due to this, about 10 per cent of fruits cracked during harvesting were not fit for marketing. In order to avoid these losses FFP designed, developed and introduced a light weight fibre harvester which harvests fruits safely and drudgery is reduced. A total number of 100 such harvesters were supplied to 10 mango farmers. ICAR-CISH comes up with safe ripening solution which is sprayed prior to packaging and transportation of fruits. This safe ripening method has been demonstrated at farmers' field. A total number of 1000 CFB boxes inscribed with GI were distributed among 10 mango orchardists. A mango mobile van was also provided to farmers for one week in order to increase the profitability and to circumvent middle men in the system. In order to reduce the production cost, demonstration of 4 sprays instead of 7 sprays was conducted which led to income enhancement. The details are as follows:

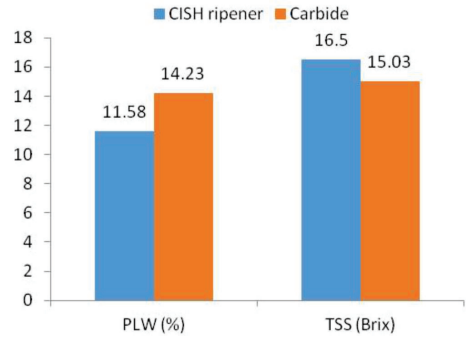


Reduction in cost of production through judicious use of pesticides

GAP recommendation under FFP reduced number of sprays per year in mango orchards from 6-7 to only 4, resulting in 18.67 per cent reduction in production cost compared to traditional production practices with better management of insect-pests and diseases.

Effect of safe ripening method on quality of mango fruits

CISH safe ripening methodology was demonstrated at farmers' field. Use of carbide for ripening is prevalent in this region. Quality of fruits was improved with the use of safe ripening method among FFP farmers. The TSS of fruits increased whereas PLW decreased significantly using CISH ripening solution.



Linking farmers to market

A mobile mango van was provided to farmers from June 18-25, 2017. Farmers who adopted Good Agricultural Practice in mango, utilized GI and used CFB boxes designed by Institute under Farmer First project were given the mobile van to sell their produce directly to consumer.

Mushroom production for landless farmers

Ten farmers were given training and spawn for cultivation of Oyster, Milky and Button mushrooms. Two workshops, on mushroom diversity adoption and milky mushroom production were organized to upgrade skill of farmers. Rural women and landless farmers have adopted this intervention.

Demonstration of Nutri-garden for nutritional security

In order to provide nutritional security to farm families, 30 nutri-gardens were established in homestead in Mohammad Nagar Talukedari and Nabi Panah villages. Farm families were given vegetable seed kits (7 types of vegetables) for Kharif and Rabi season. Besides, fruit plants of lime, guava and banana were also provided. Farm families harvested 3.2 kg vegetable / day. In 150 days, a total of 480 kg of vegetable was produced. Farmers sold surplus vegetables in market. This led to fulfilment of RDA of 300 gm vegetables/day/person with nutri garden.

Training & On-farm demonstrations

On-farm demonstrations was conducted on improved method of raw mango dried slices and *Amchur* production on May 04, 2017. Thirty rural women from the village were trained for improved method of *Amchur* production. The mango peeler, low cost solar dryer were demonstrated and distributed among farm women. An NGO, SCMD was made partner for linking these farm women to market.

On farm demonstration of bagging technology in mango was organized at farmer's field in village Nabi Panah on June 09, 2017. Paper bags were also provided to mango growers. The technology was demonstrated in 10 orchards.

On farm demonstration on safe harvesting, ripening and packaging of mango were given at farmer's field on June 24, 2017 in Nabi panah village. CISH mango harvester, safe ripening solution and CFB boxes were provided to 10 farmers.

Front line demonstrations for uniform ripening of Dashehari mango using safe ripening methods, bagging technology for Langra variety, fruit fly trap to farmers for better management of fruit fly, training and pruning in tomato and safe and effective use of insecticide for control of Mealy bug in mango were conducted at Naibasti, Kanar, Wazidnagar, Belgarah and Hasanpur villages in Malihabad and Kakori blocks. About 70 farmers were participated and benefited.

Mango wilt/ decline disease management

Mango wilt/ decline disease has become a great threat to mango industry in recent past. The technology developed for its management has been transferred to over 1250 farmers through their training in affected orchards, demonstration at identified field locations and through power point lectures in various training programmes and distribution of literature for developing awareness. The following package of practices for disease management has been extended to mango growers of Lucknow, Barabanki, Sitapur, Faizabad, Hardoi, Shahjahanpur, Aligarh, Bulandshahar, Meerut, Muzaffarnagar, Unnao, Pratapgarh, Bengaluru and Vengurle in particular and throughout India in general.

- To avoid damage to roots, minimum tillage should be adopted and deep ploughing should completely be avoided in mango orchards. Intercrops should always be grown beyond canopy area, if grown in young orchards.
- Wilt affected and nearby trees should be treated with Thiophanate methyl 70WP @ 50, 100 or 150 g per tree for trees of 2-15, 16-35 and above 35 years age, respectively as soil drench.
- Infected or wilted branches should be pruned and cut ends should be pasted with copper sulphate or oxychloride 5.0 per cent solution.
- Aerial portion of trees should be sprayed with carbendazim 50 WP or propiconazole 25 EC @ 0.1 per cent on appearance of first symptom.
- If infestation of Scolytid beetle is observed in orchard, it should be managed by spray of chlorpyriphos 20 EC @ 0.2 to 0.3 per cent at 15 days interval.
- Irrigation must be done using channels to avoid disease dispersal through water from infected tree to healthy trees.
- Recommended doses of manure and fertilizers should be applied in orchards and proper soil moisture should also be maintained.

Symptoms of wilt (A), decline (B) and treatment of affected trees (C-E)

Awareness programmes organized at Aligarh, Bulandshahar, Saharanpur and Lucknow

Kisan Gosthi

A Kisan Gosthi on Establishment of nutri-garden was organized at Nabi Panah village in which more than 150 farmers participated. Scientists addressed the farmers on importance of establishing nutri-garden on March 29, 2017. Seed kit (Zaid season vegetables) was also distributed to all the farmers during the event. An NGO, AAUBS, Malihabad was made partner in FFP program. A kisan gosthi on mango based poultry farming and intercropping was organized on April 29, 2017 under Farmer FIRST project in Nabi Panah and Mohammad Nagar Talukedari villages of Malihabad. In order to enhance income of farmers round the year in these two villages, Institute distributed improved breeds of poultry which were brought from ICAR-Central Avian Research Institute such as CARI-Hitkari, CARI-Devendra, etc. Two sets of boxes comprising 100 birds per box have been delivered to farmers.

A Scientist farmer interface was organized at Meethenagar on 22 July, 2017. A total number of 750 mother plants of guava, citrus, jamun, aonla, bael and pomegranate were distributed among the nurserymen of Bakkhakhera and Mohammad Nagar Talukedari in order to provide entrepreneurship. For raising nursery of off season vegetables, protected structure was demonstrated and distributed to 30 farmers of Mohammad Nagar Talukedari and Bakkhakhera.

Mera Gaon Mera Gaurav

Institute constituted coordination teams and demonstrated technologies, conducted on farm demonstrations, organized gosthies, scientist-farmers interface in 45 villages of Malihabad and Kakori. The details of programs are hereunder.

S.No.	Programme	Village Name	Date	Participants	Scientist
1	Field visit to provide knowledge on marigold cultivation.	Mohiddipur	June 19, 2017	10	A.K. Bhattacherjee K.K. Srivastava and Bharti Killadi
2	Discussion and advice for weed and insect pest management of vegetables and fruit crops for quality production.	Amethia Salempur	October 06, 2017	10	Naresh Babu, Subhash Chandra and Arvind Kumar
3	Advice on strawberry cultivation	Mohammad Nagar Talukedari	March 03, 2018	10	Ashok Kumar and Subhash Chandra
4	Field visit and interaction with mango growers for intercropping in orchards	Belgarha, Allupur and Garhi	March 29, 2018	15	D. Pandey, S. K. Shukla and A. K. Trivedi
5	To mobilize the farmers for attending live caste/webcaste programme of Prime Minister Sri Narendra Modi at ICAR CISH, Lucknow.	Amethia Salempur, Mohiddipur, Saidpur and Pahia Azampur	March 16, 2018	100	A.K. Bhattacherjee K.K. Srivastava, Naresh Babu and Subhash Chandra
6	Vegetable cultivation in backyard for nutritional security	Kushmora, Salempur	July 29, 2017	13	Naresh Babu & Subhash Chandra
	Kisan Gosthies Organized				
7	Scientific cultivation of gladiolus and distribution of planting materials of gladiolus	Mohiddipur and Saidpur	November 14, 2017	45	Naresh Babu, K.K. Srivastava A. K. Bhattacherjee and Arvind Kumar
8	Gosthi conducted on strawberry cultivation at farmers field	Mohammad Nagar Talukedari	January 01, 2018	20	Ashok Kumar and Subhash Chandra
9	Gosthi on round the year vegetable production in kitchen garden for nutritional security.	Kithaipara, Kanar	July 25, 2017	35	S.R. Singh and Swosti Suvadarsini Das
10	ICAR-CISH Technologies related to fruit nursery and mango production	Mohammad Nagar Talukedari	June 03, 2017	30	S.R. Singh, Muthukumar M. and Swosti Suvadarsini Das
11	To create awareness among farmers for controlling insect-pest and diseases in mango.	Tikaitganj	July 28, 2017	38	Neelima Garg S.R. Singh, Muthukumar M. and Swosti Suvadarsini Das
12	Insect-pest (hopper and thrips) management, processing and value addition of raw mango	Jagtapur	April 13, 2017	34	Ram Kumar, A.K. Verma, Israr Ahmad and P.S. Gurjar
13	Insect-pest management and processing of dropped raw mango	Wazidnagar	April 15, 2017	29	Ram Kumar, A.K. Verma, Israr Ahmad and P.S. Gurjar

14	Gosthi on safe harvesting, ripening, packaging and transport of mango	Hafijkhera and Hasnapur	May 17, 2017	30, 22	Ram Kumar, A.K. Verma, Israr Ahmad and P.S. Gurjar
	Trainings organized				
15	Hands on training for aonla products for additional income generation of rural women	Naibasti	December 11, 2017	38	Neelima Garg and Tarun Adak
16	Mango wilt disease management	Shailamau	October 7, 8, 11, 16, 2017	7	P.K. Shukla
	Scientist Farmers Interface				
17	Scientist-farmers interaction meeting on enhancing income through vegetable production	Pahia Azampur	July 31, 2017	25	Kanchan Kumar Srivastava & Naresh Babu
18	Scientist-farmers interaction on pruning of old orchard, centre opening and raising of HDP of mango and guava, rejuvenation in mango	Mohiddipur	August 4, 2017	40	V.K. Singh, A. K. Bhattacherjee, K.K. Srivastava and Bharti Killadi
	Focused Group Meeting/Stakeholder Meeting				
19	Backyard vegetable growing for nutritional security	Dugoli	April 5, 2017	12	Dinesh Kumar
20	Insect pest management in mango orchards and vegetable cultivation for nutritional security and income generation	Muzasa	October 09, 2017	21	D. Pandey, U. Hudedamani, Naresh Babu and P. Berman
21	Management of mango mealy bug in mango orchard and legume vegetables cultivation for higher income and good soil health.	Salempur	November 21, 2017	28	Naresh Babu and Subhash Chandra
22	Stakeholder meeting on need based and safe use of pesticide in mango	Jagtapur	December 17, 2017	16	Ram Kumar, P.S. Gurjar, Israr Ahmad and Gundappa
23	Stake holder meeting on GAP, safe harvesting, ripening and packaging of mango	Nabi Panah	May 12, 2017	18	Maneesh Mishra, A.K. Verma and P.S. Gurjar
24	Judicious use of insecticide during flowering and honey bee Keeping in mango orchard	Kushmora and Amethia Salempur	January 01, 2018	25	Naresh babu and Subhash Chandra
25	Organic vegetable cultivation in backyard	Golakuan	March 28, 2018	16	R.A. Ram
26	Distribution of seedlings and advisory for management of diseases and insect pests	Shailamau	August 04, 2017	14	P.K. Shukla, S.K. Shukla, S. Chandra
27	Control and management of mango leaf webber and guava fruit fly	Hafijkhera	August 08, 2017	22	Ram Kumar, P.S. Gurjar and Israr Ahmad

28	Awareness generation regarding high yielding hybrids of vegetables and their scientific cultivation	Nabinagar and Saidpur	August 11, 2017	32	V.K. Singh, A.K. Bhattacherjee, K.K. Srivastav and Bharti Killadi
29	Awareness generated among farmers and farm women on home scale processing and value addition of mango	Tikaitganj and Naibasti	August 01, 2017	25	Neelima Garg
30	Sensitization programme for management of leaf webber in mango	Nai Basti	July 25, 2017	20	Neelima Garg A.K. Singh, P.K. Shukla & Tarun Adak
31	Sensitization programme for doubling farmers income through diversification and technological interventions.	Nai Basti	December 16, 2017	24	Neelima Garg A.K. Singh, P.K. Shukla & Tarun Adak
32	Awareness about safe use of pesticide and control of Mealybug and Hopper.	Hafijkhera and Jagtarpur	December 26, 2017	20	Ram Kumar, P.S. Gurjar and Israr Ahmad
33	Sensitization of farmers on vermicompost preparation and use of neem based pesticides to encourage organic farming.	Amethia Salempur	March 28, 2018	22	Naresh Babu, Subhash Chandra and Arvind Kumar
34	Awareness programme on cleanliness organized for the school children	Saidpur and Amethia Salempur	August 11, 2017 and March 28, 2018	90	V.K. Singh, A.K. Bhattacherjee, K.K. Srivastava and Bharti Killadi
	Front Line Demonstrations				
35	Demonstration of bagging technology for Langra variety and distribution of Hindi literature on production and protection technologies	Nai Basti and Kanar	June 03, 2017	25	P.K. Shukla and Tarun Adak
36	FLD for uniform ripening of Dashehari mango using ethrel and distribution of Hindi literature related to production, post harvest and protection technologies	Nai Basti	June 13, 2017	22	Tarun Adak and P.S. Gurjar
37	On farm demonstration of safe and effective use of insecticide for control of Mealy bug in mango.	Wazidnagar and Hasnapur	December 16, 2017	20	Ram Kumar, Israr Ahmad, P.S. Gurjar and Gundappa
38	FLD for training and pruning in tomato and distribution of indeterminate tomato seedlings of cv. Himsona	Belgarah	December 16, 2017	12	V K Singh, A. K. Bhattacherjee and A. K. Trivedi
39	FLD on bagging in Dashehari mango and how to make low cost bags at farm.	Nabipanah	May 05, 2017	10	Maneesh Mishra, A.K. Verma and P.S. Gurjar
40	FLD on CISH harvester, safe ripening and packaging of mango.	Nabipanah	25 May, 2017	8	Maneesh Mishra, A.K. Verma, P.S. Gurjar and Gopal Carpenter

41	FLD on portable solar dehydrator and mango peeler	Mohammad Nagar Talukedari	17 May, 2017	32 Women	Maneesh Mishra, A.K. Verma, P.S. Gurjar and Gopal Carpenter
	Input supplied				
42	Seedlings of high yielding vegetables of summer, winter and zayad were distributed to the farm women for the backyard kitchen gardening for nutritional security and income generation.	All 40 adopted villages under MGMG programme	Throughout the year	1200 families	All the scientists of ICAR-CISH

Activities in villages field under Mera Gaon Mera Gaurav

Exhibitions

Institute participated in various state as well as national level exhibitions and displayed Institute's achievements and technologies on mandate crops as per following details. Exhibitions were highly effective in communicating the knowledge among visitors.

Sl	Programme / Occasion	Place	Organizer	Date
1.	Farmers Welfare Fair & Krishi Kumbh	Zila School Ground, Motihari, Bihar	ICAR-RCER, Patna, Bihar	April 15-19, 2017
2.	Kisan Gosthi	Dadanpur, Chakkoder, Fatehpur, Barabanki, UP	ICAR-CISH, Lucknow	June 2, 2017
3.	Mango Festival	Indira Gandhi Pratisthan, Lucknow	Uttar Pradesh Tourism, Lucknow	June 24-25, 2017
4.	National Symposium on IPR in Agricultural Research	BBAU, Lucknow	UP Council of Agricultural Research and BBAU, Lucknow	August 30-31, 2017
5.	Food Processing Summit, 2017	AP Food Processing Society, Vijayawada, Andhra Pradesh	Government of Andhra Pradesh	October 16, 2017
6.	Farmers Fair & Gosthi	KVK, Dhaura, Unnao	KVK, Dhaura, Unnao	November 4, 2017
7.	Kisan Mela-cum-Agricultural Technologies Showcasing	ICAR-CISH, Rehmankhera, Lucknow	ICAR-CISH, Lucknow	November 30, 2017
8.	5th International Agri Horti Technology Showcasing	Kanshiram Smriti Sthal, Lucknow	PHD Chamber of Commerce & Directorate of Horticulture & Food Processing, Government of UP	December 12 - 14, 2017
9.	Doing Agribusiness in Uttar Pradesh: Opportunity and Challenges	Hotel Gomti, Lucknow	Centre for Agriculture and Rural Development (CARD) with collaboration of IFPRI	December 21, 2017
10.	Agriculture Biodiversity Exhibition & Regional Workshop on Farmers Rights	ICAR-IISR, Lucknow	PVP FRA, New Delhi, ICAR-IISR, ICAR-CISH, Lucknow & ICAR-ATARI, Kanpur	January 16, 2018.
11.	Kisan Mela	CSIR-CIMAP, Picnic Spot Kukrail, Lucknow	CSIR-CIMAP, Picnic Spot, Kukrail, Lucknow	January 31, 2018
12.	State Fruit, Flower & Vegetable Show	Rajbhawan, Lucknow	Directorate of Horticulture & Food Processing, Lucknow	February 17-18, 2018
13.	North Zone Regional Farmers Fair & Gosthi	Trade Facility Centre, Varanasi, UP	ICAR-IIVR, Varanasi	February 23-25, 2018
14.	Krishi Unnati Mela	ICAR-IARI, New Delhi	Ministry of Agriculture & Farmers Welfare, Government of India, New Delhi	March 16-19, 2018
15.	8th Science Expo	RSC, Aliganj, Lucknow	RSC, Aliganj, Lucknow	March 26-28, 2018
16.	Horti-Entrepreneurship seminar on Tissue culture, Nursery & Value addition	ICAR-CISH, Lucknow	Centre for Agriculture and Rural Development (CARD), Lucknow	January 19, 2018
17.	Sensitization Workshop on "Intellectual Property, Technology Management & Entrepreneurship Development"	ICAR-IISR, Lucknow	ICAR-IISR, Lucknow	March 22, 2018
18.	Boot camp for Bio-entrepreneur	Indian Institute of Technology, Kanpur	BCIL, New Delhi	March 23-24, 2018

Hon'ble Minister for State (Independent charge) for Micro, Small & Medium Enterprises, Govt. of India, New Delhi Shri. Giriraj Singh along with Hon'ble Minister for Agriculture, Govt. of UP Shri. Surya Pratap Sahi at ICAR-CISH Exhibition stall in the Kisan Mela at CIMAP, Lucknow on January 31, 2018.

ICAR-CISH, participated & displayed it's technology showcasing exhibition stall in the North Zone Regional Farmers Fair organised by ICAR-IIVR at Trade Facilitation Centre, Badalalpur, Chandmari, Varanasi during February 23-25, 2018

ICAR-CISH participated & displayed it's technology show casing exhibition stall in the Krishi Unnati Mela-2018 at IARI campus, Pusa, New Delhi during March 16-19, 2018

ICAR-CISH participated & displayed it's technology showcasing exhibition stall in the Kishan Mela at KVK, Dhaura, Unnao on November 04, 2017.

Training - cum – Exposure Visit

	Title	Place	Date	Beneficiary
1	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	July 19, 2017	50 ATM & BTMs of Faizabad Mandal of UP
2	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	July 26, 2017	92 ATM & BTMs of Gorakhpur Mandal of UP
3	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	August 30, 2017	47 ATM & BTMs Faizabad, Barabanki, Hamirpur & Mahoba districts of UP
4	Improved cultivation of subtropical fruits	District Horticulture Office, Hardoi	September 08, 2017	50 Farmers of Hardoi, UP
5	HDP of Guava	SIMA, Rehmankhera, Lucknow	September 13, 2017	70 ATM, BTMs from Jalaun, Jhansi, Lalitpur, Raebareli, Lakhimpur, Sitapur, Faijabad, Hardoi & Lucknow
6	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	September 21, 2017	72 Technical Assistants (Agril) from Azamgarh, Mau, Bhadohi, Chandauli, Sonbhadra, Saharanpur & Kanpur districts of UP
7	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	October 05, 2017	65 ATM & BTMs from Jaunpur & Chandauli districts of UP
8	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	October 12, 2017	40 ATM, BTMs & Farmers various districts of UP
9	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	November 08, 2017	60 ATM & BTMs from Raebarelli, Behraich & Hardoi districts of UP
10	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	December 06, 2017	43 women farmers from Mathura, Hathras & Agra districts of UP
11	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	January 09, 2018	70 ATM, BTMs and farmers from Bareilly, Shahjahnpur, Lakhimpur, Badaun & Unnao districts of UP
12	HDP of Guava	Department of Horticulture, Krishna District of Andhra Pradesh	February 01-03, 2018	30 farmers of Krishna district, AP
13	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	February 08, 2018.	50 ATM, BTMs including farmers from Aligarh, Agra & Varanasi Mandal of UP
14	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	March 08, 2018.	27ATM, BTMs including farmers from Gonda, Hamirpur, Balrampur & Mahoba districts of UP
15	Improved cultivation of subtropical fruits	Department of Horticulture at BKT Unit, Lucknow	March 21, 2018	60 farmers from Bakshi-ka-Talab area of Lucknow

50 ATM, BTMs including farmers from Aligarh, Agra & Varanasi Mandal of UP under exposure visit-cum-training on February 08, 2018 (left) and 20 farmers under exposure visit from Vidisha, MP on February 08, 2018 (right)

Farmers/Students/Extension functionaries exposure visit

Two thousand fifty seven (2057) farmers including 47 rural women, 340 students and 723 ATM/BTMs/ agripreneures visited Institute's experimental fields and laboratories under farmers/extension functionary/ students (43 groups) exposure during April 2017 to March 2018. During their visit they were shown Institute's experimental farms, processing, packaging, laboratories and making them aware about our research activities and developed technologies.

Face to Face farmers counselling

About 128 farmers from UP, Gujarat, Telangana, Bihar, Punjab, MP, Haryana, Rajasthan & Kathmandu (Nepal) visited the Institute and they were counseled about their doubt those they faced during implementation of research out puts in the field.

Postal queries

Grower's queries related to various aspects of subtropical fruits were attended through correspondence. Extension folders and bulletins related to scientific cultivation of mango, aonla, guava and papaya were provided to the orchardists.

Farmer's helpline and mobile apps

Farmer's queries (358 Calls) particularly related to insect management (24.30%), availability of grafted plants of fruits (23.74%) disease control (23.18%), physiological disorders (12.84%), rejuvenation & canopy management of mango, guava (4.18%), plantations (4.18%), scientific cultivation of other fruits such as jamun, pepino, strawberry, peach, mushroom (3.35%), intercrops in fruit cultivation (2.79%) and doses of FYM/fertilizer in fruit crops (1.39%) were attended and provided their solution through telephonic conversation on Kisan Call Centre. Besides Kisan Call Centre, advisory to over 1250 farmers was given through calls on personal mobiles of the scientists of the Institute. The scientists of the Institute has formed several Whatsapp groups, eg. mango health care, milky mushroom growers, Farmers First, CISH-News media, etc. Problems of farmers are solved on the same day through these groups. Two Mobile based apps namely Raw Mango Products and Ripe Mango Products have been developed by the PHM Scientists for efficient use of raw and ripe mangoes.

5 Award and Recognitions

- A.K. Singh was appointed as external examiner for evaluation of M.Sc. (Ag.) Horticulture thesis of five students at NDUAT, Faizabad on June 25, 2017 and conducted viva voce examination on June 29, 2017.
- A.K. Singh delivered a talk in Phone in programme on "Horticulture" on June 28, 2017.
- A.K. Singh participated in Krishi Darshan programme on "Aam ke bagon me samayik karya" at Doordarshan Kendra, Lucknow on July 5, 2017, August 10, 2017, December 7, 2017 and January 18, 2018.
- A.K. Singh was nominated for screening application form of SMS (Hort.) for BUAT, Banda, UP on August 16, 2017.
- A.K. Singh was appointed as a member of selection committee for Technician at CSIR-CIMAP, Lucknow on August 24, 2017.
- A.K. Singh was appointed as external examiner for evaluation of thesis and conducted viva voce examination of two M.Sc. (Ag.) students at IGKV, Raipur on August 28, 2017.
- A.K. Singh was appointed as an expert in selection committee for the selection of Associate/Assistant Professor of Fruit Science at BUAT, Banda, UP on September 14, 2017.
- A.K. Singh was nominated as a member of DPC meeting for assessment of merit promotion of T-5 (Field/Farm) at ICAR-IIVR, Varanasi on December 10, 2017.
- A.K. Singh was nominated as a member of organizing committee for DUS Review Meeting and Farmers Biodiversity Exhibition on January 15-17, 2018 at ICAR-IISR, Lucknow.
- A.K. Singh was nominated as observer/ representative from ASRB, New Delhi for conducting LDC examination on February 24, 2018.
- A.K. Trivedi Co-chaired the technical session on "Eco-friendly management of soil health and nutrition" during National seminar on water and soil management for agriculture and livelihood security under climate change held at Sunbeam College for Women, Bhagwanpur, Varanasi from September 8–9, 2017.
- A.K. Trivedi received Eminent Scientist Award from Samagra Vikas Welfare Society during National seminar on Transforming agriculture to doubling of farmers income held at BBAU, Lucknow from February 10-11, 2018.
- A.K. Trivedi was awarded Editorial Excellence Award as Editorial Board Member of the Journal Agricultural Reviews.
- Anju Bajpai delivered a lead lecture on "Recent advancements in mango genomics approaches for precision breeding" during National symposium on Recent trends in biotechnology: technology to skill development held at SRM University, Lucknow from March 23-24, 2018.
- Anju Bajpai delivered a lead lecture entitled "Functional genomics in mango" during National conference on Current scenario & future trends in biotechnology held at Bundelkhand University, Jhansi on March 28, 2018.
- Ashok Kumar delivered invited talk on "Cost effective protected cultivation of horticultural crops in diverse climatic conditions" during Workshop cum seminar on Precision horticulture for doubling farmers' income held at PFDC, GBPUAT, Pantnagar on March 09, 2018.
- Ashok Kumar and Gundappa were identified as certified trainer by NSDC for Banana farmer (AGR/Q0301/150318/T2041) and for Gardener (AGR/Q0801/150318/T2039).
- Dipak Nayak acted as a judge for selection of best mango exhibitors during Mango & Tourism Festival in Malda.
- Dipak Nayak was nominated as a coordinator for recruitment of ATMA functionaries (ATMs & BTMs) in Malda.
- Dipak Nayak has been nominated as a member of ATMA Management Committee and ATMA Governing Body, Malda.
- Gundappa acted as external examiner to conduct the practical examination of M.Sc. (Ag.) course 'Agriculture pesticide' at C.B. Gupta Agriculture Degree College, Bhakshi-ka-talab, Lucknow.
- Gundappa was recognized as the external evaluator for the DST projects.
- ICAR-CISH RRS, Malda received appreciation for Best Mango Diversity Stall in "The Mango & Tourism Festival" held at Malda, W.B. during July 9-10, 2017.
- Israr Ahmad received first prize in poster presentation during Ist North Indian science congress and international conference on science

and technology for sustainable future held at BBAU, Lucknow from January 10-11, 2018.

- K.K. Srivastava was awarded Fellow of Horticultural Sciences by U P Academy of Agricultural Sciences, Lucknow on June 14, 2017.
- K.K. Srivastava was conferred Horticulture Society of India Fellowship on December 16, 2017 at ICAR-NRC Biotechnology, New Delhi.
- Maneesh Mishra deliverd a lead lecture on "Commercial tissue culture of banana'' during Horti-Entreprenuship Seminar on January 19, 2018 at ICAR-CISH, Lucknow.
- Maneesh Mishra acted as DBT Nominee, IBSC, ICAR-IISR, Lucknow for 2017-18 and reviewed the biotechnology research of IISR, Lucknow.
- Maneesh Mishra acted as Expert member in Selection Committee for appointment of Associate Professor (Hort.) and Subject Matter Specialist (Hort.) at BUAT, Banda from August 16-22, 2017.
- Maneesh Mishra acted as Member, Expert Committee on Agriculture & Allied Sector, UPCST, Govt. of Uttar Pradesh and reviewed project proposals submitted to UPCST.
- Maneesh Mishra acted as Observer, ASRB, New Delhi for LDC Examination at M.C. Saxena Institute of Engineering, Lucknow on February 24, 2018.
- Maneesh Mishra, A.K. Verma and P.S. Gurjar participated in *Kisan Prashn Manch* program of DD Kisan Channel on "Aam ke bagon ka prabandhan" and on "Aam ka tudaai purv evam tudaai uprant prabandhan" during June 22-23, 2017.
- Muthukumar M. delivered a lead lecture on "Accomplishments, prospects and scope of biotechnological interventions in horticulture" during National seminar on Role of biotechnology for the benefit of the people of Uttar Pradesh at UPCST, Lucknow on March 27, 2018.
- Muthukumar M. delivered a lead lecture on "Molecular breeding for improving drought and salinity tolerance in crops" during National conference on Current scenario & future trends in biotechnology on March 28, 2018 at Bundelkhand University, Jhansi.
- Neelima Garg delivered talk on "Aam mein tudaai uprant prabandhan" at AIR, Lucknow on April 19, 2017.
- Neelima Garg acted as practical examiner for students of M.Sc. Food Processing and Food Technology at Lucknow University on April 24, 2017.
- Neelima Garg acted as practical examiner for students of B.Tech Food Technology at Integral University, Lucknow on May 20, 2017.
- Neelima, Garg acted as judge for processed products in Pradeshik Aam Mahotsav at Indira Gandhi Pratisthan, Lucknow on June 24, 2017.
- Neelima Garg delivered a talk on "Phal, phul evam sabjeeyon mein mulya samvardhan" at AIR, Lucknow on October 10, 2017.
- Neelima Garg delivered a lead lecture on "Wealth from horticultural waste" during 3rd International conference on bioresource and stress management on November 8-11, 2017 at SIAM, Jaipur.
- Neelima Garg delivered a lead lecture on "Social entrepreneurship through horticultural waste management by microbial intervention" during 58th Annual conference of Association of Microbiologists of India & International symposium on microbes for sustainable development: scope & applications on November 18, 2017 at BBAU, Lucknow.
- Neelima Garg delivered a lecture on "Scope of value addition in F & V in Uttar Pradesh and innovative products of F & V" in during Horti-Entrepreneurship seminar on January 19, 2018 at ICAR-CISH, Lucknow.
- Neelima Garg acted as practical examiner for students of Food Microbiology & Toxicology at Department of Environmental Microbiology, BBAU, Lucknow on February 8, 2018.
- Neelima Garg delivered a lead lecture on "Rural women entrepreneurship avenues in the field of post harvest management of horticultural crops for doubling farm family income" during National seminar on transforming agriculture to doubling of farmers income from February 10-11, 2018 at BBAU, Lucknow.
- Neelima Garg delivered a lead lecture on "Innovative technologies in aonla processing" during One day Innovative technology on food processing sectors for potential/existing entrepreneurs at Pratapgarh on February 28, 2018.
- Neelima Garg delivered invited lecture on "Value addition of horticultural crops and their processing byproducts for enhanced profitability and entrepreneurship development" during Conference on Food processing and Kisan SAMPADA at ICAR-IISR, Lucknow on March 9, 2018.
- Neelima Garg delivered invited lecture on "Technology avenues in horticulture for enhanced profitability and entrepreneurship development" during Sensitization workshop on Intellectual property, technology management and entrepreneurship development at ICAR-IISR, Lucknow on March 22, 2018.
- P.K. Shukla acted as examiner for evaluation of M.Sc.

(Ag.) thesis and conducted viva-voce examination of students on June 30, 2017 at Department of Plant Pathology, NDUAT, Faizabad.

- P.K. Shukla delivered lecture on "Integrated management of pests of Guava'' in Farmers Seminar held at Dewadavas, Tonk, Rajasthan on February 22, 2018.
- P.N. Barman awarded with "Mahima Young Scientist Award" in Horticulture during International conference on Agricultural, allied sciences & biotechnology for sustainability of agriculture, nutrition & food security held at Banaras Hindu University, Varanasi from November 25-26, 2017.
- P.N. Barman awarded with best Research Paper by Mahima Research Foundation and Social Welfare Committee for oral presentation during International conference on Agricultural, allied sciences & biotechnology for sustainability of agriculture, nutrition & food security held at Banaras Hindu University, Varanasi from November 25-26, 2017.
- R.A. Ram Co-chaired the session "Plant canopy architecture, regulation of bearing and harvesting systems" during National conference on perspective of challenges and options in litchi production and utilization at ICAR-NRC Litchi, Muzaffarpur from June 6-7, 2017.
- R.A. Ram acted as member of Screening Committee for the selection of SMS, assistant professor, associate professor and professor of horticulture in BUAT, Banda from August 16-22, 2017.
- R.A. Ram acted as member of Screening and Award Committee for the selection of farmers for "Dharti Mitra" award presented by Organic India Pvt. Ltd. during September 10-12, 2017.
- R.A. Ram delivered a lead lecture on "Organic farming practices to sustain agriculture production in changing climate scenario" during National seminar on Effect of climate on environment, sustainable agriculture and rural development on October 29, 2017 at Hotel Bandhan, Lucknow.
- R.A. Ram was appointed as Editor for Indian research articles submitted in World Organic Congress held at Greater Noida from November 9-11, 2017.
- R.A. Ram dilivered a talk on "Research experiences in biodynamic agriculture" during World Biodynamic Workshop held at Naukuchiatal, Nainital from November 14-15, 2017.
- R.A. Ram delivered a talk on "Bagon ki samayik dekhbhal" at AIR, Lucknow on January 8, 2018.
- R.A. Ram acted as member in Technical Advisory Committee of Central Institute of Horticulture, Nagaland, Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers Welfare, Government of India.
- R.A. Ram delivered a lead lecture on "Homestead management for nutritional and food security" in National seminar on Concept of homestead management held at Assam Floriculture Society, Guwahati on March 11, 2018.
- R.A. Ram delivered a lead lecture on "Integrated farming system approach to improve economic and nutritional security of the farmers" during National seminar on Poultry, hatchery and egg management on March 13, 2018 at ICAR-IISR, Lucknow.
- Shailendra Rajan delivered a lead lecture on "Finger printing effect of climate change on fruit trees" during National conference on Climate change and agricultural production at Bihar Agricultural University, Sabour on April 6, 2017.
- Shailendra Rajan participated in the programme on "Aam ke bagon me samayik prabandhan and bazar vyavastha' telecasted under Hello Kisan at Doordarsan Khel Gaon, New Delhi on May 5, 2017.
- Shailendra Rajan chaired the first session in National workshop on Doubling income of mango growers in India held at ICAR-IIHR, Bengaluru on May 18, 2017.
- Shailendra Rajan participated in programme on "Aam ke bagon me samayik prabandhan" at Doordarshan Kendra, Lucknow on May 19, 2017.
- Shailendra Rajan delivered a talk on "Rejuvenation of fruit trees for improving productivity and profitability" in National conference on Perspective of challenges and options in litchi production and utilization at ICAR-NRC Litchi, Muzaffarpur on June 6, 2017.
- Shailendra Rajan participated in Radio Talk on "Naye baag lagane ki yojana aur unnat phal prajatiyan" at AIR, Lucknow on June 22, 2017.
- Shailendra Rajan acted as Judge during Pradeshik Aam Mahotsav for evaluation of mango exhibition stalls at Indira Gandhi Pratisthan, Lucknow on June 24, 2017.
- Shailendra Rajan delivered a lead lecture on "New technologies for mango production" during Mango seminar cum exhibition and Mango Festival organized by Directorate of Horticulture and Food Processing, Uttarakhand on July 10, 2017.
- Shailendra Rajan delivered a lecture on "Horticulture in sub-tropics – challenges and opportunities" during National consultation of bioresources for sustainable development programme at Institute of Life Science, Department of Biotechnology, Bhubaneswar on July 31, 2017.

- Shailendra Rajan acted as Co-chairman of the Session on "ICT in Horticulture" and presented keynote address on "Use of GIS in management of genetic resources in horticultural crops" during International symposium on horticulture priorities & emerging trends held at ICAR-IIHR, Bengaluru from September 5-8, 2017.
- Shailendra Rajan delivered lecture on "Initiatives for building in-house capacity to process research output for agricultural knowledge management" during National workshop on Developing a roadmap for agricultural knowledge management in India at NASC Complex, New Delhi from September 27-28, 2017.
- Shailendra Rajan participated in programe on "Purane phaldar brikhon ka jeernoddhar" at Doordarshan Kendra, Lucknow on November 16, 2017.
- Shailendra Rajan inaugurated and participated as Guest of Honour in Regional Farmers Fair in district Agriculture Summit at Lakhimpur Kheri on December 6, 2017.
- Shailendra Rajan delivered a plenary lecture on "How changing phenology of fruit trees can be an indicator for climate change" during Ist North Indian Science Congress (NISC-2018) held at BBAU, Lucknow on January 11, 2018.
- Shailendra Rajan acted as Co-chairman of the Session I-A of Plant Genetic Resources and Session I-B of Crop Improvement during Group Workers Meeting of ICAR-AICRP on Fruits held at ICAR-NRC Banana from February 14-18, 2018.
- Shailendra Rajan delivered lecture on "Guava varieties suitable for cultivation under Rajasthan conditions and techniques for higher productivity" in Farmers Seminar held at Dewadavas, Tonk, Rajasthan on February 22, 2018.
- Shailendra Rajan delivered a lecture on "Horticulture technologies for Uttar Pradesh" during Technology Vision-2035: in relevance to the State of Uttar Pradesh at UPCST, Lucknow on February 28, 2018.
- V.K. Singh acted as a Judge for screening the best mango varieties during Pradeshik Aam Mahotsav on June 24, 2017.
- V.K. Singh acted as a member for Screening Committee for the selection of Subject Matter Specialist in Horticulture in BUAT, Banda from August 16-22, 2017.
- V.K. Singh delivered a lecture on "Physiology of flowering and management of bearing in subtropical fruits" during Winter School (December 1–21, 2017) at ICAR-NRC Litchi, Muzaffarpur on December 12, 2017.
- V.K. Singh evaluated Ph.D. thesis entitled "Effect of salicylic acid on growth, physiochemical changes and yield of wheat (*Triticum aestivum* L.) under high temperature during anthesis" from NDUAT, Faizabad.
- V.K. Singh evaluated Ph.D. thesis entitled "Effect of temperature on reproductive physiology, fruit maturity and fruit quality of mango" from Jain University, Bangalore.
- V.K. Singh evaluated Ph.D. thesis entitled "Physiological characterization of rice under sodic soil" from NDUAT, Faizabad.

6 Human Resource Development

Training organized

- A.K. Verma, P.S. Gurjar and Gopal Carpenter gave 21 days summer training to 3 students (B.Tech. Agricultural Engineering) of Dr. PDKV, Akola, Maharashtra on Post harvest management of mango during May 20 to June 12, 2017.
- A.K. Verma, P.S. Gurjar, Gopal Carpenter and Maneesh Mishra organized two on-farm trainings for mango growers on Safe harvesting, ripening and packaging of Dashehari mango at Nabi Panah, Malihabad on May 25 and 29, 2017.
- Ashok Kumar coordinated three days exposure visit cum training on Nursery and orchard management of guava for six farmers of Arunachal Pradesh at ICAR-CISH, Lucknow from May 4-6, 2017.
- Ashok Kumar organized and coordinated 21 days short term training on Subtropical fruits to 12 students (B.Sc. Ag.) of Mewar University, Chittorgarh, Rajasthan during June 12 to July 3, 2017.
- Ashok Kumar and Israr Ahmad organized and coordinated short term training on Subtropical Fruits to 12 students (B.Sc. Ag.) of ITM University, Gwalior, Madhya Pradesh during July 20 to August 21, 2017.
- Ashok Kumar and Abha Singh organized and coordinated 5 days training on High density planting of mango & guava to 20 farmers including two officials from Hamirpur, H.P. during February 20-24, 2018.
- Ashok Kumar organized and coordinated 5 days training on Nursery management of fruit crops to 30 farmers from Sawai Madhopur, Rajasthan during March 13-17, 2018.
- Dipak Nayak organized Mahila Kisan Diwas at CISH Krishi Vigyan Kendra, Malda on October 15, 2017.
- Dipak Nayak started one year course of Diploma in Agricultural Extension Services for Input Dealers (DAESI) at CISH KVK, Malda on October 25, 2017.
- Dipak Nayak organized Dealers & progressive farmers' training programme at CISH RRS & KVK, Malda on November 3, 2017.
- Dipak Nayak organized trainings on Scientific mango production, scientific cattle rearing, scientific fish culture and scientific lentil production at CISH KVK, Malda during December 12-15, 2017.
- Dipak Nayak organized 3 days Refresher Course for ATMA functionaries from January 31-February 2, 2018.
- Dipak Nayak organized one day training on Tribal women empowerment for sustainable livelihood at ICAR-CISH RRS, Malda on February 10, 2018.
- Dipak Nayak organized one day training on Community pulses seed production on February 8, 2018.
- Dipak Nayak and Ashok Yadav organized Aam bagvani par saamayik kissan gosthi with tribal farmers on March 17, 2018.
- Maneesh Mishra and P.K. Shukla organized training on Milky mushroom cultivation for rural youth of Uttar Pradesh on March 21, 2018.
- Maneesh Mishra and R.A. Ram organized training cum workshop on Mango based poultry farming in collaboration with ICAR-CARI, Bareilly on August 18, 2017.
- Maneesh Mishra, P.S. Gurjar, A.K. Verma and Gopal Carpenter organized on-farm training for rural women on Improved method of mango dry slices and amchur production from raw mango at Mohammad Nagar Talukedari, Malihabad on May 4, 2017.
- Neelima Garg organized training in collaboration with UPCST for preparation of sugarcane vinegar through improved technology at Basaraiya and Ranikheda villages of Gosainganj, Lucknow on August 1 and September 1, 2017.
- Neelima Garg organized training on preparation of mango products for rural women from Nai Basti village at ICAR-CISH, Lucknow on December 11, 2017.
- S.K. Shukla organized and coordinated Gardeners' training for 76 participants sponsored by Agricultural Skill Council of India, New Delhi at ICAR-CISH, Lucknow during May 24 to June 23, 2017.
- S.K. Shukla organized a training on Health and hygiene for all for the staff of the Institute at ICAR-CISH, Lucknow on March 23, 2018.
- Subhash Chandra and Ashok Kumar organized 3 days training on Improved cultivation of subtropical fruits for 20 farmers from ATMA, Nasik, Maharashtra during November 29 to December 1, 2017.

- Subhash Chandra and Ashok Kumar organized 3 days training on Production, protection & postharvest management of subtropical fruits for 25 farmers and officials from Basti, Sidharth Nagar & Balrampur districts of UP at ICAR-CISH, Lucknow during September 21-23, 2017.
- Subhash Chandra and Ashok Kumar organized 3 days training on Production, protection & postharvest management of subtropical fruits for 25 farmers and officials from Basti, Sidharth Nagar, Balrampur, Kushinagar & Maharajganj districts of UP at ICAR-CISH, Lucknow during October 9-11, 2017.
- V.K. Singh organized a one month training programme for Green house operators under Pradhan Manti Kaushal Vikas Yojna (PMKVY) sponsored by Agricultural Skill Council of India (ASCI) at ICAR-CISH, Lucknow from January 15-February 14, 2018.

Training attended

- A K Trivedi attended short course on Phenomics: perspectives for application in improvement of abiotic stress tolerance in crop plants at ICAR-National Institute of Abiotic Stress Management, Baramati, Pune from July 20–29, 2017.
- Ashok Kumar attended 21 days training on Advances in simulation modelling and climate change research towards knowledge based agriculture at Centre for Environment Science and Climate Resilient Agriculture, ICAR-IARI, New Delhi from November 16- December 6, 2017
- Ashok Yadav undergone three months Foundation training for agricultural research service at ICAR-NAARM, Hyderabad from July 5 - October 4, 2017.
- Ashok Yadav attended one month orientation training at ICAR-CISH, Lucknow from October 16 - November 16, 2017.
- Ashok Yadav undergone three months professional attachment training at ICAR-NRCPB, New Delhi from November 20, 2017 - February 20, 2018.
- Dipak Nayak attended orientation programme of ATMA functionaries at ICAR-CISH RRS, Malda on August 8, 2017.
- Gopal Carpenter undergone orientation training as a part of 105th Foundation Course for Agricultural Research Services (FOCARS) at ICAR-CISH, Lucknow during April 17-May 15, 2017.
- Gopal Carpenter undergone three months professional attachment training at ICAR-CIAE, Bhopal during July 15-October 16, 2017.
- Neelima Garg attended training programme on Stress management at ICAR-NAARM, Hyderabad from July 12-15, 2017.
- S.K. Shukla attended training programme on Impact assessment of agricultural research and technologies at ICAR-NAARM, Hyderabad during September 12-19, 2017.
- S.K. Shukla attended training programme on TOT for master trainers organized by Agricultural Skill Council of India at ICAR-CISH, Lucknow during January 30-February 1, 2018.

7 Linkages and Collaborations

Institute has developed linkages with DAC-NCPAH, Ministry of Agriculture, DBT, PPV&FRA, UPCST, UPCAR, AMAAS and NICRA. MOUs have been signed with Amity University, Lucknow, Integral University, Lucknow, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, Banda University of Agriculture & Technology, Banda, U.P., Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar (W.B.) for pursuing research as part of M.Sc. and Ph.D. degrees of their students. Institute has signed MoC with the State Government of Andhra Pradesh for technology transfer of food processing sector. Institute is also recognized by IGNOU, New Delhi as one of the study centres for offering a Certificate course on Organic Farming. National Horticulture Mission has identified the Institute as nodal centre for imparting training on rejuvenation of old and unproductive mango orchards. Besides, the Regional Research Station of the institute at Malda has linkages with different National and International organizations such as Western Sydney University, Pernith, Australia, National Bee Board, Ministry of Agriculture & Farmers Welfare, Govt. of India, PPV&FRA, Department of Agriculture, Govt. of West Bengal, Directorate of Horticulture, Department of FPI & Horticulture, W.B., Ramakrishna Mission Ashram, Sargachi, Murshidabad, W.B., NABARD Regional Office, Kolkata and Agricultural Technology Management Agency (ATMA), Malda.

The externally funded projects carried out at the Institute are as follows

S.N.	Project Title	Principal Inv.	Period
	DAC, NCPAH, Ministry of Agriculture, GOI		
1.	Hi-tech horticulture for efficient utilization of resource through precision farming (PFDC)	Dr. V.K. Singh	2002–2019
	AMAAS, Mau		
2.	Network project on Microorganisms in agriculture and allied sectors Sub-Project: Microbial interventions for production of enzyme supplement for animal feed from fruit and vegetable mandi waste.	Dr. Neelima Garg	2017–2020
	DBT		
3.	Development of national data base on mango	Dr. S. Rajan	2013–2019
	UPCST		
4.	Mass multiplication of wilt resistant rootstock of guava through *in vitro* techniques	Dr. Maneesh Mishra	2016–2019
5.	Standardization of container gardening of fruits for catering the nutritional requirements of the city dwellers.	Dr. K.K. Srivastava	2017–2020
6.	Developing protocol for reduction of pesticide residues by microbial intervention in mango orchard soil	Dr. A.K. Bhattacherjee	2017–2020
	PPV & FRA		
7.	Developing national repository and facilities for DUS testing in Guava (*Psidium guajava*) and Litchi (*Litchi chinensis*)	Dr. S. Rajan	2012–2019
8.	Characterization of aonla varieties for developing DUS test guidelines	Dr. D. Pandey	2012–2019
9.	Validation of DUS descriptors of bael (*Aegle marmelos* Correa)	Dr. D. Pandey	2012–2019
10.	Development of morphological descriptors and DUS test guidelines for Jamun	Dr. A.K. Singh	2012–2019
11.	National DUS centre for mango crop	Dr. S. Rajan	2012–2019
12.	DUS testing centre on mango (additional centre)	Dr. D. Nayak	2017-2018
	ICAR Networking Project		
13.	Network project on transgenics in crops (Functional genomics of mango)	Dr. Anju Bajpai	2015–2020
14.	National Agriculture Innovation Fund	I/c PME	2008–2020

15.	National network project on Micronutrient management in horticultural crops for enhancing yield and quality	Dr. Tarun Adak	2014–2017
	UPCAR		
16.	Collection, evaluation and conservation of elite jackfruit (*Artocarpus heterophyllus* Lam.) germplasm (s)	Dr. G. Pandey	2014–2018
	RKVY		
17.	Refinement and demonstration of hydroponic techniques for high value vegetable production in subtropical areas	Dr. S.R. Singh	2017–2020
	Farmer FIRST Programme of KVK Scheme		
18.	Enhancing livelihood and profitability index of Malihabad farmers through diversified horti-enterprise modules	Dr. Maneesh Mishra	2016–2019
	National Initiative of Climate Resilient Agriculture (NICRA) Project		
19.	Understanding the changes in host pest interactions and dynamics in mango under climate change scenario	Dr. P.K. Shukla	2012-2020
	Seed Hub Project		
20.	Seed Hub Project at KVK, Malda	Dr. Dipak Nayak, ICAR-CISH RRS, Malda, W.B.	2016–2019
	Extramural Project		
21.	Collection, conservation and characterization of biodiversity of selected fruits and vegetables and explore the supply and market demand of fruits and vegetables in North Bengal	Dr. Dipak Nayak, ICAR-CISH RRS, Malda, W.B.	2016–2018
	Project Director, ATMA		
22.	Establishment of integrated farming system models	Dr. Dipak Nayak, ICAR-CISH RRS, Malda, W.B.	2017–2018
	National Bee Board, New Delhi		
23.	Establishment of integrated bee development centre (IBDC)	Dr. Dipak Nayak, ICAR-CISH RRS, Malda, W.B.	2018 onwards
	AICRP		
24.	AICRP on Fruits	Dr. Dipak Nayak, ICAR-CISH RRS, Malda, W.B.	2018 onwards
25.	AICRP on Honey Bees and Pollinators	Dr. Dipak Nayak, ICAR-CISH RRS, Malda, W.B.	2018 onwards

8

Regional Research Station and KVK, Malda

Background

The Regional Research Station of ICAR-Central Institute for Subtropical Horticulture at Makdumpur, Malda (West Bengal) was inaugurated on February 28, 2016 by Shri Krishnendu Narayan Chowdhury, Hon'ble Minister, Department of FPI & Horticulture, Govt. of West Bengal in the presence of Dr. N. K. Krishna Kumar, Deputy Director General (HS) and Dr. Shailendra Rajan, Director, ICAR-CISH, Lucknow. During the two year of journey, infrastructure was developed, human resources were deployed and research and demonstration activities were initiated at RRS, Malda. Integrated farming system models and nursery was established. Several training programmes were conducted at Station as well as in villages for enhancing the socio-economic status of tribal farmers. Research on characterization of fruit (mango, guava, bael, ber, jackfruit) and vegetables (amranthus, brinjal, chilli, moringa, and several minor leafy vegetables) had been initiated on DUS guidelines.

Infrastructure development

Office building

Presently, Regional Research Centre, Malda is housed in rented building of Food Park, English Bazar, Malda (West Bengal). Two scientists have joined the Centre. RRS, Malda has administrative block, common laboratory facility, one conference hall and one training hall with seating capacity of 80 and 60, respectively.

Regional Research Centre, Malda building and facilities developed

Nursery

Efforts have been made for establishment of fruits & vegetable nursery at ICAR-CISH RRS, Malda looking in to the demand of mango growers and vegetable growers. Initially, set up has been made to multiply around 30,000 grafted mango saplings which will be upscaled to 2.5 lakh plant capacity.

Fruits/vegetable nursery and ponds

Integrated farming system models

Regional Research Station, Malda developed 6 ponds over 5 acres of area and established Integrated Farming System (IFS) models by integrating different components of horticultural crops, livestock and fisheries.

Construction of boundary wall of RRS, Malda

Around 2.5 km long boundary wall of RRS, Malda has been constructed. The work is in progress.

Research Achievements

Collection of germplasm

Fruits

Germplasm of different fruit crops like mango, guava, jackfruit, ber, and acid lime were collected. Total 138 germplasm of mango were collected, out of them 65 were collected from Malda district and 73 from Murshidabad district. In case of jackfruit, ber and acid lime, 35, 26 and 12 germplasm were collected.

Vegetables

The Malda district is rich in diversity of vegetables. Major (amaranthus, brinjal, chilli, and moringa) and minor (kulekhara, kheshari, bothe, methi, chhola, lal sakh, spinach, brassica, palak, dhekisakh, notesakh, kolmi, centella, shanti Sakh, Lens, Lunia, and Surchi) vegetable crops were collected from Malda district. Maximum germplasm of moringa (70) was collected followed by chilli (27), brinjal (12) and amaranthus (5).

Characterization and evaluation of germplasm

Fruits

MANGO (*Mangifera indica* L.)

Evaluation of mango varieties revealed that maximum fruit length was observed in Mallika (13.4 cm) and minimum in Boro Darika (10.5 cm), whereas, highest fruit width was observed in Norohoro Bhog (8.3 cm), and minimum in Dudhkumar (7.4 cm). The ratio of fruit length/width was maximum in Bellia (2:1) and minimum in Boro Darika (1:7). Maximum fruit weight was registered in Norohoro Bhog (419.67 g) while minimum in Chatterjee (302 g). The TSS content varied from 18.3-20.2 °B while other varieties which had high TSS content are Chausa (20.2 °B), Nakeshari (19.5 °B), Guthi-4 (18.9 °B), Misrikant (18.8 °B), Madhu Latika (18.7 °B) and Rakhal Bhog (18.6 °B).

JACKFRUIT (*Artocarpus hetrophyllus* Lam.)

Total 35 accessions of jackfruit were collected from Malda district and characterized using DUS guidelines. The fruit length among the 35 accession varied from 23.1 to 53.4 cm. The accession AhIC-16 (53.4 cm) had highest fruit length while minimum was in AhIC-8 (40.8 cm). Among the 35 jackfruit genotypes, the fruit diameter varied from 23.5 to 45.3 cm where highest fruit diameter was observed in AhIC-20 (45.3 cm) and minimum in AhIC-4 (35.2 cm). The minimum fruit weight was observed in AhIC-34 (2.66 kg) whereas, maximum fruit weight was observed in AhIC-11 (12.51 kg).

BER (*Zyzyphus mauritiana* L.)

During series of survey, 26 genotypes of ber were collected from different parts of Malda district and characterized on morphological and biochemical parameters. The fruit length varied from 1.73 to 64.00 mm. Minimum fruit length was observed in genotype ZmIC-5 (1.73 mm) and maximum in ZmIC-23 (64 mm). Fruit width (mm) was lowest (1.8) in ZmIC-5 and highest in ZmIC-18 (34 .00) followed by ZmIC-23 (54.33), ZmIC-3 (47.33), ZmIC-25 (42.67), ZmIC-15 (33.33) and ZmIC-21 (32). Fruit weight, pulp-stone ratio, TSS and acidity varied from 2.5-74.91g, 0.73-15.53, 3.4-25.12 °B and 0.12-0.35 per cent, respectively.

GUAVA (*Psidium guajava* L.)

Among 12 genotypes collected, four were from Malda and eight from Baruipur area of West Bengal. The genotype PgIC-1 and PgIC-11 had maximum fruit length (7.53 mm) and minimum in PgIC-6 (7.20 mm). Fruit width (mm) varied from 5.53 in PgIC-3 to 7.67 in PgIC-7 followed by PgIC-6 (7.60), PgIC-11 (6.90), PgIC-8 (6.83) and PgIC-12 (6.80). Acidity content (per cent) was lowest in PgIC-4 (0.15) genotype whereas maximum acidity was observed in PgIC-3 (0.58) followed by PgIC-7 (0.57), PgIC-9, (0.50), PgIC-11 (0.34), PgIC-12 (0.33) and PgIC-6 (0.28). The TSS content varied from 3.8 (PgIC-10) to 15.47 °B (PgIC-3).

Vegetables

AMARANTHUS (*Amaranthus* spp.)

Total five genotypes of amaranthus were collected from Malda district and characterized on the basis of 26 DUS characteristics. Leaf length (cm) and leaf width was observed maximum in AtIC-4 (10.83, 7.9) followed by AtIC-5 (7.5, 5.1) whereas, minimum leaf length was observed in AtIC-2 (1.6) and leaf width in AtIC-3 (0.97). The plant height (cm) was highest in AtIC-5 (82.67) followed by AtIC-4 (77.0), AtIC-3 (72.33) whereas, least was observed in AtIC-1 (46.33). The "1000 seed weight" was recorded maximum in AtIC-1 (0.96) followed by AtIC-2 (0.83) and AtIC-3 (0.76) whereas, minimum was recorded for genotype AtIC-4 (0.55).

BRINJAL (*Solanum melongena* L.)

Fourteen genotypes of brinjal were collected from the Malda district and characterization was done on the basis of DUS guidelines. Maximum fruit length (cm) was observed in SmIC-3 (30.07), followed by SmIC-12 (22.47), SmIC-8 (21.1), SmIC-9 (20.4) whereas, minimum was observed in SmIC-1 (6.77). Fruit diameter in brinjal varied from a minimum of 3.6 cm in SmIC-8 to a maximum of 15.67 cm in SmIC-8. Fruit weight varied from 106.9 g in SmIC-8 to a maximum of 673.5 g in SmIC-3.

CHILLI (*Capsicum anumm* L.)

In chilli, total 27 genotypes were collected from Malda district and further characterization was done on the basis of 25 DUS characters. Fruit length among the 27 genotypes varied from 1.88 to 9.26 cm. Maximum fruit length (cm) was observed CaIC-23 (9.26), followed by CaIC-14 (8.67), CaIC-25 (7.81) and CaIC-9 (7.43) whereas minimum fruit length was observed in CaIC-16 (2.24). The fruit diameter and stalk length varied from 0.81-3.72 and 1.24-4.22 cm respectively.

MORINGA (*Moringa oleifera* L.)

Total 70 genotypes of moringa were collected and characterized on the basis of 14 characters. We observed phenol content in four parts of moringa i.e. leaf, flower, immature pod and mature pod. The phenol content in leaf, flower, immature pod and mature pod varied from 0.56-3.13, 0.48-2.3, 0.27-3.01 and 0.31-3.03 per cent, respectively.

9 List of Publications

Research papers

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10

Research Projects

IN-HOUSE PROJECTS

- Conservation and utilization of genetic resources for improvement of subtropical fruits for higher productivity and quality.
- Integrated nutrient, water, space and canopy management for improving productivity of subtropical fruits.
- Diagnosis of new and emerging biotic stresses, development of prediction models and devising integrated management schedules for higher productivity.
- Devising technologies for minimizing postharvest losses, value added products and marketing of subtropical fruits.
- Improving knowledge and skill of stakeholders for improving production of subtropical fruits.

Flagship Projects

- Resilience of mango (*Mangifera indica*) production to temperature, salt and moisture stresses.
- Integrated management of guava wilt.

EXTERNALLY AIDED PROJECTS (2017-2018)

S.N.	Project Title	PI	Period
	DAC, NCPAH, Ministry of Agriculture, GOI		
1.	Hi-tech horticulture for efficient utilization of resource through precision farming (PFDC)	Dr. V.K.Singh	May 2002 – March 2019
	AMAAS, Mau		
2.	Network project on Microorganisms in agriculture and allied sectors Sub-Project: Microbial interventions for production of enzyme supplement for animal feed from fruit and vegetable mandi waste.	Dr. Neelima Garg	2017-2020
	DBT		
3.	Development of national data base on mango	Dr. S. Rajan	2013-2019
	UPCST		
4.	Mass multiplication of wilt resistant rootstock of guava through *in vitro* techniques	Dr. Maneesh Mishra	2016-2019
5.	Standardization of container gardening of fruits for catering the nutritional requirements of the city dwellers.	Dr. K. K. Srivastava	2017-2020
6.	Developing protocol for reduction of pesticide residues by microbial intervention in mango orchard soil	Dr. A.K. Bhattacherjee	2017-2020
	PPV & FRA		
7.	Developing national repository and facilities for DUS testing in Guava (*Psidium guajava*) and Litchi (*Litchi chinesis*)	Dr. S. Rajan	2012 -2019
8.	Characterization of aonla varieties for developing DUS test guidelines	Dr. Devendra Pandey	2012 -2019
9.	Validation of DUS descriptors of bael (*Aegle marmelos* Correa)	Dr. Devendra Pandey	2012 -2019
10.	Development of morphological descriptors and DUS test guidelines for Jamun	Dr. A.K. Singh	2012 -2019
11.	National DUS centre for mango crop	Dr. S. Rajan	2012 -2019
	ICAR Networking Project		
12.	Network project on transgenics in crops (Functional genomics of mango)	Dr. Anju Bajpai	April, 2015 - March 2020
13.	National Agriculture Innovation Fund	I/c PME	2008- 2020
14.	National network project on Micronutrient management in horticultural crops for enhancing yield and quality	Dr. Tarun Adak	2014-2017

	National Initiative of Climate Resilient Agriculture (NICRA) Project		
15.	Understanding the changes in host pest interactions and dynamics in mango under climate change scenario	Dr. P.K. Shukla	2012- March 2020
	UPCAR		
16.	Collection, evaluation and conservation of elite jackfruit (*Artocarpus heterophyllus* Lam.) germplasm (s)	Dr. G. Pandey	2014 to 26.04.2018
	RKVY		
17.	Refinement and demonstration of hydroponic techniques for high value vegetable production in subtropical areas.	Dr. S.R. Singh	Sept, 2017-Sept. 2020
	FARMER FIRST Programme of KVK Scheme		
18.	Enhancing livelihood and profitability index of Malihabad farmers through diversified horti-enterprise modules	Dr. Maneesh Mishra	2016-17 to 2018-2019
	Seed Hub Project		
19.	Seed Hub Project at KVK, Malda (WB)	Dr. Dipak Nayak	2016-17 to 2018-2019
	Extramural Project		
20.	Collection, conservation and characterization of biodiversity of selected fruits and vegetables and explore the supply and market demand of fruits and vegetables in North Bengal	Dr. Dipak Nayak	2016-2018
	Project Director, ATMA		
21.	Establishment of Integrated Farming System Models	Dr. Dipak Nayak	2017-2018

All India Coordinated Research Project – Fruits: on-going experiments

1. Augmentation and evaluation of germplasm in mango
2. Testing of two superior mango clones of Dashehari
3. Selection from seedling progenies of improved mango hybrids (Improvement of mango through half sibs)- Ambika, Arunika
4. Scion breeding in mango
5. Development of organic package of practice for mango cv. Dashehari
6. Fertilizer scheduling for high density planting in mango
7. Effect of micronutrients on yield and quality of mango
8. Assessment of post harvest losses
9. Survey and surveillance of insect-pests and natural enemies in mango
10. Documentation and monitoring population of pollinators on mango
11. Management of mango hoppers and thrips using entamopathogens
12. Studies on seasonal occurrence of different diseases of mango
13. Cost effective management of post harvest anthracnose of mango by pre and post harvest treatments
14. Augmentation and evaluation of germplasm in guava
15. Testing the performance of promising hybrid selections of guava
16. Testing the performance of new promising hybrids/selections of guava (MLT3)
17. Enhancing input use efficiency in guava under HDP
18. New emerging pests in guava
19. Studies on seasonal incidence of different diseases of guava
20. Integrated management of guava wilt
21. Effect of climatic aberrations on mango flowering and yield

11 Consultancy, Patents and Commercialization of Technologies

Management of IP portfolio

- Institute designed and developed Fruit Fly Trap and applied for registration on 25-07-2017.
- Forty eight farmers' varieties of mango were registered with PPV & FRA.

Commercialization of technologies

- Institute commercialized Vinegar Production from Sugary Substrate using Immobilization Technique with Council of Science & Technology, U.P. for Rs. 50,000.
- ICAR-CISH technologies related information shared with ICAR-NAARM, Hyderabad on July 18, 2017 to facilitate its dissemination and commercialization.

Contract research

Contract research on 'Inclusion of Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) against powdery mildew and anthracnose of mango' was taken up with an amount of Rs. 3.00 Lakh from Bayer CropScience Limited, Lucknow.

Consultancy

- Consultancy services were provided to Self-Reliant Initiates through Joint Action (SRIJAN), an NGO for production of guava and mango.
- Technical support for strawberry transplantation and production was given to Ms. Sarita Gupta from Banthara, Kanpur Road, Lucknow on no cost basis.
- Consultancy services were provided to Mr. Aunan Sajid, Malihabad, Lucknow for nursery of capsicum seedling and mango pulp extraction on June 3, 2017.
- Consultancy services were provided to Mr. Deepak Shukla and Mr. Anchal Agrawal on June 27, 2017 for support in study of market potential of Deshehari mango pulp.

Memorandum of Understanding signed

- MoA signed with PPV & FRA and DUS Centres (Mango, Guava, Aonla, Bael and Jamun) at ICAR-CISH, Lucknow.
- ICAR-CISH signed the Memorandum of Cooperation (MoC) with State Government of Andhra Pradesh during Food Processing Summit on October 16, 2017.
- Memorandum of Understanding (MoU) for technology transfer is under process with Agro Gramin Limited (AGUN), Arunachal Pradesh.
- Memorandum of Understanding (MoU) for technology transfer is under process with Directorate of Agriculture, Uttar Pradesh.
- MoU has been signed for Probiotic Drink & Pickle Technology to Vishal Srivastav, Lucknow, Uttar Pradesh.

Consultancy to farmers through queries and exposure visits

The scientists of the institute provided consultancy to around 3133 farmers, state government officials (ATM/ BTMs) and students from various states of the country (Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Arunachal Pradesh, Bihar, Rajasthan and Punjab) regarding technologies and research activities of the institute through queries and exposure visits. Farmers queried mostly about insect and disease management in mango for hopper, mealy bug, thrips, stem borer, inflorescence midge, fruit joint insect, leaf webber, leaf cutter, shoot gall psylla, bark eating caterpillar, die back, anthracnose, black tip, wilt and malformation, irregular bearing and use of paclobutrazol in mango, rejuvenation and intercropping in mango, fertilizer doses in mango and guava, fruit drop in bael, mango and aonla, high density planting in guava along with mushroom and strawberry cultivation. They were also interested to know about the availability of grafted plants of various fruits / quality planting materials in the institute.

Awareness workshop on adoption of mushroom diversity for augmenting farmers' income

The income opportunities for rural women and landless labours are scanty in Malihabad, a famous mango belt in Uttar Pradesh. Viable livelihood options are needed for this most vulnerable group of farmers. In this connection ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow has organized "Mushroom Diversity Adoption Workshop" on September 20, 2017 under Farmer FIRST program to augment income of this targeted group of farmers. Seventy farmers

mostly rural women and small and landless farmers from Lucknow, Unnao, Lakhimpur Kheri and Hardoi districts participated in the workshop. Dr. Shailendra Rajan, Director, CISH emphasized the need to double farmer's income in next 5 years by interventions like mushroom, poultry and inter cropping of high value crops in mango orchards. Dr. Ved Ratan, Professor, Plant Pathology, C.S. Azad University of Ag. & Tech., Kanpur described in detail about button mushroom production technology. He told that there is a great demand of mushroom spawn and fruiting bodies. The farmers can earn as per their plan from a few thousands to lakhs per month from mushroom through spawn or fruiting body production. Sri Atal Bajpai, progressive farmer was also invited to motivate the farmers through his great success in mushroom production. Dr. P. K. Shukla, Senior Scientist emphasized on need to adopt round the year mushroom cultivation with button, oyster and milky mushrooms. Mushroom production kits were also distributed among the farmers after the workshop. Dr. Maneesh Mishra, Principal Investigator of Farmer FIRST project gave insight of the work being done towards doubling farmer's income.

Agriculture education for rural youth

In order to make young children acquaint about agriculture education, scientists of ICAR-CISH, progressive farmers and teachers organized a sensitization program at Golden Jubilee School at Nabi Panah (Malihabad). Director of the Institute stressed on importance of agriculture education in improving health and wealth of the nation. Students were taught about the various fields of agriculture, organic farming etc. The program was organized in Farmer FIRST village to encourage rural youth in agriculture. Two NGOs Awadh Aam Utpadak Bagwani Samiti and Society for Conservation of Mango Diversity also participated in the event. Scientist from the ICAR-CISH along with the local members of the community based organization organized awareness programme and explained the students about the prospects and requirements for the career in Agricultural Sciences. This stream of education can make them ready for available opportunities in banks, agriculture departments, state agriculture universities, ICAR and not the least in the increasing number of private companies working on production of agricultural inputs.

12 Research Advisory Committee (RAC)/ Institute Research Committee (IRC)

Research Advisory Committee

Twenty- second RAC meeting of ICAR-CISH was held on 28.11.2017. It was attended by:

i.	Dr. B.S. Chundawat, Ex-Vice Chancellor, Sardarkrushinagar Dantewada Agricultural University, Gujarat	:	Chairman, RAC
ii.	Dr. K.K. Jindal, Ex-ADG (Hort. Science) & Adjunct Professor, UGC	:	Member
iii.	Dr. N.S. Pasricha, Ex-Director, Indian Potash Institute and Ex-Head, Dept. of Soil Science, PAU, Ludhiana	:	Member
iv.	Dr. Prem Shankar Singh, Professor & Head, Dept. of Entomology, BHU, Varanasi	:	Member
v.	Dr. W.S. Dhillon, ADG (Hort.-I), ICAR, New Delhi	:	ICAR Nominee
vi.	Dr. S. Rajan, Director, ICAR-CISH, Lucknow	:	Member
vii.	Dr. R.M. Khan, Chairman, PME	:	Member Secretary

Following members could not be present owing to their pre-occupation

viii.	Dr. C. Aswath, Ex-Head, Division of Biotechnology, ICAR-IIHR, Bengaluru	:	Member
ix.	Dr. Abhijit Kar, Pr. Scientist, Division of Post Harvest Technology, ICAR-IARI, New Delhi	:	Member
x.	Shri Suvrat Pathak, Mohalla Patkana, Kannauj, nominated by Hon'ble AM	:	Non-Official member

Following intensive discussions amongst the participants, RAC made the suggestions/recommendations listed thereunder :

- Plant training system should be worked out for nursery for curtailing down the juvenile stage.
- Trees like bael should be avoided as filler crop. Rather short duration crops having market potential and compatibility with mango based cropping system should be opted.
- Institute may initiate work/programme on soil less culture/horizontal/vertical/aeroponic/hydroponic system in strawberry.
- Nutrient standards are required to be evolved with a proper understanding of deficient, optimum and high ranges of nutrient with respect to crop region. Data should also be shared with Dr. Pasricha for his guidance.
- Salt affected land in U.P. may be identified for promotion of salt tolerant rootstocks of mango.
- Work on shelf life of the fruit following withdrawal from the cold storage needs attention.
- Emphasis should be laid on development of sugar free products.
- Nutraceutical profile of varieties/promising germplasm of aonla, bael and jamun should be worked out and published.
- Product of spiced Aonla squash, Aonla Dil chew should be commercialized.
- Process should be initiated to release promising jamun and bael varieties.

Institute Research Committee (IRC)

The 40th meeting of Institute Research Committee was convened on April 29, May 1, 3, 4 and June 8, 2017 under the chairmanship of Director. Apprising the scientists about the emerging scenario particularly with reference to the resource crunch, policy framework *vis-à-vis* deliverable, issues concerning the farm productivity and farmers income, Director categorically stated that the plan of work and activities must be conceived with well defined and clear cut outcome in view. Activities lacking this cardinal principle would not find a place in any future programme. Stressing the point Director brought into sharper focus on the importance and experiences gained under MGMG for it may offer many thought provoking ideas, out of box narration and challenging opportunities for their incorporation in the research programmes. Following are the significant decisions/ suggestions:

Division of Crop Improvement & Biotechnology

- Mango germplasm collected so far need to be categorized for its utility in crop improvement/ hybridization programme.
- Parents of Arunika & Ambika or hybrids should be included in genomic studies for analysis of pulp and peel color to get better understanding.
- Studies should be planned based on the output generated in the experiments carried out on gene expression.
- New promising accession of bael-T_3 is required to be compared with B1 and B2.
- Emphasis should be laid during collection on characters like shell thickness, fruit drop and cracking in bael.
- Work should be taken up on regeneration of mango using somatic embryos and micrografting of regenerated shoots developed through somatic embryogenesis.
- Studies on transcriptome profiling of jelly seed needs to be taken up.
- Softwares developed on leaf area, disease spot identification etc. should be combined/compiled in comprehensive single software taking into account the utility points and develop a web app for use and evaluation.

Division of Crop Production

- In view of severe problem of shoot borer keeps emerging in the rejuvenated orchards, effective management schedule is required.
- Problems/factors responsible for limiting the off season production in subtropics needs to be listed out.
- Profitability factor in respect of various intercrops/ filler crops needs to be taken into account.
- Performance of guava varieties on espalier system under HDP should be evaluated.
- Fruit quality improvement in peach through flower thinning needs to be taken up.
- A collaborative approach may be adopted for working out various aspects of carbon sequestration in mango and guava orchards with changing age.
- Systematic data should be collected for addressing the bottle neck in adoption of CISH technologies, if any.
- Document needs to be developed enlisting market and consumer preferences in North India.
- Emphasis to be laid on cost effective sustainable production/multiplication of runners of strawberry.

Division of Crop Protection

- Division should develop mobile apps on insect pest and their management on mango and guava.
- In view of the livelihood of emergence of strawberry as a crop of commercial venture, work may be initiated on its pest/diseases and their management.
- Bioclimatic factors needs to be correlated with other different factors affecting pest dynamics.
- Studies may be taken up on the occurrence and prediction of different important species.
- Project should be formulated on bio management aspect with an special emphasis on pheromones for fruit fly management.
- Work may be taken up on direct and indirect factors affecting incidence of fruit fly.

Division of Post Harvest Management

- Literature available on minimally processed food should be documented with a view to develop new line of work in consonance with emerging scenario on consumer preferences.
- Aonla drinks developed in the Division should be evaluated in Pratapgarh region also.
- Safe limit of Calcium Oxalate needs to be ascertained.
- Practices being used currently after withdrawal of mango from storage should be documented and compared with the data generated by the scientist.
- Methods should also be evolved for handling large quantum of mango fruits.
- Existing recommendations on hot water treatment for ripening should be compared with current findings.
- Work carried on ethrel needs to be revisited.

Flagship Project : Integrated management of guava wilt

- Prevalence/identification of *Meloidogyne enterolobii* should also be confirmed from other regions having concentration of guava nurseries.

13 Participation in Seminars/Symposia/Conferences

Conference/Congress

Anju Bajpai participated in national conference on "Technological empowerment of women" held at Vigyan Bhawan, New Delhi during March 8-9, 2018.

Anju Bajpai and Muthukumar M. attended national conference on "Current scenario & future trends in biotechnology" at Bundelkhand University, Jhansi on March 28, 2018.

Neelima Garg, A.K. Bhattacherjee, P.K. Shukla, Bharati Killadi and Gundappa attended Third international conference on "Bioresource and stress management" held at State Institute of Agriculture and Management, Jaipur from November 8-11, 2017.

Neelima Garg attended 58th annual conference of Association of Microbiologists of India & international symposium on "Microbes for sustainable development: scope & applications" held at BBAU, Lucknow during November 16-19, 2017.

Neelima Garg attended international conference on "Microbial technology for better tomorrow" held at Dr. D. Y. Patil Arts, Commerce & Science College, Pimpri, Pune from February 17-19, 2018.

Neelima Garg attended conference on "Food processing and kisan SAMPADA" at ICAR-IISR, Lucknow on March 9, 2018.

P.K. Shukla attended international conference – AGRICON 2018 held at CSAUAT, Kanpur during February 14-17, 2018.

P.S. Gurjar and Gopal Carpenter attended "World Food India" international conference at Vigyan Bhavan, New Delhi during November 3-5, 2017.

P.S. Gurjar attended national conference on "Doubling farmers income: options and strategies" at ICAR-NAARM, Hyderabad from November 7-9, 2017.

P.S. Gurjar and Gopal Carpenter attended congress on "Recent need based and eco-friendly technologies for doubling farmers' income" at Bioved Institute, Allahabad (UP) during February 17-18, 2018.

Shailendra Rajan attended conference on "Climate change and agricultural production" at Bihar Agricultural University, Sabour, Bhagalpur, Bihar on April 6, 2017.

Shailendra Rajan and R.A. Ram attended national conference on "Perspectives of challenges and options in litchi production and utilization" at ICAR-NRC Litchi, Muzaffarpur on June 6, 2017.

Shailendra Rajan attended Ist North Indian Science Congress (NISC-2018) at BBAU, Lucknow on January 11, 2018.

Shailendra Rajan attended Director's Conference at NASC Complex, New Delhi during March 8-9, 2018.

Seminar/Symposium

A.K. Trivedi attended national seminar on "Water and soil management for agriculture and livelihood security under climate change" at Sunbeam College for Women, Bhagwanpur, Varanasi during September 8–9, 2017.

Anju Bajpai and Muthukumar M. participated in national symposium on "Recent trends in biotechnology: technology to skill development" held at SRMU, Lucknow during March 23-24, 2018.

Anju Bajpai and Muthukumar M. attended national seminar on "Role of biotechnology for the benefit of the people of Uttar Pradesh" at UPCST, Lucknow on March 27, 2018.

Maneesh Mishra, A.K. Bhattacherjee and P.S. Gurjar attended one day seminar on "Rural technology" at UPCST, Lucknow on December 8, 2017.

Neelima Garg and A.K. Trivedi attended national seminar on "Transforming agriculture to doubling of farmers income" at BBAU, Lucknow from February 10-11, 2018.

Shailendra Rajan attended two days seminar on "Agriculture research and education in relation to integrated development: challenges and solutions" as Chief Guest at ICAR-IISR, Lucknow on June 14, 2017.

Shailendra Rajan, V.K. Singh, S.K. Shukla, Dinesh Kumar, Bharati Killadi and Gundappa attended international symposium on "Horticulture: priorities & emerging trends" held at ICAR-IIHR, Bengaluru from September 5-8, 2017.

Shailendra Rajan attended "Uttar Pardesh State Credit Seminar 2018-19" at Regional Office of NABARD, Gomti Nagar, Lucknow on January 25, 2018.

Shailendra Rajan, Neelima Garg, V.K. Singh and Maneesh Mishra participated in "Horti-Entrepreneurship Seminar" held at ICAR-CISH, Lucknow on February 12, 2018.

V.K. Singh participated in national seminar on "Fertigation" at Vadodara, Gujarat on September 15, 2017.

Workshop

All the scientists of the Institute participated in one day workshop on "Agri-incubation for start-ups" at ICAR-CISH, Lucknow on August 17, 2017.

All the scientists of the Institute participated in one day workshop on "Safe use of pesticides in agriculture" at ICAR-CISH, Lucknow on December 11, 2017.

Anju Bajpai attended workshop on "Applications of single molecule real time (SMRT) sequencing and bioinformatics analysis" held at ICAR-NBFGR, Lucknow from July 25-26, 2017.

Gopal Carpenter attended workshop on "Skill and competency enhancement of scientists" at ICAR-NBFGR, Lucknow during November 6-7, 2017.

Gundappa attended 26th Annual workshop of AICRP on "Biological control of crop pests" held at DRSPUH&F, Solan during May 16-17, 2017.

Gundappa attended brainstorming session on "Thrips: challenges and management options" held at NASC Complex, New Delhi on September 22, 2017.

Gundappa attended national workshop on "Revisiting foundation course for agricultural research service (FOCARS): reflections and feedback of trained scientists" at ICAR-NAARM, Hyderabad during March 15-16, 2018.

K.K. Srivastava, Abha Singh, Ashok Kumar, P.K. Shukla, P.N. Barman and Gopal Carpenter participated in workshop on "Skill and competency enhancement of scientists" at ICAR-NBFGR, Lucknow from November 6-7, 2017.

Neelima Garg attended Sensitization workshop on "Intellectual property, technology management and entrepreneurship development" at ICAR-IISR, Lucknow on March 22, 2018.

P.S. Gurjar attended 'Krishi Unnati Mela' at ICAR-IARI, New Delhi during March 17-19, 2018.

R.A. Ram, S.K. Shukla, Maneesh Mishra, A.K. Verma, S.R. Singh, Ashok Kumar, P.K. Shukla, H.C. Verma, Gundappa, P.S. Gurjar and Dipak Nayak attended workshop on "Methodological framework for implementation of Farmers First Project" held at ICAR-CISH, Lucknow from October 3-6, 2017.

Shailendra Rajan attended the national workshop on "Doubling the income of mango growers in India" at ICAR-IIHR, Bengaluru on May 18, 2017.

Shailendra Rajan and Gundappa attended national workshop on "Developing a roadmap for agricultural knowledge management in India" at NASC Complex, New Delhi during September 27-28, 2017.

Shailendra Rajan participated in workshop on "Technology Vision-2035: in relevance to the State of Uttar Pradesh" at C.V. Raman Auditorium of UPCST, Lucknow on February 28, 2018.

V.K. Singh participated in one day workshop on "Food processing" held at State Horticulture Department, Bhopal on October 13, 2017.

Meetings

Anju Bajpai attended national meeting on Mango genomics with other ICAR partners and Dr. Robert Henry, Director QAAFI, University of Queensland, Australia held at ICAR-NRCPB, New Delhi on September 21, 2017.

Dipak Nayak attended the meeting on Market promotion and export of mango at the office of Deputy Director of Horticulture, Malda on April 30, 2017.

Dipak Nayak attended review meeting on Seed Hub on Pulses at ICAR-IIPR, Kanpur.

Neelima Garg attended "Mahila Kisan Diwas" at NASC Complex, New Delhi on June 16, 2017.

Neelima Garg attended IMC meeting of ICAR-IIHR, Bangalore on October 23, 2017.

Neelima Garg attended QRT meeting of ICAR-NBAIM, Mau on December 19, 2017.

Shailendra Rajan attended interactive meeting to discuss terms of reference for horticulture organized by ICAR Review Committee at NIAP, New Delhi on April 20, 2017.

Shailendra Rajan attended the EFC meeting at Division of Horticultural Sciences, Krishi Anusandhan Bhawan-II, Pusa, New Delhi on May 11, 2017.

Shailendra Rajan attended the review meeting of ICAR and State Govt. Department at Lok Bhawan, Lucknow on May 12, 2017.

Shailendra Rajan participated in ICAR monitoring committee-North Zone meet at Dr. YSPUH&F, Nauni, Solan, H.P. on May 25, 2017.

Shailendra Rajan attended third regional advisory summit meeting of "Kheton, kisano aur gramin chhetron ki samridh hetu chhetriya salahkar samuh" at NABARD, Lucknow on July 4, 2017.

Shailendra Rajan attended 17th Advisory (Expert) Committee meeting at Council of Science & Technology, U.P., Lucknow on July 7, 2017.

Shailendra Rajan participated in interface meeting on "Integrated development of horticulture in Western U.P. and Uttarakhand" at ICAR-IIFSR, Modipuram, Meerut on July 11, 2017.

Shailendra Rajan attended regional interactive session with stakeholders on India's sixth national report to the convention on biological diversity at CSIR-NBRI, Lucknow on August 23, 2017.

Shailendra Rajan attended first meeting of the Task force of action plan for Uttar Pradesh in connection with State agricultural research system at Directorate of Agriculture, Krishi Bhawan, Lucknow on August 24, 2017.

Shailendra Rajan attended a meeting on "Sankalp se sidhhi karyakram" at ICAR-IISR, Lucknow on August 29, 2017.

Shailendra Rajan attended ICAR Monitoring & Review Team of North Zone meet at GBPUA&T, Pantnagar, Uttarakhand during September 4-5, 2017.

Shailendra Rajan attended SFC meeting for consideration of schemes of DARE/ICAR for the period 2017-2020 at Krishi Bhawan, New Delhi from September 13-14, 2017.

Shailendra Rajan attended 25th meeting of Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Horticultural Crops at ICAR, Krishi Bhawan, New Delhi on September 18, 2017.

Shailendra Rajan attended ICAR Monitoring Committee-North Zone Meet at BHU, Varanasi during October 5-6, 2017.

Shailendra Rajan, V.K. Singh, R.A. Ram and P.K. Shukla attended 5th group discussion of ICAR-AICRP on Fruits at NRC for Banana, Tiruchirapalli during February 15-18, 2018.

Shailendra Rajan attended ICAR-IISR, Lucknow Scientific Advisory Committee Meeting at ICAR-IISR, Lucknow on March 13, 2018.

Shailendra Rajan attended meeting on "Doubling farmers income in five years" at Kisan Mandi Bhawan, Gomti Nagar, Lucknow.

V.K. Singh attended meeting for smooth function of PMKSY programme "Per drop more crop – micro irrigation" at Directorate of Horticulture & Food Processing, UP on August 25, 2017.

V.K. Singh participated in meeting of Mid-term review of PFDCs at ICAR-CIAE, Bhopal during October 12-13, 2017.

V.K. Singh attended the meeting to finalize the DPR on Cluster based study of mango of Saharanpur area at Directorate of Horticulture and Food Processing, UP on January 17, 2018.

V.K. Singh attended meeting for registration of firms for implementing the micro irrigation yojna under PMKSY programme Per drop more crop at Directorate of Horticulture and Food Processing, UP on January 27, 2018.

V.K. Singh attended the meeting to review the priority of research in U.P. at UPCAR, Lucknow on March 12, 2018.

14 Seminars/Workshops/Trainings/Events Organized

Training on Subtropical Fruits

A training programme on the cultivation of subtropical fruits was organized at ICAR-CISH from June 12 to July 3, 2017. As many as 12 students from Nagaland, Orissa and MP participated in the training programme on production technology of subtropical fruit crops. Participants were made aware of new high yielding varieties, high-density planting, integrated nutrient and water management, pest and disease management. During the training programme, the students were exposed to nursery management of fruit crops as well as tissue culture. Hands-on training on grafting, budding, pruning and other techniques used in orchards and nursery management were also demonstrated. The participants were exposed to various modern equipment required for research in the field of horticulture, biotechnology and other related subjects. The students had practical exposure to various techniques to which they had not been exposed so far. Exposure to the postharvest division was one of the interesting parts of the training. The students also learned how to manage polyhouse and shade net houses. The training also included strawberry cultivation under subtropics.

Participation in mango exhibitions and festivals

ICAR-CISH participated and displayed rich diversity of mango in Mango Festival held at Indira Gandhi Pratisthan, Lucknow during June 24-25, 2017. The mango varieties displayed by the Institute was a major attraction to the visitors. About 300 mango varieties and hybrids were displayed by the Institute. Mango varietal display motivated many mango lovers to plant multi-variety orchards which are gradually disappearing due to the dominance of commercial varieties. Honorable Chief Minister, Uttar Pradesh Shri Yogi Adityanath Ji visited Institute exhibition stall during festival. He showed interest in mango hybrid Arunika developed at ICAR-CISH, Lucknow. He took keen interest in mango diversity conserved at CISH which is the largest mango variety collection of the world. He was appraised about the new hybrids being developed in the Institute. ICAR-CISH Lucknow was awarded first prize for displaying maximum number of varieties in the show.

ICAR-CISH participated and displayed mango varieties and hybrids in 29th National Mango Festival at New Delhi during July 1-3, 2017. Arunika and Ambika

varieties developed by the Institute attracted the masses in Delhi. Dozens of coloured varieties were displayed by different research organisations and private growers but the most attractive varieties were Ambika and Arunika and several other hybrids displayed at the stalls of the Institute. Honorable Minister for Tourism, Delhi Govt. Shri. Rajender Pal Gautam visited Institute stall and keenly observed the varieties released by our Institute. He also appreciated Institute for displaying large number of varieties and hybrids.

Workshop on Stress management: causes and remedies

Institute organized a workshop on "Stress management: causes and remedies" on July 29, 2017 for its Scientists, Officers and Staff to improve the human resource development capabilities. The workshop was inaugurated by Dr. Shailendra Rajan, Director, ICAR-CISH, Lucknow. The chief guest of the workshop, Dr Vijay Narayan Tiwari, Joint Director (OL), CSIR-CDRI, Lucknow addressed the audiences on stress management. He explained the initial, central and extreme level of stress. On this occasion, Dr. Neelima Garg, Head, PHM also gave a talk on stress management.

Workshop on Sensitization on agri-incubation for startup

Workshop on "Sensitization on Agri-incubation for Startup" was organized at ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow on August 17, 2017. On this occasion, Dr. Shailendra Rajan, Director, ICAR-Central Institute for Subtropical Horticulture welcomed all participants and enlightened on entrepreneurship in horticulture. Dr. Poonam Jayant Singh, Dr. A. K. Sharma and Dr. T. Damodaran, Scientists from different ICAR institutes delivered lectures on entrepreneurship and startup. Dr. Singh from ICAR-NBFGR, Lucknow told about Atal Innovation Mission, NITI AYOG Policy, Seed Capital, Angle Inventors and Venture Capitals. Dr. Sharma from ICAR-IISR, Lucknow said about National Entrepreneurship Policy, E-Agriculture Strategies, Entrepreneur Development Policy etc. Dr. T. Damodaran, RRS, ICAR-CSSRI, Lucknow delivered a lecture on "Prospects of entrepreneurship development in bio-hardening and bio-formulation production venture" and Dr. Tarun Adak, ICAR-CISH, Lucknow delivered a lecture on "Training need of farmers under skill development programme for entrepreneurship and start-up.

Workshop on mango based poultry farming

A workshop was organized on August 18, 2017 in the Institute on mango based poultry farming. Fifty five farmers belonging to Farmer First project participated in this program. Mango based poultry is an innovative effort. In this farmers have been given new varieties of poultry like CARI-Devendra, Hitakari, Upvari, Shyama and Nirbhik, developed at ICAR-Central Avian Research Institute, Bareilly. The mango farmers are keeping them in their orchards. The poultry starts feeding in orchards after 8 weeks, which not only reduces the number of insects in mango but also reduces the expenditure on feeding which makes it a profitable business. The latest information related to family poultry farming was given by Dr Chandrahas, Senior Scientist, ICAR-Central Avian Research Institute, Bareilly to the farmers. He told how compared to the broiler, the cost of family poultry can be reduced and more profit can be earned. Former Principal Scientist, ICAR-Central Avian Research Institute, Bareilly and Poultry expert Dr R. B. Rai trained farmers on issues related to poultry diseases and their health. This workshop was organized by Dr. Ram Awadh Ram and Dr. Maneesh Mishra. Two non-governmental organizations Awadh Aam Utpadak Bagwani Samiti,

Nabi Panah and Society for Conservation of Mango Diversity, Kasmandi Kalan also participated in this program.

Training on organic farming

Institute organized training programme on organic farming at Rath and Hamirpur in Bundelkhand region on September 11, 2017 in collaboration with Organic India Pvt. Ltd. More than 200 farmers learned to produce organic inputs at the farm with locally available materials.

Workshop on Methodological framework on implementation of Farmer FIRST Project

A four day workshop on Methodological framework on Implementation of FFP was organized jointly by ICAR-NAARM, Hyderabad and ICAR-CISH, Lucknow during October 3-6, 2017 at Institute. Eleven ICAR Institute and SAU from zone-II and zone-III participated in the workshop. Experts from ICAR-NAARM, ICAR-DKMA, ICAR-IASRI and ICAR-NCAP gave training to participants on qualitative and quantitative impact assessment analysis, participatory technology development, participatory appraisal tools, documentation and report writing and database management. Project Management Committee also visited Nabi Panah and Mohammad Nagar Talukedari villages of Malihabad to review the progress of Farmer FIRST project of ICAR-CISH, Lucknow.

DDG (HS) visits Farmer FIRST adopted villages

DDG (Horticulture Sciences) Dr. A.K. Singh visited Nabi Panah village of Malihabad to see mango based poultry farming on November 23, 2017 and interacted with stakeholders. Director, ICAR-CISH, Lucknow and scientists of ICAR-CISH accompanied him to village.

DDG (AE) reviewed the Farmer FIRST Project

Deputy Director General (Agril. Extension) Dr. A.K. Singh visited Farmer FIRST villages to review the ongoing activity of the program being carried out by ICAR-CISH, Lucknow towards doubling farmers income in Malihabad on December 11, 2017. He interacted with the farmers who adopted mango based farming system and appreciated the efforts of scientists and farmers on augmenting income of small and marginal farmers.

Kisan Mela cum Agricultural Technology exhibition organized

Kisan Mela-cum-Agricultural Technology Exhibition was organized by ICAR-CISH, Lucknow on November 30, 2017. More than 450 farmers adopted under Farmer FIRST and PFDC projects took part in the event. Kisan Mela-cum-Agricultural Technology Exhibition was inaugurated by Dr. B.S. Chundawat, Former Vice-Chancellor, Sardar Krushinagar Dantewada Krishi Vishwa Vidyalaya along with Dr. Shailendra Rajan, Director, ICAR-CISH, Lucknow, Dr. Mathura Rai, Former Director, ICAR-IIVR, Varanasi and Dr. U.S. Gautam, Director, ICAR-ATARI, Kanpur. The farmers expressed their gratitude to the Institute and its mission mode program such as Farmer FIRST, Precision Farming Development Centre and Mera Gaon Mera Gaurav for providing technological back up for augmenting their income. Farmers under Farmer FIRST project brought their produce for sale at the Exhibition. Institute has introduced a diversified horti-module *viz*., mango based poultry farming which has spread to 4 villages in Malihabad and helped in doubling income to close to 100 farmers in 8 months time. Institute honoured 10 progressive farmers who could augment their income many fold through Institute's initiative. Many publications containing information on horticultural technology were inaugurated during the event. Dr. Shailendra Rajan, while addressing farmers, said that horticulture is one of the most important sectors in realizing the vision of Hon'ble Prime Minister Sri Narendra Modi on doubling farmer's income.

World Soil Day celebrated

World Soil Day was celebrated on December 5, 2017 in ICAR-Central Institute for Subtropical Horticulture, Rehmankheda, Lucknow. Under this, information was given to nursery men on how to prepare the disease-free plant material in the Lucknow district. Speaking on the occasion, Dr. Shailendra Rajan, Director of the Institute, said that soil health is important for sustained high yielding but equal attention is not given on this side. For nursery owners, the sick soil of their nursery is unsafe, which also spread diseases and high levels of nematode infestations are also seen in new areas. The infestation of nematodes is a serious issue in the soil of the nursery, which has been harmful for the cultivation of guava in different parts of the country. Keeping in view the importance of the use of soil health and balanced nutrients of crops, the Government of India has distributed 100 million Soil Health Cards to the farmers. ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow is also contributing in this direction. On this occasion, Dr. R.M. Khan, Principal Scientist (Nematology), Dr. P.K. Shukla, Senior Scientist (Plant Pathology), Dr. R.A. Ram, Principal Scientist (Horticulture) and Dr. Tarun Adak, Scientist (Soil Physics) gave information on soil health management.

Awareness workshop on Safe use of pesticides in agriculture

One day workshop on 'Safe use of pesticides in agriculture' was organized in collaboration with Bayer CropScience Limited on December 11, 2017 for discussing careful use of pesticide to reduce its dreadful effects on the human health and environment. Importance of Public Private Partnership to create awareness among the farmers to inculcate good agricultural practice to reduce the adverse effects of the pesticides was also deliberated. Farmers of the Farmer FIRST project also participated in the workshop.

27th Institute Management Committee Meeting held

Institute organized 27th Institute Management Committee Meeting on December 20, 2017. Dr. Shailendra Rajan, Director in his introductory remark gave detailed account of the progress made by Institute since last IMC meeting. Action taken report was presented by Sri R. N. Mallik, Senior Administrative Officer. Dr. Maneesh Mishra, Principal Scientist and special invitee of IMC made presentation on achievements of Farmer FIRST project. A total of 7 agenda items were presented before the committee which were approved. Dr. Amresh Chandra, Head, ICAR-IISR, Lucknow, Dr. B.L. Ram, Chief Horticulturist, Directorate of Horticulture, Govt. of UP., Dr. Neelima Garg, Head, PHM Division and Dr. G. Pandey, Head, Crop Production were present during the meeting.

Annual review meeting of DUS organized

The ICAR-CISH organized the Annual DUS Review Meeting at ICAR-IISR, Lucknow during January 15-17, 2018. Dr. S. Rajan, Director underlined the need to standardize on-site test methodology of DUS testing of fruit crops for completing the testing in 2 years which usually takes more time due to long juvenile period. Progress on on-site certification of mango, kagji lime and walnut varieties were reviewed during the meeting. During the meet, it was observed that the Institute should provide technical assistance to facilitate the farmers' variety registration.

Greenhouse operator training under ASCI

The ICAR-Central Institute for Subtropical Horticulture, Lucknow under the aegis of Precision Farming Development Centre conducted Skill Development Training of 200 hours as per the guidelines of Agriculture Skill Council of India for Greenhouse Operators at its experimental farm at Rehmankhera from January 15 to February 14, 2018 for developing entrepreneurship in the area of green house production and management. Thirty trainees from different parts of the country attended the training. With the increasing number of greenhouses for cultivation of high value vegetables, flowers and nursery production, there is an increasing demand of greenhouse operators who can manage protected structures effectively. The training is exceedingly useful for those youth who wish to opt for greenhouse operator as a profession. Dr V.K. Singh and Dr. S. R. Singh, Principal Scientists of the institute were the key resource persons.

Agro-biodiversity Exhibition

ICAR-CISH, Lucknow showcased the diversity of mango, guava, jamun and aonla maintained by the Institute at ICAR-IISR, Lucknow premise on January 16, 2018. Initiatives made by the Institute for the protection of farmers' varieties with the help of communities were also displayed. More than 400 farmers visited the exhibition. Diversity in anola, guava, bael and sem (Dolicos bean) were also displayed. A good number of temperate vegetable varieties were displayed which include different types of lettuce, Swiss chard, kale.

Horti-entrepreneurship seminar

The ICAR-Central Institute for Subtropical Horticulture, Lucknow in collaboration with Centre for Agriculture and Rural Development (CARD) organized a one day Horti-entrepreneurship seminar on January 19, 2018. It was inaugurated by Shri Sudhir Garg, Principal Secretary (Horticulture), Govt. of U.P., Lucknow. Dr. Anis Ansari, Chairman, CARD, Dr. S. Rajan, Director, ICAR-CISH, Mr. Nabin Roy, AGM, NABARD, Ms. Neera Chakravarty, Zonal Manager, Indian Bank and scientists from ICAR-CISH and different other Institutes attended the seminar. During the seminar, technical sessions on entrepreneurship development in the field of tissue culture, green house cultivation, high tech nursery and value addition were organized and attended by seventy experts and entrepreneurship aspirants and bankers. Financial assistance available for different areas of Horti-entrepreneurship was discussed among state department officers, bankers and delegates. The potential Horti-entrepreneurs attended the seminar from various districts of the Uttar Pradesh. On this occasion, legal issues, registration and government clearances related with financial requirement of different technologies were explained by the resource persons.

Workshop on Display methods for extension of agro-technologies

Workshop on "Display methods for extension of agro-technologies" was organized at ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow on February 2, 2018. The workshop was inaugurated by Dr. Shailendra Rajan, Director, ICAR-CISH, Lucknow. All the scientists of the institute participated in the workshop. On the occasion, Dr. Shailendra Rajan, delivered a talk on "Over view of agriculture based museums in India'' and apprised how museum can play major role in extension of technologies. The scientists delivered lecture on Infographic methods, digital presentations, miniature physical agro-technology models and different types of charts used to showcase technologies in the museum.

Horti-entrepreneurship seminar organized

ICAR-CISH, Lucknow in collaboration with SDSH and CARD organized Horti-entrepreneurship seminar on February 12, 2018 which was inaugurated by Smt. Anju Bala, Member of Parliament, Misrikh. A total number of 154 potential entrepreneurship participated from different parts of Uttar Pradesh. The seminar was focussed on entrepreneurship development in value addition, nursery, green house and tissue culture. Experts from research institutions, industry and state Government officials gave detail accounts of starting business in these four niche areas. Dr. Shailendra Rajan, Director spoke in detail about entrepreneurship development in nursery of horticultural crops. The participants were given exposure visit to CISH nursery, poly houses, processing hall and tissue culture lab. Demonstration was given to all the participants in these areas.

Live broadcasting of Prime Minister's speech

Honorable Prime Minister Narendra Modi inaugurated 25 new Krishi Vigyan Kendras in the country on the occasion of Krishi Unnati Mela, 2018 organized by ICAR-Indian Agricultural Research Institute, New Delhi from March 16-18, 2018. On this occasion, ICAR-Central Institute for Subtropical Horticulture under the guidance of Dr. Shailendra Rajan, Director arranged live broadcasting of Prime Minister's speech for farmers. The stall of the Institute was installed in which the technologies developed by the institute were displayed. Farmers and gardeners from all over the country took knowledge of the technologies developed by the institute and showed eagerness to adopt them. At the same time, more than 500 farmers were invited at ICAR-Central Institute for Subtropical Horticulture to listen the direct speech of the Honorable Prime Minister. Following a direct broadcast speech of the Prime Minister in the Rehmankhera campus, a discussion was also organized on the issues related to horticulture in which Dr. Maneesh Mishra, Dr. V.K. Singh, Dr. S. K. Shukla, Dr. P.K. Shukla, Dr. (Mrs.) Neelima Garg explained the solution of various problems of the gardeners.

Training programme on milky mushroom cultivation

A training programme on the cultivation of milky mushroom was organized at ICAR-CISH, Lucknow on March 21, 2018. Milky mushroom is not common among the farmers but with the gradual interest of consumers increasing in it, it is becoming popular and ICAR-CISH thought of conducting training on it for increasing the profit of the farmers as well as use of resources when the season of button mushroom is over. ICAR-CISH has helped to overcome the problem of mushroom growers by regular production and supply of spawn to the growers as per the season. About 120 farmers participated in this programme along with 10 rural women of village Mohammad Nagar Talukedari. Farmers were given tips on how they could improve the quality of the produce as well as retain its white color and freshness for a longer period. The importance of cleanliness in mushroom production was also discussed. Dr. P.K. Shukla assured the entrepreneurs to regularly provide technical assistance and consultation to the mushroom producers by the institute.

Training programmes

The Precision farming Development Centre (PFDC), ICAR-CISH organized three training programmes in three districts of Uttar Pradesh, *viz.* Basti, Sultanpur and Mirzapur on drip irrigation, polyethylene mulching and protected cultivation of high value vegetables. About one hundred eighty farmers, orchardists and state government officers were trained. Apart from these trainings, 28 on-farm trainings and field visits were also conducted. A special training programme for Green House Operator was organized from January 15 to February 14, 2018 under Pradhan Manti Kaushal Vikas Yojna (PMKVY) in flagship scheme of the Ministry of Skill Development & Entrepreneurship (MSDE) under Agricultural Skill Council of India (ASCI) in PFDC project with objective to provide the expertise in Green House operation and crops production techniques with skill certification that will help the youth in securing a better livelihood.

Training Programmes and Field Visit at Basti

Training Programmes and Field Visit at Sultanpur

Training Programmes and Field Visit at Mirzapur

Skill development programme for Green House Operator

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Distinguished Visitors

1. Shri Amit Srivastava, Asstt. Vice President, Conifer Agro Connect, Gurgaon (April 10, 2017).
2. Shri Parkash Kulkarni, Agricultural Technologist, Pune (April 17, 2017).
3. Shri Parvesh Kumar Chaturvedi, 60, Bannubal Nagar, Delapir, Bareilly (April 17, 2017).
4. Shri S.A. Khan, Proprietor, Indo Danis Laboratories, Lucknow (April 18, 2017).
5. Dr. Azab Singh, D.S. Group, Katni, M.P. (April 21, 2017).
6. Dr. T. Damodaran, Principal Scientist, Regional Research Station, ICAR-Central Soil Salinity Research Institute, Lucknow (April 21 & May 6, 2017).
7. Shri Mohsin Khan, Shri Satish Kumar, Member Export Cell, U.P. Mandi Parishad, and N.C. Lohakare, AGM, APEDA, New Delhi (April 22, 2017).
8. Shri Farhad Goharzad & Fariborz Shohrati, Head of International Affairs in PPO of I.R. Iran (April 25, 2017).
9. Dr. Ayaz Ahmad, Resource Person, Central Institute of Indian Languages, Department of Higher Education, Govt. of India, Hunsur Road, Mysuru-570006 (May 1, 2017).
10. Shri A.K. Shah, Progressive Farmer, Itanagar, Aruanchal Pradesh (May 4, 2017).
11. Dr. R. B. Rai, Ex. Director, ICAR-CARI, Port Blair, A & N Island (May 6, 2017 and February 13, 2018).
12. Shri Narendra Kumar, Project Coordinator Dhan Foundation, Kasmandi Kalan, Malihabad (May 9, 2017).
13. Shri Shivam Naik, YMC (NGO) Funded by NABARD, Renukoot, Distt. Sonbhadra, U.P. (May 19, 2017).
14. Dr. S. N. Tirpathi, Director, Training, Academy of Management Studies, Faizabad Road, Lucknow (May 27, 2017).
15. Shri Rakesh Kumar Singh, Admn. Officer, India Literacy Board, Shakshrata Niketan, Kanpur Road, Lucknow (May 31, 2017).
16. Shri Yuri V. Plagatar, Dr. S.C. Corr and 5 other member of the Russian Academy of Sciences, Director of the Nikitsky Botanical Gardens, National Scientific Centre of the RAS Yatta, Russia (June 1, 2017).
17. Shri Randeep Ghosh, VNR Nursery, Raipur (June 8, 2017).
18. Dr. Harvansh Singh, and Dilip Rai, Dabur India Ltd., Lucknow (June 7, 2017).
19. Shri Mukul Sharma, D.D. Kishan, New Delhi (June 7, 2017).
20. Dr. Ravi Parkash, Registrar (Farmer's Rights, Forestry and M & AP), PPV & FRA, New Delhi (June, 9, 2017).
21. Dr. P. K. Singh, Principal Scientist, ICAR-IISR, Lucknow (June 9, 2017).
22. Shri Keshaw Singh Bhadauria along with 6 farmers from Bhind, Madhya Pradesh (June 12, 2017).
23. Shri S. S. Rana, Hindustan Insecticide Limited, Lucknow (July 4, 2017).
24. Ms. Priyanka Upadhyay, Sr. Manager (Technical), Bee Chems, New Delhi (July 5, 2017).
25. Dr. Arvind Kumar Shukla, Project Coordinator, MSPE, IISS, Bhopal (July 11, 2017).
26. Professor Y.K. Sharma, Botany Department, Lucknow University, Lucknow (July 11, 2017).
27. Shri Gaveshwar Tyagi, Farmer, House No. 604, Ward-I, Ballabhgarh, Faridabad, Haryana (July 12, 2017).
28. Shri Alok Gupta, Bureau Incharge, Sahara News Bureau, Sahara India Network, Ist Floor, Ramkumar Plaza, Hazratganj, Lucknow (July 13, 2017).
29. Shri Vinay Shukla, Exporter, Agrarian Development Consoultant Pvt. Ltd., Lucknow (July 24, 2017).
30. Shri Vikash Dixit, Senior Reporter, Sahara News, Kanpur (July 24, 2017).
31. Shri Sanjiv Kapur, Sr. Manager, Business Development, Goldmine Advertising Ltd., Lucknow (July 24, 2017).
32. Dr. K.J. Singh, Scientist Fellow, CSIR-NBRI, Lucknow (July 25, 2017).
33. Shri Anwar Ali, National Powerlifting Champion, Government of India and International Powerlifting Federation, Balaganj Chauraha, Hardoi Road, Lucknow (July 25, 2017).
34. Shri Ritesh Sharma, Farmer, Ex. Chairman, Municipal Council, Dhaulpur, Rajasthan (July 26, 2017).
35. Shri Bhim Singh, Addl. Chief Project Coordinator, Lupin Human Welfare & Research Foundation, 160, Krishna Nagar, Bharatpur-321001, Rajasthan (July 27, 2017).
36. Dr. S.K. Sharma, Former Director, ICAR-CAZRI, Bikaner, Rajasthan (July 27, 2017).
37. Shri Rohit Singh, Project Manager, Pradhan Mantri Kaushal Vikas Yojana. EOS DDU Venture Pvt., Lucknow (August 3, 2017).
38. Shri Umesh Chandra Shukla, Secretary, Praga Gramothan Sewa Samiti, Prithvipuram Colony, V.I.P. Road, Fatehpur, U.P. (August 4, 2017).
39. Dr. Ajay Kumar Gupta, Product Development Manager, Dupont Crop Protection (August 8, 2017).

40. Professor S.W. Akhtar, Vice Chancellor and Dr. Mohammad Haris Siddique, Director Research, Integral University, Lucknow (August 9, 2017).
41. Dr. B.P. Singh, Ex. Director, ICAR-CARI, Izatnagar, Bareilly, Uttar Pradesh (August 9, 2017).
42. Shri Rohit Singh, Skill India, Lucknow (August 11, 2017).
43. Shri Mohammad Khan, Retd. Executive Engineer, Village and Post, Paatehpur Khas, Moradabad, U.P. (August 25, 2017).
44. Dr. A. K. Mishra, Sr. Horticulture Officer, National Horticulture Board, 2 Sapru Marg, Directorate of Horticulture, Lucknow (September 12, 2017).
45. Shri Ashim Siddiqui, Tains Natural Health Care Centre, Bilgram Road, Hardoi (September 21, 2017).
46. Dr. Narendra Singh. Corporate Cane Development Coordinator, Team Leader-CoEC, Lucknow (September 26, 2017).
47. Dr. Purshottam Kumar Mishra, Field Development Manager, Crop Science Division, Bayer Crop Science Limited, Lucknow, U.P. (September 26, 2017).
48. Dr. Y. P. Dubey, Ex. Principal Scientist, Department of Organic Agril., CSKHPKV, Palampur, Himachal Pradesh (October 3, 2017).
49. Shri Shobhit Srivastava, CARD, Lucknow (October 12, 2017).
50. Shri Mohd. Saeed Ansari, Manager-Special Projects, (Central & Eastern U.P.), Aliganj, Lucknow (October 12, 2017).
51. Shri Balram Singh and Shri Ratan Singh, Organic Farming India Ltd., Lucknow (November 11, 2017).
52. Dr. Sameer Sawant and Dr. Vidhu Sane, Scientists, CSIR-NBRI, Lucknow (December 7, 2017).
53. Shri Anurag Bajpai, Senior Sales Officer, Force Motor Limited, Lucknow, Uttar Pradesh (December 12, 2017).
54. Shri Prateek Singhal, Area Manager-Sales, Eurofins, Genomics, Lucknow (December 7, 2017).
55. Dr. P.K. Mishra, Field Development Manager, Crop Science Division, Bayer Crop Science Limited, Lucknow (December 8, 2017)
56. Dr. A.K. Singh, DDG (Agril. Extn.), ICAR, KAB-I, New Delhi-110 012 (December 11, 2017).
57. Dr. R.K. Thakur, Joint Director (Ento.), Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, HP (December 19, 2017).
58. Dr. Nisha Kakhesh, Research Adviser, Western Sydney University, NSW, Australia (December 19, 2017).
59. Shri B.N Srivastava, Deputy Director, CPWD, Lucknow (December 20, 2017).
60. Shri Vijay Rastogi, Consultant, Horticulture Consultancy Group, Lucknow (December 27, 2017).
61. Shri A.J.S. Gohar, Managing Director, Gohar Group, Sector 53, Noida-201307 (December 28, 2017).
62. Dr. Pankaj Kumar Tyagi, Dy. General Manager, Regional Manager, National Seeds Corporation, Barganwa, Near Picadilly Hotel, Lucknow (December 28, 2017).
63. Dr. O.P. Chaturvedi, Director, ICAR-IGFRI, Jhansi (January 4, 2018).
64. Shri Ram Gobind Singh, Farmer, Begusarai, Bihar (January 4, 2018).
65. Dr. T. K. Behra, Principal Scientist (Hort.), ICAR-IARI, New Delhi (January 16, 2018).
66. Shri Naresh Modi and Krishna Kaushal, Joint Project Director, NCPAH, New Delhi (January 18, 2018).
67. Shri Nitesh Kumar, FlCP, SRIJAN, Delhi (January 27, 2018).
68. Dr. V.P.Pandey and Dr. M.K. Pandey, NDUA&T, Faizabad (January 29, 2018).
69. Shri Rajesh Yadav, UPBO, Director, Known-You Seed India Pvt. Ltd., Ashiana, Lucknow (February 2, 2018).
70. Shri R.B. Singh, Seed Production Officer, U.P. Beej Vikas Nigarm,Vanarasi (February 6, 2018).
71. Dr. P.C. Dubey, IFS, Addl. PCEF, Madhya Pradesh (February 19, 2018).
72. Shri Anurag Srivastava, Director, Hishu Solutions Pvt. Ltd., Vibhuti Khand, Gomti Nagar, Lucknow (February 20, 2018).
73. Dr. S. I. Anwar and Dr. R.D. Singh, Principal Scientists, ICAR-IISR, Lucknow (March 3, 2018).
74. Dr. Murtaza Khan, Add. Cane Commissioner, U.P. (Retd.), Aashiana Colony, Lucknow (March 5, 2018)
75. Shri Ramchandra, Ex.DD (Seed Certification), U.P. State Seed Certification, Lucknow, Uttar Pradesh (March 15, 2018).
76. Dr. D. K.Verma, DHO, Lucknow (March 16, 2018).
77. Shri Deepak Parsadm, Lead Auditor (ISO), Member Quality Council of India, CEO (Acting), SeHat, New Delhi (March 19, 2018).
78. Shri P.K. Rathi, Lead Distt. Manager, Bank of India, LDM Office, 1 Nawal Kishore Road, Hazratganj, Lucknow-226001, Uttar Pradesh (March 21, 2018).
79. Shri Bhikhari Singh, Ex. Dist. President BJP, Lucknow, Nabipanah, Malihabad Lucknow (March 22, 2018).
80. Shri Manoj Kumar, Knowledge Management and Capacity Building Expert, TSA-VCSC Technoserve India), 2nd Floor, Core 5-8 India Habitat Centre, Lodhi Road, New Delhi-110003 (March 23, 2018).
81. Dr. Bangali Babu, Former National Director, NAIP, New Delhi (March 27, 2018).
82. Dr. Milind R. Patil, Agronomist, Jain Irrigation, System Ltd., Jalgaon, Maharashtra (March 28, 2018)

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Personnel

Scientific

S. No.	Name of the Scientist	Degree	Designation
1.	Dr. S. Rajan	Ph.D.	Director, ICAR-CISH
	Division of Crop Improvement and Biotechnology		
2.	Dr. Devendra Pandey	Ph.D.	Principal Scientist (Hort.) & I/C Head CI&BT
3.	Dr. A.K. Singh	Ph.D.	Principal Scientist (Hort.)
4.	Dr. Ram Kumar	Ph.D.	Principal Scientist (Hort.) Retired on 31-1-2018
5.	Dr. Maneesh Mishra	Ph.D.	Principal Scientist (Hort.)
6.	Dr. (Ms.) Anju Bajpai	Ph.D.	Principal Scientist (Genetic & Cyto.)
7.	Mr. H.C. Verma	MCA	Scientist S.G. (Computer Application)
8.	Dr. Muthukumar M.	Ph.D.	Scientist (Biotech.)
9.	Dr. Israr Ahmad	Ph.D.	Scientist (Biotech.)
10.	Mr. Umesh Hudedamani	Ph.D.	Scientist (Pl. Breeding)
11.	Ms. Veena G.L. (on study leave)	M.Sc.	Scientist (Fruit Sci.)
12.	Ms. Antara Das (on study leave)	M.Sc.	Scientist (Biotech.)
13.	Ms. Swosti Suvardarsini Das (on study leave)	M.Sc.	Scientist (Fruit Sci.)
	Division of Crop Production		
14.	Dr. Ghanshyam Pandey	Ph.D.	Principal Scientist & I/C Head Crop Production
15.	Dr. V.K. Singh	Ph.D.	Principal Scientist (Pl. Physiology)
16.	Dr. R.A. Ram	Ph.D.	Principal Scientist (Hort.)
17.	Dr. S.K. Shukla	Ph.D.	Principal Scientist (Hort.)
18.	Dr. Dinesh Kumar	Ph.D.	Principal Scientist (Hort.)
19.	Dr. Naresh Babu	Ph.D.	Principal Scientist (Hort.)
20.	Dr. K.K. Srivastava	Ph.D.	Principal Scientist (Hort.)
21.	Dr. Shyam Raj Singh	Ph.D.	Principal Scientist (Hort.-Veg. Science)
22.	Dr. Ajaya Kumar Trivedi	Ph.D.	Principal Scientist (Pl. Phy.)
23.	Dr. Ashok Kumar	Ph.D.	Principal Scientist (Environmental Sci.)
24.	Sh. Subhash Chandra	Ph.D.	Scientist (S.G.)(Agril.Ext.)
25.	Dr. Tarun Adak	Ph.D.	Scientist (Soil Phy./Soil & Water Conservation)
26.	Dr. Prananath Barman	Ph.D.	Scientist (Hort.-Fruit Sci.)
27.	Dr. Atul Singha (Till 24.06.2017)	Ph.D.	Scientist (Soil Microbiology)
	Division of Crop Protection		
28.	Dr. R.M. Khan	Ph.D.	Principal Scientist (Nematology) & I/C Head
29.	Dr. P.K. Shukla	Ph.D.	Senior Scientist (Plant Pathology)
30.	Dr. Gundappa	Ph.D.	Scientist (Agricultural Entomology)
31.	Dr. M. Balaji Rajkumar (Till 24.06.2017)	Ph.D.	Scientist (Agricultural Entomology)
	Division of Post Harvest Management		
32.	Dr. (Ms.) Neelima Garg	Ph.D.	Principal Scientist (Microbiology) & Head
33.	Dr. A.K. Bhattacherjee	Ph.D.	Principal Scientist (Ag. Chem.)
34.	Dr. (Ms.) Abha Singh	Ph.D.	Principal Scientist (Food & Nutrition)
35.	Er. A.K. Verma	M. Tech.	Scientist (S.G.)(FM&P)
36.	Dr.(Ms.) Bharti Killadi	Ph.D.	Scientist (Hort.- Veg. Science)
37.	Dr. Pawan Singh Gurjar	Ph.D.	Scientist (Fruit Sci.)
38.	Ms. Jotirmayee Lenka (on study leave)	M.Sc.	Scientist (Fruit Sci.)
39.	Er. Gopal Carpenter (w.e.f. 15.04.2017)	M. Tech.	Scientist (Farm Mach. & Power)
	RRS-Malda		
40.	Dr. Dipak Nayak	Ph.D.	Scientist (Fruit Sci.)
41.	Dr. Ashok Yadav (w.e.f. 28-02-2018)	Ph.D.	Scientist (Fruit Sci.)

Technical

S. No.	Name of the officer	Highest Degree	Designation	
1.	Dr. S.K.S. Raghav	Ph.D.	T-9	CTO (FT)
2.	Mr. Santosh Kumar	M.Sc. (Ag.)	T-9	CTO (FT)
3.	Dr. Raghubir Singh	Ph.D	T-9	CTO (FT)
4.	Mr. Sanjay Kumar	M.Sc.	T-9	CTO (LT)
5.	Mr. Abhay Dixit	M.Sc.	T-9	CTO (LT)
6.	Mr. S.K. Arun (till 31.12.2017)	B.Sc. (Ag.)	T-9	CTO (LT)
7.	Dr. Vinod Kumar Singh	Ph.D.	T-9	CTO(LT)
8.	Smt. Rekha Chaurasia	M.Sc.	T-7-8	ACTO(LT)
9.	Mr. Anil Kumar Singh	M.Sc.	T-7-8	ACTO(LT)
10.	Mr. D.K. Shukla	M.Tech.	T-7-8	ACTO(LT)
11.	Mr. Bahadur Singh	Dip. (Refrig.)	T-7-8	ACTO (WS)
12.	Mr. Chandra Bhal	B.Sc.	T-7-8	CTO (LT)
13.	Dr. Om Prakash	Ph.D.	T-6	STO (LT)
14.	Mr. Ramendra Tewari	B. Tech	T-6	STO (WS)
15	Mr. Arvind Kumar	M.Sc. (Ag. Extn.)	T-6	STO (LT)
16.	Smt. Priti Sharma	M.Sc., M.Phil.	T-6	STO (LT)
17.	Mr. Brajendra Kumar Pushkar	M.Sc. (Hort.)	T-6	STO (FT)
18.	Mr. Ganga Sharan	M.A.	T-5	TO (LT)
19.	Mr. R.K. Mishra	High School	T-5	TO (Arts)

Administrative

S. No.	Name of the officer	Degree	Designation
1.	Mr. R. N. Mallik (w.e.f. 03.04.2017)	B.Sc.	Senior Administrative Officer
2.	Mr. Dhiraj Sharma	M.A. (English)	Assistant Director (OL)
3.	Mr. Ashish Srivastava	B.Sc., L.L.B.	Finance & Accounts Officer
4.	Mr. S.D.P. Dixit	M.A. (Hindi)	Assistant Administrative Officer
5.	Mr. G.P. Misra	Intermediate	Private Secretary

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Other Information

Lecture delivered at TEDx

Dr. Shailendra Rajan delivered a lecture on KING OF FRUITS "MANGO" and the craft that goes into creating new varieties in TEDx SRMU on January 20, 2018. TEDx provides a platform where many successful entrepreneurs, social workers, artists, engineers, doctors etc. share their experiences.

Rare books on mango varieties

A monograph on Mango of Uttar Pradesh in two volumes written by Dr. L.B. Singh and Dr. R N. Singh and "The Mango" by Drs S.R. Ganguly, Ranjit Singh, S.L. Katyal and Daljit Singh, written more than sixty decades back were gifted by Padma Shri Dr. K. L. Chadha to ICAR-CISH library.

DD Kisan in Malihabad

Activities undertaken in adopted villages for enhancing farmer's income under Farmer FIRST project at ICAR-CISH, Lucknow was covered by DD Kisan Channel on June 6 and 7, 2017. A farmer–scientist interaction based on mango orchard planting, management, plant protection, safe harvesting, ripening, packaging, marketing, value addition of raw and ripe mango and poultry was conducted under "Kisan Prashn Manch" television programme, later on it was telecasted on National DD Kisan channel. The queries related to mango production and post harvest management raised by farmers were answered by scientists.

Farmers gosthi and vegetable seedlings distribution

Institute organized a farmer's goshti under Mera Gaon Mera Gaurav programme on August 4, 2017 at Mohiddipur village of Kakori block of Lucknow district. More than 40 farmers from Mohiddipur, Saidpur, Nabinagar and Pahiya Azampur participated in the gosthi as these villagers are mainly involved in vegetable farming and floriculture. The hybrid seedling of bitter gourd, bottle gourd and pumpkin were distributed to the farmers. The farmers also enlightened about the techniques to double their farm income through vegetable production.

Vigilance awareness week

ICAR-CISH observed the Vigilance awareness week during October 30 to November 4, 2017. The theme of the week was "My Vision-Corruption Free India". Awareness created among staff members to eradicate corruption from the system. The essay, quizzes and

debate competitions on how to make corruption free India were organized at the Institute. Awareness programme was also conducted at schools, Panchayat Bhavan and Anganbadi kendras in villages adopted under Mera Gaon Mera Gaurav.

Capacity building of farmers from eastern Uttar Pradesh

A three day's training programme was conducted on various technologies for subtropical fruit production at ICAR-CISH for 30 farmers from eastern districts of Uttar Pradesh during October 9-11, 2017. The training was sponsored by the centre of excellence for mango situated at Basti. The trainees were exposed to various theory and practical aspects on varieties, crop production, insect pest management and post harvest management. This training was useful for learning various aspects of advance nursery management practices, improved cultivation practices, value addition and setting up large scale nursery for fruits in Eastern UP.

Training on aonla products

ICAR-CISH organized one day hands on training at December 11, 2017 on aonla products in the Division of Post Harvest Management. A group of 38 women and students from the Naibasti village under Mera Gaon Mera Gaurav programme enthusiastically participated in the training programme.

Attracting youth in agriculture

Fifty students of 9th and 12th standard along with 5 teachers and Principal of the school visited ICAR-CISH, Lucknow as a part of their educational tour on December 16, 2017. In course of their visit, the students were addressed by the scientists. Students visited the farm where they saw the scientific cultivation of different crops and poly house cultivation of tomato. They visited post harvest technology and molecular biology laboratory and interacted with the scientists on different aspects of fruit crops.

Scientist-farmers interactions meet

A scientist-farmers interactions meet was organized at Belgarha village, Malihabad, Lucknow under the ICAR networking project on "Micronutrient management in horticultural crops for enhancing yield and quality" on August 29, 2017. Scientists interacted with the farmers and suggested measures for enhancing their income and discussed about the need for rejuvenation in old and senile orchards, canopy management, nutrient management, drip fertigation, precision farming and post harvest technologies. Two free mobile apps developed on raw and ripe mango products on Google Play Store were displayed.

Kisan Gosthi at Hafijkheda

Institute organized a farmer's goshti under Mera Gaon Mera Gaurav Programme on May 17, 2017 at Hafijkheda village of Malihabad block of Lucknow district. More than 45 farmers mainly mango growers and some nurserymen from Hasnapur, Wazidnagar, Shahimabad and Hafijkheda participated in the gosthi. CISH mango harvester was demonstrated to the farmers for safe harvesting of mango fruits. Farm women enlightened about processing and value addition of raw mango dropped during occurrence of dust storm. Efficient methods for peeling, cutting and drying of slices were explained to rural women. Farm women were advised for organized and direct marketing of their produce to earn more income.

Malihabad farmers participated in National Workshop

ICAR-NAARM, Hyderabad organized a National Workshop on "Let's Listen to Farmers" during December 22-23, 2017. From Uttar Pradesh, five farmers (Mohammad Harun, Upendra Kumar Singh, Mohammad Shafique, M. P. Singh and Ram Kishor Maurya, all from Malihabad) from Farmer FIRST Project participated in this workshop. Hon'ble Minister of Agriculture (State) Sri Gajendra Singh Sekhawat listen to all the five farmers. Farmers from across the country participated in the workshop. A road map for doubling farmers' income was developed through this workshop.

Hindi Diwas celebrated

Hindi Diwas program was organized on September 14, 2017 at the Institute. It was inaugurated by Dr. Neelima Garg, Director Incharge. On this occasion, she emphasized the relevance of the official language of Hindi and gave many statistics related to Hindi which reflects the growing importance of Hindi language Dr. Ghanshyam Pandey, in-charge crop production division, spoke on the constitutional requirement of Hindi. Hindi Pakhwada 2017 programs were started from Hindi Diwas.

International Yoga Day

Institute celebrated International Yoga Day on June 21, 2017. All staff of Institute participated and performed yoga.

World Environment Day celebrated

World Environment Day Celebration held at ICAR-CISH on June 5, 2017. Director I/C Dr. D. Pandey emphasized on the role of biodiversity conservation, plantation of new mango varieties as well as judicious use of natural resources. Dr. Ashok Kumar presented his view on adaptation of diversified crops like strawberry and pepino under subtropical environmental condition. Dr. Gundappa discussed on pesticide free mango orchards followed by discussion about soil carbon sequestration to mitigate elevated atmospheric CO_2, climate change and environmental pollution by Dr. Tarun Adak.

ICAR-CISH, RRS, Malda, WB

The mango and tourism festival

The mango and tourism festival was organized by Department of Tourism and Department of Horticulture and FPI, Govt. of West Bengal during July 8-9, 2017 in Malda district of West Bengal. A huge crowd visited ICAR-CISH stall and was astonished to see the rich diversity of mango (115 varieties). More than 100 farmers participated in the festival and motivated for conserving the diversity in traditional varieties. ICAR-CISH RRS Malda received appreciation for Best Mango Diversity Stall in the Festival.

Mahila Kisan Diwas

RRS, Malda organized Mahila Kisan Diwas on October 15, 2017 in presence of Dr. Debabrata Majumdar, TIFAC, Ministry of Science and Technology, Govt. of India as Special Guest and officials from District Line Departments. About 75 tribal farm women attended the programme.

Inauguration of DAESI programme

One year course of Diploma in Agricultural Extension Services for Input Dealers (DAESI) was inaugurated at ICAR-CISH, KVK, Malda on October 25, 2017 by Shri Subrata Biswas, IAS (Principal Secretary and Commissioner, Malda Division) as a Chief Guest in presence of District Magistrate, Malda, Director SAMETI, Director, ICAR-CISH and other dignitaries.

Dealers and progressive farmers training programme

Dealers and progressive farmers' training programme was organized on November 3, 2017 at ICAR-CISH RRS and KVK, Malda by Fertilizers Association of India-Eastern Region in collaboration with IFFCO (Indian Farmers Fertilizers Cooperative Company Limited).

Refresher course for ATMA functionaries

A refresher course for ATMA functionaries (ATMs & BTMs) was held at ICAR-CISH KVK, Malda during January 31 to February 2, 2018 with financial support from Department of Agriculture, Govt. of West Bengal. Fifty ATMA functionaries attended the programme from 15 different blocks of Malda district.

Tribal farmers meet at Kheribari

The scientists of ICAR-CISH RRS, Malda interacted with the tribal farmers of Kheribari village on March 15, 2018. The knowledge regarding the kitchen gardening was given to the farmers. The seed of different vegetables (brinjal, chilli, bottle gourd, cowpea, bitter gourd, pumpkin) which were suitable for kitchen gardening, were given to the tribal farmers.

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Meteorological Parameters

	Temperature (°C)		Humidity (%)		Bright Sunshine (hour/day)	Wind speed (km/hour)	Wind Direction (Code)	Rainfall (mm)	Evaporation in 24 hour (mm)
	Max.	Min.	Max.	Min.					
April, 2017	38.4	18.6	87.9	24.0	8.1	3.6	25.0	0.0	9.4
May, 2017	39.5	22.2	91.0	30.7	8.6	4.4	22.7	12.6	10.9
June, 2017	39.1	25.1	89.5	41.8	7.4	3.8	22.4	41.0	13.7
July, 2017	32.6	25.4	94.4	68.7	3.3	3.4	25.3	417.0	7.1
August, 2017	33.1	25.7	93.6	66.1	3.3	3.3	22.5	374.6	7.0
September, 2017	34.4	24.6	94.3	58.7	6.4	1.9	24.5	53.2	8.4
October, 2017	34.1	18.9	84.4	53.7	7.3	0.6	23.7	0.0	6.2
November, 2017	28.1	10.3	74.5	44.3	5.1	0.7	20.7	0.0	4.0
December, 2017	23.7	7.0	79.7	44.6	5.0	0.8	20.4	0.0	3.4
January, 2018	19.7	4.4	83.5	53.7	4.8	1.6	23.3	18.6	3.5
February, 2018	26.3	8.0	85.7	43.3	6.7	2.2	25.6	0.0	5.1
March, 2018	33.2	12.3	90.4	37.6	8.4	2.7	24.5	6.0	7.8

Monthly average weather data for 2017-18

Meteorological data recorded during the year 2017-18 at the Institute's observatory indicated the highest and lowest mean monthly maximum temperatures 39.5 and 23.7 °C during the months of May and December, 2017, respectively. Similarly, the highest and lowest mean monthly minimum temperatures were recorded 25.7 and 4.4 °C during the month of August 2017 and January 2018, respectively.

Maximum and minimum relative humidity (RH) was varied between 74.5 to 94.4 per cent and 24.0 to 68.7 per cent, respectively. Average wind speed of 0.6 to 4.4 km/h and average bright sunshine hours of 3.3 to 8.6 h were also recorded. A range of 9.4-13.7 mm per day pan evaporation was recorded during fruit setting and developmental stages (April – June) while 3.4-5.1 mm per day in winter season (November - February). Total rainfall of 923.0 mm was received during the year. The rainfall amount was restricted from May to September with highest value of 417.0 mm in the month of July 2017. Unseasonal rainfall of 18.6 mm was recorded in the month of January.

Based on the weather data, agro-advisories were issued to the growers for effective orchard management during the season on weekly basis both in Hindi and English.

स्वच्छ भारत, समृद्ध भारत

एक कदम स्वच्छता की ओर

हर कदम, हर डगर
किसानों का हमसफर

भारतीय कृषि अनुसंधान परिषद

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