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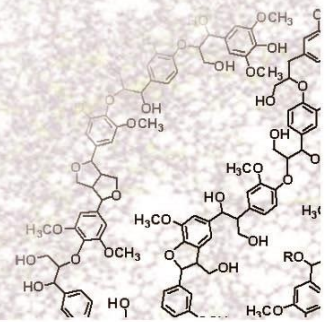
Agenda Notes

IRC Meeting

03-04 March 2020



ICAR-INDIAN INSTITUTE OF SPICES RESEARCH

Kozhikode- 673012, Kerala

DIVISION OF CROP IMPROVEMENT AND BIOTECHNOLOGY

Project I: Conservation, characterization and sustainable utilization of genetic resources of spices
[Project leader: Dr. K.V. Saji]

1. Gen. XXVIII (813): Conservation and characterization of *Piper* germplasm (2008-2020) [Dr. K.V. Saji, Dr. M.S. Shivakumar and Dr. Honnappa Asangi]

Decisions:

- Record of the germplasm has to be maintained in the division.
- Collect germplasm for a trait, which should immediately go into evaluation.
- A list of cultivars available in the germplasm has to be prepared.
- All the exotic varieties has to be planted and evaluated in the field.
- The promising drought tolerant accessions collected recently has to be multiplied and evaluated on priority basis.

Technical programme	Achievements
Conservation of germplasm (nursery and field gene bank) at Peruvannamuzhi	Three thousand 466 accessions are maintained at the Germplasm nursery at the experimental farm, Peruvannamuzhi.
Conservation of field gene bank at Kozhikode	The field gene bank of black pepper comprising 223 accessions is maintained properly.
Conservation of field gene bank at CHES, Chettalli	At present the field gene bank at CHES, Chettalli are with 627 cultivar accessions. These plants are in second year of bearing stage. Yield characters were recorded. In addition to this 108 more accessions were planted in the new block. 12.68-acre additional land was allotted for extending the black pepper field gene bank. Clearing the area, planting of new standards and germplasm accessions will be taken up in a phased manner.
Characterization and evaluation of germplasm accessions.	Eighty-two germplasm accessions of black pepper aggregated from pepper cultivating tracts of Karnataka, Kerala, Goa and Maharashtra were characterized for 17 quantitative and 12 qualitative traits as per the IPGRI descriptors during 2018-19 at the field gene bank. Wide range and high coefficient of variation (CV) was recorded for dry berry weight, fresh berry weight and number of spikes vine^{-1} whereas, lower CV was observed for berry size.
Collection of germplasm from the unexplored regions	A unique black pepper accession with extra-long spike (34.5 cm) collected from the estate of Tata Coffee, Madikeri. In addition to this an exploration program conducted to unexplored areas of Andaman and Nicobar Islands and collected 4 accessions of *Piper* spp.
Planting of germplasm accessions in the field	A new field gene bank established consisting of 300 accessions. Established black pepper plot with released varieties, promising lines and famers varieties on non-living standards. This includes nine released varieties and 19

	promising lines (10 each) and farmers varieties.
Multiplication, conservation and evaluation of drought tolerant	50 accessions were shortlisted. They are being multiplied and conserved for further evaluation.

2. **Gen. XIX (813): Conservation, characterization, evaluation and improvement of *Zingiber* and *Curcuma* sp. (2007-2020) [Dr. D. Prasath, Dr. K.V. Saji, Dr. Aarthi S., Dr. H.J. Akshitha & Dr. Honnappa Asangi]**

Decisions and Action taken:

- Turmeric genotypes without bitterness and astringency, suitable for salad purpose may be identified: Turmeric genotypes will be screened for bitterness and astringency, after harvest of germplasm lines and varieties.
- Control variety has to be kept and compared while screening germplasm for quality.
- Genotypes suitable for dry ginger have to be identified: One hundred and twenty two genotypes of ginger were evaluated for the quality attributes namely, dry recovery, essential oil, oleoresin, crude fibre, volatile and pungent components and genotypes with specific quality traits were identified.

Technical programme	Salient achievements
Maintenance of ginger and turmeric germplasm.	668 ginger accessions are being maintained in the field gene bank. The ginger germplasm conservatory was enriched with 12 ginger accessions which includes five red ginger accessions, from Nagaland, four *Z. officinale* and nine *Zingiber* sp. from Andamans. 1404 *Curcuma* accessions are being maintained in the field gene bank. The germplasm conservatory enriched with four turmeric accessions from Nagaland, three *Curcuma longa* and five *Curcuma* sp. from Andaman.
Characterization of turmeric germplasm (200 accessions)	Characterization of 165 turmeric accessions was carried out based on different morphological traits. A total of 12 quantitative and 10 qualitative characters were recorded for each turmeric accession.
Evolving extra-long and bold turmeric lines through clonal selection and OP seedling progenies.	12 accessions of Salem Local (Erode and Salem district of Tamil Nadu) and four accessions of Mydukkur (Andhra Pradesh) were characterized for morphological characters. Also, open pollinated seeds of 17 turmeric accessions from germplasm were collected and raised 420 seedling progenies. Collected 13 open pollinated seeds of Salem Local turmeric accession. Seedlings yet to germinate.
Evaluation and characterization of high oil ginger genotypes.	122 ginger genotypes were evaluated for the essential oil, oleoresin, crude fibre, essential oil constituents and gingerol content. The essential oil, oleoresin and crude fibre varied between 1.0-3.0%, 2.85- 10.26% and 3.1-

	8.6% respectively. 20 exotic ginger accessions were evaluated for morphological, rhizome and quality characters. Two shortlisted mango ginger (*Curcuma amada*) accessions have been included in the new CVT trial 2019 on mango ginger. The seed rhizomes of two genotypes (Acc. 265 and Acc. 347) were multiplied and supplied to seven AICRPS centres for planting of new CVT.
Multiplication of nucleus seed of released varieties	Multiplied three ginger and seven turmeric varieties (Suvarna, Sudarsana, Suguna, IISR Prabha, IISR Prathibha, IISR Kedaram and IISR Alleppey Supreme) as nucleus seed.

3. **Gen. XXXIII (813): Identification of core collection, characterisation and maintenance of cardamom germplasm (2012- 2020) [Dr. Honnappa Asangi, Dr. H. J. Akshitha, Dr. S. J. Ankegowda, Dr. Mohammed Faisal Peeran, Dr. Sharon Aravind Dr. Balaji Rajkumar, M & Dr. K. Anees]**

Decisions and action taken:

- Dr. Honnappa Asangi will be the PI of the project and Dr. Akshitha will be Co-PI: Project is taken over by Dr. Honnappa Asangi.
- Dr. Anees K. may be associated with the project. Ms. Sivaranjini will be disassociated from the project: Dr. K. Anees is associated.
- All farmers' varieties have to be collected and maintained in the germplasm: Thirteen farmer's varieties are maintained in farmer's varieties trial and DUS block.
- A booklet on farmer's varieties has to be prepared.
- The specific traits contributing resistance in thrips tolerant lines has to be recorded: Recorded.
- Unique collections have to be registered with NBPGR: Will be done.
- Accessions with dual resistance to rhizome rot and leaf blight have to be identified: Out of 168 lines screened under field conditions germplasm lines IC349358; IC349333, IC349334 showed dual resistance (Resistant to Moderately resistant reactions for Rhizome rot and leaf blight). Pot culture experiment showed resistance reaction to rhizome rot.
- The germplasm block has to be given highest importance and it should be maintained perfectly.
- Honey bee colonies has to be maintained in cardamom block to ensure pollination: Four honeybee hives are being maintained.
- Drought escapes in cardamom has to be collected: Will be taken up.

Technical programme	Achievements
Maintenance of cardamom germplasm	A total of 622 cardamom germplasm accessions have been maintained at National Active Germplasm Site (NAGS) which consist of 423 accessions from Appangala; 102 accessions from Pampadumpara; 41 accessions from Mudigere and 56 from Sakaleshapura
Identification of accessions with dual resistance to rhizome rot and leaf blight	Out of 168 lines screened under field conditions germplasm lines IC349358; IC349333, IC349334 showed dual resistance (Resistant to moderately resistant reactions for rhizome rot and leaf blight). Pot culture experiment showed resistance reaction to rhizome rot
Biochemical characterization of cardamom germplasm	Oil estimation of 36 germplasms accessions has been done
Multiplication of leaf blight and thrips tolerant genotypes for AICRPS trial	Leaf blight tolerant entries *viz.,* IC 547156 (R), IC 547222 (R), IC 349650 (R), IC 349648 (R) and IC 349649 (MR) are under multiplication. Thrips tolerant lines *viz.,* IC 349364, IC 349606, IC 349370 and IC 349362 are under multiplication for taking up further AICRPS trial.
Recording of yield data from the germplasm accessions	Yield data of germplasm accessions has been recorded.

4. Gen. XXXVII (813): Conservation of *Vanilla* spp. and their utilization in crop improvement (2018-2023) (Dr. Aarthi, S., Mr. Muhammed Nissar V. A., Dr. Mohammed Faisal Peeran &Ms. R. Sivaranjani)

Decisions:

- Molecular characterisation of cultivated vanilla has to be done.
- Vanilla species available with JNTBGRI has to be collected.
- Application of growth regulators may be attempted to get early flowering.
- *V. pompona* may be introduced with the help of ICAR-NBPGR.
- Participate in the next Vanilla Congress.
- Appangala may be used as an alternative site.

Technical programme	Achievements
Maintenance of *Vanilla* germplasm conservatory at ICAR IISR, Chelavoor.	65 *Vanilla planifolia* and 12 *Vanilla* spp. total 77 accessions were established in polyhouse and field conservation at Chelavoor campus.
Multiplication of germplasm for alternate germplasm site.	The accessions are grown in polyhouse and multiplication of the same is done.
Molecular characterization of germplasm.	Molecular characterization of 14 collections

	from Andaman was done along with *V. planifolia* using ISSR primers.
Collection of vanilla germplasm.	Two *Vanilla sp.* were collected from Mr. George at Wayanad.
Quality profiling of vanilla germplasm.	Quantification of major flavor compounds of vanilla viz., vanillin, p-hydroxybenzoic acid, p-hydroxybenzaldehyde and vanillic acid using a modified RP-HPLC method.

5. Gen. XXXVI (813): Genetic resources management in tree spices (2018-2023)[Mr. Muhammed Nissar V A, Dr. Rema J., Dr. Shivakumar M.S., Dr. Anees K. & Dr. Honnappa Asangi]

Decisions:

- Major cinnamon growing plantations of Kerala has to be surveyed for collection of germplasm.
- list of cinnamon accession available at Appangala has to be prepared.
- Species identity of entire tree spice accessions has to be corrected.
- Visit TBGRI and try to get one set of all accessions.
- Elite clove trees has to be identified from major clove growing estates of Nagercoil, Ambanad and Thottilapalam.
- Use GIS and find out the site suitability for clove.
- GIS prediction maps for each spice crop has to be prepared.
- Digital herbarium of tree spices has to be prepared.
- IISR has to become the referral center for tropical tree spices.
- Important accessions of Garcinia at NBPGR has to collected and maintained at IISR.

Technical programme	Achievements
Collection of genetic resources of cinnamon.	Four accessions of cinnamon and two wild species of cinnamon were collected from Andaman and Nicobar Islands.
Collection of genetic resources of clove and allspice.	Five wild species of Syzigium were collected from Andaman and Nicobar Islands. Ten elite accessions of allspice were collected from farmer's field at Wayanad.
Collection of genetic resources of Garcinia.	*Garcinia andamanica* (4 accessions). *G. dulcis* (4 acc.) *G. cowa* (5 acc.), *G. kydia* (4 acc.) G. *dhanikhariensis* (5 acc.) and *G. speciosa* (5 acc were collected from Andaman and Nicobar Islands. A high yielding accession of G. *gummi-gutta* was collected from farmer's field at Thrissur.
Characterization of germplasm in Garcinia.	The yield and morphological data of 15 elite trees of *G. gummi-gutta* at Peruvannamuzhi were recorded.
In situ evaluation of allspice accessions in farmers field.	Ten elite trees of all spice were identified in farmer's field at Wayanad and the yield and morphological data were recorded.
In situ evaluation of clove accessions	Ten elite trees of clove were identified in farmer's

in farmers field.	field at Thottilpalam and the yield and morphological observations were recorded.
Maintenance of genetic resources in tree spices.	The existing collections of tree spices and nursery and field are maintained. Planting /gap filling of Garcinia accessions at Chelavoor was completed.

Project II: Development of trait specific and improved varieties of spices through conventional breeding and biotechnological approaches [Project Leader: Dr. D. Prasath]

1. Gen. XXXI (813): Breeding black pepper for high yield, quality and resistance to stresses (2012-2022) [Dr. M.S. Shiva Kumar, Dr. K. V. Saji, Dr. P. Umadevi, Dr. K.S. Krishnamurthy & Dr. A. Jeevalatha]

Decisions:

- Dr. A. Jeevalatha may be associated in the project: Dr. A. Jeevalatha is associated in the project.
- List of hybrids has to be maintained in the division: List of hybrids was prepared and submitted to Head, Crop Improvement.
- The PI has to visit AICRPS centres periodically to monitor the progress of black pepper evaluation trials: Visited few AICRPS centres, other centres will be visited.
- Plant the 40 drought tolerant lines immediately: PET with drought tolerant lines planted in field.
- Hybrid progeny number may be assigned to HP 117 x Thommankodi: Hybrid progeny number HP 2173.

Technical programme	Achievements
Maintenance of the trial plot and yield recording.	A replicated yield trail (RBD-3replication) involving 10 improved lines/selections plus 2 controls. Harvesting is completed and HP 2173 recorded the highest yield.
Establishing new preliminary evaluation trial of drought tolerant accessions.	Thirty eight BP accessions found tolerance to drought from initial screening were multiplied and field planted in September 2019.
Field evaluation of promising germplasm accessions.	Evaluation trial comprising of 17 accessions with good yield and yield attributing traits shortlisted from germplasm characterization were field planted (RBD-2 replication).
Identifying genotypes for high altitude.	Germplasm accessions collected from high altitude are being multiplied along with Malabar excel, girimunda and Thevam to take up field evaluation trial.
Variety demonstration plot.	Demonstration plot of IISR-Thevam is established at IISR, RS, Appangala.
PEP/CI/3.7 CVT 2018 on black pepper-Series IX.	Trial was planted with 3 replications (RBD design) in the 2018. Hundred percent plant stand is maintained.

Tagging of Phytophthora resistance.	The receptor like kinase gene specific primer showed amplification in all the tested genotypes (IISR Shakthi, IISR Thevam, Subhakara, Sreekara, Girimunda, Panchami, Pournami, Panniyur-1, PLD-2, P24O4, Kalluvalli, Karimunda, Malabar Excel, Narayakodi, Vadakkan, Chumala, Agali, ACC-114, Cultivar-1324, New HP, HP-780, 1108-Perambramundi) of varying resistance except P24O4 (Open pollinated progeny of IISR-Shakthi).. The sequencing & ORF analysis of Shakthi, Subhakara, Karimunda, Thevam &Panniyur 1 showed differential ORF in terms of length. R gene specific primer showed amplification as single band for the genotypes Vadakkan, Agali and ACC-114 & a unique pattern for Narayakodi & Chumala on agarose gel. Whereas the MultiNA analysis was able to differentiate all the genotypes with specific banding pattern.

2. Gen. XXVI (813): Evolving high yielding and high quality nutmeg clones by selection (2007-2021) [Dr. J. Rema, Dr. K.V. Saji, Dr. S. Aarthi & Mr. V.A. Muhammed Nissar] (Dr. N. K. Leela-External Support)

Decision and action taken:

- Keralashree may be notified to Central Variety Release Committee: Variety was recommended in the 27th meeting of central sub-Committee on crop standards.

Technical programme	Achievements
Collection and conservation of elite nutmeg.	Three nutmeg accessions (two monecious and one female nutmeg) were collected from Sirsi during the period under report. All the nutmeg accessions were maintained well and observations on yield parameters of the germplasm were recorded. Quality analysis of few promising lines was also done.
Conservation and evaluation of seedling/clonal progenies of monoecious nutmeg trees.	All the accessions were maintained and observations were recorded. Some of them are found promising.

Evaluation of grafts of elite lines having high myristicin and elemicin in nutmeg and mace oils.	Maintained and observation recorded regularly.
Evaluation of grafts of elite lines having low myristicin, elemicin and safrole and high sabinene in nutmeg and mace oils.	Maintained and observation recorded regularly.
Evaluation of seedling progenies of yellow maced nutmeg.	Seedlings started flowering last year. Observations were recorded.

3. Gen. XXXIV (813): Induction of variability in ginger through induced mutation for yield and disease resistance (2012-2020) [Dr. D. Prasath, Dr. R. Ramakrishnan Nair & Dr. R. Suseela Bhai]

Decision:

- Polyploidisation has to be attempted in red ginger.

Technical programme	Salient achievements
Maintenance and multiplication of promising mutants	10 M1V6, 102 (M1V11) mutants have been maintained in pots. The rhizomes of six promising mutants were multiplied for multiplication. After harvest a new MLT trails will be undertaken in the ensuing season.
Multilocational field evaluation of promising mutants	Two shortlisted mutants have been included in the new CVT trial 2019 in ginger. The seed rhizomes of five mutants were multiplied and supplied to five AICRPS centres for multiplication and planting of CVT. Four promising mutants which escaped second round of screening were planted for multiplication.
Multiplication and evaluation of tetraploids	The two tentraploids (0.1/48/3, 0.1/48/5) were characterized and multiplied. Out of two autotetraploids of cv. Rejatha, cytological characterization showed 0.1/48/5 is a stable tetraploid. The new putative tetraploids (15) were multiplied for further studies.

4. Gen. XXXV (813): Genetic improvement in turmeric through seedling selection and hybridization (2013-2020) [Dr. R. Ramakrishnan Nair & Dr. S. Aarthi]

Decisions and action taken:

- All the seedling progenies of turmeric has to be maintained: Efforts are being made to maintain all the seedlings, hybrids and selfed progenies with the available facilities.
- Seedling progenies suitable for salad purpose may be identified: Available seedlings will be checked for very light yellow colour and low curcumin content.
- Promising progenies which retains boldness after drying has to be shortlisted for evaluation: All the promising lines under filed trial will be checked for this parameter.

Technical programme	Achievements
Maintenance of seedling progenies, hybrids and inbreds of turmeric.	First generation seedlings (204 Nos), mother genotypes (20 Nos), second generation seedlings (432Nos), Third generation seedlings (47) first generation inbreds (839 Nos), second generation inbreds (11 Nos), third generation inbreds (402), fourth generation inbreds (367) and inter-varietal hybrids (36 Nos) were maintained. One Hundred and Seventeen F2 hybrids of H1 (36), H2 (81), and nine open-pollinated progenies of high curcumin line SLP 389/1 were also maintained. Additionally, intercross hybrids (29), back cross hybrids (7), OP progenies of two inter-varietal hybrids (30) and 60 somaclones were also maintained.
Replicated trials of promising seedlings and hybrids of turmeric in the field.	Replicated trial involving three hybrids and four seedlings were laid out at Chelavoor and three hybrids and three seedlings were planted at Peruvannamuzhy. Morphological characters recorded and yield was recorded from the trial at HQ, Chelavoor. SLP 359/2, 65/12 and 389/1-OP-4 recorded average yield above 12 kg per bed. The trial at Farm Peruvannamuzhi is yet to be harvested.
Chromosome number analysis of seedlings, hybrids and inbreds of turmeric.	Chromosome preparations made in 14 inbreds, 20 OP seedlings and 1 hybrid. Mitotic metaphase plates were photographed. Chromosome counting in progress.
Self-pollination studies in inbreds.	Self-pollination has been performed in 17 fourth generation inbreds of 138/11/1, Fruit set was observed in one ($138/11/1/I_1$-12-I_2-2-I_3-64-I_4-1). Germination of seeds was not started.
Self-pollination studies in triploid commercial cultivars.	Self-pollination was performed in 7 triploid commercial cultivars. No fruit set was observed.
Studies on reproductive biology of turmeric.	Pollen fertility based on stainability has been checked in five inbreds and two OP seedlings
Characterization of inbreds of 69/5/22.	Molecular characterization of SLP 69/5/22 and its 12 first generation inbreds were done using 25 SSR primers.

5. **ICAR-CIB 1. Computational and experimental biology approaches for delineation of selected secondary metabolite pathways and antimicrobial peptides (AMPs) in major spices" [Dr. P.Umadevi, Dr. T.E. Sheeja, Dr. R. Praveena, Ms. R. Sivaranjani, Dr. Dinesh Kumar, Dr. Sarika, Dr. M.A. Iquebal & Dr. U.B. Angadi (IASRI)]**

Decision and action taken:

- Find out whether rotundone standards are available at ICAR-National Research Center for Grapes: Rotundone standard was not available at ICAR –NRC for Grapes. But the identification of rotundone precursor compounds using metabolome fingerprinting was done from that institute.

Technical programme	Achievements
Identification of major secondary metabolite pathways in *Piper nigrum* & *Piper longum*.	KEGG pathway analysis of berry transcriptome from *P. nigrum* & *P. longum* showed the enriched genes belonging to monoterpenoid, diterpenoid sequiterpenoid, tropane, flavanoid pathways. Around 15 new compounds were identified from *P. nigrum* berry transcriptome analysis.
Cloning of important secondary metabolite synthesis genes & Bioinformatics analysis.	The monoterpenoid synthases viz., linalool synthase, neomenthol transferase, 1,8 cineole & tropinone reductase gene of tropine alkaloid synthesis were isolated with gene specific primers & sequenced and phylogentic analysis and homology modeling were done.
Discovery of 'Peppery' flavor compound Rotundone.	By combining transcriptome mining, realtime expression, targeted amplification, sequencing and head space LC-MS analysis the back bone genes viz., alpha quaiene synthase and oxidase for peppery flavor compound rotundone synthesis were identified in black pepper.
Characterization of AMPs from Tree Spices.	-

6. **Biotech. XIV (813): DNA fingerprinting and barcoding in spices (Dr. T.E. Sheeja, Dr D. Prasath & Dr. M.S. Shivakumar (2018 - 2023)**

Decisions and action taken:

- DNA fingerprinting lab has to be identified in Central Facility: DNA fingerprinting and barcoding facility is established in Central Facility.
  Molecular work done in ginger, turmeric and black pepper may be presented in IRC: Presented.
- Join mapping population programme: Associated in mapping population programme.

- Dr A.I. Bhat may go through the SOP for DNA fingerprinting for NABL accreditation: Completed review of SOP and submitted for uploading.

Technical programme	Achievements
Screening of important cultivars/varieties of black pepper and identification of polymorphic DNA markers for varietal identification.	Identified and shortlisted 5 polymorphic ISSR primers for fingerprinting 21 accessions of black pepper. Unique markers identified for distinguishing 13 varieties. Screened 75 SSR primers and identified 7 polymorphic primers using multi NA multichip electrophoresis system.
Developing suitable marker strategies for DNA fingerprinting in major and minor spices from various centres of AICRPS.	Developed protocols for DNA isolation and PCR amplification in fennel and celery. Identified polymorphic primers for fingerprinting of fennel, celery and cardamom.
Developing unique DNA profiles of major and minor spices from various centres of AICRPS for PPV and FRA registration and report preparation.	Completed fingerprinting of one each of black pepper, fennel, celery and two each of cardamom and coriander from various AICRPS Centers for varietal release.

7. Biotech. XV (813): Identification & characterization of gene editing targets for *Ralstonia* resistance in ginger (2018-2021) (Dr P. Umadevi & Dr D. Prasath)

Decisions:

- One plant pathologist should be associated with this project.
- Attempt tissue culture to get higher probability of resistance: Literature survey is made and the tissue culture will be attempted in the next quarter.
- Developing resistance in ginger should be the top priority: The new generation technology & tissue culture will be applied to target this.

Technical programme	Achievement
Identification of (Putative) target proteins (inducing susceptibility) from the Ginger-Ralstonia transcriptome.	The glutathione biosynthesis pathway genes are compared in Ginger Vs Amada to locate the variation which could yield the good candidate target genes as they are reported to be involved in Ralstonia resistance in wild ginger.
Designing of gRNA.	gRNA synthesis (*in silico*) was attempted for selected gene from ginger transcriptome.

8. **Biotech. XV (813): DBT Twining: Survey, identification and characterization of unique ginger and turmeric land races endemic to North Eastern Region of India (2018-2021) [D Prasath & VA Muhammed Nissar]**

Decision:

- Funding from the institute will be given for development of further infrastructure inside the newly constructed ginger house.

Technical programme	Salient achievements
Identification and collection of know local types, cutlivars and wild types of ginger and turmeric from NER.	12 ginger, which includes 5 red ginger accessions and 4 turmeric accessions were collected from Nagaland.
Development a molecular profiles for ginger genotypes collected from NER.	Molecular characterization was carried out in the 40 ginger landraces collected during December 2018. A total of 30 SSR markers (already available) were screened and 18 were showing amplification in the ginger genotypes. Only those 18 primers were used for further PCR analysis. From the 18 primers a total of 5 primers were showing polymorphism (ZOC 28, ZOC 49, ZOC33, ZOC64 and ZOC 179) within the NE genotypes. Representative gel picture is given in Fig. 3. (ZOC 179 primers, resolved on 3.5% agarose gel). A total of 100 new primers were designed using Batch primer online tool from the available ginger Transcriptome database. Among 100 primers, 93 primers were screened. Among the 93 primers, 67 primers produced amplicons. All 40 genotypes were screened using 67 SSR primers and 21 of them are showing unique polymorphic bands.
Evaluation of unique NER collections.	Two red ginger accessions were multiplied. Four NER ginger genotypes along with Rio De Janeiro were characterized for different quality characters.
Conservation of the unique ginger and turmeric genetic wealth at NAGS.	The collected ginger and turmeric genotypes were planted and maintained in National Active Germplasm Site (NAGS) of ginger and turmeric at Peruvannamuzhi Farm. Also, a new conservatory is established at ICAR-IISR under the project for conserving unique ginger and turmeric genotypes.

9. **Evolving high yielding, biotic and abiotic stress resistant cardamom lines through selection and hybridization [Dr. H. J. Akshitha, Dr. S. J. Ankegowda, Dr. Balaji Rajkumar, M & Dr. M. S. Shivakumar]**

Decisions:

- The project is approved.
- Include drought characters also into the program: Included.
- Register all accessions immediately: Will be done

- Do both selection and hybridization: Taken up both the programs selection as well as hybridization.
- Visit severe drought affected gardens and collect few lines: Will be taken up during this summer.
- Study inheritance pattern of these genes: From the F_1 progenies inheritance pattern will be studied.

Technical programme	Progress made
Development and maintenance of OP progenies from pre potent cardamom lines.	Raising of OP progenies of IC 349422 (Clone 37), IC 584058, IC 349627 (Sampaje clone), IC 349537 (Clone 893) and *Njallani* Green Gold is under progress.
Screening of OP progenies for moisture stress tolerance and selection of moisture stress tolerant genotypes.	Screening of OP progenies of IC 584058 for moisture stress at seedling stage using PEG is carried out.
Multiplication of thrips tolerant genotypes for carrying out hybridization.	Parental material including thrips tolerant lines are planted in pots for carrying out hybridization.
CVT on farmers varieties of cardamom.	The trial with Nine farmer's varieties of small cardamom *viz*., *Arjun, Wonder Cardamom, Panikulangara, Thiruthali, Elarajan, Pachakai, Paupali, Njallani, PNS Gopinath* supplied by National Innovation Foundation (NIF) and a local check variety Appangala-1 was planted during June 2017. Observations on morphological and yield contributing traits were recorded. First year yield observations were recorded.
CVT on hybrids of small cardamom – 2018 Series VII.	The CVT trial consisting of nine hybrids *viz.,* Bold × IC 547219, (GG×Bold) ×Appangala 1 and (GG×NKE 19)×Bold from IISR RS, Appangala; MHC-1 & MHC-2 from ICRI, Myladumpara; SHC-1 & SHC-2 from ICRI RS, Sakaleshapura and PH-13 & PH-14 from Pampadumpara was laid out with national check variety *Njallani* green gold. And the trial is in first year of growth.

10. DUS project (Dr. K. V. Saji, Dr. D. Rema, Dr. D. Prasath, Dr. S. Aarthi, Dr. H. J. Akshitha, Dr. Honnappa Asangi and Dr. M. S. Shivakumar)

Decisions:

- DNA fingerprinting may also be done for clearly distinguishing the varieties.
- Prepare a one page write up on DUS traits of various varieties.
- Document on model varieties and evaluated varieties should be prepared separately for ginger and black pepper.

Technical programme	Achievements
Maintenance of example varieties of black pepper at Peruvannamuzhi and Chettalli.	Maintaining 21 example varieties of black pepper at CHES, Chettalli. Example varieties are multiplied and maintained at Peruvannamuzhi.
Maintenance of example varieties of cardamom at Reg. station, Appangala.	15 cardamom varieties are being maintained at Reg. station, Appangala.
Maintenance of example varieties of Ginger and turmeric.	29 example varieties of ginger and 35 turmeric are maintained and multiplied at Peruvannamuzhi and Kozhikode.
Ongoing DUS testing/ onsite.	Ginger – 2, Turmeric-4, Black pepper-4 and small cardamom-6.
Registration of new varieties.	Three black pepper varieties registered.

DIVISION OF CROP PRODUCTION and POST HARVEST TECHNOLOGY

Project III: Development of resource conservation and management technologies for improving productivity of spices [Project leader: Dr. V. Srinivasan]

1. Phy. X (813): Evaluation of black pepper and cardamom elite lines for yield and quality under moisture stress (2010–2020) [Dr. S.J. Ankegowda, Dr. K.S. Krishnamurthy, Dr. M. Alagupalamuthirsolai & Dr M.S. Shivakumar]

Decisions:

- Plan for arranging a cardamom fest at Appangala for popularisation of varieties and technologies related to cardamom – Conducted two programme and exhibition.
- Prepare GAP document and a mobile App on cardamom – In process.
- Collect data on IISR Thevam at Sirsi and notify Central Variety release committee- Data collection in progress.
- Collect data on increased farmer's income through our intervention in cardamom and black pepper- Data collection in progress.

Technical programme	Achievements
Recording of growth characters in different genotypes during establishment in cardamom.	Six genotypes of cardamom (IC 349537, IC 584058, GG × NKE-12, IC 584078, CL 668, HS 1, IC 584090) with one check (Appangala 1) were evaluated for drought tolerance under AICRP (Spices). Mositure stress was imposed in summer from February to April in stress block by withholding irrigation. The control block was irrigated by sprinkler (25 mm) once 12-15 days interval. Growth and yield data was recorded.
Field testing of black pepper germplasm accessions for drought tolerance.	Among the ten accessions, acc 4226 maintained highest relative water content, lowest membrane leakage and higher activity of antioxidant enzymes during stress period followed by acc no. 807 and acc no 1495. Yield was higher in acc no. 1495 compared to other accessions.
Screening of black pepper germplasm accessions (100 Nos) for drought tolerance.	Seventy germplasm accessions were screened for drought tolerance. Among them, acc no. 8068 maintained highest relative water content and lowest membrane leakage after 18 days of water stress.
Assessment of Impact of climate change on pepper and cardamom in distinct environments .	Monthly rainfall data of 2019 was collected from 20 different locations /different estates. Spike length, spike intensity / $0.5m^2$ and berry set percentage were recorded in black pepper in these locations to study the influence of rainfall on yield parameters. Data is collected in three locations in cardamom.

2. **SSC VI (813): Nutrient cycling and soil C sequestering potential of spice crops under different management systems (2011-2021) [Dr. V. Srinivasan, Dr. R. Dinesh, Dr. S.J. Ankegowda,Dr. A. Ishwara Bhat, Dr. C.N. Biju, Dr. K.S. Krishnamurthy, Dr. M. Alagupalamuthirsolai & Dr. S. Hamza]**

Decision:

- The programme will continue.

Technical programme	Achievements
Working out the C foot print in spices crops.	The C equivalence is being worked out for inputs used for spices crops based on state level data usage pattern.

3. **ICAR Mega Seed Project (Agr. XXXVII(813): Production of nucleus planting materials of improved varieties of spice crops (2006-2022) [Dr. K. Kandiannan, Dr. V. Srinivasan, Dr. S.J. Ankegowda, Dr. J. Rema, Dr. K.V. Saji, Dr R. Praveena, Dr. P Rajeev, Dr. D. Prasath, Dr. TE Sheeja, , Dr. Sharon Aravind Dr. Ljio Thomas, Dr. Honnappa Asangi & Mr. Muhammad Nissar]**

Decisions and action taken:

- Booklet on nursery practices and SOPs for planting – published.
- Vertical garden of spices may be attempted on experimental basis – will be done.
- Nursery certification need to be done through DASD – will be submitted.
- Since Dr. R. Suseela Bhai is superannuating, Dr R. Praveena - included in the project.

Technical programme	Achievements
Production of rooted black pepper cuttings.	Improved varieties of black pepper are being multiplied from Main Campus (MC), Kozhikode and Regional Station (RS), Appangala and distributed. Totally 1.0 Lakh cuttings were produced.
Production of ginger and turmeric seed rhizomes and nutmeg.	Improved varieties of ginger 200 beds and 400 beds of turmeric are planted and maintained for seed production at Experimental Farm, Peruvannamuzhi. Around 3.0 tonnes of ginger seed rhizome and 10.0 tonnes of turmeric seed rhizome will be produced.
Microrhizome production of ginger and turmeric.	Inoculated the explants of ginger varieties (Athira, Mahima, Varada) and subcultured at regular intervals. Standardized the media for multiple shoot formation in ginger and turmeric. Maximum multiple shoots (5-6) were produced in ginger in the media composition of MS media with BA (3 mg/ L) and NAA (0.5 mg/ L). Around 5000 micro rhizome were generated.

FLD on IDM of bacterial wilt of ginger.	Demonstrations were conducted at nine AICRPS centers across India, and at farmer's field also. The package includes: Treat ginger seeds with *Bacillus licheniformis* (Bacillich 2%) @ 2 kg/100 L of water. Drench the soil with the bacterial suspension (1%) (1 kg/100 L of water) at the time of planting and at 30, 45, 60 and 90 days @ 5 L / 3x1 m size bed depending on the disease incidence. Other practices as usual as in package of practice. With this for chemical treatment the incremental Benefit Cost ratio (IBCR) is 2,88 and for bioagent it is 3.23.
Varietal authenticity and purity identification of black pepper.	Twenty selected released varieties and cultivars of black pepper were tested with polymorphic primers to identify and develop the varietal specific markers, where variety specific bands were identified for few varieties. The study is in progress with more set of primers.
FLD on organic production of black pepper, ginger and turmeric.	The farmers adopting organic farming practices in ginger and turmeric were selected and inputs distributed.
MIDH Farmers Training/Seminar.	District level training on Spice based cropping systems for enhancing farm incomes – 28 Nov 2019 at ICAR-IISR, Kozhikode Dist. Kerala where more than 150 farmers attended.

4. ICAR-CPPHT-4: Micronutrient management in spice crops for enhancing yield and quality (2014-2020) [Dr. R. Dinesh, Dr. V. Srinivasan, Dr. S.J. Ankegowda, Dr. C. Sarathambal & Dr. S. Hamza]

Decision and action taken:

- Consortium of PGPR may be developed for ginger and turmeric: Developed

Technical programme	Achievements
Isolation and characterization of multi trait PGPR.	More than 100 PGPR were isolated and characterized for their growth promotion and nutrient solubilization characteristics. 18 strains with multiple beneficial traits were shortlisted.
Characterization for Zn solubilization potential.	Out of 18 shortlisted strains, two, IISR TB4- *Bacillus safensis and* IISR GB7 (3)- *B. cereus*) were found to be the most promising for Zn solubilization *in vitro*. The two strains were further tested in liquid medium and in soil per se for their Zn solubilization capacity The two strains were then Co-inoculated to determine their synergy in terms of Zn release in soil.
AM fungi- ZnSB interaction on soil Zn solubilization and bacterial community structure.	*Rhizophagus irregularis* and *B. megaterium* were co inoculated and studied for synergistic effects on soil Zn acquisition and bacterial community structure.

5. AGR. XXXI (813). Development of fertigation schedule for better productivity in black pepper (2015-2018) [Dr. C.K. Thankamani, Dr. R. Dinesh, Dr. K. Kandiannan and Dr. M. Alagupalamuthirsolai]

Decision:

- Collect data on genotypes suited for shade and protected cultivation.

Technical programme	Achievements
Soil sample collection & Analysis.	Soil samples were collected and analyzed for nutrients.
Imposing the treatments.	All the treatments were imposed as per the schedule.
Recording the observations.	Drip irrigation @ 8 liters, NPK 50 RDF and fertigation 24 splits recorded maximum yield (2 kg/vine) in Girimunda where as in Thevam, drip irrigation 8 liters, 100 RDF in three splits recorded maximum yield.

6. Phy. XII (813): Physiological interventions for yield improvement in small cardamom (*Elettaria cardamomum* Maton) under weather extremities (2016-2021) [Dr. M. Alagupalamuthirsolai, Dr. S.J. Ankegowda, Dr. Sharon Aravind and Dr.M.Murugan)

Decisions:

- GCMS profile of released varieties and promising lines may be published by Dr N K Leela and Dr K Anees: GCMS is not in running status. Essential oil samples from various locations has been stored for GCMS analyses.
- Shade regulation for managing the quality of cardamom which can be used for protected cultivation: Included.

Technical programme	Achievements
Standardized chemicals/natural extracts to alleviate drought in small cardamom.	Spraying of drought tolerant chemicals will be done in first week of March at CRS, Pampadumpara.
Estimate Yield and Quality of ecotypes established under Idukki and Coorg.	Essential oil has been extracted in samples from Idukki and Coorg and stored for GCMS analysis.
Study the variation in stigma receptivity under different light intensity.	Stigma receptivity will be observed during summer season.

7. ICAR-CPPHT 5: Delineation of spices zone beyond boundaries using climate analogue tools in changing climate (2016-19) [Dr K.S. Krishnamurthy, Dr. K. Kandiannan, Dr. M. Alagupalamuthirsolai and Mr. K. Jayarajan]

Decisions:

- Soil parameters may also be included while forecasting new areas of spice cultivation by 2050: Soil parameters have been included in the map.

- A status paper on efficient spices zones may be prepared.

Technical programme	Achievements
Identification of efficient cumin producing zones.	Efficient cumin producing zones were identified through relative yield index and relative spread index.
Geo referencing and mapping.	Efficient producing zones were geo referenced and mapped.
Identification of analogues sites for cumin.	Climate analogues sites (453 districts) for cumin were identified.
Report writing.	Report writing will be taken up in the last quarter.

8. Biochem. X (813): Study on spike abscission: Developing chemically induced method for harvesting black pepper (*Piper nigrum* L.) (2018-2022) [Dr. Anees K., Dr. K.S. Krishnamurthy & Dr. Biju C.N.]

Decision:

- Study of spike abscission using chemicals may be done on bush pepper only.

Salient Achievements:

Technical programme	Achievements
Establishment of bush pepper garden.	Bush pepper garden (100 pots) has been established at Vanilla plot, Chelavoor.
Histology of abscission zone of spike and leaf.	Microscopic images of leaf and spike abscission zones was taken using Pholoroglucinol, Toluidine blue and Ruthenium red.
Studying biochemical parameters during of spike and leaf abscission.	Temporal variations in biochemical parameters (Enzymatic assays for polyphenol oxidase, peroxidase and catalase) during abscission process was studied using ripe, mature and immature spike and leaf samples.
Comparative analysis of Abscission zone biochemistry.	Analysis of both physical (Force gauge) and biochemical parameters (Enzymatic assays for polyphenol oxidase, peroxidase and catalase) was done.
Use of chemical inducers for spike abscission.	Use of Ethral in combination with ascorbic acid was attempted.

9. Development of drought mitigating physiological strategies in black pepper (Dr. M. Alagupalamuthirsolai, Dr. K. S. Krishnamurthy, Dr. C. K. Thankamani, Dr. C. Sarathambal C)

Decisions and action taken:

- Project is approved for 5 years: RPP I submitted.
- For field experiments, select areas where water is scarce: This will be followed.

Technical programme	Achievements
Establishment of runner cuttings in pots under glass house.	Runner cuttings established with IISR varieties.
Establish of field trial with released variety .	Planting completed with variety IISR Thevam.

Project IV: Development, refinement and demonstration of integrated cropping system for improved total factor productivity in spices [Project Leader: Dr. V. Srinivasan]

1. **Hort. VII (813): Evaluation of nutmeg for its suitability for high density planting (2011-2021) [Dr. J. Rema, Dr. Sharon Aravind & Dr. C.K. Thankamani]**

Decisions and action taken:

- Attempts may be made to advance the flowering so that crop harvest comes before the monsoon: Will be attempted.

- Collect data on genotypes with differences in maturity time: Tree wise harvest data is available which has to be analysed.

Technical programme	Achievements
Planting and evaluation of nutmeg grafts for its suitability for high density planting.	Observations on the experimental plants were recorded regularly and data recorded.
Nutrient management studies in nutmeg grafts.	Application of Coir pith compost 2 kg/plant during May, soil application of recommended nutrients (140:126:350 g/plant) during June and September, foliar spaying of micronutrient 0.5% and spraying of BA (10 ppm) at June recorded maximum canopy spread in North south (253 cm) and East-west (260 cm) direction.

Project V: Development, refinement and demonstration of organic production technology of spices for improved productivity, quality and soil health [Project leader: Dr. C.K. Thankamani]

1. **ICAR-CPPHT-1: Network project on organic farming (2014-2020) [Dr. C.K. Thankamani, Dr. V. Srinivasan, Dr. R. Praveena Dr. C. Sarathambal & Dr. S. Shanmughavel]**

Decision and action taken:

- Speedy composting process developed may be perfected: This is being attempted.

- Since the PI Dr T John Zachariah superannuated on 30/11/18, he may be dissociated from the project: Dissociated.

Technical programme	Achievements
To study the impact of organic, conventional and integrated management practices on productivity and quality of turmeric varieties.	Maximum oil content was recorded by organic 100% and organic 75% management system as 5.3 %. Among the varieties significantly higher oil content was noticed in varieties Prathibha and Alleppy supreme. Higher oleoresin content was recorded in organic 75% management (13.6%), on par with INM1. The varieties Prabha and Pragathi (14.7) were superior in oleoresin content and least was recorded in Sona (10.8%). Organic management system (100% and 75%) recorded maximum curcumin and least curcumin in chemical management.
Budgeting the farming system model.	The plot with spices, fodder and vegetables combination was established at Chelavoor farm. The crops pepper, turmeric, fodder grasses (Congo signal grass, CO-3, CO-4), Tapioca, Banana, cowpea, Arrow root, Elephant foot yam, Yam, Maize and pineapple were planted and established. Three cows and their calves are maintained at IISR farm. Turmeric 480 kg, Banana 100 kg, Tapioca 75 kg, Elephant foot yam and Yam 20 kg each, Pineapple 10 kg, Arrow root 17 kg, Maize 19 kg and vegetable cowpea 10 kg and 2200 nos coconuts were harvested. Fodder grass was fed to the cows maintained at IISR farm. A profit of Rs 1.23 lakhs was received from one acre. 415 man days employment /year was generated.

2. ICAR-CPPHT-2: Network on Organic Farming in Horticulture Crops (2014-20) (Dr. V. Srinivasan, Dr. K. Kandiannan, Dr. R. Dinesh, Dr. J. Rema, Dr. S.J. Ankegowda, Dr. C.N. Biju Dr. C.M. Senthil Kumar & Dr Honnappa Asangi)

Decision:

Dr. Honnappa Asangi will associate in the project in place of Dr Narendra Chaudhary.

Technical programme	Achievements
Monitoring the soil health and pest and disease incidence under different management systems.	The treatments were imposed with combinations of vermicompost, FYM, Neem cake and the balance P & K as rock phosphate and sulphate of potash. A pplication of bioinoculants like *Trichoderma harzianum* was done twice with foliar spray of Spinosad thrice for control of thrips. Soil samples from treatments were analyzed for

	nutrient availability and quality analysis is in progress. The biometric observations like no. of panicle bearing shoots per clump, number of panicles per clump, number of cincinni per panicle, no of capsules per panicle were recorded treatment wise.
Evaluating different management system for yield sustainability in cardamom.	Treatments on fully organic, integrated and chemical management on cardamom were also imposed for comparing the yield sustainability under different management systems. Yield and quality parameters are being recorded.

Project VI: Development and refinement of post harvest handling, processing and value addition technologies for minimization of post harvest losses and diversified use of spices
[Project leader: Dr. N.K. Leela]

1. PHT VII (813): Developing energy efficient processing technologies for spices (2013-2020) [Dr. E. Jayashree and Dr. N.K. Leela]

Decisions:

- Drying method suitable for reduction in colour of the turmeric without losing curcumin content may be developed.
- Re-design the slicing machine.
- Find out how the product looks at different temperatures.

Technical programme	Achievements
To determine the effect of temperature on drying of turmeric.	The effect of drying temperature and curing of turmeric on drying and quality of turmeric was studied. Drying of cured and uncured sliced turmeric (IISR-Alleppey Supreme) was performed in mechanical dryer for temperatures varying from 50 to 100°C and the quality compared to that obtained by drying in solar tunnel drying and sun drying. Drying time was lower for mechanical drying as compared to sun drying or solar tunnel drying. Minimum drying time of 10 h was recorded for drying of cured sliced turmeric (5mm thick) by oven drying at 100°C and maximum of 165 h (6.88 days) was recorded for sun drying of uncured sliced turmeric.

To evaluate the quality evaluation of the solar dried product.	• Maximum essential oil content of 5.53% was observed for the uncured sliced turmeric when dried in a mechanical dryer at 50°C. • The maximum oleoresin content of 13.07 was obtained for uncured sliced turmeric dried in a hot air oven dryer at 50°C. • Curcumin content recorded a maximum value of 5.01% for uncured sliced turmeric when oven dried at 50°C. • Degradation of primary and secondary metabolites was higher when subjected to higher drying temperatures.

2. ICAR-CPPHT-3: Network project on high value compounds and phyto-chemicals (2014-2020) (Dr. N.K. Leela, Dr. Santhosh J. Eapen, Ms. R. Sivaranjani & Dr. K. Anees)

Decision:

- Include identification of novel compounds in technical programme.
- Work out the average curcumin content from all our studies.
- Do chemoprofiling of *C. aromatica*, *C amada* and *C caesia* and identify those compounds of high value.
- Analysis of seed spices and cardamom may be entrusted to Dr. Anees K.

Technical programme	Achievements
Characterization of anti-diabetic constituents of cinnamon.	Major Anti-diabetic compound has been identified.
Cinnamon - based anti-diabetic product formulation and its validation.	Cinnamon – based Antidiabetic product formulation is in progress.
Chemoprofiling of *C. aromatica, C amada* and *C. caesia* for high value compounds.	Chemoprofiling of volatiles of *C. aromatica, C amada* and *C. caesia* has been carried out.
In vivo studies on rats using cinnamon fractions for blood sugar reduction efficacy testing.	In vivo studies on rats are yet to be started. This experiment will be conducted along with the newly approved extramural project in the month of May 2020 subjected to ethical committee clearance.
Utilization of bio-waste after extraction of essential oil and oleoresin.	Nutritional quality evaluation of spice industrial waste for turmeric and cinnamon was carried out. Total contents of protein, carbohydrate, fat, phenol and tannin were measured from both fresh sample and waste material after oleoresin/essential oil extraction.
Purification of few compounds from the column chromatography fractions of allspice extract.	Two fractions of allspice chloroform extract were partially purified using preparative TLC. In vitro antidiabetic activity of purified extract was carried out.
Characterization of the purified compounds of allspice extract.	The HPLC separation of different compounds of purified extracts was carried

	out. The extracts were sent to SAIF, IIT Bombay for HRLC-MS characterization.
Molecular docking studies of turmeric derived molecules associated with diabetic signaling pathway.	By molecular docking studies probable druggable molecules from turmeric were identified.

3. KERALA State Project 'Establishing a value chain incubation facility for processing of spices (ginger and nutmeg) through value addition for entrepreneurship development at Indian Institute of Spices Research, Kozhikode'(2017 - 2019) (Dr. E. Jayashree and Dr. Anees K.]

Decisions:

- Prepare modules for establishing spice processing plants for consultancy projects.
- Document addresses of various equipments/ models for establishing similar facility in other places on consultancy mode.
- The facility should be functional by September 2019.
- List out the licenses to be obtained and start the process immediately.

Technical programme	Achievements
Installation of purchased equipments and trial evaluation	All the equipments purchased under the project have been installed in the new Spice Processing Unit.
Conduct of Entrepreneurship training programme.	Two EDP trainings were conducted. 'Value addition of nutmeg' was conducted on 12-12-2019 in which about 16 participants were trained and 'Value addition of ginger' was conducted on 27-12-2019 where about 10 persons were trained. At present the facility is used for the commercial production of ginger and nutmeg based value added products.

***4.* Biochem. IX (813): Evaluation of chemo-diversity and microencapsulation of selected spices (2018-2023) [Ms. R. Sivaranjani, Dr. N.K. Leela & Dr. Anees K.]**

Decisions:

- Compile earlier results obtained regarding quality parameters of various accessions of black pepper tested so far and consider it while comparing with new results. And attributes of unique high quality accessions may be compiled .
- Germplasm must be categorized based on the chemo profile.
- Identify the factors that contribute to variation in chemo profile over the years.
- Confirm whether curcumin content (7.2%) of SLP 389/1 is consistent over the years.
- Normalization of spice quality data is to be done by including control samples during analysis representing low, medium and high value for each quality parameters.
- Check the chemoprofile of Nithyashree and Navashree once again.
- Improvement in extraction procedures should be a separate project.

Technical programme	Salient Achievements
Effect of chemical elicitors on improved quality of turmeric.	The field evaluation for the year 2019-20 was done at Peruvannamuzhi. Morphological and photosynthetic measurement of treated and control samples are measured. The extract for enzyme assay is prepared.
Quality analysis of selected black pepper germplasm.	Estimation of essential oil content, Oleoresin and piperine content of 21 germplasm accessions are completed. Estimation of piperine content of around 25 samples are completed.
Evaluation of chemical quality on ginger and turmeric.	Ginger: 122 accessions analyzed for quality attributes. Turmeric: 70 accessions are evaluated for quality attributes.
Characterization of distinct Accessions of Cinnamon and Garcinia by GC-MS and HPLC respectively.	Essential oil from 10 distinct accessions of Cinnamon was extracted and GC-MS profiling is being carried out. *Garcinia* fruits from 15 accessions are collected and analysis is in progress.

DIVISION OF CROP PROTECTION

Project VII: Bio-intensive management of pests in spices [Project Leader: Dr. C.M. Senthil Kumar]

1. ICAR-CP 1. ICAR-Consortium research project on borers in network mode (2014-2019) [Dr. C.M. Senthil Kumar, Dr. T.K. Jacob &Dr. M. Balaji Rajkumar]

Decisions:

- The project may be extended for 2 years: Extended for 2 years.
- Generate information on cost- benefit ratio for effective insecticides and residual data: Residue data is being generated and the CB ratio will be generated upon completion of trials.
- Surveys may be undertaken to study occurrence and distribution of insect pollu in black pepper growing regions: Surveys for incidence of pollu beetle were conducted in Wayanad District of Kerala and Kodagu and Mysore Districts in Karnataka. Further surveys will be undertaken in the ensuing season.
- Field trials may be taken up on *Metarhizium* in the next season: Field trials will be taken up in the next season.

Technical programme	Achievements
Spray schedule optimization of low risk insecticides against shoot borer of ginger and turmeric.	Three low risk insecticides (chlorantraniliprole, flubendiamide and spinosad), which were found to be effective earlier and a combination treatment of spraying chlorantraniliprole and spinosad alternatively were screened under field conditions at Peruvannamuzhi farm for spray schedule optimization at two different spray schedules (*i.e.* 15 and 30 days' interval) against shoot borer infesting ginger and turmeric. Results indicated that spraying insecticides at fortnightly intervals rather than spraying at monthly intervals is more effective in controlling the pest.
Seasonal incidence of *C. punctiferalis* infesting ginger and turmeric in relation to crop phenology and time of planting.	Seasonal incidence of *C. punctiferalis* infesting ginger and turmeric in relation to crop phenology and also the influence of time of planting on the incidence of the pest was studied by recording the incidence of the pest at fortnightly intervals. In case of ginger, when the crop was planted in May (early planting), the incidence of the pest was first observed in the first week of August and the infestation reached its peak during first week of October. Whereas, when the crop was sown during June (normal planting), the incidence of the pest was first noticed during second fortnight of August and the peak infestation was during second fortnight of October.

	In turmeric, with early planting the pest incidence was first noticed during second fortnight of August and it reached its peak during first fortnight of October. Whereas, with normal planting, the pest attack started in the second week of August and the population of the pest reached its peak during first fortnight of October.
Screening of low risk insecticides against pollu beetle infesting black pepper.	Three green labelled low risk insecticides (chlorantraniliprole, flubendiamide and spinetoram) at two doses (0.3ml/l and 0.5ml/l) along with quinalphos as control were screened for their efficacy against pollu beetle (*Lanka ramakrishnai*) under field conditions at Chelavoor, Kozhikode. Among the insecticides, chlorantraniliprole was very effective in controlling the pest at all the doses tested followed by flubendiamide and spinetoram.

2. Integrated management of mealy bug (Pseudococcidae: Hemiptera) infesting black pepper (2019 – 2022) [Dr. M. Balaji Rajkumar and Dr. C. M. Senthil Kumar]

Decisions:

- The project is approved.
- Identify new species of mealy bugs: New species not encountered during this period.
- Information on the available biocontrol agents for mealy bugs may be compiled: Available information compiled.

Technical programme	Achievements
Survey for mealybug in black pepper growing areas.	Surveys for incidence of mealy bugs infesting black pepper was carried out in twenty locations in Kerala and Karnataka. Mealybug species belonging to *Ferrisia* and *Icerya* genus were mainly found on young shoots and berries, whereas *Planococcus* spp. was found to be associated with berries, collar region and root system.
Collection and culturing of mealybug in laboratory.	Mealy bugs feeding on different plant parts such as leaves, berries, cling roots, collar region, stem and roots were collected, coded and wet preserved in the insect repository at ICAR-IISR, Kozhikode The mealy bugs are being cultured using potato sprouts and squash under laboratory conditions.
DNA isolation and PCR amplification.	Genomic DNA isolated for seven samples collected from Karnataka and Kerala.

3. **Nema. VII (813): Prevalence of lesion nematodes in turmeric growing tracts of India and their economic significance (2018-2022) [Dr. C. Sellaperumal, Dr. Santhosh J Eapen & Dr. R. Praveena]**

Decisions:

- Screening of turmeric germplasm may be done.
- Mapping of nematodes of turmeric from AP, TN & Telangana.

Technical programme	Achievements
Survey and population dynamics of lesion nematode infecting on turmeric.	Samples were collected from different locations of Guntur dt, Cintapally dt and Kammarapally dt, of AP and Telangana states which revealed that *Pratylenchus* spp and *Meloidogyne* spp were infecting majorly in Guntur regions. Population dynamics study is in progress.
Pathogenicity of root lesion nematode on turmeric.	It is confirmed that *Pratylenchus* spp was able to infect and reproduce in turmeric. The symptom were recorded previously from Guntur regions and Peruvannamuzhi farm in turmeric.

Project VIII: Integrated management of fungal and bacterial diseases of spices [Project leader: Dr. R. Suseela Bhai]

1. **Path. XXIV (813): Surveillance, documentation and development of decision support system for pests and diseases of major spice crops (2016-2020) [Dr CN Biju, Dr. Santhosh J. Eapen, Dr. Santhosh J. Eapen, Dr. T. K. Jacob, Dr. R. Suseela Bhai, Dr. A. Ishwara Bhat, Dr. C. M. Senthil Kumar, Dr. R. Praveena, Dr. Mohammed Faisal Peeran, Dr. C. Sarathambal, Dr. M. Balaji Rajkumar, Dr. Lijo Thomas, C. Sellaperumal, Dr. A. Jeevalatha & Mr. K. Jayarajan]**

Decision:

- Decision Support System on pests and diseases of major spices shall be developed and compendium prepared.

Technical programme	Achievements
Development of Decision Support System on pests and diseases of major spices.	In progress.
Preparation of Compendium on pests and diseases of major spices.	In progress.

2. **Path. XXV (813): Spatiotemporal dynamics in relation to ecology and epidemiology of fungal foliar diseases in ginger and turmeric and management (2016-2020) [Dr. R. Praveena, Dr. R. Suseela Bhai, Dr. A. Ishwara Bhat, Dr. K S. Krishnamurthy, Dr. A. Jeevalatha and Dr. C. Sarathambal)**

Decisions:

- The nutrients (in soil) favoring the establishment and growth of *Trichoderma* may be studied: Will be taken up.
- A patent application on rhizome priming using *Trichoderma* may be immediately processed and filed by BPD: Provisional patent application submitted to ITM-BPD unit.
- Rhizome priming technology may be tested in AICRPS trials: The technology proposed as new trials under AICRP for the year (2020-21).
- Information on varieties that are susceptible and tolerant to foliar diseases may be provided: List of varieties susceptible and tolerant to foliar diseases will be prepared.

Technical programme	Salient achievements
Morphological and molecular characterization bacterial antagonists.	Morphological and molecular characterization of five strains of *Trichoderma* and eighteen isolates of bacteria were completed. The identified *Trichoderma* strains were *T. lixii* (IISR KA 15), *T. asperellum* (IISR TN 3), *T. harzianum* (IISR KL 3), *T. erinaceum* (IISR APT1) and *T. atroviridae* (IISR APT2).
Evaluation of potential bacterial antagonists and *Trichoderma* isolates against pathogens of ginger under glass house conditions.	Under glasshouse conditions, the potential bacterial antagonists were evaluated against the soft rot pathogen, *Pythium myriotylum* in ginger. The plants challenge inoculated with the pathogen showed yellowing of emerging tillers one week inoculation, whereas the ginger rhizomes treated with the bacterial isolate IISRGB7 (3) (*Bacillus spp*) and IISR TB4 (*Bacillus safensis*) did not develop soft rot symptoms. The two bacterial isolates *viz*., IISR GB7 (3) (B*acillus* spp.) and IISR TB4 (*Bacillus safensis*) were effective against foliar pathogens, *Exserohilum rostratum* and *Colletotrichum gloeosporioides,* infecting ginger under glass house conditions.
Analyzing soil nutrient status in the development of foliar diseases.	Different levels of nitrogen on the development of foliar diseases on ginger were studied under pot culture conditions. Higher doses of nitrogen application resulted in increased incidence and intensity of leaf diseases.

3. **Path. XXVI (813): Revisiting wilt diseases of vanilla and exploitation of associated microbiome for its management (2016-2019) [Dr. Mohammed Faisal Peeran, Dr. C. Sarathambal, Dr. M. Alagupalamuthirsolai, Dr. Aarthi, S., Ms R. Sivaranjini]**

Decisions and action taken:

- The project is extended for 1 year.
- A biochemist may be associated with the project: Ms R Sivaranjini is associated.

- Regions outside Karnataka may also be included in the survey: Survey has been conducted in Yercaud, Kolli Hills and Thadiyankudisai and no big plantations found. Valparai yet to be completed in TN.
- Characterization of metabolites shall be carried out under Path. XXVII (813): Cultures are grown in synthetic media and extraction need to completed.

Technical programme	Achievements
Field trials of *Bacillus amyloliquefaciens* and *Chaetomium globosum*.	Laid out micro trials at Appangala for efficacy testing and found disease incidence less than 20 %whereas in control disease more than 60%.
In planta biochemical activity by challenge inoculation.	Increased activity of Peroxidase, Poly phenol Oxidase, Catalase, Superoxide dismutase and glucanse were found in B. amyloliquefaciens treated challenge inoculated plants. Experiment is under repetition for consecutive results.

4. Path. XXVIII (813): Novel strategies for managing bacterial wilt and soft rot diseases of ginger (2018-2022) [Dr. C. N. Biju & Dr. Mohammed Faizal Peeran]

Decisions:

- The programme will continue.
- Make a video film on managing bacterial wilt and soft rot diseases of ginger.
- Bacillich should be used only for demonstration trials, not for commercial sale.
- Dr CN Biju will take over the project from December 2019.

Technical programme	Achievements
Evaluation of capsule formulation of *Bacillus licheniformis* under field conditions.	Will be taken up in the ensuing season.
Analyzing the effect of $CaCl_2$ and *B. licheniformis* on other major pathogens in ginger.	The incidence of soil-borne diseases were comparatively low and yield was high in solarized + $CaCl_2$ treatment.

5. Strategic approaches for management of black pepper diseases (2019 – 2024) [Dr. Biju, C. N., Dr. A. Ishwara Bhat, Dr. Praveena, R., Dr. A. Jeevalatha, Dr. Mohammed Faisal Peeran, Dr. C. Sellaperumal, Dr. Santhosh J. Eapen & Dr V. Srinivasan]

Decisions:

- The project is approved.
- Dr. V. Srinivasan shall be associated with the project.
- A demonstration plot of black pepper involving all our technologies may be established at Peruvannamuzhi or Appangala.

Technical programme	Achievements
Establishment of demonstration plot of black pepper at Peruvannamuzhi.	Will be taken up in the ensuing season.
Interaction of *Phytophthora capsici*, *P. tropicalis* and *Fusarium* sp. with nematodes.	Under progress.

6. Path. XXVII (813): Development of microbial biostimulants for growth promotion and disease resistance in major spices (2018-2021) [Dr. C. Sarathambal, Dr. A. Jeevalatha, Dr. Mohammed Faisal Peeran & Ms. R. Sivaranjani]

Decisions:

- Possibility of enhancing food preservation through biostimulants may be explored.
- Function of each biostimulant and their mechanisms may be shown in a tabular form.
- Spice oils for food preservation may be investigated.

Technical programme	Achievements
Effect of arbuscular mycorrhizal (AM) fungi on growth, nutrition, antioxidant enzymes and physiological parameters of black pepper cuttings.	Effect of AM fungi on growth of black pepper cuttings were analyzed up to 150th day. Influence of AM fungi on the uptake of N, P, K, Ca, Mg and micronutrients of black pepper were assessed at monthly interval. Effect of AM fungi on soil enzymes activity (Phosphatase, urease, dehydrogenase and β-gluconase) were assessed at monthly interval. Effect of AM fungi on antioxidant enzymes activity and physiological parameters of black pepper are under progress.
Optimization of mycorrhizal inoculum production by using soil less medium.	The impact of different substrates, namely perlite, vermicompost, coir pith, and FYM @ 10 % in vermiculite medium on growth and multiplication of AM fungi were assessed. Two plant species viz. maize (*Zea mays*), and napier grass (*Pennisetum purpureum*), were examined for mass multiplication of the AM fungi.
Effect of AM fungi on growth, nutrition, antioxidant enzymes and molecular responses of ginger.	Analysis is under progress.

Project IX: Development of diagnostic kits and integrated management of viral diseases of spices
[Project Leader: Dr. A. Ishwara Bhat]

1. DST CP-I: Identification, characterization and development of diagnostics for unknown viruses associated with cardamom and ginger (2016-2019) [Dr. A. Ishwara Bhat & Dr. C. N. Biju]

Technical programme	Achievements
Sequence analysis of the virus belonging to the Tombusviridae infecting ginger	Analysis of complete genome sequence of the virus belongs to the family, *Tombusviridae* consist of 4143 nucleotides containing six ORFs coding six proteins (readthrough protein, RNA dependent RNA polymerase, movement protein 1, movement protein 2, coat protein and p14 protein). The complete genome of the virus was aligned with members of the *Tombusviridae* family and pair wise comparison of the complete nt sequence of GCFaTV showed identities ranging from 34 to 47% with different genera of Tombusviridae with the highest (47%) similarity to Panicovirus followed by Machlomovirus (46%). Among different genera of Tombusviridae, the present virus isolate showed the maximum identity of 52% and 49% at the nt and aa levels in the complete genome and individual ORFs of panicoviruses. The per cent identity in the complete genome and individual ORFs between different genera of Tombusviridae ranged from 38-59% at the nt level and 9-56% at the aa level. Phylogenetic analysis of the complete genome and aa sequence of different ORFs also showed distinct nature of the present virus infecting ginger that is well separated from the members of panicoviruses, machlomoviruses. Based on these analyses, present virus does not fit under any known genera of *Tombusviridae* and should consider as a new genus under the family *Tombusviridae* for which we propose the name *Gingivirus*. The proposed name of the virus species is ginger chlorotic flecks.
Sequence analysis the virus belonging to the genus *Ampelovirus* infecting ginger	Based on the per cent identity and phylogenetic anaysis of sequenced region and proteins, it is clear that *Ampelovirus* isolate infecting ginger is a novel virus species that belongs to genus *Ampelovirus* and proposed the name ginger chlorotic fleck associated ampelovirus (GCFaAV).
Development and validation of diagnostic assays for viruses infecting ginger.	RT-PCR, SYBR Green-based real-time RT-PCR, RT- LAMP and RT-RPA assays were developed to detect both viruses, GCFaTV and GCFaAV in infected ginger. Parameters like incubation time; temperature and concentration of components ($MgSO_4$ and betaine for RT-LAMP, MgOAc for

	RT-RPA) were optimized for isothermal amplification assays such as RT-LAMP and RT-RPA. Sensitivity of RT-PCR, real-time RT-PCR, RT- LAMP and RT-RPA for te detection of both GCFaTV and GCFaAV were determined. For GCFaTV, real-time RT-PCR was found 100 times more sensitive than RT-LAMP and 1000 times than that of RT-RPA. RT-LAMP and RT-RPA methods are 100 and 1000 times more sensitive than conventional RT-PCR. In the case of GCFaAV, real-time RT-PCR was found 100 times more sensitive than both RT-LAMP and RT-RPA assays and 10000 times more sensitive than conventional RT-PCR.
Development and validation of diagnostic assays for the nucleorhabdovirus infecting cardamom.	RT-PCR, SYBR Green-based real-time RT-PCR, RT-LAMP and RT-RPA were developed for the detection of CdVCV from virus infected cardamom plants. These assays were standardized for the specific and sensitive detection of CdVCV. All assays were able to detect the virus in infected cardamom as positive controls produced specific amplifications and no product was seen with total RNA from healthy plant. Real-time RT-PCR was found most sensitive method (10 times more than RT-LAMP, 100 times more than RT-RPA and ten thousand times more than RT-PCR in detecting CdVCV. All the assays successfully detected CdVCV in field samples of vein clearing diseased cardamom plants which indicated the specificity and sensitivity of the developed assays.
Screening ginger accessions for the presence viruses through real-time RT-PCR.	Out of 520 no of germplasm collection of ginger, 96 non-symptomatic plants were tested for the presence of viruses. Of these, 42 accessions were found free from both viruses while 11 accessions showed only GCFaTV.

2. **DBT CP-VII: Characterization of episomal and endogenous pararetroviruses infecting black pepper (2018-2021) [Dr. A. Ishwara Bhat & Dr K.S. Krishnamurthy]**

Decisions: Nil

Technical programme	Achievements
Effect of temperature stress on incidence of PYMoV in different varieties of black pepper.	Asymptomatic PYMoV infected (confirmed by RT-PCR assay) plants of 19 popular black pepper varieties maintained in the polyhouse where average maximum and minimum temperature ranged from 34°C to 40°C and 22°C to 27°C respectively and relative humidity between 56 to 93%. Results of the experiment showed gradual increase in per cent disease incidence of PYMoV infected plants from 9 to 39% during 13th March, 2019 to 6th June, 2019 when temperature and relative humidity increased from 34°C to 38°C

	and 70 to 76%, respectively. There after there was a fall in the disease incidence from 39 to 1%, when average temperature decreased from 38 to 32 and RH ranged between 70 to 86%. SYBR Green real-time reverse-transcriptase PCR assay conducted regularly at two months' interval revealed a higher copy number of the virus during high temperature period.
Physiological and biochemical changes in plants subjected to temperature stress.	Quantifiable changes in physiological and biochemical parameters such as total chlorophyll, proteins, phenols, carbohydrates, peroxidase and lipid peroxidase were observed in plants subjected to higher temperature and plants kept at normal temperature.
Development of recombinase polymerase amplification assay (RPA) for the detection of PYMoV in black pepper.	RPA and reverse transcription (RT) RPA assays were optimized for the detection of piper yellow mottle virus (PYMoV) infecting black pepper. A magnesium acetate concentration of 18 mM, 40 min of incubation time and a temperature of 37 °C to 42 °C was found optimum for detection of the virus in RPA assay. Comparison of sensitivity of detection revealed that RPA could detect the virus up to 10^{-5} dilution of the total DNA. RPA was further simplified using crude extract as template which could detect the virus up to 10^{-3} dilution. RT-RPA was optimized for the detection of PYMoV using total RNA isolated from infected plants as the template. Both RT-RPA and RPA assays were validated using field samples of black pepper representing different varieties and geographical regions by using CTAB isolated DNA, crude DNA extract and cDNA.
Characterization of piper DNA-1 (PDV 1) virus infecting black pepper.	Eight pairs of primers were designed to amplify, PDV1 based on the sequence of the contig. A contiguous sequence of 5536 bases corresponding to the hypothetical protein of the virus obtained when analyzed showed high resemblance to piper DNA virus-1 and about 42% and 25% similarity with tungro and badnaviruses. Further, presence of the repetitive sequence and its occurrence in the black pepper genome suggest that this could be a endogenous virus integrated in the genome of black pepper.

DIVISION OF SOCIAL SCIENCES

Project X: Improving knowledge and skill of stakeholders for increasing production of spices
[Project Leader: Dr. P. Rajeev]

1. DBT-SS1: Distributed Information Sub-Centre (2000-2019) [Dr. Santhosh J. Eapen, D Prasath & K Jayarajan]

Decisions: Nil

Technical programme	Achievements
Development and maintenance of databases.	The following databases/portals were developed or updated and maintained during the period. *Ralstonia* portal was completed. Besides, support was given for maintaining institute websites.
Support for NGS data analysis.	Two strains of *Pseudomonas aeruginosa* were sequenced and compared with other sequences available in the public domain. Data mining for understanding the differences between clinical and non-clinical isolated is being continued. Comparative genomics of *Ralstonia* isolates from India was carried out to their phylogeny and evolution.

2. Ext. VI (813). Capacity building and front-line intervention programmes for (spice sector development in NE states and tribal empowerment (2014-19) (Dr. P. Rajeev & Dr. Lijo Thomas)

Decisions and Action taken:

- In all equipment/ machines we give, IISR emblem should be displayed: During all the programs conducted under Tribal Sub plan and Aspirational districts program all banners and back drop had ICAR and IISR Emblems.

- Document the improvement in the status of tribals after our intervention: Improvements in productivity in turmeric due to introduction of HYV Roma and IISR Pragati was estimated including increase in net income of farmers in Paderu tribal agency area.

- Visit Attapadi and make a video: Yet to be taken.

- Focus should be on aspirational districts: Three programs for two districts in Assam and one in Arunachal Pradesh were carried out.

- Present the TSP report in August 2019: Prepared detailed report for TSP in NE and Wayanad and Palakkad districts.

Technical programme	Achievements
Training and Workshops in NE states and tribal areas.	Three workshops and training programs were organized in two aspirational districts Assam-Golpara and Kamrup Rural and one district in Arunachal Pradesh, Namsai. A programme on area expansion of black pepper in Assam state as an intercrop in Arecanut and tea plantations will be chalked out through promotion of decentralized nurseries. The demonstration of turmeric cultivation will be scaled up to 100 ha in 2020 season in Namsai District. A ten hectare demonstration plot of improved verities of ginger will be set up in 2020 in Namsai district.
Organizing front line demos in tribal farmers' fields -Improved varieties, GAP and Community assets.	Four demonstrations on primary processing of turmeric using boilers and polishers were operationalized with four identified FPOs in Chintappalli and Paderu Mandals in AP. A master black pepper nursery with nucleus planting material supplied from IISR (3000 cuttings) established at Horticulture Nursery and Training Institute under the ITDA-Integrated Tribal Development Agency, Vishakhapatnam agency area supplied 75000 rooted cuttings this season. A tree spice mother garden with nutmeg, clove cinnamon Allspice was established at Chintappalli in AICRPS centre. A turmeric seed garden with 2 tons of IISR Pragati and black pepper mother garden with 3000 cuttings of improved varieties was set up in ACFS farm, Palakkad.
Diagnostic field visits and advisories.	Visited various demonstration units and provided advisory and technical support services in AP and Wayanad District, Kerala.

3. Eco. III (813): Economic analysis of technology, market dynamics and policy scenario in major spice crops (2014-19) (Dr. Lijo Thomas & Dr. P. Rajeev)

Decisions and action taken:

- Dr Lijo Thomas and Director will meet Dr Suresh pal and appraise him of our technologies: A document on valuation of research gains arising from existence of ICAR IISR was prepared and submitted to Dr. Suresh Pal.

- Impact of our varieties and technologies may be studied in economic terms and economic, social and environmental benefit of our technologies may be projected and published: Economic impact of varietal gains has been calculated. It shall be published.

- Visit private industries and find out how much research they conduct: To be undertaken
- Prepare a document on the research funding for spices and what should be our strategy for spread of technologies: Data is being collected and document shall be completed by March, 2020.

Technical programme	Achievements
Study on policy environment for spice trade.	Analysis of FTA's in general and AIFTA in particular was done. The shifting pattern of trade completion for tropical spices analyzed Study on supply chain characters and impact of tariffication.
Crop specific Commercial viability studies.	Crop specific study on commercial cultivation of ginger and turmeric completed.
Generating estimates on Employment generation in spices sector.	Estimates on number of holdings cultivating specific spice crops developed. Estimates on employment generation prepared.
Status and policy studies on yield gap, technology impact and monetization of research benefits	Valuation of research gains in spice sector was done. The yearly monetary value of the research gains calculated.

4. Kerala State – CPPHT-4: Enhancing the economic viability of coconut based land use systems for land use planning in Kerala state. (2014-2019) [Dr. V. Srinivasan, Dr. R. Dinesh, Dr. R. Praveena, Dr. Lijo Thomas, Dr. S. Hamza, Dr. K.M. Prakash, Dr. P.S. Manoj, Dr. P. Ratha Krishnan & KVK, Ernakulam)

Decisions: Nil

Technical programme	Achievements
Maintenance of experimental and demonstration plots with supply of inputs at farmer's fields.	All the inputs for coconut, black pepper and nutmeg (fertilizers, bio agents, amendments) were supplied to farmer's plots. The application of inputs at field, prophylactic pest and disease management were observed. Foliar supplementation of the micronutrients for black pepper was done.
Collecting soil/ leaf samples in experimental plots in coconut + black pepper / nutmeg systems and recording observations on yield.	Soil (profile) and berry samples were collected from experimental and demonstration plots of pepper (in Naduvannur and Arikulam panchayats of Kozhikode) and nutmeg (at Mookanur panchayat of Ernakulam). Analysis is in progress.
Conducting awareness trainings sector.	One day scientist-farmer interaction meet on Optimizing coconut based land use systems for Kerala was conducted on 11 October 2019 attended by 100 farmers across Districts.

Krishi Vigyan Kendra

- During the period, KVK conducted total of 109 on-campus and off-campus training programmes in various disciplines, benefitting 5807 participants.
- Three vocational trainings including On Job Trainings of three day's duration were conducted on "Good Agricultural Practices", "Breeding and culture of ornamental fish culture" and Apiculture to students of VHSC Meppayur, Thamarassery and farmers respectively.
- Two ASCI sponsored one-month skill development trainings on "Quality seed production" and "Friends of Coconut" were conducted for total forty beneficiaries. Three days duration paid training programmes on Breeding and culture of fresh water ornamental fishes and HORTICORP supported training on "Bee keeping" were also organized.
- KVK also organized two of batches "Friends of Coconut programme" sponsored by Coconut Development Board, Kochi and Three days training on "Planting material production and nursery management "sponsored by District Kudumbasree Mission.
- In addition, total three inter institutional collaborative training programmes on "Bonsai making", "Production and management of tropical tuber crops" and "Integrated pest and disease management in Banana" were organized in collaboration with KAU and CTCRI. Programmes on "Soil and spice crops management after flood in Kozhikode" for the ATMA staff of Kozhikode District and "Value added products Development" for Extension functionaries were also organized by KVK.
- District Level Seminar on "Scientific coconut cultivation technologies, post-harvest technologyand value addition" was held at ICAR - Krishi Vigyan Kendra, Indian Institute of Spices Research, Peruvannamuzhi on World Coconut Day (2nd Sep, 2019).
- On the eve of Hon'ble Prime Minister's birth Anniversary, one day farmer's seminar on "Mushroom Cultivation" and mass tree plantation campaign were organized.
- On and off campus awareness activities through rallies, common area cleaning, planting of saplings, street play, drawing competition, monthly cleaning activities were actively participated by staff for the benefit of public as Swachh Bharat Activities.
- The Kendra organized and participated in five field days, four seminars, participated in fourteen exhibitions, delivered one radio talk, six TV programmes and conducted three studies cum exposure tours for farmers to various research institutes.
- Sixteen technologies for demonstrations and five On Farm Trials for technology assessment were implemented in 145 and 26 farmer fields respectively. KVK also documented two success stories on Bush pepper cultivation and Layer chick's management under cage system.
- The nursery and polyhouse of KVK produced total about 20054 seedlings of vegetables, pepper rooted cuttings, nutmeg grafts, Arecanut (Mohitnagar) seedlings, etc and sold to 1619 farmers.
- About 7.49 quintals of IISR Pragathi, Prabha turmeric seeds were produced and made available to farmers. The hatchery unit at KVK produced about 21482 layer chicks (Gramasree) and 1844 ornamental fishes for sale.