Dr. S. Geetha
Director, Centre for Plant Breeding and Genetics,
TNAU, Coimbatore

The Directorate of Centre for Plant Breeding and Genetics is being a major Centre in TNAU involved in crop improvement activities and comprised of eight departments *viz*., Department of Rice, Department of Millets, Department of Pulses, Department of Oilseeds, Department of Cotton, Department of Forage Crops, Department of Plant Genetic Resources and Department of Genetics and Plant Breeding. The Breeder Seed Unit functioning under this Directorate is monitoring and coordinating the Breeder Seed Production of entire Tamil Nadu for both Agricultural and Horticultural Crop. The mandates of this directorate includes teaching, research and extension *ie.,* handling courses on Genetics, Cytogenetics, Plant Breeding and PGR related courses to UG, PG and Ph.D students through quality teaching, conducting research on crop varietal development and dissemination of knowledge on crop varieties to the farmers. It is one of the highly reputed Directorate which is the main centre for many of All India Coordinated Research trials (AICRP) of various crops. Many network research projects are handled in various departments of this Directorate in collaboration with National and International Institutes. This Directorate is monitoring and coordinating all the teaching and research activities of entire TNAU with respect to Plant breeding and Genetics. The varieties released during 2018-2020 and their special features are detailed below.

Research Highlights 2017-2020

2018

Paddy ADT 51

It is a cross derivative of BPT 5204 / I. W. Ponni and maturing in 154 days. It is recommended for cultivation during *Samba* season (August sowing) in delta districts of Tamil Nadu. It recorded an average grain yield of 6533 kg / ha with 9.8 and 12.7percent increase over CR 1009 and ADT 50 respectively. Resistant to blast and moderately resistant to pests like leaf folder, stem borer, BPH, and diseases like sheath blight and sheath rot. The grain is medium grade, white rice with 1000 grain weight of 23.9 g.

Cowpea VBN 3

It is a cross derivative of TLS 38 / VCP 16-1 with a duration of 75-80 days. The average yield is1013 kg/ha under rainfed which is 17.0 and 17.2 percent increased yield over Vamban 1 and CO (CP) 7 respectively. The variety is determinate plant type, synchronized maturity,multiple resistanceto Bean Common Mosaic Virus, rust and anthracnose diseases and also to pod borer and pod bug. Theprotein content is 25.22%. It is suitable for both *kharif* and *Rabi* seasons in all the districts of Tamil Nadu.

Groundnut TMV 14

It is a cross derivative of VRI (Gn) 6 x R 2001 and matures in 95-100 days. It gives an average pod yield of 2124 kg/ha under rainfed condition. It possesses moderate resistant to late leaf spot and rust disease under field conditions. The shelling percentage is 70.6% and oil content of 48%. . It is suitable for cultivation underrainfed conditions in groundnut cultivated l districts of Tamil Nadu

Sunflower hybrid CoH 3

The hybrid developed from male sterile line COSF 6A and a restorer line IR6. It matures in 90-95 days. The average yield is 2214 kg/ha which is 20.5% yield increase over check hybrid Sunbred 275 (1838 kg/ha. It has oil content of 42% with the oil yield of 765 kg/ha. It has high seed volume weight (47.0g/ 100ml) when compared to check hybrid Sunbred 275. It is recommended for cultivation during *Kharif* and *Rabi* seasons.

Sugarcane COG 6

The average cane yield under normal condition is 140.56 t/ha and under salt affected soil it is 131.74 t/ha. The average sugar yield is 18.39 t/ha. The canes are erect. Medium thick and non lodging.It is suitable for jaggerymaking and cultivation in salt affected soils of Tamil Nadu. This variety is moderately resistant to red rot and smut disease and resistant to wooly aphids.

2019

Paddy ADT 53

It is a cross derivative of ADT 43 / JGL 384 and matures in 105 – 110 days. The variety is erect, medium tall, non lodging plant type with well exerted compact panicle. The mean grain yield of the variety is 6334 kg/ha and potential yield of 9875 kg/ha was recorded at Alanganallur, Madurai district. It has medium slender rice, rich in Zinc (26.06 ppm) and Iron (14.70 ppm) content with high milling outturn and Head Rice Recovery. The variety is moderate resistance to pests *viz.,* stem borer, leaf folder and diseases *viz*., blast, sheath rot and brown spot. This variety is recommended for cultivation during *Kuruvai / Kodai / Navarai* seasons in rice growing districts of Tamil Nadu.

VGD 1

It is a cross derivative of ADT43 / Seeragasamba with duration of 125-130 days. It gives an average grain yield of 5859 kg/ha with 32.56 and 13.80 per cent yield increase over Seeragasamba and TKM 13 respectively. The variety is semi-dwarf, erect, high tillering, non lodging plant habit and photo-insensitive. It possesses short slender grain with good LER (2.1), intermediate amylose (21.9%) and head rice recovery (62.1%). The cooked rice is non-sticky and soft. It is suitable for making briyani. It is moderately resistant to leaf folder, blast and brown spot. It is recommended for cultivation during Samba/Late samba /Thaladi seasons in all rice growing zones of Tamil Nadu.

Samai - ATL 1

It is a cross derivative of CO (Samai) 4 / TNAU 141 with a duration of 85-90 days. It recorded an average yield of 1587 and 3109 kg/ha of grain and straw under rainfed condition. The panicles are long and semi-compact with non-shattering grains. The variety is Input responsive. The sturdy culm and uniform maturity with non-lodging trait suitable for mechanized harvesting. The variety is tolerant to drought. Bold grains, high milling out turn (66.3%) and suitable for value addition with consumer preference.

Greengram VBN 4

It is a cross derivative of PDM 139 / BB 2664 and matures in 65-70 days. The average yield of 1024 kg/ha which is 16.8% and 21.3% increased yield over VBN (Gg)3 (876 kg/ha) and CO 8 (844 kg/ha) respectively. It gives high yield due to multi bloom with non shattering pods. It has moderate resistance to Mungbean Yellow Mosaic Virus (MYMV) and powdery mildew diseases and resistance to urdbean leaf crinkle virus disease. This variety is recommended for cultivation during *Kharif*, *Rabi* and *Summer* seasons in all greengram growing districts of Tamil Nadu except Nilgiris and Kanyakumari.

Groundnut BSR 2

It is a cross derivative of VRI 2 / TVG 0004 and maturing in 105 – 110 days. It recorded a mean pod yield of 2222 kg/ha and 2360 kg/ha under rainfed and irrigated conditions which is 5.9% and 15.5% superior over the best check VRI 8 (2099 kg/ha and 2044 kg/ha). It is moderately resistance to late leaf spot and rust diseases, sucking pests (aphids, thrips, jassids) and defoliators. It is suitable for cultivation in *Kharif* and *Rabi* summer seasons in all the groundnut growing districts of Tamil Nadu.

Castor YTP 1

Castor variety YTP 1 is a cross derivative of TMV 6 / Salem Local. The average yield is 1456 kg/ha and it can be maintained upto3 years and gives 1st harvest on 115-120 days after sowing. This variety is suitable for both perennial and annual system as it gives 3kg of castor bean per plant per annum in mixed cropping / inter cropping system and perennial system. This variety is resistant to wilt disease.

Pigeonpea CRG 2012-25 - CVRC

This variety is released for cultivation in South Zone comprising of Tamil Nadu, Andhra Pradesh, Telangana, Karnataka and Odisha. It is a cross derivative of CO 6 x IC 525427 with duration of 170-180 days. It gives an average yield of 1700 kg/ha which is 19% superiority over the best national check WRP-1, 17.58% and 14.61% over zonal checks CO 6 and ICP 8863 respectively. It possesses moderately resistant to SMD and wilt diseases and moderately tolerant to *Helicoverpa* and *Maruca* pests.

Blackgram VBG 9 (CVRC)

The blackgram variety VBG 9 is a cross derivative of Mash 114 x VBN 3. It matures in 70-75 days and suitable for rice fallow season. It has determinate plant type with synchronized maturity. It recorded an average yield of 1230kg/ha which is 14.5, 24.5, 20.3% increased yield over the check varieties LBG 787, LBG 752 and ADT 3 respectively. It has moderate resistance to Mungbean Yellow Mosaic Virus (MYMV), urdbean leaf crinkle virus, leaf curl virus and powdery mildew diseases. This variety is recommended for cultivation in South Zone comprising Tamil Nadu, Karnataka, Andhra Pradesh, Telangana and Odisha.

Blackgram VBG 10 (CVRC)

It is released for cultivation in south zone comprising of Tamil Nadu, Andhra Pradesh, Telangana, Karnataka and Odisha. It is a cross derivative of VBN 1 x UH 04-04. It matures in 70-75 days and suitable for *Rabi* season. It has determinate plant type with synchronized maturity. The overall average yield is 1130 kg/ha. This variety is resistant to Mungbean Yellow Mosaic Virus (MYMV), urdbean leaf crinkle virus and leaf curl virus diseases.

***Cenchrussetigerus* (Black Kolukattai grass) CO 2**

It isidentified for release in SZ (TN, AP, Telangana& Karnataka). This perennial grass is a selection from *Kangayam* local. It is Pasture land grass with lesser ADF (42.5 %) and NDF (64.17 %) indicating higher digestibility and intake. It has yields 45 t of green fodder per ha per year and 10.2 t of dry matter per ha per year.

***Desmanthus* (Hedge Lucerne)CO 2**

It is a Gamma ray mutant of *Desmanthus* CO 1. It is the perennial fodder has an average yield potential of 130 t/ha/yr green fodder with 33 t/ha/yr dry matter yield. It possesses Crude protein content of 16.5%, more palatable and resistant to rust.

2020

Paddy ADT 54

This variety is a cross derivatives of I.W. Ponni / Bansakthi with a duration of 131 days. It recorded an average yield of 6123 kg/ha which is 9.8 % increase over BPT 5204 and 11.2 % increase over ADT 49. It is suitable for cultivation in *Thaladi* /late *Samba* seasons. It is medium slender rice with good LER-1.6 and HRR 60.1%. The physical and cooking qualities are on par with White Ponni. This variety is moderately resistant to BPH and brown spot diseases.It is recommended for Late samba /Thaladi seasons in all rice growing zones of Tamil Nadu.

Paddy CO 53

It is a cross derivative of PMK (R) 3 / Norungan and matures in 115 – 120 days. It recorded an average grain yield of 3718 kg/ha which was 12.19 per cent increase over TKM (R) 12 and 14.08 per cent over Anna (R) 4 under dry condition; 3866 kg/ha with 18.40 per cent improvement over TKM (R) 12 and 8.67per cent over Anna (R) 4 under semi dry condition. The grain is short bold, white rice with high milling percentage (69.6), good head rice recovery (59.6 %) and intermediate amylose content (23.5 %). It is suitable for idly making. This variety is a drought tolerant and had better agronomic and physiological efficiency than TKM (R)12 and Anna (R) 4 under control and drought conditions. It is moderately resistant to multiple diseases *viz.,* leaf blast, neck blast, sheath rot, brown spot and RTD and moderately resistant to WBPH. It is recommended for cultivation in drought prone districts of Tamil Nadu as direct seeded semi dry or rainfed rice.

Sorghum CO 32

The dual purpose variety is a cross derivatives of APK 1 / M 35-1 and matures in 105 - 110 days. Yellow white grains borne on medium semi-compact ear heads.It gives mean yield of 3051 kg/ha (Irrigated) 2231 kg/ha (Rainfed) which is 10% higher than Check CO 30. It has high protein (11.31-14.66%) and fibre content (5.8%) along with better cooking quality traits (Cooking grade 9). The stover quality is also best with 6.15 % protein and *in-vitro* dry matter digestibility of 54-58%. It possesses moderately resistant to shoot fly and stem borer pest and grain mould and downy mildew diseases. It is recommended for general cultivation in Tamil Nadu for both in rainfed and irrigated condition.

Tenai ATL 1

It is a cross derivatives of PS 4 x ISe 198 and matures in 80 - 85 days. It recorded average yield of 2117 kg/ha grain and 2785 kg/ha fodder yield.Bold grain with high bulk density, non shattering and high milling out turn (68.1%). The plant has sturdy culm, uniform maturity with non-lodging trait which amenable for mechanized harvesting. This variety possesses high tillering ability, drought tolerant, fertilizer responsive and no serious pest and disease occurrence.

Blackgram VBN 11

It is a cross derivative of PU 31 x CO 6 and matures in 60-65 days. It recorded mean grain yield of 940 kg/ha under irrigated and 865 kg/ha in rainfed conditions. It possess resistant to Mungbean Yellow Mosaic (MYMV) and moderately resistant to Powdery Mildew and leaf crinkle disease. The protein content is 22.6 %. It is the bestalternate variety for ADT 5 in summer irrigated condition. It is suitable for cultivation in all seasons in pulses growing districts of Tamil Nadu.

Cotton CO 17

The cotton variety CO 17 is a cross derivative of Khandwa x LH 220 and matures in 140 days. The average seed cotton yield recorded 1835 kg/ha which is 15.95% increase over the check variety Suraj. It possesses compact and erect plant type, zero monopodia and short sympodial branch, 15-20 bolls/plant, boll weight between 3.50 g and 4.00 g, synchronized boll maturity, High ginning outturn of 35.10 %, Upper Half Mean Halo length is 27.0 mm and High bundle strength of 26.1g/tex.

Dr. S. Mohankumar
Director, Centre for Plant Molecular Biology & Biotechnology,
TNAU, Coimbatore

The Centre for Plant Molecular Biology & Biotechnology (CPMB&B) was established in 1990 to take up research in plants based on cues from the science of plant molecular biology. During the formative years, the centre received liberal funding from the Department of Biotechnology, Government of India and The Rockefeller Foundation, USA, in the form of research grants and manpower training.

Since the inception of CPMB there have been several research initiatives in major crops with multitude objectives but leading to one broader goal – Crop improvement. Set to achieve the goals, we believed in bringing together scientists from ifferent disciplines such as plant breeding and genetics, crop physiology, plant pathology, agricultural entomology, microbiology, bioinformatics and chemistry. Until recently there have been only two departments functioning under this centre viz. Department of Plant Molecular Biology and Biotechnology and Department of Biochemistry.

Towards accomplishing sustained research outputs in priority research areas and with an eye on the future, CPMB has been renamed as Centre for Plant Molecular Biology & Biotechnology (CPMB & B) and the departments were reconstituted as well. The Department of Plant Molecular Biology and Biotechnology has been bifurcated into the Department of Plant Biotechnology and Department of Plant Molecular Biology & Bioinformatics and the Department of Biochemistry remains as such. The DBT sponsored Biotechnology Information System (BTIS) has been an added component aiding in bioinformatics activities at this centre.

Research Highlights (2017-2020)

CPMB&B is a pioneering institute in the field of Plant Biotechnology research in the country. CPMB&B has diversified its activity in tune with the pace of development elsewhere in the world and possesses modern molecular biology and biotechnology laboratories with sophisticated equipment.The research programs of CPMB&B focus on the following themes.

Theme 1: Evolving molecular and biotechnological tools, processes and products

Major objectives of this theme are

- Developing newer molecular tools, processes and products for developing genotypes with enhanced efficiency and productivity
- Developing improved genotypes for yield and agronomic traits using newer molecular tools
- Understanding molecular mechanisms of stress resistance through Omics technologies
- Assessing Impact of biotechnology products
- Genome editing for enhancing disease resistance and nutritional properties in rice
- Synthetic biology for antimicrobial, insecticidal and pharmacological compounds

Theme 2: Bioprospecting and Plant Tissue Culture

The key objectives of this theme are

- Biochemical profiling of nutritionally/medicinally important native genetic resources
- Identification, isolation and *in silico* analysis of novel biomolecules/genes from under exploited indigenous plants and microbes
- Micro-propagation of tree and horticultural crops
- Development of doubled haploids plants for trait enhancement

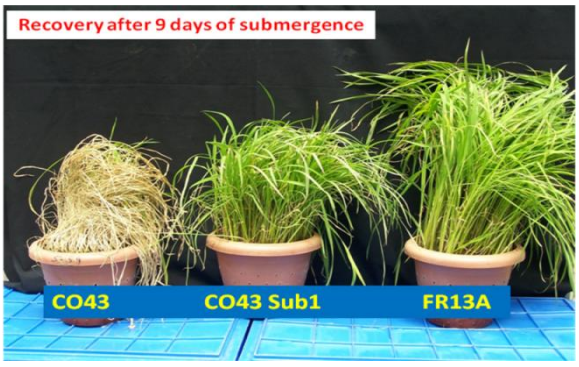
Theme 3: Genomics approaches for characterization, gene identification and molecular evolution

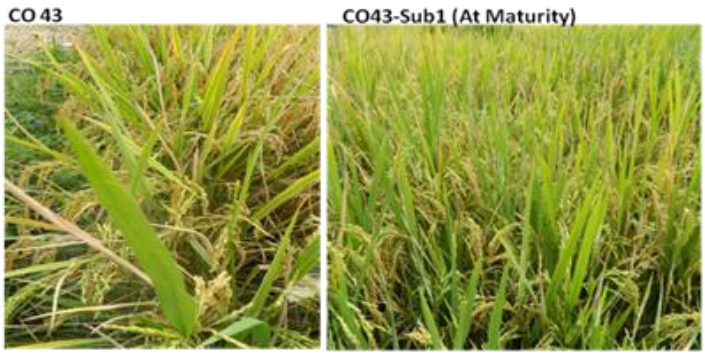
Following activities have been given priority under this thematic area:

- Molecular diversity in plants and associated organisms
- Whole genome sequencing of native crops (such as Moringa) and beneficial micro-organisms
- Genomic insight and allele mining
- Development of databases for agricultural crops and new bioinformatics tools for genome analysis
- DNA fingerprinting of varieties of major crops of Tamil Nadu

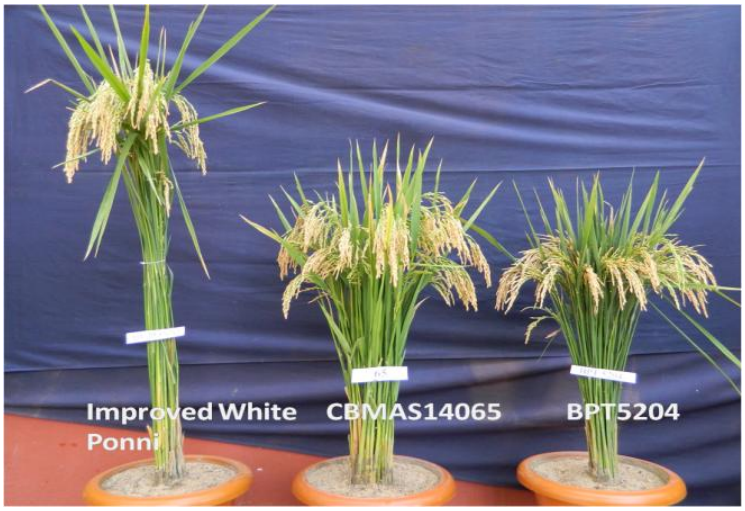
Major Research Accomplishments

FOR ADOPTION:
CO43-Sub1, a submergence tolerant rice
Submergence tolerant version of a popular rice variety CO43 was developedthrough Marker Assisted Backcross Breeding approach. CO43 *Sub1* exhibited on-par performance against its recurrent parent CO 43 (with an average of 4% increased yield) under normal conditions. It out yielded CO43 by recording 23.5% increased yield under submergence. It recorded 58.8% increased yield over the best check, Swarna*Sub-1* under submergence.





FOR ON-FARM TESTING (2019-20)
CBMAS 14065 (Improved White Ponni x Apo), a medium duration fine grain rice
CBMAS14065 is a medium duration (130-135 days) culture with short slender grain (L = 5.4 mm; B = 2 mm and L/B ratio 2.6), yield potential of >5 t/ha, better head rice recovery (62%) and good cooking quality. This performed better than the checks, TKM 13 and BPT 5204 under MLT and ART. Having potential to withstand moderate drought due to possession of drought tolerant QTLs which was confirmed through molecular markers.

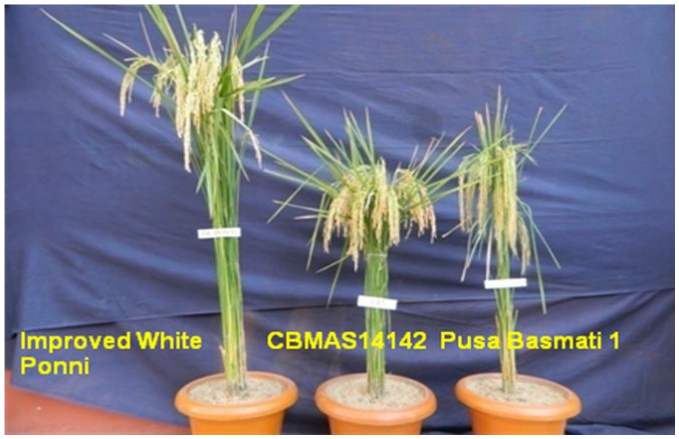


AD (Bio) 09518 (ADT 43 x IRBB 60-5-1) – a bacterial blight resistant rice culture

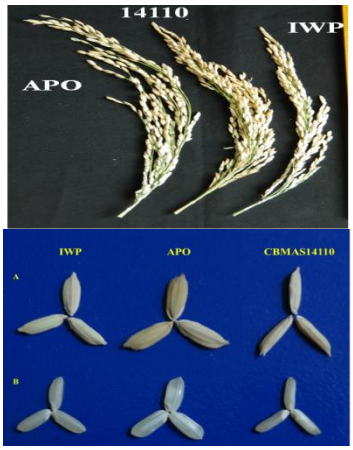
A short duration (115-120 days) rice culture, AD (Bio) 09518 (ADT 43 x IRBB60-5-1) with the yield potential of 5767 kg/ha and high resistance to bacterial blight has been developed through marker-assisted pedigree breeding. It has medium slender grains with high head rice recovery (80.6%). This culture was tested under adaptive research trial (ART-Rice 14/2015-16, 2016-17, Special transplanted Early (May-June sowing) for the two consecutive years.

FOR INFORMATION (ART/MLT)

CBMAS14142, a short duration (115-120 days) culture with long slender grain (Length = 7.3 mm; breadth = 1.9 mm and L/B ratio 3.8) is recommended for third year of evaluation under ART. This culture has high yield potential 4.5 – 5 t/ha, high head rice recovery (>60%) and high linear elongation ratio after cooking. This culture was recommended for ART in Vellore, Dharmapuri, Salem, Erode, Coimbatore, Dindigul, Theni, Karur, Trichy and Perambalur districts. Now, it is recommended for maintenance breeding.

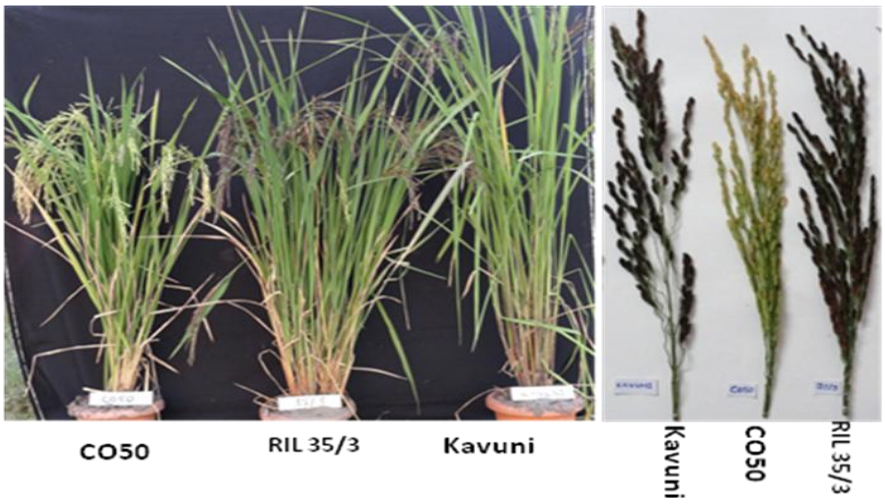


CBMAS 14110, a high yielding (6t/ha) and short duration (110 – 115 days) rice culture possessing fine grainsdeveloped through marker-assisted pedigree breeding is recommended for second year of evaluation under MLT. It is a medium tall genotype with dark green leaves. Possess very high grain number per panicle (300 – 350 grains per panicle). It harbours 3 mega effect QTLs of Apo contributing for grain yield under drought.



Therapeutic rice Kavuni

A traditional therapeutic rice "Kavuni" is characterized for biochemical properties associated with anti-diabetes and age related macular degeneration (ARMD). High yielding (3 – 3.5 t/ha) and photo-insensitive versions of Kavuni possessing all major therapeutic clues have been developed and nominated for special MLT. Now, it is recommended for OFT.

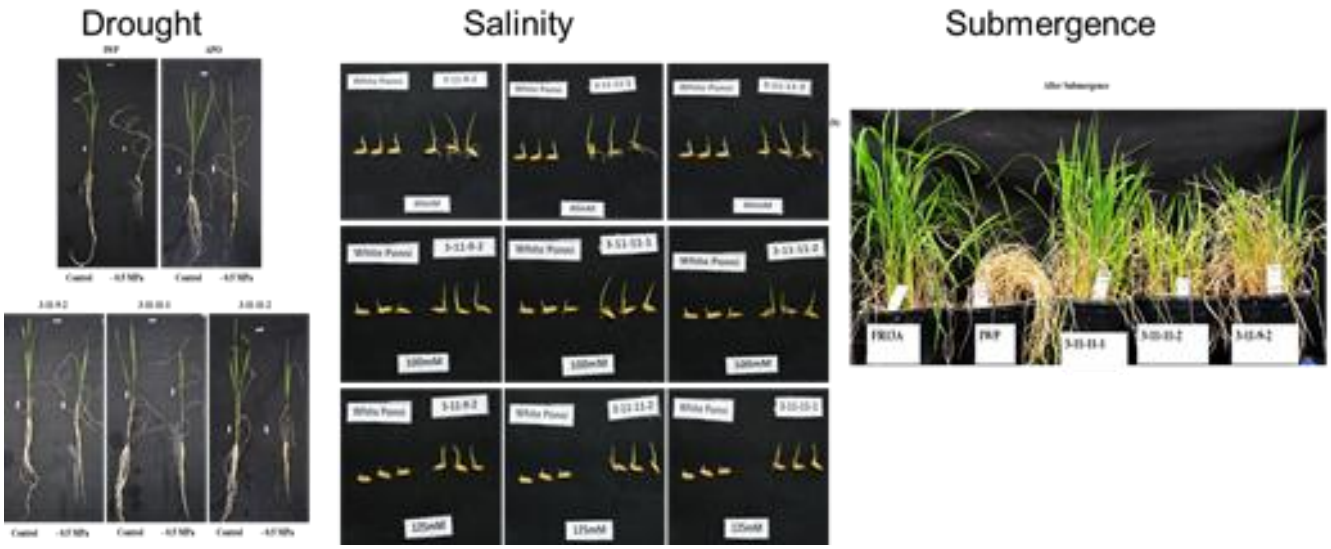


Maize hybrid in MLT

The Maize hybrid ACM M15009 (UMI1200β x UMI1230 β) is nominated for MLT during 2018-19 with CO 6 as a check. The hybrid is having high yield potential of 10730 kg/ha which is 11.3 % increase yield over the existing hybrid CO6 with the β carotene content of 9.60 µg/g.

Triple trouble (drought, salinity and submergence) tolerant rice:

Advanced backcross progenies of White Ponni exhibiting tolerance against the above three abiotic stresses have been developed through MABB. Superior NILs have been identified and are under multiplication.

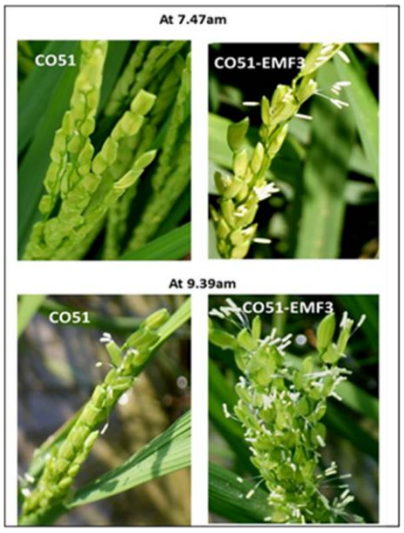


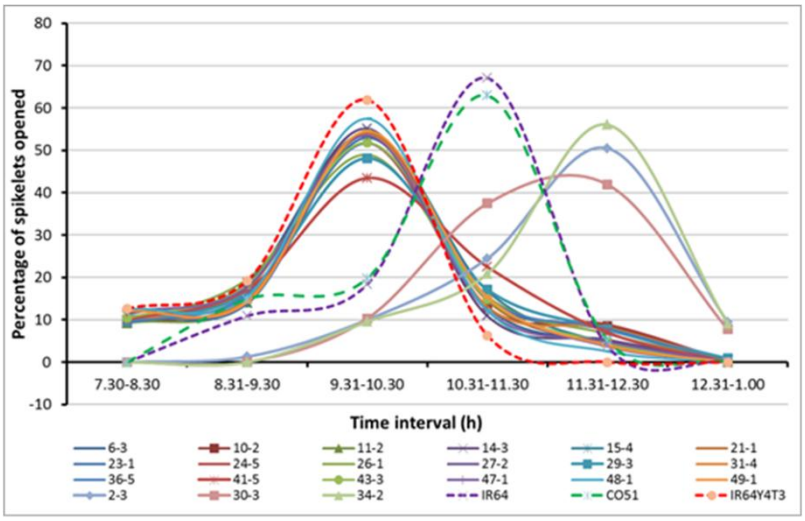
Development of multiple stress tolerant rice through QTL pyramiding

BC2F2 progenies of CBMAS14065 harboring 8-9different QTLs in different combinations have been developed. They have attained homozygosity at 7-8 target loci with 1-2 loci under heterozygous condition. In CO1 genetic background, F2 progenies derived through inter-mating of back cross progenies of CO51 harbouring 9 QTLs (5 progenies with 83-92% RPG recovery), 8 QTLs (12 progenies with 76-92% RPG recovery) and 7 QTLs (27 progenies with 76-92% RPG recovery) were developed.

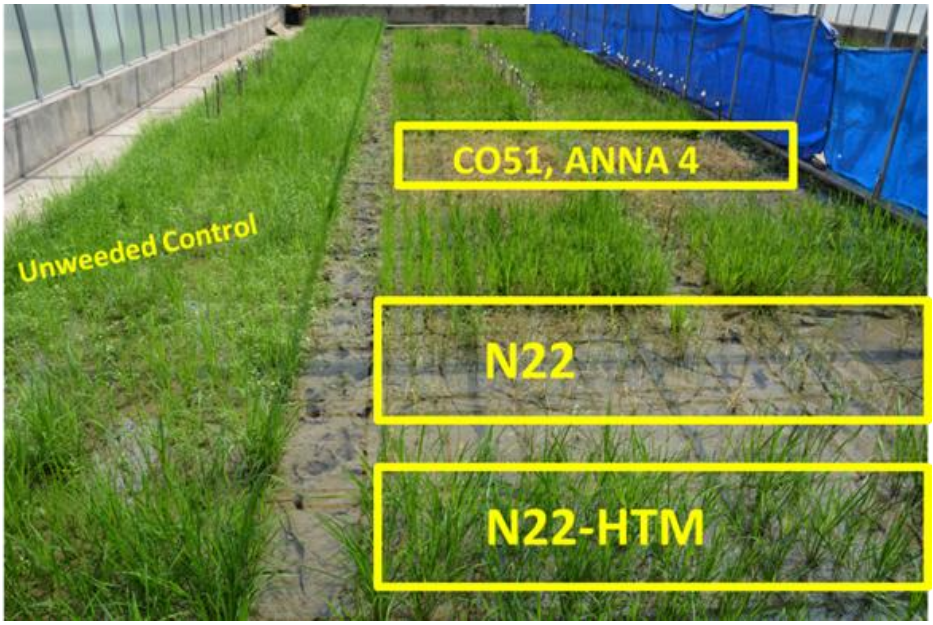
Early morning flowering version of CO51 to mitigate heat induced spikelet sterility

A QTL qEMF3 controlling anthesis time in rice has been mobilized into CO51 through MABB. NILs of CO51 harboring qENF3 with 1 to 1 ½ hrspreponement in anthesishave been developed.



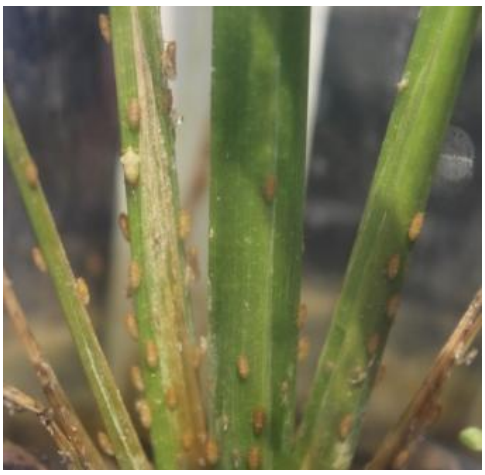


- DPB, CPMB&B in collaboration with Dept. of Rice has developed herbicide tolerant versions (Imazethapyr resistant) of CO 51, Anna 4, ADT 43 and CBMAS 14110. Efficacy of rice herbicide tolerance trait was tested under direct seeded cultivation. Advanced back cross progenies (BC3F1) of CO51 harboring herbicide tolerance loci have been developed.



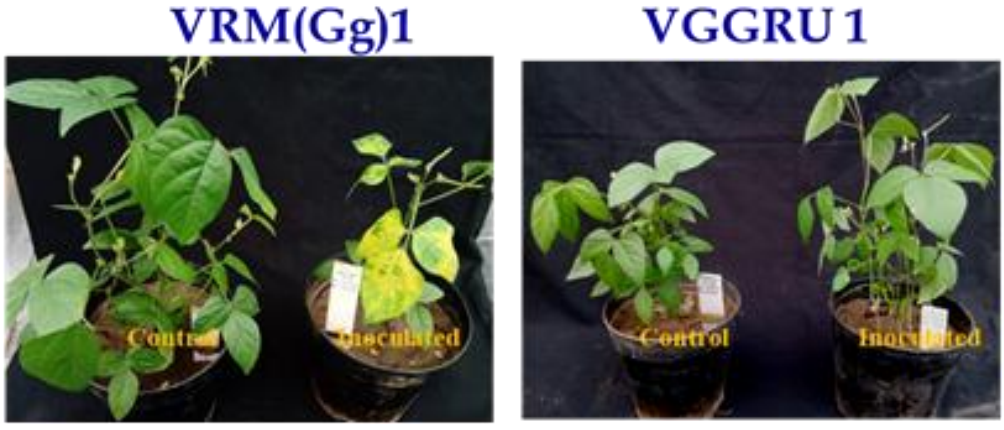
- Genome editing platform for creating targeted mutations has been set up for accelerated trait improvement. Genome edited rice plants exhibiting mutations in genes controlling aroma and virus resistance have been developed.

- Transgenic rice plants producing siRNA for suppressing the expression of *Chitin synthase 1* of *Nilaparvatha lugens* were developed. Bio-assay studies identified few moderately resistant events were identified



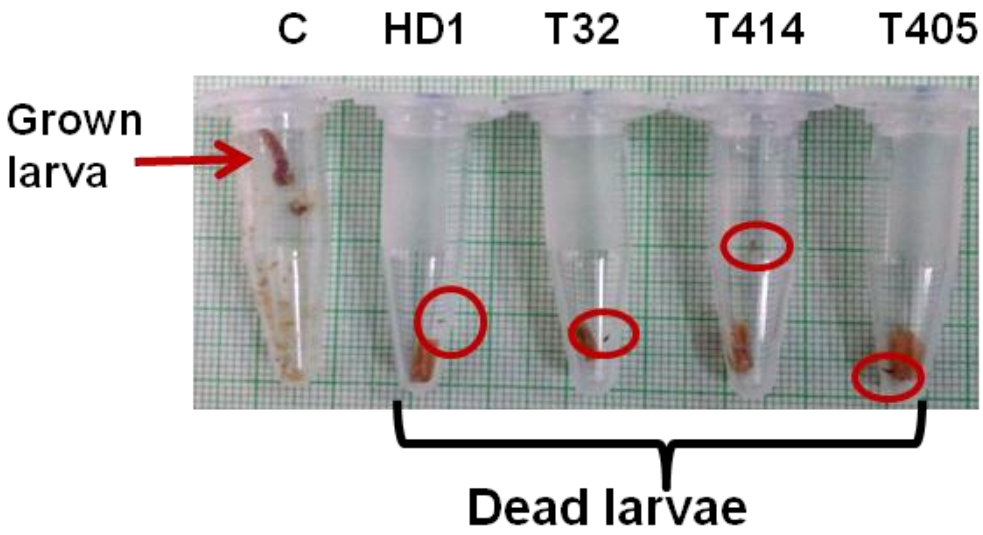
- **Transgenic banana (Rasthali) exhibiting resistance against BBTV has been developed through RNAi technology.**

- A laboratory protocol "Agroinfection" is optimized for screening mungbean and urdbeangermplasm/breeding populations against MYMV



Exploring native Bt diversity for novel insecticidal toxins

DPB is involved in Bt research for the past 20 years. Scientists of DPB have invented novel Bt toxins and flied 3 patents so far. In this series, recent exploration has led to the identification of novel Bt isolates exhibiting toxicity against maize Fall Army Worm *Spodoptera frugiperda.*



- Medicinal and anti-microbial compounds from native plants, *Annona muricata*, *Aegle marmelos*, Mangosteen etc., isolated through bioprospecting

Bioinformatics

- Genome complexity of native rice genotypes ASD16 and ADT43; blackgram (Co-5); moringa (PKM1) unraveled;
- Genetic fingerprinting of advanced cultures of TNAU were carried out
- Antiviral properties of native herbals studied through molecular simulation modeling and *in silico* approach.

Biochemistry

- A termiticidal compound was isolated from *Lantana camara* . Further characterization of fractions and product development is in progress.

Details of Collaborations established

(a) National organizations

- Indian Agricultural Research Institute (IARI), New Delhi
- Indian Institute of Rice Research (IIRR), Hyderabad
- Assam Agricultural University, Jorhat on rice molecular breeding
- University of Agricultural Sciences Dharwad, Bangalore

(b) Non-Governmental Organizations

- MS Swaminathan Research Foundation, Chennai on rice biofortification
- M/s. Scigenom Research Foundation, Cochin
- M/s. Bioseed Research India Pvt. Ltd., Hyderabad

(c) International organizations

- International Rice Research Institute, Philippines
- Queensland University of Technology, Australia on Banana Bunchy Top Virus (BBTV) resistance and drought tolerance in rice
- University of Queensland and Department of Agriculture and Fisheries, Brisbane, Australia on ensuring food security from storage insect threats with special reference to storage insect pest resistance to phosphine
- University of California Davis, California, USA on Bioavailability of major nutrients in rice
- International Centre for Genetic Engineering and Biotechnology, New Delhi

Patent(s) filed and commercialized

S.No	Name of the Innovation	Scientist & Department	Date Filing/Grant
1.	Groundnut germ oil extraction by cold processing thereof (No. 201841004040)	Dr. C. Sivananth, BIRAC Innovation Post Master Fellow (2016-2018) under UIC-TNAU Scheme operating at Dept. of Plant Biotechnology, CPMB&B	Complete patent filed on 01.02.2019
2.	Codon optimized synthetic nucleotide sequences encoding *Cry2Ai* protein and uses thereof.	Dr. V. Udayasuriyan Dr. D. Sudhakar Dr. N. Balakrishnan Dr. S. Mohankumar & Scientists of BRI (Joint patent of TNAU and Bioseeds Research India)	Complete patent filed on 24.04.2019
3.	Techniques to prepare formulation of mycoparasiticbiofungicide for use against powdery mildew disease of plants (No. 201841044650)	Dr. S. Parthasarathy, BIRAC Innovation Post Master Fellow (2016-2018) under UIC-TNAU Scheme operating at Dept. of Plant Biotechnology, CPMB&B	Complete patent filed on27.11.2019

Technology Transfer

1. **Novel insecticidal gene Cry2Ai was commercialized to M/s. Bioseed India Pvt. Ltd., Hyderabd**

AGRICULTURAL COLLEGE & RESEARCH INSTITUTE,EACHANGKOTTAI

S.No	Particular	Rate (kg/litre) (Rs.)	Quantity (kg or litre)	Amount (Rs.)	Revenue generated (Rs.)
Seed production					
C.	**Foundation seed**				**Rs.40,360.00**
	Black gram (VBN 8)	95/-	328 kg	31160/-	
	Black gram (ADT 6)	115/-	80 kg	9200/-	

Dr. S. Sundareswaran
Director, Seed Centre,
TNAU, Coimbatore

A path breaking success of Tamil Nadu Agricultural University in evolution of new varieties and production of Breeder, Foundation, Certified and TFL seeds to meet out the quality seed requirements and to ensure high Seed Replacement Rate and Varietal Replacement Rate, formed the basis for establishment of a separate Directorate of Seed Centre. In 2006, a major initiative was made by Tamil Nadu Agricultural University to take up large scale seed production programmes in various college campuses and Research Stations of the University and to implement Single Window System of seed production. Ultimately, following the guidelines of the ICAR, the "Seed Centre" was established in TNAU on 27.10.2006 under the control of Special Officer (Seeds). Then the Seed Centre was upgraded into Directorate of Seed Centre and Special Officer (Seeds) was redesignated as Director from 01.07.2018. The Director, Seed Centre is vested with the responsibility of managing and strengthening the seed production chain of the TNAU released varieties to cater to the needs of the farmers and to ensure food security of the State.

Research Highlights (2017-2020)

I. Production of quality seeds

2017-18

S. No.	Crop	Foundation seed (q)	Certified seed (q)	TFL seed (q)	Total (q)
I.	**Seeds**				
1.	Paddy	4299.30	255.88	2677.73	7232.91
2.	Millets	-	15.00	71.85	86.85
3.	Pulses	529.04	1224.00	409.46	2162.5
4.	Oilseeds	-	-	86.90	86.9
5.	Cotton	-	-	3.50	3.5
6.	Forage	-	-	15.31	15.31
7.	Green manure crops	-	-	92.54	92.54
8.	Vegetable Crops	-	-	90.41	90.41
	Total	**4828.34**	**1494.88**	**3447.70**	**9770.92**
II.	**Planting materials (setts / Rhizomes)**				
1.	Turmeric	-	-	324.93	324.93
2.	Sugarcane	-	-	837.16	837.16
	Total	-	-	**1162.09**	**1162.09**
	Grand Total	**4828.34**	**1494.88**	**4609.79**	**10933.01**

2018-19

S. No.	Crop	Foundation seed (q)	Certified seed (q)	TFL seed (q)	Total (q)
I.	**Seeds**				
1.	Paddy	2,730.41	1,851.06	4,121.62	8,703.09
2.	Millets	45.90	46.40	88.09	180.39
3.	Pulses	164.43	789.69	40.64	994.76
4.	Oilseeds	233.37	-	519.93	753.30
5.	Cotton	-	-	9.52	9.52
6.	Forage Crops	-	-	19.26	19.26
7.	Green manure	-	-	24.55	24.55
8.	Vegetable Crops	-	-	53.18	53.18
	Total	**3,174.11**	**2,687.15**	**4876.79**	**10738.05**
II.	**Planting materials (setts / Rhizomes)**				
1.	Turmeric	-	-	280.09	280.09
2.	Sugarcane	-	-	653.99	653.99
	Total	**-**	**-**	**934.08**	**934.08**
	Grand Total	**3,174.11**	**2,687.15**	**5,810.87**	**11,672.13**
III.	**Planting materials (Seedlings) (Nos.)**	-	-	**11,26,819**	**11,26,819**

2019-20

S. No.	Crop	Foundation seed (q)	Certified seed (q)	TFL seed (q)	Total (q)
I.	**Seeds**				
1.	Paddy	5190.19	532.02	8692.45	14414.66
2.	Millets	38.77	63.33	236.53	338.63
3.	Pulses	348.94	447.80	355.27	1152.01
4.	Oilseeds	257.04	489.53	156.49	903.06
5.	Cotton	-	-	13.19	13.19
6.	Forage Crops	-	-	37.77	37.77
7.	Green manure	-	-	74.13	74.13
8.	Vegetable Crops	0.29	0.08	89.76	90.13
	Total	**5835.23**	**1532.76**	**9655.59**	**17023.58**
II.	**Planting materials (setts / Rhizomes)**				
1.	Turmeric	-	-	406.68	406.68
2.	Sugarcane	-	-	1180.00	1180.00
	Total	**-**	**-**	**1586.68**	**1586.68**
	Grand Total	**5835.23**	**1532.76**	**11242.27**	**18610.26**
III.	**Planting materials (Seedlings) (Nos.)**	-	-	**23,81,416**	**23,81,416**

II. Improved seed production technologies

Seed yield maximisation in *Desmanthus*

Foliar application of either 2% DAP or 1% TNAU Pulse wonder at 50% flowering and at pod formation stages is the best method for obtaining higher seed yield with higher germination and vigour in *Desmanthus*.

Pre-sowing seed treatment for saline / sodic soils in rice

Soaking rice seeds in equal volume of 80µM concentration of sodium nitroprusside for 16 hrs is recommended for raising nursery in saline / sodic soils.

Seed priming for enhanced productivity of rainfed horsegram

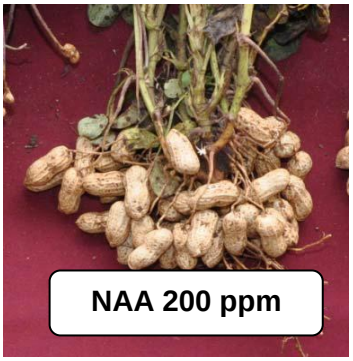
Priming the seeds with 100 ppm $ZnSO_4$ @ 1:1 seed to solution ratio for 3 hours and sowing by seed drill followed by foliar spray of 0.5 % $ZnSO_4$ at 50 % flowering is recommended for increased productivity of rainfed horsegram.

Unprimed

Primed

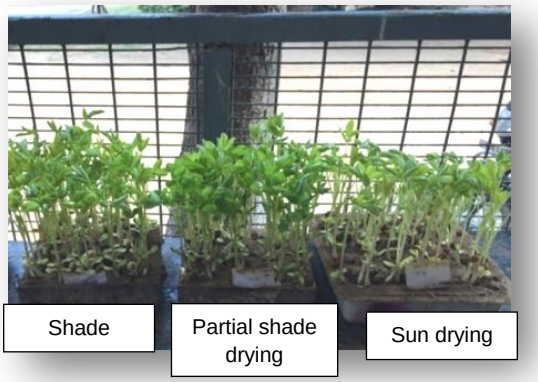
Arresting late formed flowers to improve seed yield in groundnut

Foliar application of NAA@ 200 ppm at 60 days after sowing is recommended to arrest late formed flowers and increase the seed yield in groundnut.



Seed drying methods to improve the storability of oilseeds

Groundnut seeds dried under shade (7 days) to 8 % moisture content and stored in ambient condition in cloth bag maintained highest vigour and viability up to eight months of storage.



Seed priming for improving seed vigour and yield in groundnut

Groundnut seeds primed with $CaCl_2$ @ 0.5 % with a seed to solution ratio of 1:1 and soaking duration of 8 hours improved 10 % seed germination in medium vigour lots.

Prevention of pre-harvest sprouting by inducing temporary dormancy in rice varieties

Foliar spray of ABA @ 250 ppm or sodium molybdate @ 100 ppm at the time of flowering or NaCl @ 1 % at 10 days before harvest is recommended for inducing temporary dormancy and to arrest the pre-harvest sprouting in rice.

Redefining ODV standards for foundation and certified seeds of rice varieties

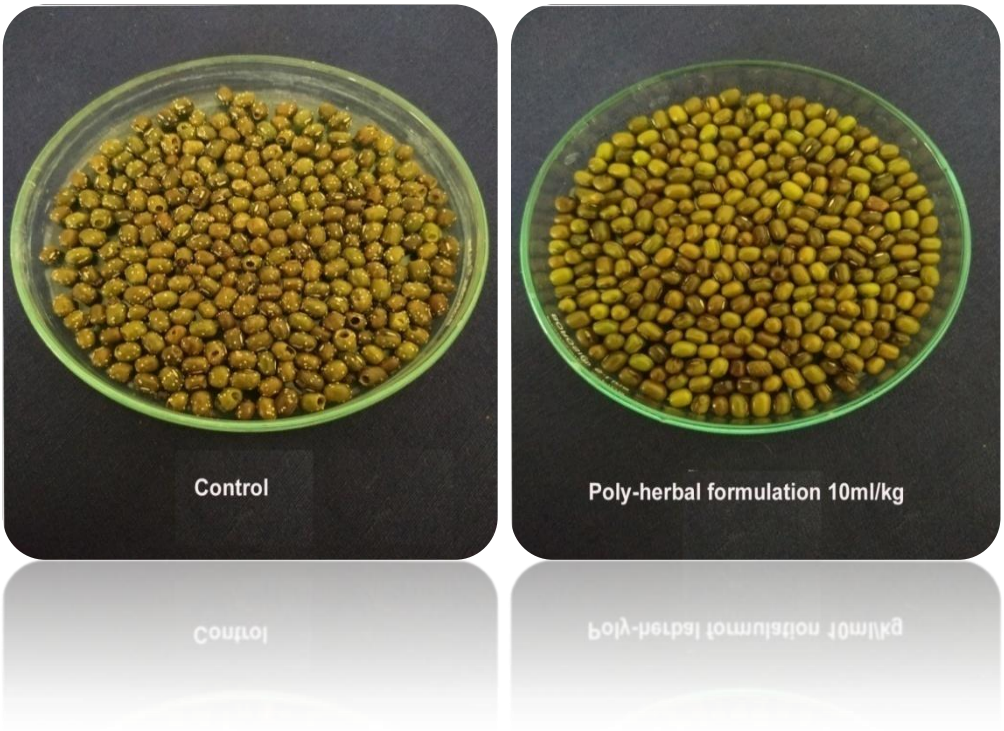
In foundation class seed, lower number of ODV (8 No / kg) was observed than the prescribed limit (10 No / kg); whereas in certified class seed higher number of ODV (28 No / kg) was observed than the prescribed limit (20 No / kg) as per IMSCS 2013. Hence, the permissible limit of ODV standard for certified class seeds of rice need to be revised as 30 No / kg instead of existing 20 No / kg.

Pre-storage seed treatment for redgram and soybean

Pre-storage seed treatment with Zinc oxide nano particles @ 500 ppm or Silicon dioxide @ 500 ppm maintained higher seed germination (81%) even after 13 months of storage in pigeon pea seeds. In Soybean, the seeds treated with Zinc oxide nano particles @ 500 ppm recorded the maximum germination (%) and field emergence (%) than the control.

Pre-storage seed treatment for greengram

Greengram seeds treated with poly-herbal formulation @ 10ml/kg of seeds and packed in polythene bag maintained significantly higher seed quality parameters than control and other treatments.



Pre-sowing seed treatment for blackgram

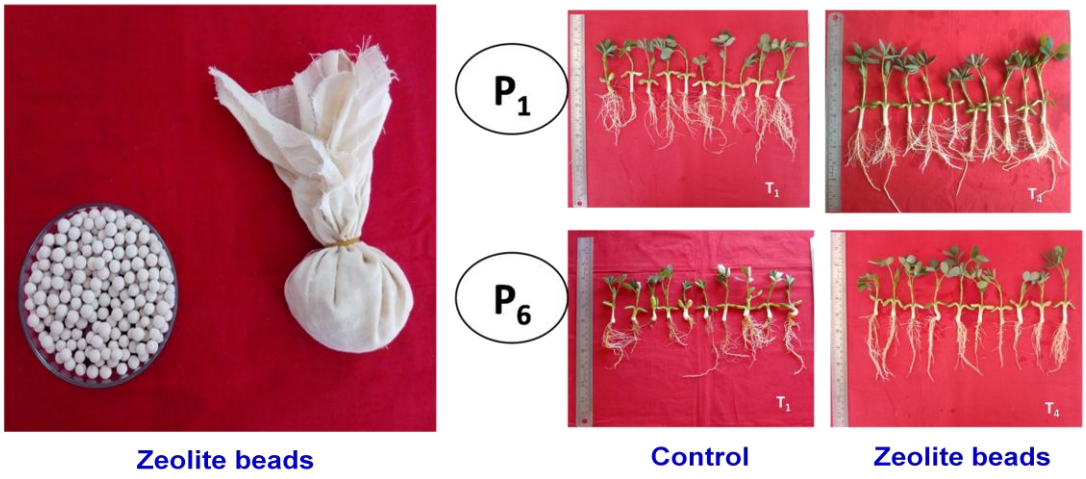
Blackgram seeds coated with hydrophilic polymers xanthan gum, carageenan and agar (4:1:1) or xanthan gum and agar (4:1) @ 20g/kg performed better under different water holding capacities *viz.* 100, 80, 70, 60, 50 and 40% of the substratum and also under PEG 6000 induced water stress conditions *viz.,* -2, -4, -6, -8 and -10 pascal under laboratory condition.

Seed maturity assessment through chlorophyll florescence technique in groundnut and maize

High seed germination and seedling vigour were well coincided with the minimum chlorophyll florescence at physiological maturity stage. As maturity progresses, chlorophyll fluorescence of groundnut leaves decreased from 0.753 to 0.634. At physiological maturity, chlorophyll florescence reached a minimum of 0.634, coincided with high seed germination and seedling vigour. In maize as maturity progresses, chlorophyll fluorescence of maize leaves decreased from 0.782 to 0.623. At physiological maturity, chlorophyll florescence reached a minimum of 0.623, coincided with high seed germination and seedling vigour.

Pre-storage seed treatment for groundnut

Storage of groundnut pods with Zeolite beads (@ 300 g/kg of pods) in poly lined gunny bag maintained the germination of more than IMSCS (70%) even after six months of storage.



Crop management practices for yield improvement in annual moringa PKM 1

Pinching at the height of 60 cm and sprayed with boric acid (0.2%) before initiation of flowering recorded the maximum pod set percentage (2.18%), no. of pods (112) and seed yield per tree (525.4 g) while control recorded the minimum pod set percentage (1.91%), no. of pods (87) and seed yield per tree 387.8% under open condition.

Open condition

Insect proof condition

Storage techniques for onion seeds

Onion seeds with a seed moisture content of 6% and packed in aluminum foil pouch maintained 85% germination upto ten months under cold storage condition (10^0C). The marginal seed lots with 70% germination could be improved to 84% by soaking the seeds in 0.05% Glutathione for 3 hrs.

Untreated seed embryo

Glutathione (0.05%) treated seed embryo

Dr. V. Geethalakshmi
Director, Crop Management,
TNAU, Coimbatore

Directorate of Crop Management has been established on 1.4.2010 in Tamil Nadu Agricultural University, Coimbatore with the objectives to impart higher education, undertake research and outreach programs in the field of component sciences *viz.,* Agronomy, Agro Climate Research Centre, Crop Physiology, Sustainable Organic Agriculture and Veterinary & Animal Sciences. This directorate was formerly known as Soil and Crop Management Studies since 1984 and bifurcated during 2010 into Directorate of Crop Management (DCM) and Natural Resource Management (NRM).

Coordinating to strengthening the research programmes in field management, farming system, weed science, irrigation, organic agriculture, weather science, stress physiology and animal husbandry for the productivity enhancement. Identifying crop management related field problems in different Agro Climate Zones of Tamil Nadu and solve them on location specific research.

Providing crop management solutions from ploughing to post harvest, nutrient and drought stress management and weather based agro advisories to improve crop productivity and input use efficiency. Imparting and facilitating higher education in components sciences. Facilitating the crop management scientists in all the units of TNAU to obtain externally funded schemes at National and International levels

Ressearch Highlights (2017-2020)

AGRONOMY

A. CEREALS
I. RICE

YEAR (2017)

Evaluation of nitrogen and weed management practices for unpuddled machine transplanted rice

- Pre-emergence application of Pretilachlor @ 750g a.i / ha followed by early post emergence application of Bispyibac sodium @ 25 g a.i /ha reduced the weed growth and increased the growth, yield parameters which in turn enhanced the grain yield.

Non-Puddled machine Transplanted Rice (NPTR)

- Traditional transplanted rice cultivation requires 1200-1400 mm of water of which puddling consumes 250 mm of water.
- In NPTR, puddling is replaced with dry ploughing (using cultivator and rotavator) followed by laser leveling and wetting.
- Soil is allowed to settle for 12-24 hrs before transplanting very light irrigation is given again to maintain a uniform depth of 1 cm standing water.
- Machine transplanting is adopted in the wetted soil. Alternate Wetting and Drying Irrigation method is followed for water management.
- Though there was a yield reduction, considerable water saving under NPTR from 120 to 245 mm.

Alternate Wetting and Drying Irrigation (AWDI)

- Safe Alternate Wetting and Drying Irrigation (AWDI) is to monitor the depth of ponded water on the field using 'Field Water Tube' (FWT) which is made of 40 cm long plastic pipe with a diameter of 15 cm so that water table is easily visible.
- Tube is perforated with 0.5 cm diameter holes in the bottom and the top 15 cm portion is non-perforated. Above the perforated portion, markings are made for 5 cm so that irrigation at 5 cm depth could be done.
- One Field Water Tube is required for adopting the AWDI in an area of 1 acre. The FWT is installed in the field using mallet and it is inserted upto the perforated portion buried inside the soil. The soil inside the tube is to be removed.
- FWT to be installed near the field levies so that the water level inside the FWT could be monitored easily.
- Safe AWDI of 10 cm depletion in light soils and 15 cm depletion in heavy soils was found to improve the water use efficiency in rice.

YEAR (2018)

Standardization of soil medium for production of sturdy rice seedlings suitable formachine transplanting

- Seedlings produced in Media with 70% soil + 20% well decomposed FYM + 10 % rice hull + DAP @ 7 g / tray + Vermicompost @ 100 g/ tray + *Azophos* 14 g / tray with a seed rate of 20 kg/ha had more suitable for machine planting.

YEAR (2019)

Package of Practices for Mechanised semidry rice cultivation

- Sowing of hardened seeds by seed drill with a seed rate of 40 kg/ha + Application of pre emergence herbicide Pretilachlor @ 0.45 kg /ha on 5 DAS and two machine weeding (power weeder) on 30 and 45 DAS + Alternate Wetting and Drying irrigation + STCR based NPK practices.

Non Puddled transplanted rice in Kuruvai and No-till in Thaladi in Cauvery Delta Zone

- Growing rice Direct seeded rice (Kuruvai) – Puddled transplanted rice (Thaladi) – No tillage (Summer) or Non Puddled transplanted rice (Kuruvai) - Puddled transplanted rice (Thaladi) - No tillage (Summer) could be best crop establishment methods for obtaining higher system productivity and profitability.
- Under water scarcity condition, adoption of either Non Puddled transplanted rice or Direct seeded rice during Kuruvai season followed by No tillage during Thaladi season as an alternate method to Puddled transplanted rice in Cauvery Delta Zone for obtaining higher productivity with lesser quantity of water

Alternate cropping system for Cauvery Delta Zone

- An alternate system of Pulse - Rice - Pulse and Maize - Rice – Pulse is recommended for Aduthurai and Thanjavur respectively against existing system (Rice - Rice - Pulse).

Traditional rice cultivation through organics under rainfed ecosystem

- Traditional variety Chithiraikar and Norungun are recommended along with application of FYM @12.5 t/ha + Panchakaviya (3%) + PPFM (1%) spray under traditional rainfed rice growing regions

YEAR (2020)

Cost effective weed management in direct seeded rice under puddled low land condition

- Application of pre and early post emergence herbicide augmented broad spectrum weed control in puddled direct seeded rice. Pre emergence herbicide application of Pyrazosulfuron ethyl 10% WP @ 20 g ha-1 at 3 DAS + Early post emergence application of Bispyribac sodium 10% SC @ 25 g ha-1 at 2-3 leaf stage (20-25 DAS) effectively control the weeds and resulted higher weed control efficiency.

Alternative crops for *Kuruvai* season a contingent plan in Canal irrigated limited water situation

- Pre-monsoon sowing of Greengram (Co 8) for canal irrigated area where water is not released for irrigation for first season as contingent plan. It recorded higher yield, B:C ratio and higher water productivity in pre-monsoon sowing.

Improvement of grain filling in rice by foliar spray of nutrients and growth promoters

- Foliar application of 2% MAP + 1% KCl at heading and grain filling stages (or) 6 – Benzylamino-purine (30 ppm) at heading and grain filling stages increases grain filling duration (25 to 27 days) and grain filling rate (1.11 to 1.19 mg grain-1day-1) in four varieties (ADT 49, ADT 53, CO 51 and CO 52) and also

Nutrient response trials on selected AVT 2 – IM (TP) rice cultures under high and low input management

- Pre germinated paddy seeds were used for developing a package of practices for wet seeded rice under aerobic situation the trial was initiated with paddy and dhaincha drum seeded, line sowing and broad casting. Medium duration Culture IET 27263 with 100 % RDF (150:50:50 kg NPK /ha) recorded higher grain yield (6.13 t/ha) and also resulted higher net return (Rs. 47,875/-) and BCR (2.23) when compared to other cultures. IET 26263 medium duration culture responded well under 100% recommended dose of fertilizer (150:50: 50 Kg NPK ha) and it was recorded higher grain yield, (6.13 t ha^{-1}), net return (Rs.47,875/-) are B : C ration (2:23) when compared to other cultures which was tried during 2019-20.



Nutrient response trials on selected AVT 2 Bio-fortified rice cultures under high and low input management

- Bio-fortified culture IET 27179 with 100 % RDF (150:50:50 kg NPK /ha) recorded higher grain yield (5.41 t/ha) and it was superior over check variety Kalanamak (3.43 t/ha) also resulted higher Net return (Rs.44,600/-) and BCR (2.02) when compared to other checks.

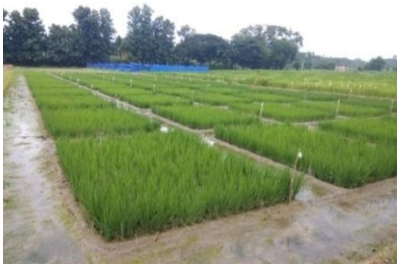


Development of package of practices for wet direct deeded rice (Wet DSR).

- Among the crop establishment methods, sowing by using Paddy + Dhaincha drum seeder during normal sowing time (IInd fortnight of June) resulted higher grain yield of 5.39 t/ha. Whereas, broadcasting and line sowing methods resulted lesser yield due to poor establishment and more weed population at active tillering stage.


Enhancing the productivity of direct seeded rice with iron coating under different rice ecologies

- Iron-coated seeds exhibit improved anchorage in establishment stage. The high density of Fe-coated seeds are resistant to birds damage and seed borne disease (Blast). Fe coating significantly increased grain yield (5.14 to 5.26 t/ha) over non-coating (4.49 to 4.62 t/ha).
- In time of sowing, 1st date of sowing (09.08.2019) and 2nd date of sowing (16.08.2019) resulted higher grain yield than those of delayed sowings. There was significant reduction in grain yield due to delay of one week from 2nd sowing.



II. MAIZE
YEAR (2017)

Effect of planting density and nutrient management practices on the performance of hybrids in rabi season

- Maize hybrid CO H (M) 7 under 50 x 20 cm spacing with the RDF (250:75:75 NPK kgha^{-1}) is the best management practice for achieving higher grain yield (7872 kg ha^{-1}), net return (79,829 Rs.ha^{-1}) and B:C ratio (2.53).

Evaluation of new biofertilizers in maize

- Application of 60 kg P_2O_5/ha + NPK consortia recorded higher grain yield(5308 kg ha^{-1}), net return (Rs.44834ha^{-1}) and B:C ratio (2.02).Among the liquid bio fertilizers,NPK consortia is the most suitable liquid biofertilizer for obtaining higher yield in maize

Performance of pre release medium maize maturity genotypes in rabi under varying planting density and nutrients levels

- Experimental results revealed that IMR 663 (G_3) is the best medium maturity genotype under 50 x 20 cm spacing with 250:80:100 NPK kg/ha which recorded higher grain yield (7733 kg ha^{-1})**,** net return (Rs.82529ha^{-1}) and B:C ratio (2.56)

YEAR (2018)

- Among the late maturity maize genotypes, G_1 and G_4 were found to be the promising genotypes under 50 x 20 cm spacing with 100 % RDF
- Among the medium maturity maize genotypes, G_1 and G_2 were found to be the promising genotypes under 50 x 20 cm spacing with 100 % RDF.
- Among the sweet corn genotypes, G_6 and G_5 were found to be the promising genotypes under 60 x 25 cm spacing with 100 % RDF.
- Ecological Intensification (EI) practice resulted in higher grain yield (859 kg ha^{-1}), net return (Rs. 25,786/ha) and BC ratio (1.87) in greengram.
- Application of 100% RDF (250:75:75 Kg NPK/ha) recorded higher grain yield (7244 kg ha^{-1}), net return (Rs.72132/ha) and B:C ratio (2.48) in maize.

YEAR (2019)

Application of Atrazine at 1kg ai/ha as pre emergence followed by Topramezone at 25.2 g ai/ha on 25 DAS as post emergence recorded higher grain yield (7586 kg ha^{-1}),net return (Rs. 70,928 ha^{-1}) and B:C ratio (2.28) in maize due to lesser weed menance, more weed control efficiency, more population stand than other treatments

- Among the late maturity maize genotypes,G_1(ADV 1390064)was found to be the promising genotype under 60 x 20 cm spacing with 100 % RDF(200:65:80 NPK kg/ha) which recorded higher grain yield (9595 kg ha^{-1}), net return (Rs. 94,704/ha) and B:C ratio (2.51).
- Among the sweet corn genotypes, none of the genotypes responded significantly over nutrient levels. Nevertheless, G_1 (NUZI 260) recorded higher green cob yield (23680 kg ha^{-1}), net return (Rs. 112810/ha) and BC ratio (3.12) under 60 x 20 cm with 150% RDF (180:90:68 NPK kg/ha).
- Ecological Intensification (EI) practice resulted in higher grain yield (896 kg ha^{-1}), net return (Rs. 28,042/ha) and BC ratio (1.94) in greengram
- Application of 100% RDF (250:75:75 Kg NPK/ha) recorded higher grain yield (7392 kg ha^{-1}), net return (Rs.73412/ha) and B:C ratio (2.50) in maize.
- Among the sweet corn hybrids, no significant influence of treatments was observed. However, H_2 (MISTHI) recorded higher green cob yield (15728 kg ha^{-1}), net return (Rs. 61243/ha) and BC ratio (2.38) under 60x15 cm with 100% RDF (120:60:45 NPK kg/ha).Whereas, H_1 (CSCH-15001) recorded lower green cob yield (15134 kg ha^{-1}) , net return (Rs. 58180/ha) and BC ratio (2.31) under 60 x 15 cm with 100% RDF.

III. SORGHUM
YEAR (2017)

Complete mechanization in sorghum

- Sowing and weeding operations is possible through mechanization under altered spacing of 60 x 10 cm instead of recommended spacing of 45 x 15 cm.

Response of grain sorghum varieties to fertilizer levels

- None of the test varieties produced higher grain yield over the check entries.

Evaluation of spacing and fertilizer doses for multi-cut forage sorghum

- There was a significant influence of different spacing on green forage yield. The narrow spacing (30x10 cm) recorded statistically higher green forage yield. It was followed by 30x15 and 30x20 cm spacing. The wider spacing of 30x25 cm had statistically lower green forage yield than 30x10 cm spacing.

YEAR (2018)

Response of grain sorghum genotypes to different fertilizer levels

- Application of 100 % RDF registered higher yield and all the genotypes responded to increasing levels of fertilizer application. Among the genotypes tested, SPV 2437 performed better than the checks, with respect to yield parameters and yield.

Influence of Soil moisture stress on later cuts of multi-cut forage sorghum

- The variety CSV 33 MF , a multicut forage sorghum was better in producing higher fodder yield and number of tillers under stress conditions.

Mechanization in kharif grain sorghum

- Adoption of mechanized operations of sowing, weeding and harvesting for grain sorghum will be a better option to help the farmers for getting high yield and economic returnswith respect to labour saving and time.

YEAR (2019)

Quantifying the response of pre-released kharif grain sorghum genotypes to different fertility levels under rainfed environments

Application of 125 % RDF registered higher yield and all the genotypes responded to increasing levels of fertilizer application. Among the genotypes tested, SPV 1886 performed better than the checks, with respect to yield parameters and yield.

Quantifying the response of pre-released sweet sorghum genotypes to different fertility levels under rainfed conditions

Application of 125 % RDF registered higher juice yield and all the genotypes responded to increasing levels of fertilizer application. Among the genotypes tested, CSV 24 SS performed better with respect to juice yield and brix.

Quantifying the response of kharif grain sorghum to different levels and sources of sulfur

Application of RDF + FYM @ 6t/ha+Gypsum (21%S) 30kg recorded higher grain yield and B:C ratio for better income to the farmers.

Mechanization in *kharif* grain sorghum

Adoption of mechanized operations of sowing, weeding and harvesting for grain sorghum will be a better option to help the farmers for getting higher yield and economic returns with respect to labour saving and time.

IV. PEARL MILLET

YEAR (2017)

Response of pearl millet advance hybrids and/or populations to different levels of nitrogen

Application of Nitrogen influenced upon the growth and yield of the Pearl millet hybrids. Application of 30 kg/ha influenced the yield and there was a further increase in the application of N up to 90 Kg/ha.The highest growth parameters *viz*., plant height (192.2 cm), total tillers/plant (5.5) and Test weight (11.44g) were recorded with the application of N at 90 Kg/ha. As well as the yield parameters and yield (2215 kg/ha) were also higher with the application of N at 90 Kg/ha.

A similar trend was observed with the Stover yield (46.29 q/ha) of the Pearl millet. The entries MH 2047, MH 2035, MH2053 and MH 2008 were found performing well over other entries.

Integrated nutrient management for pearl millet hybrids under optimum management

Between the three hybrids, 86M86 followed by 86M64 performed better than GHB 558. The growth, yield parameters and yield were good with these hybrids. Four nutrients Management tried 75% RDF + PSB + Azospirillum + 5 t FYM (T3) has resulted in more growth and yield and this was closely followed by 50% RDF + PSB + Azospirillum +7.5 t of FYM. The economics worked out also indicated a similar trend on gross returns, net returns and B/C ratio.

Response of pearl millet hybrids to foliar application of iron

Foliar application of Iron for Pearl millet hybrids, the hybrid GHB 558 followed by 86M88 performed better than Kaveri Super Boss. The growth, yield parameters and yield were good with these hybrids. Among the four foliar applications tried, 0.75% foliar application of Iron at tillering stage (25-30 days) has resulted in more growth and yield and this was closely followed by 0.50% foliar application of Iron at tillering stage (25-30 days). The economics worked out also indicated a similar trend on gross returns, net returns and B:C ratio.

Maximization in the pearl millet productivity under late sown situations

Sowing Pearl millet hybrids in late sown situations under various nutrient management system.. Sowing time was shown difference in the performance of the entry. Among the four nutrient management tried RDF + FYM @ 5.0 t/ha + NPK foliar spray (19:19:19 Grade) @ 0.5% at 20-25 DAS (T4) has resulted in more growth and yield and this was closely followed by T3 and T2. The economics worked out also indicated a similar trend on gross returns, net returns and B:C ratio.

Evaluation of pearl millet advance hybrids under different sowing dates during *kharif* season

The experiment was laid out with new entries MH 2010, MH 2024, MH 2008, MH 2053, MH 2035, MH 2047, MP 552, NHB 5767 (c), 86 M 86 (c) and RAJ 171 (c).These entries were sown in three different dates, *i.e*. July 5-10, July 20-25 and August 5-10. The experiment was laid out in a split plot design with sowing dates in Main plot and entries in subplot. The treatments were replicated three times..Sowing time showed significant difference in the performance in all the entries. Sowing time (S_2) was shown more growth and yield parameters and this was closely followed by S_1 and difference in the performance of the entries. The entries MH 2047, MH 2035, MH2053, MH 2008 and MH2024 were found performing well over other entries.

YEAR (2018)

- Application of crop residue mulch @ 5.0 t/ha + hydrogel @ 7.5 kg/ha was found to be a effective crop management practice to conserve the soil moisture and thereby enhancing the pearl millet productivity under rainfed condition.
- Integrated weed management practices comprising of pre-emergence application of atrazine @ 400gm a.i./ha *fb* one HW at 3-4 weeks after sowing significantly registered the higher weed control efficiency, better growth parameters, yield attributes, grain yield in pearl millet and thereby maximum benefit: cost ratio.
- Integrated nutrient management practices, comprising of 100 *per cent* recommended dose of nitrogen (80 kg N ha^{-1}) through vermicompost and biomix (*Azospirillum* +PSB +*Mycorrhizae* recorded higher plant height, productive tillers, yield parameters, grain and dry fodder yield under rainfed condition.


YEAR (2019)

Studies on Performance of Pre release Pearl Millet Hybrids under Different Spacing and Nutrient Levels

Among the hybrids of pearl millets studied, pre release hybrid of TNBH 08804 recorded significantly recorded higher growth parameters *viz*., plant height (152.2 cm), total tillers/plant (5.7), yield attributes and yield *viz*., effective tillers/plant (4.3), ear head length (25.7cm), ear head girth (12.1cm), ear head weight (64.5 gm) and test weight (25.1g), grain yield (3124 kg/ha) and dry fodder yield (4242 kg/ha) followed by hybrids of 86M11 and TNAU hybrid CO 9. In terms of spacing investigated, 45 x 15cm is the most suitable for obtaining maximum grain yield of 3061kg/ha and dry fodder yield of 4020kg/ha and thereby better economics in pearl millet cultivation than 50 x 15cm . With regard to nutrient levels, 100% RDF (80:40:40kg NPK ha^{-1}) found to be the economically optimum dose for maximizing the productivity of pearl millet than 120% RDF (96:48:48kg NPK ha^{-1}) and 80% RDF (64:32:32kg NPK ha^{-1}) and it accounted the maximum net return of Rs. 38112/ha and B: C ratio of 2.36.


Effect of Mulching and Hydrogel on the Productivity of Pearl Millet under Rainfed Conditions

Application of crop residue mulching and hydrogel at different doses and its combinations were significantly influenced the growth parameters, yield attributes, grain and dry fodder yield of the rainfed pearl millet. Application of crop residue mulch @ 5.0 t/ha + hydrogel @ 7.5 kg/ha significantly registered higher plant height (155.0 cm), total tillers/plant (5.0), effective tillers/plant (3.7), grain yield (3324 kg/ha) and dry fodder yield (4487 kg/ha)**.** With regard to economics of the rainfed pearl millet, maximum gross return of Rs. 66,480/ha was recorded in application of crop residue mulch @ 5.0 t/ha + hydrogel @ 7.5 kg/ha, whereas the maximum net return Rs. 66,480/ha and B:C ratio of 2.20 were recorded in application of crop residue mulch @ 5.0 t/ha + hydrogel @ 5.0 kg/ha**.**

Performance of different weed management practices on pearl millet productivity

Among the weed management treatments studied, hand weeding twice at 3 & 5 weeks after sowing significantly registered the higher weed control efficiency of 88.9% and 92.0% at 30 DAS at harvest stage respectively and followed by pre-emergence application of atrazine @ 400gm a.i./ha *fb* one HW at 3-4 weeks after sowing and early post emergence application of tembotrione 42% SC @ 100 gm a.i./ha at 3-4 leaf stage of weeds. In terms of growth parameters, yield attributes, yield and economics, pre-emergence application of atrazine @ 400gm a.i./ha *fb* one HW at 3-4 weeks after sowing registered significantly the maximum plant height (212.4 cm), effective tillers/plant (6.2), test weight (13.1g), grain yield (3254 kg/ha), dry fodder yield (5760 kg/ha) and B:C Ratio (2.73) followed by early post emergence application of Tembotrione 42% SC @ 100 gm a.i./ha at 3-4 leaf stage of weeds.

Nutrient management through organic sources in rainfed pearl millet

Application of inorganic fertilizer, Recommended Dose of Nitrogen (RDN) through different sources of organic manure *viz*., FYM and Vermicompost and its combination with bio-fertilizer consortia (Biomix) significantly enhanced the growth parameters, yield attributes and yield of the rainfed pearl millet. Among the different sources of organic manure either of FYM and vermicompost and its combination with microbial consortia, application of recommended dose of nitrogen through vermicompost + biomix, recorded significantly higher plant height of 160.3 cm, effective tillers of 4.1/hill, ear head length of 22.6cm and girth of 8.9cm, grain yield of 3653 kg/ha and dry fodder yield of 4996 kg/ha followed by application of recommended dose of nitrogen through vermicompost alone. With regard to economics, higher B: C ratio of 2.10 was recorded in recommended dose of fertilizer through inorganic fertilizer @ 80:40:40kg NPK/ha.

B. PULSES

I. BLACK GRAM

YEAR (2017)

Foliar application of pulses

Application of RDF + Urea phosphate 2% foliar spray twice, viz., at flowering and 15 days there after, recorded 20 and 5.5 % yield increase over control (No foliar spray) and DAP 2% spray respectively.

Mechanizing Pulses production

Mechanized pulses production using tractor operated seed drill, power operated weeders, multi bloom sprayer and combine harvester has resulted in higher grain yield of 873 – 926 kg/ha (26.5 – 27.4%) and BC ratio (2.46 – 2.79) besides minimizing labour requirement from 48.62 to 8.00 as against the grain yield of 685 – 732 kg/ha and B:C ratio of 2.07 – 2.11 in conventional cultivation.

Foliar nutrition on urdbean productivity

Foliar nutrition by TNAU pulse wonder @ 5kg ha^{-1} at flower initiation registered maximum number of pods $plant^{-1}$ (72), number of seeds pod^{-1} (8.6), grain yield (879 kg ha^{-1}), gross return (₹70,320 ha^{-1}), net return (₹38,068ha^{-1}) and benefit: cost ratio (2.18). It could be concluded from the results, that foliar nutrition by TNAU pulse wonder @ 5kg ha^{-1} at flower initiation, the best and viable foliar nutrition practices for augmenting the productivity of urdbean / blackgram (Co 6) during *Kharif* season

Effect of land configuration and weed management on urdbean productivity

It could be concluded from the results, that sequential application of herbicide namely, pendimethalin 30%EC @ 1.0kg a.i. ha^{-1} as pre emergence (PE) at 3DAS *fb* imazethapyr 10% SL @ 40g a.i. ha^{-1} as early post emergence (EPoE) at 20 DAS in ridges and furrow land configuration is found to be a resource efficient and economically viable options for maximizing the urdbean and productivity

Validation of best management practices on yield maximization of urdbean/blackgram

It could be concluded from the results that, to realize the maximum productivity in urdbean/ blackgram under the best agronomic management practices, TNAU (Blackgram) Co 6 and TNAU (Blackgram) VBN 6 varieties are most suitable varieties for normal sowing than delayed sowing during *Kharif* season.

YEAR (2019)

Field experiment was conducted during the summer and *kharif*2019 to evaluate the different methods of application of seaweed extract in blackgram and its impact on growth and yield of blackgram. Basal application of seaweed extract granules and foliar spray of sea weed extract are two methods of application.

Foliar spray of seaweed extract (0.25%) during flowering and pod formation stage along with RDF (25:50:25 kg NPK ha^{-1}) recorded higher seed yield of blackgram (660 kg /ha). The yield increment was 20 per cent as compared to RDF alone. Foliar application of seaweed extract along with RDF to blackgram found advantageous as it produced higher net return (Rs. 37960 / ha) and benefit cost ratio (2.21).

II. GREEN GRAM

Year (2017)

Herbicidal weed management in mungbean and its carry over effect on succeeding *rabi* crops

Integrated weed management practices with pre-emergence application of Valor 32%EC (Pendimethalin 30% EC + Imazethapyr 2% EC (Ready-mix)) @ 1.0 kg a.i. ha^{-1} - PE at 3 DAS + one hand weeding at 30 DAS is the better and efficient weed management practices for mungbean/greengram (Co 8) crop system.

Foliar nutrition on mungbean productivity

Concluded that foliar nutrition of TNAU pulse wonder @ 5kg ha^{-1} at flower initiation, the best and viable foliar nutrition practices for augmenting the productivity of mungbean/greengram (Co 8) during *Kharif* season.

III. REDGRAM
YEAR (2017)

Intercropping in rainfed Finger millet with Redgram

Finger millet intercropped with pigeon pea at 4:1 ratio recorded higher finger millet equivalent grain yield of 5767 kg/ha and registered 31.97% and 10.23% increase in grain yield over sole crop and finger millet intercropped with the pigeon pea at 8:2 ratio respectively. Finger millet + pigeon pea at 4:1 ratio recorded higher net return of Rs. 22341 / ha and B:C ratio of 2.17. The increase in net returns was 245.4 % and 8.23 % higher over sole crop of finger millet and inters cropping of finger millet + pigeon pea at 8:2 ratio respectively.

YEAR (2018)

Pigeonpea

In Pigeonpea, tank mix application of insecticide like Indoxacarb 15.8 EC and TNAU pulse wonder at flowering and Rynaxipyr 18.5 EC at 15 days later recorded higher pigeonpea grain yield, net returns and benefit cost ratio. Under drip irrigation system, higher grain yield and benefit cost ratio was obtained with irrigation at 100% CPE and plant spacing of 120 x 60 cm. Under rainfed condition, application of Pusahydrogel with FYM @ 5t /ha or with vermicompost @2.5 t/ha recorded higher grain yield. However, application of pusa hydrogel alone or seed hardening with $CaCl_2$ registered higher Benefit cost ratio of 2.47. Foliar application of all 19 @ 0.5%, MAP@1%, $FeSo_4$ @0.5%, ZnSo4 @0.5% and pulse magic@1% increases the yield of pigeonpea to the tune of 12- 44 per cent as compared to with foliar spray. Among the different nutrients, foliar spray of 19:19:19 @0.5% recorded 43 per cent higher yield than without foliar nutrition.

YEAR (2019)
Enhancing production potential of redgramthrough foliar nutrition

Field experiment was conducted during*kharif*2019 with nine treatments *viz*., RDF only, RDF with foliar spray of 19:19: @5%, MAP @1%, pulse magic @1%, urea @ 2%, $ZnSo_4$ @0.5%, $FeSo_4$ @0.5%, $ZnSo_4$ @0.5% + $FeSo_4$ @0.5% and TNAU pulse wonder 1%. Foliar spray of nutrients recorded higher seed yield of redgram when compared to without foliar spray (control). The yield increases was ranged from 12-43 per cent.Foliar spray of 19:19:19 @ 0.5% recorded higher grain yield of 1300 kg /ha. It was followed by foliar spray of MAP @1% and TNAU pulse wonder @ 1%. Foliar spray of all nineteen (19:19:19) gave higher net return (Rs. 47166 /ha) and BC ratio of 3.00.



Evaluation of post emergence herbicides inredram

Field experiment was conducted during *Kharif* 2019 to evaluate the post emergence herbicide for weed management in redgram. Pendimethalin was applied as pre emergence herbicide on 3 DAS. Different post emergence herbicides like chlorimuron ethyl, fenoxaprop ethyl, Propaquizalop, sodium acifluorfen + clodinafoppropargyl were sprayed on 25 DAS.

Among different weed management practices, application of PE pendimethalin 3 DAS followed by Imazethapry + Imazamox on 25 DAS and one intercultural operation on 50 DAS recorded higher weed control efficiency (91 %), seed yield (1228 kg /ha), net income (Rs.36240/ha) and BCR (1.81) in redgram.

Redgram based crop intensification under rainfed ecosystem

To find out suitable redgrambased intercropping system under rainfedecosystem On Farm Field experiments were conducted during *kharif (*2019). Redgram (Co8) was raised as main crop and cotton (Co14) and blackgram (VBN 8) were raised as intercrop in all three centres. In redgram + cotton system four rows of redgram and four row of cotton were raised while in redgram + blackgram system four rows of redgram and five rows of blackgram was raised and redgram also raised as sole crop for comparison.

The result shows that, higher plant height (364.9 cm), number of branches per plant (19.5), number of pods per plant(234), test weight (9.8) and seed yield (782 kg/ha) were recorded under sole crop of redgram whereas higher CEY of 995 kg /ha, net return (Rs.28296/ ha) and BCR (1.87) were recorded in Redgram + cotton (4:4) intercropping system compare to Redgram + blackgram (4:5) intercropping system


IV.SOYBEAN
YEAR (2017)

Evaluation of AVT – II entries under different sowing dates

20 days late sown soybean crop registered 24.5 % yield reduction and 18.6% reduced rainfall use efficiency compared to normal sowing (1205 kg/ha & 6.70 kg/ha.mm, respectively). Among the different AVT II entries studied, regardless of sowing dates RSC 10 - 46 recorded the maximum soybean yield of 1262 kg/ha followed by KDS 869 (1103 kg/ha) and the check RKS 18 registered 1157 kg/ha.

Sustainable soybean production through crop diversification and tillage
Conventional tillage registered higher average grain yield both in Soybean (1356 kg/ha) and maize (4510 kg/ha) crop. Conventional tillage registered increased yield of 13.5% in soybean and 8.7% in maize crop compared to minimum tillage practice. Among the crops studied maize recorded the higher net return (Rs.39384/ha) and B:C ratio (2.20) compared to soybean (Rs.17153/ha and 1.63, respectively).

Application of foliar nutrition on soybean productivity
Application of recommended dose of fertilizer with foliar spray of 19:19:19(NPK) 2% at pod initiation stage recorded the maximum soybean yield and B:C ratio (1330 kg/ha & 1.63, respectively) and it was comparable with DAP 2% spray (1304 kg/ha & 1.60, respectively).

Effect of hydrogel on soybean productivity

Hydrogel application @ 2.5 kg/ha immediately after sowing registered 17.2 % increased yield compared to without hydrogel treatment (1110 kg/ha). Among the two varieties studied, CO (Soy) 3 recorded the higher yield of 1340 kg/ha with hydrogel application and it was 1264 kg/ha in variety CO 2.

C.OILSEEDS

I. SUNFLOWER
YEAR (2017)

Assessment of agronomic requirement for AHT II entries

Among the hybrids, hybrid CSFH 12205 recorded the highest yield of 2194 kg/ha and which was on par with the KBSH 74 and KBSH 44. Among the fertilizer level 150% RDF recorded highest yield which was on par with the 100 % RDF and 50% RDF recorded the lowest yield. Among the hybrids, hybrid CSFH 12205 recorded higher oil content (39.8 %) and there was no significant different in oil content due fertilizer levels.

Enhancing sunflower productivity through Integrated Crop Management Approach

The results shown that the yield of 2425 kg/ha was realized due to adoption of all the improved practices with BCR of 1.85.

YEAR (2018)

Altering crop geometry to suit mechanized weeding in sunflower
Pre emergence application of Pendimethalin @ 1 kg a.i ha^{-1} + power weeding at 30 DAS with an altered spacing of 75 x 25 cm recorded significantly higher yield (1950 kg ha^{-1}) and BCR (1.75).

YEAR (2019)

Weed management in sunflower under modified spacing

Weed free environment (T_9) resulted in producing significantly higher seed yield of 2212 kg/ha and it was on par with Pre emergence application of Pendimethalinfb hand weeding or power weeded at 30 DAS and all Pendimethalin as PE at seed row + power weeder at 15 & 30 DAS except Pendimethalin (30 EC) @ 1.0 kg ai/ha as PE at seed row (Before irrigation) + power weeder at 15 & 30 DAS. Highest net returns of Rs. 18,581 /- and benefit cost ratio of 1.34 was observed in Pendimethalin (38.7 CS) @ 1.0 kg ai/ha as PE at seed row (After irrigation) + power weeder at 15 & 30 DAS.
Hence, to control weeds effectively and economically in sunflower is application of Pendimethalin (38.7 CS) @ 1.0 kg ai/ha as PE at seed row (After irrigation) + power weeder at 15 & 30 DAS.

Good agricultural practices for sustainable productivity of cropping systems involving sunflower

Demonstration was conducted in the station with full improved package of practices from seed to seed with groundnut – sunflower cropping system. The results shown that the sunflower yield of 2395 kg/ha was realized due to adoption of all the improved practices with BCR of 1.50. Yield increased over farmers' practices is 22 per cent.

Technology Validation- Integrated weed management

Pendimethalin @ 1.0 kg ai/ha as PE + power weeder at 30 DAS resulted in producing significantly higher seed yield of 2125 kg/ha. Economics wise Pre emergence application of Pendimethalin@ 1.0 kg ai/ha fb power weeded at 30 DAS is the best and record higher net return of Rs. 19,224 with higher BCR of 1.36.

Response of sunflower to varying planting geometry and fertilizer levels under different land configurations under rainfed conditions

The entire period of cropping period received the adequate rainfall for the growth and development. The rainfall received during the cropping period was 475.1 mm with 30 rainy days. The results revealed that the growth parameters, yield attributes and yield parameters of sunflower were significantly influenced by land configurations and graded level of fertilizers. Among the land configuration ridges and furrow sowing recorded significantly higher growth parameters, yield attributes and yield (1259 kg/ha) and it was followed by flat

bed. Among the fertilizer levels, 125 % RDF recorded significantly higher growth parameters, yield attributes and yield (1159 kg/ha) over 75 % RDF but 125% RDF was comparable with 100% RDF. The economics revealed that among the land configuration ridges and furrow sowing recorded higher net return (Rs. 8,517) and BCR (1.25).

Optimizing spacing and nutrient levels for prerelease sunflower hybrid

The results revealed that the plant height was not significantly influenced by intra row spacing, but nutrient level was significantly influence on sunflower plant height. Among the different level of fertilizer application higher dose of fertilizer application recorded taller plant. Days to 50 % flowering was not significantly influenced by intra row spacing and different level of fertilizer application. Number of grains per plant and yield of sunflower were significantly influenced by intra row spacing and different level of fertilizer application. 60 x 35 cm spacing recorded significantly higher number of grains per plant and it was on par with the 60 x 30 cm spacing. 60 x 25 cm spacing recorded significantly higher sunflower yield and it was on par with the 60 x 30 cm spacing. With respect to level of fertilizer application number of grains per plant and yield of sunflower were increasing with increasing levels upto 110 % STCR and there after they were decreasing. Among the different level of fertilizer application, application of fertilize at 110 % STCR recorded significantly higher yield attributes (1099 nos. of grains per plant) and yield (2080 kg / ha). The economics revealed that among the different plant spacing, 60 x 25 cm recorded higher net return (Rs. 34678) and 60 x 25 cm and 60 x 30 cm both recorded higher BCR (1.88). With respect to fertilizer level, 110 percent STCR level recorded higher net return (Rs. 35380) and 110 percent STCR and 100 percent STCR both recorded higher BCR (1.90).

II. CASTOR
YEAR (2019)

Optimizing nipping practices for newly released perennial castor variety YTP 1

The results of the experimental trials revealed that nipping (N1) of primary branch at 8th node produced significantly shorter plant (106.0 cm) followed by nipping at 10th node and nipping at 12th node (134.8 & 145.6 cm, respectively). While higher plant height of 180.9 cm was noticed under unnipped plant. However, higher number of branches per plant was recorded under nipping at 12th node (12.47). The next best treatment was nipping at 10th node (9.50). Similar to this character, No. of effective spike per plant was also higher under nipping at 12th node followed by 10th node (9.30 & 8.10, respectively). In contrast to this, the highest spike length (54.43 cm) was observed with unnipped treatment over other three nipped plot at 8th, 10th and 12th node (45.33, 43.90 & 42.90 cm, respectively). Likewise, No. of capsules per spike were also higher with unnipped plot over rest of the treatment.

However, the parameters like shelling percent, test weight and oil content did not significantly influenced by nipping practice. With respect to seed yield, nipping primary branch at 12th node recorded significantly higher grain yield of 2254 kg /ha which was observed to be on par with nipping at 10th node (2058 kg/ha). The lowest seed yield of 1080 was recorded under unnipped plot (1080 kg/ha). With regard to intercropping, the highest castor equivalent yield (CEY) was recorded with groundnut over fodder cowpea and higher inter crop yield and CEY (1231 kg/ha) were recorded under unnipped plot as compared to nipped plot. Regarding economics, higher net returns of Rs.100762/ha with BCR of 3.23 were registered under nipping at 12th node followed by nipping at 10th node with net returns of Rs.90651/ha and BCR of 3.02. The lowest values of these parameters were recorded under unnipped treatment.

D. FIBRE CROPS

I. COTTON
YEAR (2017)

Agronomic requirements of promising pre-release/ recently released *hirsutum, arboreum* genotypes/ hybrids of Cotton

G. hirsutum genotype HS 292 recorded significantly higher seed cotton yield of 1242 kg/ha. Comparable seed cotton yield was obtained with TSH 04/115 (1000 kg/ha) and CCH 13-2 (982 kg/ha). The check hirsutum variety MCU 13 recorded a mean seed cotton yield of 811 kg/ha. Genotypes significantly responded to different spacing. Comparable seed cotton yield was obtained with a spacing of 60 x 30 cm (1076 kg/ha) and 75 x 30 cm (1057 kg/ha). For all three genotypes, the recommended spacing of 75 x 30 cm is found optimum. Genotypes responded to different fertilizer levels as well. Seed cotton yield obtained was comparable with recommended fertilizer dose (80:40:40 kg NPK /ha; 1004 kg/ha) and higher dose of 100:50:50 kg NPK /ha (1096 kg/ha). Considering the cost on fertilizer, for all three genotypes, the recommended fertilizer dose of (80:40:40 kg NPK /ha) is found to be optimum.

Agronomic requirements of promising pre-release/ recently released *barbadense* hybrids of cotton

The cultivar GSB 44 produced significantly higher seed cotton yield (1347kg ha^{-1}) compared to check suvin (1015kg ha^{-1}). Among the spacing, 90 x 45 cm significantly produced higher seed cotton yield (1264 kg ha^{-1}) which was comparable with 75 x 45 cm. With respect to nutrient level, application of 80:40:40 NPK kg ha^{-1} produced significantly higher seed cotton yield which was comparable with100:50:50 kg NPK per ha.

Agronomic requirements of promising pre-release/ recently released *hirsutum* genotypes of cotton

The hybrid RHH 1007 performed better with a seed cotton yield of 1245 kg/ha. Recommended spacing of 120 x 60 cm with a fertilizer schedule 120:60:60 kg/ha is comparable with a spacing of 90 x 60 cm with a fertilizer schedule 150:75:75 kg/ha.

Agronomic requirements of promising pre-release/ recently released *hirsutum* hybrids of cotton

Effect of spacing and nutrient levels on yield revealed that among the hybrids, RHB1014 performed better with a seed cotton yield of 1813 kg/ha. Recommended spacing of 90 x 60 cm with a fertilizer schedule 120:60:60 kg/ha is comparable with a spacing of 90 x 60 cm with a fertilizer schedule 150:75:75 kg/ha

Evaluation of compact culture under HDPS with different nutrient levels

Among the cultivars tested, ARBC 1301 (1761 kg ha^{-1}) recorded significantly higher seed cotton yield compared to TCH 1819 (1398 kg ha^{-1}). Among the spacing, 60 x 10 cm significantly produced higher seed cotton yield (1834 kg ha^{-1}). With respect to nutrient level, application of 125 % RDF (100:50:50 NPK kg ha^{-1}) produced significantly higher seed cotton yield.

Developing suitable Agronomy for *Bt* hybrids of the region

Higher seed cotton yield (2014 kg ha^{-1}) was produced by the combined effect of increased plant population (increased by 10,800 plants /ha) + additional nutrients of 30:15:15 NPK kg ha^{-1} + foliar spray of cotton plus 6 kg ha^{-1} at flowering and boll development + soil application of 12.5 kg ha^{-1} of TNAU micro-nutrient mixture and application of 0.5 per cent of $MgSO_4$ + 1 per cent of Urea + 1 per cent of $ZnSO_4$ on 50^{th} and 80^{th} day for controlling reddening.

Foliar application of nutrients for Bt cotton

Application of RDF (120:60:60 kg NPK/ha) combined with foliar nutrition of 1 % Mono Potassium Phosphate (MPP) or 1 % Poly feed (19-19-19) or TNAU Cotton plus 1.25% at 75 & 90 DAS registered higher seed cotton yield. Hence, recommended for yield maximization in cotton.

Drip fertigation for cotton

Drip fertigation with conventional fertilizer was superior in registering higher seed cotton yield of 33.14 q/ha (23.24% increase) compared to farmer's practice of soil application of conventional fertilizer at 100% RDF (150-75-75 kg NPK/ha) to cotton (26.89 Q/ha). By drip fertigation with conventional fertilizer, the additional net seasonal income was Rs.21186 per ha compared to farmers' practice. The water saving under drip fertigation with conventional fertilizer was 28.10% compared to furrow irrigation. The gross benefit cost ratio was 4.77 under drip fertigation with conventional fertilizer, compared to 5.35 under farmers practice. Hence considering the B:C ratio, drip fertigation with conventional fertilizer at 100 WRc + fertigation at 100% RDF with conventional fertilizer in Bt cotton (Mallika BG II) is found to be the superior technology for getting higher income per rupee invested.

YEAR (2018)

To study the performance of promising *Hirsutum* x *Barbedense* hybrids of cotton for spacing and fertilizer levels

Genotypes RHB 1008 responded for spacing and fertilizer levels.

Evaluation of compact culture under HDPS with different nutrient levels

The spacing, 90 x 10 cm produced significantly higher seed cotton yield (1733 kg/ha) compared to other lower spacings. With respect to nutrient level, application of 120:60:60 NPK kg/ha produced higher seed cotton yield of 1637 kg/ ha .

YEAR (2019)

Labour saving techniques in Cotton cultivation

Result revealed that the treatment combination including application of herbicides (PE and POE) along with intercultural operation using tractor drawn implements and drip fertigation recorded a yield of 2761 kg /ha which was comparable with mechanized land shaping (2569 kg/ha) and Drip fertigation + Poly mulch (2482 kg/ha).

Technology for organic cotton production

Combination of seed treatment and soil application of azospirillum @ 2 kg/ha and foliar application of PPFM, Neem cake 250 kg/ha and raising of sunhemp between rows and incorporated before flowering recorded higher yield (1703 kg /ha).

E. FORAGE CROPS
YEAR (2018)

Optimizing the area of green fodder production for balanced nutrition to livestock

Based on the two years experimental results and on farm trial results, it was concluded that cultivation of 13.6 cents of green fodder (Cumbu Napier hybrid grass: 8.4 cents and Desmanthus: 5.2 cents) are needed for a milch animal with a milk yield of 10 lit./day/ animal. In addition, cultivation of 2.3 cents of green fodder (Cumbu Napier hybrid grass: 1.2 cents and Desmanthus: 1.1 cent) are needed for a goat with average body weight of 40 kg.

Suitability of single budded setts in Cumbu Napier hybrid grass

Horizontal planting of manually prepared single budded setts with sett treatment recorded the highest green fodder yield, dry matter yield and crude protein yield and it was on par with vertical planting of two budded setts (existing practice).Hence, it was found to be a viable option for reducing the sett requirement and cost of cultivation.

YEAR (2019)

Assessing the suitability of single budded setts in Cumbu Napier hybrid grass CO (BN) 5

Results of on farm trials conducted in 12 locations of 5 agro climatic zones of Tamil Nadu showed that horizontal planting of single budded setts with sett treatment registered higher establishment percentage (92.4%) with higher number of tillers (19.25) and green fodder yield (79.1 t/ha/cut). Hence, it was found to be a viable option for reducing the sett requirement to the tune of 50% and cost of cultivation.

Studies on carbon sequestration in perennial grass based cropping systems

Cumbu Napier hybrid grass raised in paired rows (60/120 cm) + *S. grandiflora* recorded the highest green fodder yield (10604 q/ha), dry matter yield (2394 q/ha) and crude protein yield (351 q/ha) with fixation of significantly higher total carbon (165.72 t/ha) in 3 years. Guinea grass alone planted in recommended spacing registered the lowest green fodder yield (7453 q/ha), dry matter yield (1549 q/ha) and crude protein yield (136 q/ha) with less fixation of total carbon (123.81 t/ha) in 3 years.

BN Hybrid sole crop

***Guinea* grass sole crop**

Agase + BN Hybrid

Agase+ *Guinea* grass

Studies on the performance of top feeds under varied planting geometry with and without intercrop

Among the cropping systems, intercrop has recorded significantly higher green fodder (195.9 t/ha/6 cuts), dry matter (46.4 t/ha/6 cuts) and crude protein yield (8.3 t/ha/6 cuts). Regarding the top feeds, *S. grandiflora* recorded significantly higher green fodder (177.9 t/ha/6 cuts), dry matter (43.5 t/ha/6 cuts) and crude protein yield (7.7 t/ha/6 cuts). With respect to planting geometry, planting at 2m x 0.5m recorded significantly higher green fodder yield (146.7 t/ha/6 cuts), dry matter yield (35.2 t/ha/6 cuts) and crude protein yield (6.4 t/ha/6 cuts).

***Moringa* sole crop**

***Moringa* + BN Hybrid**

Agase sole crop

Agase+ BN Hybrid

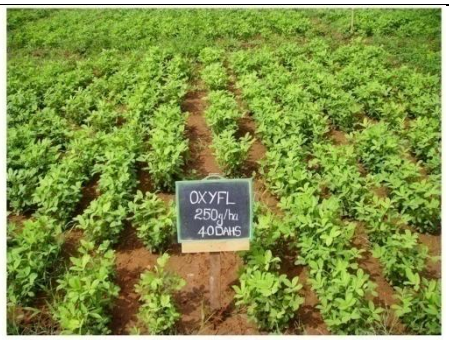
Optimizing the spacing and fertilizer levels in fodder maize pre release culture TNFM 131-9

Adopting a spacing of 40 x 15 cm resulted higher green fodder yield (45.10 t/ha) and dry matter yield (12.25 t/ha) and it was on par with 30 x 15 cm. In addition, application of 60:40:20 kg NPK/ha was found to be optimum for achieving higher green fodder yield (45.93 t/ha) and dry matter yield (12.49 t/ha).

F. WEED MANAGEMENT (2017-2020)

The following TNAU technologies have been included in the State Package of Practices and Crop Production Guide released by the Government of Tamil Nadu

S. No	Technology developed	Adoption Rate	Photos
1.	System of rice intensification and pre-emergence application of pyrazosulfuron-ethyl 30 g /ha at 3 DAT + weeding with finger type double row rotary weeder at 40 DAT in Rice	75%	
2	Pre-emergence application of pyrazosulfron ethyl @ 25 g /ha fb POE bispyribac sodium@ 20 fb 25 g /ha for transplanted rice.	95%	
3	Integration of weed control by butachlor 0.75 kg/ha for *kharif* rice and pretilachlor 0.75 kg/ha + 2, 4-DEE at 0.4 kg/ha with integration of 100% inorganic nitrogen for transplanted rice	50%	
4	Conventional tillage (disc ploughing + two harrowing) with PE application of atrazine 0.5 kg /ha for maize and pendimethalin 1.0 kg/ha for sunflower + hand weeding on 45 DAS.	60%	

5	Pre-emergence application of oxyflourfen 250 g /ha followed by POE- imazethapyr 100 g /ha + quizalofop ethyl 50 g /ha on 15 DAS for groundnut.	90%	
6	Pre-emergence application oxyflourfen at 250 g /ha on 3 DAS followed by twin wheel hoe weeder on 45 DAS for onion.	90%	
7	Pre emergence application of atrazine 1.0 kg/ha on 3 DAP + HW on 45 DAP + earthing up on 60 DAP + POE 2,4-D Na salt 5g/L + urea 20g/L on 90 DAP fb trash mulching at 5 t/ha on 120 DAP for Striga Management in sugarcane	95%	
8	Pre-emergence application pendimethalin 1000 g /ha on 3 DAT followed by hand weeding on 35 - 40 DAT for tomato.	90%	
9	Post emergence application of glyphosate 1.5 kg/ha + 2,$-D Na salt 1.25 kg/ha + wetting agent 2 ml litre of water was found to be effective in reducing density and dry weight of *Solanum elagaenifolium* and with no regeneration even after 60 days after herbicide application.	95%	

G.INTEGRATED FARMING SYSTEM (2017-2020)

Experiment 1 (1a): Identification of cropping systems module for different farming systems

Maize - Chillies - Radish system recorded the highest maize equivalent yield (30.45 t/ha), system productivity (83.4 kg/ha/day), water productivity (23.42 kg/ha.mm), net return (Rs. 4,31,197) and B:C ratio (3.65) followed by Onion - Cotton- Maize system.Vegetable based cropping systems are nutritionally and economically viable.

Experiment 2: Sustainable resource management for climate smart IFS

Integrated farming system adopted in 1.0 ha irrigated dry land by involving crop + dairy (2+2) + goat (10+1) + poultry (150 nos.) + horticulture + kitchen garden + boundary planting + vermicompost as components under Western zone of Tamil Nadu recorded higher net income of Rs. 3,63,122/- with a B:C ratio of 1.59 and generated an employment of 551 man days. By residue recycling the total quantity of nutrients added was 201 kg N, 87 kg P and 131 kg K.

Overview of 1a experiment

Cropping system
Integrated farming system for irrigated dryland

Goat rearing (Salem Black)

Dairy Unit

Poultry Unit

CORE PROJECT

Core Project 1. In vitro* establishment and improving the absorption and translocation of foliar applied herbicide in *cyperus rotundus

Salient findings:

- Sterilization of explants and suitable medium composition for *in vitro* establishment of *Cyperus rotundus* has been standardized.
- Medium for tuberization of *Cyperus rotundus*has been standardized.
- Higher concentration of glyphosate (800 to 1000 ppm) effectively controlled the *Cyperus rotundus*
- Chemical method of synthesizing nanoparticles Fe_2O_3, ZnO, Ag were standardized

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td colspan="2">In vitro establishment of Cyperus rotundus</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Glyphosate @ 500 ppm</td><td>Glyphosate @ 1000 ppm</td></tr>
</table>

Core Project 2. Nutrient management for transplanted ELS cotton

Salient findings:

The experimental results revealed that the survival of plants was recorded (86.77) 5.57 percentage higher in seedling transplanting than seeding methods (82.22) during summer and 8.29 percentage during winter2019.The cotton growth as measured by plant height, DMP and yield attributes as shown by number of sympodial branches, no. of bolls/plant, single boll weight and similarly the physiology of cotton as indicated by LAI were all favored by intercropping green gram, black gram and onion in cotton as compared to sole cotton as seeding and also seedling transplanting.

Cotton seedlings was transplanted (18 days old) with wide spacing of 120 x 60 cm. In-between the wide spacing two rows of pulses such as synchronized maturing black gram or green ram could be raised for suppression of weed at early stage and additional income with 125 % of RDF or STCR based fertilizer application was found economical.

Core Project 3. **Influence of nipping on the productivity of rainfed horsegram under altered crop geometry**

Salient findings:

In Horsegram, increased yield of 19.8% in manual nipping and 12.6 to 26.2% in chemical nipping *viz.*, chlormequat chloride & mepiquat chloride with 125 & 250 ppm spray @ tendril initiation over no nipping (672 kg/ha). Broadcasting of horsegram and nipping by spraying chlormequat chloride 250 ppm @ tendril initiation stage is economical (Grain yield: 949 kg /ha; B:C 1.87; net return: Rs.14,991/ha than no nipping(Grain yield: 669 kg /ha; B:C 1.38; net return: Rs.6041 /ha).

Core Project 4. **Ecofriendly sustainable *parthenium* management**

Salient findings:

From the experiments conducted at three different levels, it could be concluded that, pre emergence or post emergence application of *Terminalia chebula pod* extracts + acid lime extract either with 25 or 50% resulted reduced Parthenium seed germination, dry weight and higher Parthenium control efficiency.

Hence, *Terminalia chebula pods*+ acid lime extract may be recommended to control Parthenium as eco friendly way of management in non cropped areas.

Core Project 5. **Integration of rice + duck farming system in irrigated transplanted rice under organic farming**

Salient findings:

Based on the results of two seasons (*Navarai* 2018-19 and 2019-20), the following results were obtained.

Integration of ducks with rice, increased the rice yield (5.0 to 31%) compared to conventional cultivation. Rice + duck @ 400 Nos./m^2 released from10 or 20 or 30 DAT recorded significantly higher yield of rice compared to other duck introduced treatments. Integration of duck in transplanted rice @ 400/ha from 10 DAT increased the duck yield compared to others. Due to better rice yield and duck weight, gross return, net return and B:C ratio were also increased in integration of rice duck @ 400/ha released from 10 DAT in both the years of the study.

Core Project 6. **Developing low cost agronomic management strategies in irrigated maize for the control of fall army worm (*Spodoptera frugiperda*) in western agro-climatic zone of Tamil Nadu**

Salient Findings:

- During *Kharif*, 2019 season, delayed sowing of maize, preferably during August 15th has produced higher grain yield of maize, compared to the other two sowing dates (June15th & July 15th), might be due to less FAW infestation as per the pest scoring value.
- Among the intercrops tested, maize with soybean has produced higher grain yield with less FAW infestation than the other intercrops and control.

Research Field Overview **Maize + Cowpea Intercropping**

Maize + Sunnhemp Intercropping **Sole Maize**

IFFCO Project on "Effect of seaweed extract on growth, productivity and profitability of greengram (*Vigna radiata* (L) Wilczek)"
Salient findings:

- The present investigation revealed that the combined use of seaweed extract through seed treatment and foliar application increased the growth and yield parameters and yield of *kharif* greengram under irrigated condition.
- Irrespective of nutrient sources used in seed treatment, the foliar application of seaweed extract at low concentration on 25 DAS and 35 DAS had shown superior performance in all growth, yield and quality traits of greengram.
- From the study it was concluded that application of RDF + seed soaking in SWE (0.1%) for 30 minutes and ST with *Rhizobium* + foliar spray with SWE (0.25%) on 25 DAS and 35 DAS is a viable nutrient management package for getting higher yield and returns in *kharif* irrigated greengram.
- Application of 100% RDF integrated with seed soaking in (0.1%) SWE followed by seed treatment with *Rhizobium* and foliar application of SWE (0.25%) on 25 and 35 DAS has been found to be beneficial in increasing the growth characters, yield attributes, yield (1248 kg/ha) and B:C ratio of irrigated greengram.

AGRO CLIMATE RESEARCH CENTRE

1. TNAU AAS - Web Cum Mobile App

An important outcome of research from the ACRC is, "TNAU AAS – Web cum Mobile APP" to disseminate farmers specific, crop specific, stage specific, weather based agro advisories directly to the farmers' mobile with zero human intervention which was launched during 2018. Timely and specific messages ensured climate resilient farming. The AAS - Mobile App has saved the cost of SMS for agro advisory dissemination. Available in http://aas.tnau.ac.in and Google play store. The agro advisory using the weather information thro' app is in the phase of up scaling to other states for the betterment of farming community. Recently, the app has been linked to TN Govt. Uzhavan App for wider utility.

2. TNAU Medium Range Weather Forecast

Since 2011, ACRC is issuing medium range weather forecast for Rainfall, Temperature, Relative Humidity, Wind Speed with a lead time of six days and updating daily in public domain http://tawn.tnau.ac.in. With the continuous research, our MRW forecast has reached the accuracy of 70 – 85%, varying with seasons. TNAU has been the pioneer in providing block level weather forecast to the farming community. In addition to farmers, the government officials, general public are also using TNAU's MRW forecast. Recently, TNEB has requested to share ACRC's forecast directly to their server and using for their grid maintenance.

3. TNAU Seasonal Forecast

The seasonal Climate forecast for South West Monsoon and North East Monsoon are being disseminated during last week of May and September, respectively since 2014. During 2017-19, research had been made toimprove the accuracy of TNAU's seasonal forecast by including Indian Ocean Dipole Index, El Nino Southern Oscillation (ENSO) index and SST. The NEM 2019 forecast from ACRC perfectly matched with the observed values for most of the districts in Tamil Nadu. TNAU is the only SAU, issuing district level seasonalrainfall prediction for the entire state. Research is in progress for further improvement in accuracy, spatial resolution from "district to block" and temporal scale from "seasonal to monthly".

Climate change and crop weather relation ship

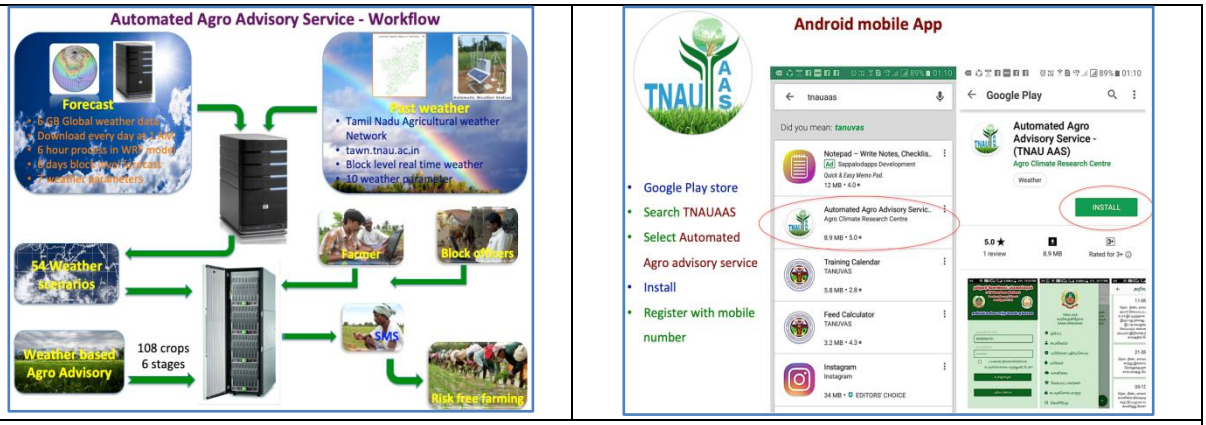
With new infrastructural establishments such as SPAR, Climate Control Champers, and Temperature Gradient Tunnel, ACRC faculties and students are continuously doing crop – weather relationship, drought and climate change on food crops. Using ensemble models on both climate and crop weather model, the impact of projected decadal climate change from 2030 to 2100 have been studied for rice, maize, groundnut, sugarcane and cattle and necessary management options have been developed to mitigate the impact.

4. Astrometeorology forecast

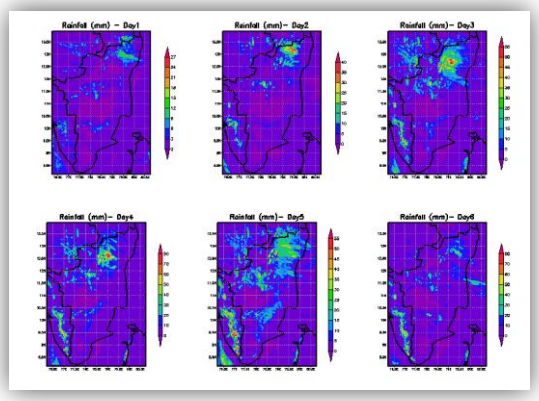
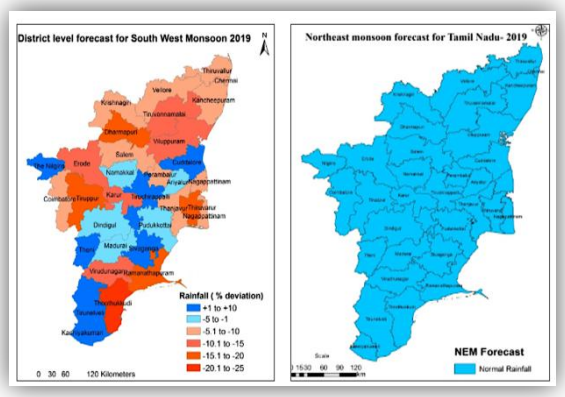
TNAU is pioneering in astrometeorology since 2011and identified astromet rules for hourly rainfall forecast (2017), wind speed influencing planets' positions (2018) and cyclone producing planet positions (2019). ACRC has also developed a planet activeness chart for rainfall and wind speed.

5. Crop Efficient Zonation

Studies were undertaken since 2016 for identifying the efficient cropping zones for rice, maize, cumbu, sorghum, groundnut, redgram, blackgram, Greengram, sugarcane and cotton. The findings facilitate policy makers in implementation of new developmental and insurance schemes. It helps to identify the lacuna in technologies or extension and to select the alternate efficient crops for the district.



Automated Agro Advisory Service – Web cum Mobile App

	
Medium Range Weather Forecast	Seasonal Forecast

CROP PHYSIOLOGY

Yield enhancement in rice through nutrient and growth promotor spray:

- Foliar application of 2% Mono Ammonium Phosphate (MAP) + 1% KCl at heading and grain filling stages increased the grain filling duration from 26 to 30 days and grain filling rate from 1.01 to 1.18 mg grain^{-1} day^{-1} in three varieties (ADT 46, ADT 49 and CO 52). The grain yield increased from 14 to 19 % over control.

Drought Management in rice:

- Foliar spray of silicon (Silixol 0.6 %) at 75 and 90 DAT, resulted in higher leaf silicon content with erect leaves that helped in lower light transmission, higher leaf area index, higher photosynthetic rate with improvement in yield by 20 % in Irrigated to 24 % in drought condition.

Marker assisted introgression of *Sub 1* locus conferring tolerance to flooding into elite rice varieties of Tamil Nadu:

- CO 43 was selected as a target genotype for marker assisted introgression of *Sub1* locus from FR 13A. Superior backcross progenies of CO 43 harboring *Sub 1* of FR13A were developed through MABB. NILs were generated and tested for their agronomic performance and CO 43 *Sub 1* is now released as a central variety exhibiting flooding stress tolerance.

Rice varietal variation in flowering response to temperature:

- The heat tolerant donar, N22 showed advancement in time of flower opening and reached peak anthesis before 10:45 am, while peak anthesis of IR 64 and IR 52 was after 11.30 am that affected spikelet fertility and yield.

Mitigation of drought using a new growth regulating compound Melatonin in greengram:

- Application of Melatonin @ 40 µM tank mixed with Pulse wonder (2%) has significantly increased relative water content, photosynthetic pigments, stomatal conductance and photosynthetic rate under drought stress condition.

- Foliar spray of melatonin @ 40 µM tank mixed with Pulse wonder (2%) significantly improved the yield of greengram both under irrigated (23.21%) and drought (30.81%) conditions.

Drought Management in pulses:

- Foliar application of nanocerium @ 100 µg g^{-1} under both irrigated and drought stress has improved pod weight (11 and 29%, respectively) and seed yield m^{-2} (10 and 22%, respectively) in green gram.

Screening greengram germplasm lines for drought and high temperature stress tolerance:

- Greengram genotypes were screened for drought high temperature stress tolerance. The greengram genotypes viz., COGG 1332, VGG 15029, VGG 16069, VGG 17003, VGG 17004, VGG 17009 and VGG 17019 were found to be tolerant to drought and high temperature stress at seedling, vegetative and stage. These genotypes showed higher proline content, chlorophyll stability index, relative water content and antioxidant enzyme activity.

Salinity stress Management in Blackgram:

- Under saline conditions, foliar application of brassinolide (0.5 ppm) at 20 and 40 DAS, has effectively mitigated the negative effects of salinity stress in Blackgram.

Yield enhancement in horse gram through nutrient and growth regulator:

- Foliar application of CCC (250 ppm) + MAP (0.5%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) at flowering stage of horse gram showed higher chlorophyll index (15.8), soluble protein (14.54 mg g^{-1}), NR activity (133.4 µg NO_2 g^{-1} h^{-1}) and RWC (80.9%). The yield increased by 26% over control with BC ratio of 2.32.

Physiological Effect of Melatonin on Drought Alleviation in Finger Millet (*Eleusine coracana* L.):

- Application of melatonin @ 60 µM as seed treatment plus foliar spray during drought stress at vegetative /reproductive stage has greater role in osmoregulation and enhancing antioxidants and thus substantial yield improvement. Hence, melatonin @ 60 µM as seed treatment plus foliar spray could be considered as an effective management technology for obtaining higher yield in finger millet under drought stress.

Growth promoting nutrients to enhance the cane yield and sucrose accumulation in sugarcane crop:

- Foliar spraying of macro and micro nutrient solution at weekly twice to protray from 10th to 25th DAP + soaking of bud chips in 0.01% ethrel and 0.1% calcium chloride for 2 hrs. [macro nutrients- KNO_3 (202g/l) + Ca $(NO_3)2$ (236g/0.5l) + $MgSO_4$ (493g/l) + 1M NH_4NO_3 (80g/l) + $FeSO_4.7H_2O$ (15g/l) and micro nutrients- H_3BO_3 (2.86g/l) + $MnCl_2$ $4H_2O$ (1.81g/l) + $ZnSO_4.7H_2O$ (0.22g/l) + $CuSO_4.5H_2O$ (0.051g/l) + $H_3MoO_4.H_2O$ (0.09g/l)]

Exogenous application of ascorbic acid in mitigating salt stress in sugarcane:

- Sett treatment with 1mM ascorbic acid + foliar spray of 1mM ascorbic acid at 45th after planting to mitigate the salt stress in sugarcane

Postharvest Physiology

Banana

- Grand Naine and Ney Poovan banana fruits at 25% ripening stage, treated with vaporization of 1- Methyl Cyclo Propene (1-MCP) @ 600 ppb enhanced shelf life to 17 and 15 days respectively under cold storage conditions (17 °C) while the untreated control fruits showed a shelf life of 12 days (Grand Naine) and 10 days (Ney Poovan). The increase in shelf life can be attributed to higher level of firmness, lesser physiological loss in weight, delayed change of colour, reduced PPO activity, reduced disease incidence and higher levels of titrable acidity and ascorbic acid.

Mango

- Mango fruits of 25 % ripening stage treated with 1- MCP @ 900 ppb for 16 hours under cold storage condition (16°C) showed significant influence on shelf life by delaying the ripening and maintaining the quality of fruits. Among the varieties, Banganapalli recorded a shelf life of 11 days while Neelum registered a shelf life of 15 days. The increased shelf life was found associated with higher firmness, greater peel thickness, lesser physiological loss in weight, higher ascorbic acid and total antioxidant activity; delayed change of colour and reduced PME activity.

SUSTAINABLE ORGANIC AGRICULTURE

Activities of the Department of Sustainable Organic Agriculture

- Evaluation of organic, inorganic and integrated production systems and development of organic package of practices for major agricultural and horticultural crops
- Evaluation of response of different varieties of major crops for organic farming
- Development and maintenance of Integrated Organic Farming System model

- **Evaluation, characterization and validation of organic inputs *viz*., bio-inoculants, bio-pesticides and test verifying through laboratory and field trials.**
- Organizing monthly paid training on "organic farming & organic input preparations" on 7th of every month
- Production and sale of organic inputs such as Panchagavya and Vermicompost to the organic growers
- Analytical services like soil nutrient analysis and pesticide residue analysis
- Farm advisory services on organic cultivation, bio-input preparation, pest and disease management and organic certification

Accomplishments

1. Evaluation of organic, inorganic and integrated production systems in vegetable crops (Brinjal, Tomato and Chillies)

- The brinjal yield was more (24,556 kg/ha) in nutrients supplied as per state recommendation of FYM @ 25 t/ha + Azophos @ 2 kg/ha + recommended doses of NPK fertilizers.
- The yield of chilli was the highest (13,052 kg/ha) in 50% organic manures (FYM + vermicompost) and 50% inorganic fertilizers applied treatment.
- The tomato yield was more (13914 kg/ha) under 75% organic and 25% inorganic sources of NPK nutrients.
- In brinjal, the net return was more in 75% organic (FYM + vermicompost) followed by foliar spray of Panchagavya @ 3% as foliar spray whereas the benefit cost ratio was more in 100% organic manures (FYM + vermicompost) applied plot.
- In both chilli and tomato the net return and benefit cost ratio was more in 75% organic manures (equally as FYM + vermicompost) and 25% inorganic fertilizers applied treatment.
- The quality parameters are better under 100% organically managed crops.

2. Evaluation of organic, inorganic and integrated production systems in barnyard millet

- The plants grown under state recommended management practices registered the maximum grain yield (1982 kg/ha) followed by plants grown under 75% organic + innovative organic practice (3% Panchagavya + Azophos @ 2kg/ha) with the yield (1786 kg/ha).
- Among the different management practices, 75% organic + innovative organic (3% Panchagavya + Azophos @ 2kg/ha) management practices followed plots has fetched the maximum net return per hectare (Rs.21,262) followed by 100% organic management practices applied plots (Rs. 18,998).

- Plots maintained under 75% organic + innovative organic practice (3% Panchagavya + Azophos @ 2kg/ha) showed the highest BCR of 2.08 followed by plots maintained under 100% inorganic management practices.

3. Evaluation of organic, inorganic and integrated production systems in finger millet

- The plots that treated with 75% organic (50 % FYM + 50 % vermicompost) + 25% inorganic fertilizers registered the maximum yield of 2905 kg/ha.
- The highest straw yield of 9168 kg/ha was recorded under RDF alone, which is followed by state recommended practices (8472 kg/ha).
- The plots applied with 75% organic (50 % FYM + 50 % vermicompost) + 25% inorganic management practices fetched maximum net return of Rs.40,764/ha followed by 75% organic + innovative organic practice (3% Panchagavya + Azophos @ 2kg/ha) applied plots (Rs. 39,983).
- BCR was higher (2.59) in plots maintained under recommended dose of fertilizers alone.

4. Evaluation of organic, inorganic and integrated production systems in pearl millet

- The highest grain yield of 1896kg/ha was recorded in plots treated with 75% organic (50 % FYM + 50 % vermicompost) + 25% inorganic manures.
- The treatments that received 50% organic (50 % FYM + 50 % vermicompost) + 50% inorganic fertilizers recorded the highest straw yield of 6650kg/ha.
- The highest net returns of Rs.20,334/- was realized in plots treated with 100% inorganic fertilizers management practices.
- The benefit cost ratio was maximum (2.15) in 100% inorganic management practices (RDF alone) applied plots followed by 75% organic (50 % FYM + 50 % vermicompost) + 25% inorganic management practiced plots (1.82).

5. Evaluation of response of different rice varieties suitable for organic farming

- Among the twelve rice varieties evaluated for their performance under organic production system, the rice variety CO (R) 48 had recorded the highest grain yield (4898 kg/ha) followed by improved white ponni (4762 kg/ha), CB05022 (4708 kg/ha), mappillai samba (4385 kg/ha) and bhavani (4161 kg/ha)
- The straw yield was higher in mappillai samba (10833 kg/ha) followed by CB 05022 (9349 kg/ha), CO (R) 48 (8884 kg/ha) and improved white ponni (8749 kg/ha).
- The traditional variety improved white ponni has fetched the highest net returns (Rs.58, 286 /ha) followed by mappillai samba (Rs.56, 245/ha), CO 48 (Rs.42, 803/ha), CB 05022 (Rs.41, 128/ha) and seeraga samba (Rs.34993/ha).
- Highest benefit cost ratio was also realized only from traditional varieties white ponni (2.10) and mappillai samba (2.06), followed by CO 48 (1.81), CB 05022 (1.78) and seeraga samba (1.66).

6. Development of Integrated Organic Farming System (IOFS) Model

- The IOFS model comprising of crop, livestock, fodder, perennial horticultural plantations, composting units, agro forestry, pest repellent cafeteria and bee keeping is the most suitable and efficient farming system model giving the highest system productivity for irrigated agro-ecosystem of Tamil Nadu.
- It has considerable potential to provide food security, nutritional benefits, employment generation and providing additional income to resource poor small farmers. The present study has provided the net income of Rs.74220 per annum with BCR of 2.17 generating an average of 557 man days per year.
- It was also known that the addition of organic residues in the form of animal and plant wastes help in improving the soil health and thereby productivity over the period of seven years with increased profit margin.
- The nutritional requirement of the system was self-sustained through resource recycling which curtails the cost of cultivation and increases profit margins and employment.
- Therefore, it is imperative to state that to sustain food and nutritional security, the IOFS approach is promising and will conserve the resource base through efficient recycling of residues and wastes within the system.
- It is an efficient way of using the same land resource to produce both carbohydrate and animal protein concurrently or serially as well as meeting the vitamins and mineral requirement through cultivation of vegetables and fruits on dykes and bunds, thus providing balanced diet to farm family, reducing malnutrition of the small and marginal farmers.

7. Characterization of organic and bio-inputs for sustainable organic agriculture

- Characterized and validated the organic bio-inputs scientifically
- Bio-inputs were prepared and distributed to the organic farmers
- Created awareness on organic farming and different organic bio-inputs preparations to the farmers through training and demonstrations

8. Geo-referenced characterization of organic and SPNF farmers

- Dindigul district is popularly referred as city of locks and tanneries. Diversified climate situation of the district favoured the farmers to cultivate high value crops such as onion, bhendi, tomato and brinjal, flowers and fruits.
- Majority of the organic farmers (80 %) are adopting diversified crops *viz*., vegetables cultivation (60 %) flowers (60 %) and fruits trees (55 %) as evinced from field survey.
- About 80 per cent of the organic farmers are using FYM as basal application for nutrient management followed by three fourth (75 %) of the organic farmers spray panchagavya @ 3 % as both nutrients source and for pest management.
- About half of the organic farmers (65%) are using neem extract as pest repellents followed by jeevamurth (60 %).Majority of the organic farmers (80 %) were practicing organic cultivation without organic certification.

- Three fourth of the farmers (80 %) are selling their products though local merchant followed by local market (30 %) and few through online (10 %).
- Reasons for adoption of organic farming as evinced through interaction with farmers were, use of locally available farm wastes, less labour intensiveness, easy to manage, satisfaction in producing eco- safe food and service motto to save environment as expressed by 80 % of the organic farmers.
- Individual member of the groups involved in entrepreneurial activities and produces value added product such as moringa powder exported to Middle East countries.

9. Cluster based demonstration of Organic Farming Package under TSP

Name of the district	Nilgiris
Name of the village	Pariyur (Lower Kotagiri)
Number of ST farmers covered	25
Name of interventions	• Crop rotation • Nutrient Management • Weed Management • Seed treatment techniques Vermicomposting • Panchagavya production • Organic vegetable cultivation • Organic pest management • Mushroom cultivation • Apiculture • Organic certification and PGS
Net benefit to farmers (Rs/ha) after intervention	• **Improved livelihood and proceeding to sustainable farming**

10. Cluster based demonstration of Organic Farming Package under SCSP

- Conducted PRA approach and collected soil and water samples in Cuddalore district
- Carried out demonstrations on seed treatment with bio-fertilizers, Panchagavya preparation, Jeevamirtham production and vermicomposting techniques.
- Conducted capacity building on organic nutrient and weed management
- Conducted capacity building on organic pest and disease management
- Distributed organic inputs such as paddy seeds, vermicompost, bio-fertilizers, bio-control agents and hand book in Tamil on 'Organic Agriculture for Organic Paddy Cultivation'
- Provided continued support from sowing to sale of produce.


Department of Sustainable Organic Agriculture
DEVELOPING ORGANIC PACKAGE OF PRACTICES
FOR FINGER MILLET
Project period : November 2018 - October 2020
Treatments
Main Plot (Manures)
Sub Plot (Foliar nutrition)


TAMIL NADU AGRICULTURAL UNIVERSITY
ICAR-NETWORK PROJECT ON ORGANIC FARMING


Dept. of SOA
ICAR - NPOF


Dept. of SOA
ICAR - NPOF
Cropping System


MING(NPOF)

Dr. R. Shanthi
Director, Natural Resource Management,
TNAU, Coimbatore

The Directorate of Natural Resource Management has been established and is functioning in TNAU from April 2010 and is located at the main campus of Tamil Nadu Agricultural University, Coimbatore. The vision of this Directorate is the management and utilization of natural resources *viz.,* Soil, Water, Plant Nutrients and Microorganisms for sustainable Agriculture, Horticulture and Forestry. Developing appropriate and cutting edge technologies for the efficient management of natural resources like soil, water, plant nutrients and microbes and to understand and promote positive impact of environment on these resources for sustainable agricultural production and improvement of soil health

Research Highlights (2017-2020)

SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

1. Soil Test Crop Response Based Integrated Plant Nutrition System for crops (STCR-IPNS)

i. Development and validation of STCR-IPNS based fertiliser prescription for various crops

- STCR-IPNS based fertiliser prescriptions have been developed and validated for desired yield targets of maize (Vertisol & Inceptisol), hybrid pearl millet (Inceptisol), Big onion (Inceptisol), Chrysanthemum (Alfisol) and little millet (Inceptisol), the STCR-IPNS based fertilizer prescriptions have been developed for tuberose (Inceptisol).

- Results of validation experiments revealed that targeting of 10 - 11 t ha^{-1} for maize (Vertisol), 9 - 10 t ha^{-1} for maize (Inceptisol), 3 - 4 t ha^{-1} for pearl millet (hybrid), 30 - 32 t ha^{-1} for big onion,17.5 - 20.0 t ha^{-1} for chrysanthemum and 2 t ha^{-1} for little millet were found to be ideal. The mean increase in yield in STCR – IPNS over blanket, blanket +FYM and farmer's practice ranged from 25.2 to 61.7; 15.42 to 18.8 and 57.4 to 76.4 respectively; the corresponding increase in fertiliser use efficiency (response ratio) ranged from 1.34 to 13.42; 1.21 to 9.33 and 1.54 to 12.83 kg kg^{-1} respectively for the above mentioned crops.

- The highest BCR of 2.27, 2.37, 1.87, 3.03 and 2.87 were recorded in STCR – IPNS for the above mentioned yield targets in maize (Vertisol), maize (Inceptisol), pearl millet, big onion and chrysanthemum respectively.

ii. Long term STCR-IPNS Experiment on rice-rice sequence

- The results of 22 years old long term STCR - IPNS experiment on rice - rice sequence on Noyyal soil series revealed the benefits of adoption of STCR-IPNS based fertiliser prescription (FYM @ 12.5 t ha^{-1}, Azospirillum and Phosphobacteria each @ 2 kg ha^{-1} + inorganic fertilizers) by recording the highest mean grain yield of 6835 and 6060 kg ha^{-1} and response ratio of 16.96 and 18.08 kg grain yield per kg of nutrient applied respectively for kharif and rabi respectively besides sustained soil fertility. The increase in yield due to adoption of STCR-IPNS technology over blanket was 23.7 - 25.9 %. There was maintenance of available N (280 to 263 kg ha^{-1}), built up in organic carbon (4.6 to 8.7 g kg^{-1}) and available P (20.2 to 28.4 kg ha^{-1}) and lower magnitude of decline in available K (670 to 590 kg ha^{-1}) in STCR-IPNS treatment.

Field experiments

Maize -Manickapuram, Theni Dt.,

Little millet -Denishpet, Salem Dt..

Chrysanthemum- Sundakkapatyy, Salem Dt.

Tube rose - Kannimarpalayam, Dindigul Dt .

Pearl millet - Kottur Avarampatti Dindigul Dt.

Maize - Kammalapatty, Salem Dt.

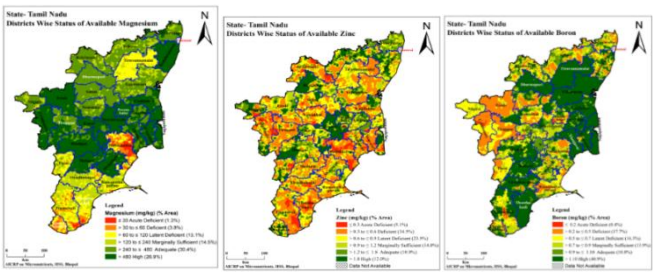
Big onion - Lakkayankottai, Dindigul Dt.

Chrysanthemum - Jodukuli, Salem Dt.

Long term Experiment – wetlands, TNAU, Coimbatore

2. Secondary and micronutrient recommendation for crops

- The soils of Tamil Nadu were predominantly Zn deficient (42.0%) followed by B (19.9%) and Cu (16.7%). The magnitude of S, Ca, Mg, Fe and Mn deficiency was less than 10 -15 per cent in the soils. The thematic maps have been prepared district wise and for the state of Tamil Nadu as a whole.



- Critical limit for Mg in acid soils (<42 mg kg^{-1}) and for potato crop (0.27%)has been fixed and refined the critical limits for available Zn: soils < 0.85 mg kg^{-1} and 36.8 and 23.5mg kg^{-1} for rice and maize respectively; for available Cu soils < 0.63 mg kg^{-1} and 4.82 and 8.00 mg kg^{-1} for rice and onion respectively.
- Genotypes of rice (Zn deficiency), groundnut (S deficiency) and cotton (Mg deficiency) having efficiency for bio-fortification of the respective nutrients have been identified.
- Optimized the rate of secondary and micronutrients recommendations for various crops
  - ✓ Soil application
    - Carrot - 40 kg S ha^{-1} ; Potato : Plains - 60 kg $MgSO_4$; Hills - 80 kg $MgSO_4$ ha^{-1};Aggregatum Onion : 5 kg $CuSO_4ha^{-1}$; 25 kg $ZnSO_4$ ha^{-1}; Garlic : 10 kg $ZnSO_4$ ha^{-1}
  - ✓ Foliar spraying
    - Aggrgatum onion -0.30 % $CuSO_4$spray twice at 30 and 45 days after planting ; Hybrid Tomato - 0.75% $ZnSO_4$ spray twice at vegetative and flowering stages ; Groundnut - 0.50% $FeSO_4$ + 0.10% citric acid thrice or 1.0 % $FeSO_4$ + 0.10% citric acid twice at vegetative, flowering and pegging stages.
  - ✓ Cropping systems
    - Maize -Sunflower: 10 kg borax ha^{-1} once in a year to maize; Rice- Rice: 12.5 kg $ZnSO_4$ ha^{-1} for every rice crop or 37.5 kg $ZnSO_4$ ha^{-1} once in a year

Field experiments

Phasing Experiment on Zinc: Rice-Rice sequence

Phasing Experiment on Boron : Maize-Sunflower sequence

Critical limit for Mg in potato

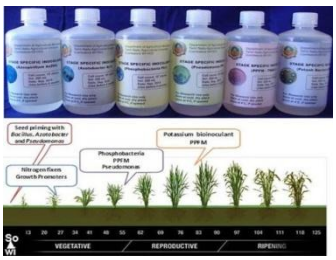
II. AGRICULTURAL MICROBIOLOGY

1.Biofertilizers

The nitrogen fixing bacteria: *Rhizobium*, *Azospirillum*, *Azotobacter*, *Gluconacetobacter*, cyanobacteria; phosphorus solubilizing bacteria, potassium releasing bacteria; pink-pigmented facultative methylotroph (PPFM), phosphorus mobilizing fungi, Arbuscular mycorrhiza and N fixing green manure, *Azolla* are presently being multiplied in large quantity and distributed to the farmers. The location-, soil- and crop specific strains are being maintained in the Department of Agrl Microbiology, TNAU, Coimbatore to be sold as mother cultures to various government and private biofertilizer production units. This department serves as nodal agency for Biofertilizer production and Quality control of the state.

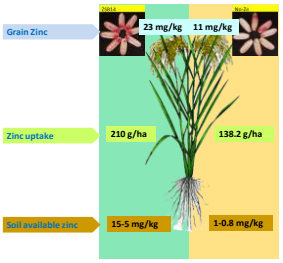
2. Pink-Pigmented Facultative Methylotrophs (PPFM) for terminal drought stress alleviation in rice: Method of Application: 500 ml/ha; Foliar Spray as 0.1 % at 15-days interval

3. Stage-Specific Inoculants for Rice



Seed treatment: 125 ml/ha; Soil application: 500 ml/ha; Foliar spray: 500 ml/ha; **Early stage**: nitrogen-fixing Azospirillum, *Azotobacter* or *Rhizobium* and P solubilizing inoculants; **Active growth and flowering stage**: growth promoting substances -*Pseudomonas* and pink-pigmented facultative methylobacteria (PPFM) and Potassium releasing bacteria (KRB).

4. Zinc Solubilizing Bacteria



Seed treatment: 20 ml/kg of seed

Seedling dip: 20 ml/lit of water (Roots should be soaked for 30 min before transplanting)

Soil application: Mix 120 ml/6 kg of vermicompost and broadcast at 1kg/plot (Total of 6 plots) a day after transplanting

5. Seed Coating / Pelletization of Microbial Inoculants

Seed coating with powder formulations of *Rhizobium* and Arbuscular Mycorrhiza each @ 1g kg^{-1} of seed increased nodulation and yield in blackgram and redgram.

Sett (two budded) treatment with powder formulations of AM fungi and *Gluconacetobacter diazotrophicus* each @ 9 g ton^{-1} (with 75 % N&P + 100% K RDF) increased both sugar yield and cane yield.

6.Rhizotron facility

The Rhizotron facility established at Department of Agricultural Microbiology is funded by Tamil Nadu State Planning Commission under Tamil Nadu Innovative Initiative scheme which is the biggest and first ever developed in Asia. Rhizotron facility is aiming to understand the plant-soil-microbe interactions which will ultimately recognize the role of plant microbiome for better crop growth and fitness under varied soil characteristics.

AC&RI, Eachangkottai

S.No	Particular	Rate (kg/litre) (Rs.)	Quantity (kg or litre)	Amount (Rs.)	Revenue generated (Rs.)
Bioinnoculants					
A.	**Biofertilizer**				**Rs. 2,25,717.00**
	Potash releasing bacteria	60/-	135 kgs	8100/-	
	PPFM liquid	350/-	11.5 lit	4025/-	
	PPFM talc	60/-	2 kg	120/-	

III. ENVIRONMENTAL SCIENCES

Bioinoculants - TNAU Biomineralizer

TNAU Biomineralizer is a microbial consortium developed to accelerate the composting process and is the best suited for all the regions of the state. The application of TNAU Biomineralizer consortium will reduce the period of composting by facilitating quick decomposition of the biodegradable wastes including all the lignocellulosic waste material into nutrient rich manure through composting process. It finds an ecofriendly solution for waste management, clean environment, employment and income generation from waste by converting them into organic manures as well as a key player in circular bio-economy. This can be positioned as a key component in the integral part of the sustainable crop cultivation. The results of the OFTs conducted in KVKs using different crop residues revealed that the TNAU Biomineralizer performed well and reduced the period of composting. TNAU Biomineralizer is supplied to various stakeholders like State Department of Agriculture,farmers, Corporations, municipalities, panchayats and house hold composting in urban areas for biocompost preparation from biowastes. TNAU Biominerlizer is also promoted through TNAU-KVKs and other NGO-KVKs in a large scale and the commercialization of TNAU Biomineralizer production technology is also in progress.

IV. NANO SCIENCE AND TECHNOLOGY

A. Technologies for Adoption

1. Enhanced Freshness Formulation (EFF)

Pre-harvest spray and Post-harvest dip of EFF facilitates extended fruit retention by 3 weeks on trees and another three weeks of shelf-life extension under storage conditions.

2. Nano Stickers

Hexanal encapsulated nano-stickers enhance the shelf-life of mango and banana for 2-3 weeks under ambient storage conditions.

3. Pheromone Nano formulation to monitor yellow stem borer in rice

The advanced nano formulation aids in the controlled release of pheromone molecules that would result in the eco-friendly management of yellow stem borer in a cost effective manner**.**

EFF

Pheromone Nanoformulation

B. Technologies under various stages of validation for commercialization

1. Multi Nutrient Nano pellets

The Multi nutrient nano pellets technology has been field validated in Black gram and maize and helps in the sustained release of macro and micro nutrients

2. **Designer Seeds**

The process of Seed invigouration of bioactive molecules (fungicide and hormones) incorporated nano polymer matrix to improve the seed germination and seedling vigour in groundnut, cotton and pulses (Greengram and Blackgram) has been standardized and field validated

3.Chitosan nanospheres for fungal decontamination in coconut copra

Chitosan nanospheres with a size range 150- 200 nm shows excellent anti fungal and anti bacterial activity and can be used to preserve coconut copra by replacing the toxic sulphur

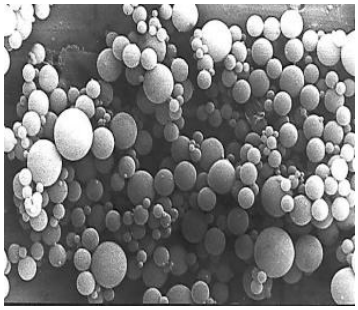
4. Super absorbent Bio-Polymer

Cellulose based ecofriendly polymer cross linked with oxalic acid demonstrated increased sorption and desorption capacity when compared with various acrylamide based materials in market. This technology is under further validation using commercial grade chitosan to make it cost effective.

5. **TNAU Nano hand sanitizer for prolonged hand hygiene**

TNAU Nano hand sanitizer consists of ICMR approved ingredients that are embedded in **polymeric Nano systems** for the sustained release of disinfectants to ensure prolonged hand hygiene. The hand hygiene is ensured between **15 and 30 minutes** based on the post application activities of the individual

Designer seeds



Chitosan nanospheres

Super absorbant biopolymer

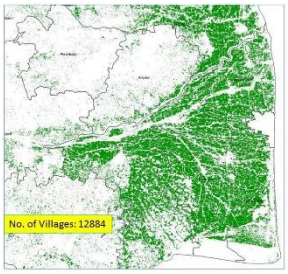
Nano Sanitizer

REMOTE SENSING AND GIS

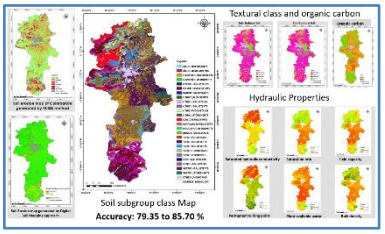
1. Assessing impact of Agriculture Disasters using Satellite images, drones and mobile applications

A new GIS lab for disaster monitoring was established in the Department of Remote Sensing and GIS which ensured preparedness for meeting out the challenges during disasters viz., agricultural drought, floods and cyclones. The innovative lab with world class softwares and hardware equipments resulted in generating periodical reports for **drought assessment**, precise assessment of damages caused to coconut plantations during **GAJA cyclone 2018** and mapping of **Kerala floods 2018**.

2. Remote Sensing Technology for Crop Mapping and Insurances



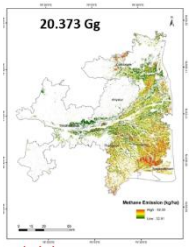
TNAU RIICE remote sensing technology for crop insurance was developed integrating Sentinel 1A SAR data with ORYZA/DSSAT crop growth model with defined outputs of precise crop area in rice, maize, cotton and groundnut, spatial yield estimates of crops, products indicating start of season, leaf area index with crop signature leading to identification of villages under prevented/failed sowing and crop failure resulting in yield loss in turn quicker payouts of crop insurances.



3. Digital Soil Mapping using Machine Learning techniques

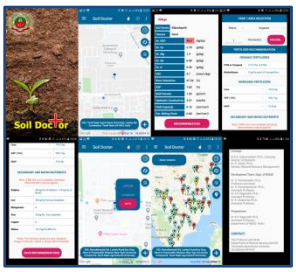
The Department of Remote Sensing has introduced the concept of Digital Soil Mapping using artificial intelligence and machine learning tools to generate digital database of soil class and properties viz., soil organic carbon, texture, erosion, and 32 environmental covariates at pixel level spatially. The digital soil maps will lead to developing AI based precision agriculture technologies.

4. Spatial estimation of methane emission from paddy fields using remote sensing



A research study on 'Monitoring Methane Emission from Rice fields at regional scale through Remote sensing in Cauvery Delta Zone has been initiated to estimate methane emission spatially. Multi temporal Sentinel 1A satellite data at VH polarisation with 20 m spatial resolution was acquired from August, 2018 to January, 2019 at 12 days interval and processed using MAPscape-RICE software. The total methane emission for Cauvery Delta Zone was found to be 19.155 and 20.373Gg during 2017 and 2018 respectively.

5. TN Soils – A Mobile based soil application



TN Soils - A mobile based soil application is an initiative to provide fertilizer recommendations to the farmers at their door step with the available soil information of TamilNadu state. The app is intended to generate location-based user requested fertilizer recommendation. For arriving STCR-IPNS based fertilizer recommendations, Decision Support System for Integrated Fertilizer Recommendation (DSSIFER) software is to be used.

6. Developing Drone based spraying techniques for foliar application of nutrients, organics and plant protection chemicals

The advent of drones with high range, endurance and payloads, the drone applications in agriculture are increasing multifold leading to interdisciplinary research on mapping and monitoring field crops and plantations, natural resources, artificial intelligence, precision agriculture and spraying organics, nutrients, growth regulators and plant protection chemicals underlines the need for standardizing drone application and spraying techniques in Agriculture.

Dr. K. Prabakar
Director, Centre for Plant Protection Studies,
TNAU, Coimbatore

The Centre for Plant Protection Studies (CPPS) was established in April, 1984 in TNAU to coordinate and strengthen teaching, research and extension activities in Plant Protection and Sericulture. Agricultural Entomology, Plant Pathology, Plant Nematology and Sericulture are the constituent departments of this Directorate. Established in April, 1984, the high-end courses provided by the Centre are aimed towards holistic development of students and the enviable success rate in term of employments boasts of many niche positions in both India and abroad. Our faculty members are young and enrich of corporate world experience backed by excellent academic expertise. Excellent infrastructure which includes Modernized instruments, infrastructures, separate laboratory for each specialization and providing online teaching notes and other learning enjoyable and easy to absorb. Apart from the students' placement committee, dedicated faculty members along with the support of entire faculty fraternity prepare and guide the students for securing placement.

The institute has earned repute as a centre for quality education for its prime infrastructure tied up with modern equipment's and a disciplinary environment. An academically strong and committed faculty is the backbone of CPPS. A special mention about our Alumni, who are eminent and hold significant position in their profession in India and abroad. They are a continuous source of inspiration for our regular students. We heartily welcome you to explore a brand new wonderful life and a bright future ahead

Research Highlights (2017-2020)

AGRICULTURAL ENTOMOLOGY

Management of Invasive Pests

The Department of Entomology encountered three invasive pests *viz.,* Coconut Rugose Spiralling Whitefly (RSW), *Aleurodicus rugioperculatus,* Fall Armyworm, *Spodoptera frugiperda* and Cassava mealybug, *Phenococcus manihoti* during the period under report. The efforts undertaken to contain the invasive alien species were enlisted below.

Management of Rugose spiralling whitefly (RSW)

Status of RSW in Tamil Nadu

- Rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin (Aleyrodidae: Hemiptera), an invasive species of whitefly was first reported in coconut in the Pollachi tract, Coimbatore district, Tamil Nadu during August, 2016.
- In Tamil Nadu coconut is cultivated in about 4,36,000 lakh hectares with an average productivity of 12, 291 nuts/ha/annum. There are two invasive whiteflies such as Rugose spiralling whitefly (RSW) and Bondars' Nesting whiteflies (BNW) posing real thread to the coconut farmers in Tamil Nadu in recent times. According to the progressive coconut farmers, the yield loss due to invasive whiteflies is ranged from 40 to 60% when the population of the whiteflies remain uncontrolled.

Technology capsule for the management of Rugose spiralling whitefly (RSW)

- Setting up of yellow sticky traps/ sheets smeared with castor oil (5 x 1.5 ft) @ 8 sheets / ac at 5-6 feet height or on truuk to monitor and mass trap adult whiteflies. Smearing of castor oil is to be done once in 3 – 4 days.
- Setting up of yellow light traps (100volt bulb) @2/ha during 7 – 11 pm (in front of yellow sticky trap if possible)

		
Light trap	**Yellow sticky trap in between trees**	**Yellow sticky trap on trunk**

- Natural suppression by *Encarsia guadeloupae* and predators to an extent of 40-70% has been observed in coconut gardens and many predators *viz.,* Mallada boninensis *Cybocephalus* spp., *Cryptolaemus montrouzieri* Muls., *Chilocorus nigrita* (Fabricius), *Cheilomenes sexmaculata* (Fab.), Curinus coeruleus (Mulsant), *Mallada astur* (Banks), *Chrysoperla zastrowi sillemi* (Esben – Petersen), praying mantis and spiders were also recorded as natural enemies of *A. rugioperculatus* in Tamil Nadu. Hence, spraying of synthetic insecticides is not recommended in order to conserve the natural enemies.
- If, predators and parasitoids are not observed in the gardens, release *Encarsia guadeloupae* by stapling leaflets containing parasitised cocoons on the under surface of the infested leaflets or stapling paper strip containing Chrysopid (*Chrysoperla zastrowi sillemi* / *Mallada sp.)* eggs @ 1000/ha.

		
Nymphs parasitized by *Encarsia guadeloupae*	***Encarsia guadeloupae* adult**	**Stapling leafbits containing parasitised cocoons**
		
Chrysopid eggs	**Chrysopid grub**	**Stapling paper strip containing Chrysopid eggs**

- To contain this pest, awareness/ training programmes were organized for the benefit of the farmers and extension functionaries in a war footing manner in Coimbatore, Tiruppur, Erode, Salem, Dharmapuri, Krishnagiri, Dindigul, Thanjavur, Tiruvarur, Kanyakumari, Tirunelveli, Cuddalore, Thirvannamalai, Thiruvallur, Nammakkal, Karur, Ramanathapuram and Theni districts.
- TNAU is continuously mass culturing and supplying *Encarsia* parasitoids (35,00,000 lakh to cover 35,000 ha and to 20,000 farmers) and *Chrysoperla* predators (38,00,000 lakh eggs to cover 3,800 ha and to 18,000 farmers) directly to the farmers and through the Department of Agriculture, Government of Tamil Nadu since 2016. Adoption of TNAU RSW management capsule in Tamil Nadu resulted in the reduction of whiteflies to a tune of 40 to 50% in well maintained coconut gardens. Moreover, conservation of biocontrol agents, environmental sustainability and insecticide residue free nuts and tender coconut are ensured by using the TNAU developed RSW management capsule
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- TNAU also supplied 19,48,600 nos. of the parasitoid, *Encarsia guadeloupae* for 3,118 ha and 19,60,300 Nos. of predator, *Chrysoperla zastrowi silemmi* for 3,920 ha.

Management of Maize Fall armyworm (FAW)

Status of FAW in Tamil Nadu

- FAW, is a dangerous transboundary insect with a high potential to spread rapidly due to its natural distribution capacity and opportunities presented by international trade.
- In Tamil Nadu, there was a massive occurrence of FAW on maize during July 2018. Since then, FAW has invaded all maize growing districts and caused wide spread damage in 2.2 lakh ha to a level of 40 to 60%. Farmers have experienced 40--70% yield loss. Instead of an average yield of 2000 kg/ac they got only 600 to 1200 kg/ac due to the ravaging behaviour of FAW. Despite experiencing severe damage and yield loss, farmers are interested for the continuous maize cultivation as maize grains, and maize stalks with partly matured cobs are in heavy demand for cattle and poultry feed, starch and other industries. Due to favourable climatic conditions for continuous reproduction of FAW, and the continuous availability of maize crops all through the year in many areas, FAW has become a resident pest in Tamil Nadu.

- After the invasion of FAW in Tamil Nadu, TNAU quickly surveyed on FAW damage across Tamil Nadu, organized four Brain storming sessions, six Workshops on FAW to the Department officials, TNAU scientists and farmers. Our scientists organized several Field Days and Press Coverage on FAW *a*t TNAU and farmers holdings, Video programmes, Live Phone in Programmes in AIR, Doordhasan and other popular TV Channels. FAW deliberations were presented in State level sub-Committee, State level Pre-Kharif, Pre-Rabi workshops, Awareness in Monthly zonal workshops and Farmers Grievance Day meetings in the Collectorate of all the maize growing Districts
- Research activities were undertaken in TNAU on emergency basis. Agro-ecology based FAW management technology capsule was formulated. These *adhoc* technologies were approved by the Agricultural Production Commissioner and Director of Agriculture, Agriculture Department, Government of Tamil Nadu, and disseminated to all the Joint Directors of Agriculture of maize growing districts for uniform adoption on contingent basis.

TNAU FAW Management Technology Capsule

- Application of neem cake @ 250 kg/ha during last ploughing and seed treatment with thiamethoxam 30 FS or *Beauveria bassiana* @ 10 g/ kg;
- Adopt spacing of 60 x 25 cm for irrigated and 45 x 20 cm for rainfed maize and rogue spacing of 75 cm for every 10 rows
- Raise border crop of cowpea, sunflower or gingelly and intercrop with black gram or green gram to attract and conserve natural enemies
- Use FAW sex pheromone traps @ 50/ha for mass trapping of adults from 10-15 DAS
- Application of azadirachtin 1% EC 20 ml or thiodicarb 75 WP 20 g or emamectin benzoate 5 SG 4g per 10 litre of water during early whorl stage or first window stage (15 – 20 DAS)
- Application of *Metarhizium anisopliae* 80 g with 1 x 10^8 cfu/g or spinetoram 12 SC 5 ml or novaluron 10 EC 15 ml or flubendiamide 480 SC 4 ml or chlorantraniliprole 18.5 SC 4 ml per 10 litre of water during late whorl stages or second window stage (40-45 DAS)
- Application of either one of the insecticides recommended for second window, If FAW incidence is noticed during tasselling and cob formation stage or third window stage (60 – 65 DAS)

		
Deep ploughing and neem cake applicaton	**Seed treatment**	**Rogue spacing of 75 cm once in 10 rows**

		
Mass trapping FAW males	**Border cropping with sunflower**	**Whorl application of insecticides**

TNAU Extension lead in FAW management

- We nominated TNAU Core Team for the entire State and Task Force Scientists for each maize growing District to coordinate with the extension officials to mitigate FAW on maize. The TNAU Core Team and Task Force Scientists travelled across the State and organized 435 diagnostic field visits in 27 major maize growing districts, 120 Front Line Demonstrations in six districts on FAW management capsule; participated in 410 awareness campaigns and 25 Kisan Melas; and sensitized 42500 farmers, 2650 input dealers and 3550 extension officials

GoTN Interventions in FAW management

- The Government of Tamil Nadu immediately came for the rescue and the severely affected maize farmers were given compensation to a tune of Rs186. 25 Crore under State Disaster Management Fund during 2018-19 based on the damage assessment made by TNAU FAW scientists.
- Government of Tamil Nadu extended sustainable significant support to maize farmers by making arrangements to adopt TNAU developed IPM capsule such as deep ploughing and application of neem cake, provision of seed treatment biopesticide, FAW pheromone traps and FAW sex lures, border and inter cropping and window based application of insecticides and biopesticides.
- GoTN sanctioned an amount of Rs.47.66 Crores for "Mass Ground Spraying of Recommended Chemicals" to control the spread of FAW quickly in 1.2 lakh ha at the early and late whorl stages @ Rs. 5,500/ha.
- During the same review meeting, considering the urgent response to the rapid spread of FAW, the Hon'ble Chief Minister sanctioned 5.0 crore to TNAU to undertake radical, direct and coordinated research and extension measures to strengthen prevention and sustainable pest control capacities for FAW in Tamil Nadu.

GoTN sponsored special drive FAW R&D Project

- The Honourable Chief Minister of Tamil Nadu conducted the review meeting on 19.09.2019 on the action taken on the management of FAW in Tamil Nadu with the Chief Secretary, the APC&PS, Principal Secretaries to the Hon'ble Chief Minister, Directors of Agriculture, Horticulture, Veterinary and Marketing, and the Vice-Chancellor, TNAU, and TNAU FAW Core team. During the review meeting the Hon'ble Chief Minister has announced the sanctioning of Rs. 5.0 crore research grant for taking up immediate research programmes to mitigate FAW permanently in the coming years.
- Accordingly, TNAU developed a special drive research proposal. This proposal relates to the Fall Armyworm research experiments on "*Developing IPM Module for Maize Fall Armyworm and Validation through Farmer Participatory Approach"* at an outlay of Rs. 4.5327 crore. The research programmes envisaged in the proposal are

proposed to be taken up in two years period in four operating centres of Agricultural Colleges viz., Coimbatore, Madurai, Trichy and Killikulam to coordinate demonstrations and other research activities across the State.

- The focus of the project is refinement of TNAU developed FAW Management Technology Capsule with all IPM components such as suitable plant health management methods, early protection options, evolving resistance or tolerance plant sources; ecological engineering pest managements; conservation of natural enemies; use of appropriate natural enemies like *Trichogramma* and *Telenomus* parasitoids, predators and entomopathogens through intensive research; fixation of ETL for FAW for various stages from seedlings to cob maturity to ensure cost effective IPM technologies; conservation and augmentation of natural enemies of FAW in maize fields; development of innovative strategies using newer products and processes; newer insecticide molecules of different mode of action, insecticide combinations, insecticide resistance management strategies, newer plant products; using various spray gadgets including drones; and integration of all the effective components into a refined module. Refined IPM modules will be validated across 34 TNAU Centres. Demonstrations will be organized in 810 farmer's holdings each one acre in 27 major maize growing districts to obtain feed-back on IPM and economic benefit.

Management of Cassava Mealybug, *Phenacoccus manihoti*

Status of cassava mealybugs in Tamil Nadu

- Cassava is being grown in an area of 75,000 ha in Tamil Nadu. Major districts growing cassava are Salem, Namakkal, Erode, Cuddalore, Villuuram, Dharmapuri and Kanyakumari.
- Cassava mealybugs *Phenacoccus manihoti* is indigenous to South America. It was accidentally introduced from South America to the Congo Republic in 1973. It has spread in Africa in a period of 16 years. Its accidental introduction damaged a staple crop during a time of drought, leading to famine. From Africa to practically all countries where cassava is grown, in a broad belt from West through to East Africa and down to the eastern edge of South Africa. During March, 2020 cassava mealybugs have been noticed in cassava plants of Trissur, Kerala
- Since then, cassava plants in all the major cassava growing districts have been regularly monitored for the presence of *Phenacoccus manihoti.* Quick survey by TNAU teams revealed 30 to 40% infestation in Namakkal District, 10 to 15% infestation in Erode Districts and 10 to 15% infestation in Salem District.

Management of cassava mealybugs

The following contingent management practices are in practice to completely avoid further spread .

1. Collection and complete destruction of mealybug infested plants from the infested area.
2. Continuous and extensive monitoring for *P. manihoti* and natural enemies on cassava, alternate host plants and weed plants in major cassava growing Districts by the farmers, extension officers and TNAU scientists
3. Avoid using cassava cuttings from infested areas for further planting as they may carry mealybug colonies
4. Immersion of cassava cuttings in insecticide solution for 60 minutes and plant them

5. Use imidacloprid 600 WS or thiamethoxam 25 WG @ 5 g/ 10 lit of water or FORS @ 250 g/ 10 lit of water
6. Use of NSKE 3% or any other botanicals based formulations
7. Record and use of local natural enemies
8. For the management of ants, soil drenching with chlorpyriphos 20 EC @ 30 /10 lit water

Research initiatives by TNAU

- In all the cassava mealybugs infested Districts, plant samples were collected along with mealybug colonies for the identification of the cassava mealybug species and its natural enemies. The mealybugs were identified as *Phenacoccus manihoti* Matile-Ferrero
- The following predators and parasitoids were observed in the mealybug colonies.

Predators:

1. *Hyperaspis maindroni* Sicard (Coleoptera: Coccinellidae) (Identified by Dr. N. Chitra of TNAU: and confirmed by Dr. Poorani, ICAR-NRCB, Trichy)

2. *Cheilomenes sexaculata* (Coleoptera: Coccinellidae)

3. *Cryptolaemus montrouzieri* (Coleoptera: Coccinellidae)

4. *Mallada sp.* (Neuroptera: Chrsopidae)

Parasitoids:

1. *Homalotylus turkmenicus* Myartseva (Hymenoptera: Encyrtidae) – Parasitoid of *Hyperaspis maindroni* which is a predator of cassava mealybug. (Identified by Dr. Poorani, ICAR-NRCB, Trichy: Identity confirmed by Dr. Ankita Gupta, ICAR-NBAIR, Bengaluru)

2. *Prochiloneurus aegyptiacus* Mercet- (Hymenoptera: Encyrtidae) (Identified by Dr. Ankita Gupta, ICAR-NBAIR, Bengaluru)

3. **Bethylidae – (Identified by Dr. Ankita Gupta, ICAR-NBAIR, Bengaluru)**

4. ***Tetrastichus* sp. (Hymenoptera: Eulophidae) (Identified by Dr. Ankita Gupta, ICAR-NBAIR, Bengaluru)**

			
Cassava mealybugs *Phenacoccus manihoti*	*Hyperaspis maindroni* - grub of mealybug predator	*Hyperaspis maindroni* - Adult predator of mealybug	*Homalotylus turkmenicus*- Parasitoid of *coccinellid predatori*

- *Anagyrus lopezi* is an invasive effective parasitoid of cassava mealybugs available in other countries.
- Steps are being taken by ICAR- NBAIR, Bengaluru to import a potent exotic parasitoids *Anagyrus lopezi* from Thailand for the classical biological control of the cassava mealybug.
- Once the parasitoids specificity and safety are established in quarantine by the ICAR- NBAIR, TNAU can obtain *A. lopezi* culture for further mass production and field release in farmer's fields as we did for *Acerophagous papayae* for the management of papaya mealybugs

PLANT PATHOLOGY

1. Disease monitoring through surveillance programme

Continuous pest surveillance is being done for the existing and newly emerging diseases in all agroecosystems of Tamil Nadu to forewarn the farmers in order to prevent the disease outbreaks.

2. Diagnostics for major diseases of crop plants

Plant diseases greatly reduce agricultural productivity, and new pathogens are continuing to emerge that create new disease problems requiring novel control measures. Accurate and timely diagnosis of plant diseases is extremely important so that appropriate control measures can be implemented. Detection and identification of phytopathogens are important for preventing the spread of disease by seeds and other propagative materials and also to implement plant quarantine regulations. Early diagnosis enables to take decisions about how and when chemicals can be used most effectively. Traditional methods of detecting plant pathogens involve the interpretation of visible symptoms followed by microscopic observations and culturing of pathogens in the laboratory. The crop diseases that are caused by microorganisms are being diagnosed now at DNA or at protein level. Immunoassays particularly the enzyme-linked immunosorbent assay (ELISA), DIBA, TIBA and PCR-based assays were standardized for the detection and identification of several pathogens *viz*., fungi, bacteria, phytoplasmas and viruses. Analysis of diversity of pathogens and vectors in a geographical location to address epidemic problems were also concentrated. The molecular epidemiology of *Mungbean yellow mosaic virus* and its interaction with vector, whitefly was also studied. The diversity of several plant viruses *viz*., *Groundnut bud necrosis virus*, *Cucumber mosaic virus*, Begomoviruses (*Tomato leaf New Delhi virus* and *Mungbean yellow mosaic virus*) were studied at molecular level.

3. Host - pathogen interactions

Plant diseases are being controlled by agronomic practices that include crop rotation and use of agrochemicals and by breeding new varieties that contain new resistance conferring genes. The use of agrochemicals poses many dangers that include harmful effects on the ecosystem and an increase in the input cost of the farmers. Breeding of resistant crops is time consuming and has to be a continuous process as often new races of pathogens evolve and crops become susceptible. Unraveling the mechanism of interaction between pathogens and hosts gene products to elicit basic information on molecular mechanisms of pathogenicity is addressed in plant virus interaction by characterizing the

Microbe-associated molecular patterns (MAMPs) / molecular signatures. The studies on the seed microbiome and its beneficial traits are also under progress.

4. Identification of resistant sources for the development of disease resistant varieties in crops

Host plant resistance is one of the components in the integrated plant disease management. Use of disease resistant cultivars is an ideal method to manage plant diseases, if plants of satisfactory quality and adaptation to the growing region with adequate levels of durable resistance are available. With this background, the resistant sources / germplasms for major diseases in different crops *viz*., rice, millets, pulses, oilseeds, cotton, vegetables, fruits, medicinal crops etc. are being identified under high disease pressure of open and artificial conditions in order to evolve resistant verities. The mechanism of resistance is also studied for important diseases in major crops and its utilization in disease management.

5. Aerobiological studies of air borne pathogens

A low cost impaction and suction spore traps were designed and their performances were evaluated against air borne pathogens of rice and grapes. A highly sensitive rapid LAMP assay protocol has been standardized for early detection of grapevine mildew pathogens and rice blast, brown spot, false smut pathogens.

6. Biological control of crop diseases through rhizosphere, phyllosphere and endophytic organisms

The biological control of crop diseases is a cheap and eco-friendly method. It is also an important potential component of integrated disease management. Several native isolates of *Bacillus* spp., *Trichoderma* spp. and *Chaetomium* spp. were isolated and tested their efficacy on different soil borne diseases. Similarly, the native isolates of A*mpelomyces* have also been isolated, identified and tested their bioefficacy against foliar disease, powdery mildew of different crop plants. The mycoparasite, *Sphaerellopsis* spp. has been isolated and evaluation against the rust fungi is under progress. Several endophytic microbes are also isolated from different plants and their evaluation against major diseases in inducing resistance is under progress.

7. RNA silencing technology for the management of virus diseases

The RNA interference (RNAi) constructs using the major virus genes *viz*., coat protein and replicase of *Groundnut bud necrosis virus* (GBNV) and *Cucumber mosaic virus* (CMV) were developed. The efficacy of the RNAi constructs based on coat protein and replicase of GBNV was tested on tomato for their resistance. Both the constructs were found to be effective in conferring resistance against GBNV in tomato. The results indicated that the transformants did not show any symptoms of infection until harvest. On the contrary, non-transformed plants were severely affected with distinct necrosis symptoms of GBNV. ELISA results indicated that the non-transformed plants inoculated with GBNV recorded the highest virus concentration compared to the transgenic lines.

8. Development of integrated management strategies for major diseases of agricultural and horticultural crops

The integrated management strategies for major / newly emerging diseases of agricultural and horticultural crops and high valued crops under protected cultivation were developed for the effective management of disease complexes with nonchemical methods emphasizing the biological to avoid pesticide residues in the produce.

9. Mushroom research

Worldwide mushroom production technology has been emerging as million dollar industry. The mushroom production is the best biotechnology process for integrated agro-waste management to uplift rural livelihood and to address protein malnutrition. Mushroom fungi are biodynamic network of knowledge and a new frontier of science fully packed with a wide array of nutraceutical, pharmaceutical and biopesticidal molecules. Any attempt to conserve fungi will have a greater stake hold in agriculture, horticulture and forestry eco-system. TNAU is the pioneer in mushroom research in India since 1940s.Over years TNAU has released several mushroom varieties and newer strains of oyster, milky, button and paddy straw mushrooms and innovative production systems. As an outreach programme, mushroom production trainings are regularly organized at various Colleges, Research stations and KVKs of TNAU. It is a record making event that the Department of Plant Pathology, TNAU, Coimbatore offers regular One Day Mushroom Training Programme on a fixed date (5^{th} of every month, if 5^{th} is a holiday, the next working day) since 1988. So far, around 450 such programmes have been organized and more than 25,000 people have been trained. Now during the COVID-19 lock down period the training is being organized on

virtual media. Several beneficiaries are attending the online training by paying the fee online. In addition, special entrepreneurship programmes, hands on training (five days duration) are also organized regularly for the benefit of farmers, farm women, SHG and youth. Through such programmes excellent impact on mushroom production technology has been created in India by TNAU.

Ten different wild mushroom specimens which include *Calocybe*, *Pleurotus*, *Volvariella*, *Ganoderma*, *Coriolus*, *Cordyceps* and *Schizophyllum* have been collected, identified and pure cultured and conserved for further exploration. Exotic specimens of White button mushroom, *Portabella, Shiitake, Auricularia* and *Flammulina* have been collected, pure cultured and conserved for further use.

Production of oyster mushrooms in different container systems like poly bags of different sizes (60x30 cm; 35x25 cm and 25x10 cm); PP bottles (1800ml) and carton box (36x18x12cm) have been evaluated for the cultivation of *Pleurotus florida* (PF), *P. platypus* (PP); *P. eous* (var.APK1) and *Hypsizygus ulmarius* (Var.CO 2). Polybag and Carton box methods were found to be suitable for the cultivation of all oyster mushroom species. Bottle technology was found to be suitable for the cultivation of *P. platypus* (PP) and *Hypsizygus ulmarius* CO 2 oyster mushroom.

The studies on biomolecules of mushroom on the plant pathogens revealed good results in inducing resistance and managing the plant diseases. A biomolecule, squalene isolated from *Ganoderma lucidum* was found to be effective against *Groundnut bud necrosis virus* in tomato. An compound, benzothiazole from *Ganoderma lucidum* was found to be effective against the anthracnose pathogen, *Colletotrichum capsici*. Similarly, Coprinol from *Coprinus comatus* was found effective against soil borne pathogens and cordiceptin from *Ophiocordyceps sinensis* was highly effective against root rot and wilt pathogens.

In addition, a milky mushroom (*Calocybe indica*) strain TNAU-CBE 1523 is under Multilocation evaluation.

10. Post harvest technology

a. Detection of Aflatoxin B1

The polyclonal antibodies were developed and found to be highly sensitive and could detect Aflatoxin B1 (AFB1) at a dilution of 1:10,000 and the detection limit of AFB1 was 10 ppb. In order to understand the magnitude of AFB1 contamination, a total of 68 samples consisting of maize-based foods and poultry feed samples collected from retail shops, supermarkets, poultry farms and poultry feed dealers of Tamil Nadu, India were analyzed

for AFB1 contamination by ELISA. AFB1 contamination in maize based food products was detected in nine samples out of 17 samples tested. However, only one sample exceeded the tolerance level of 20 µg/kg. AFB1 contamination in feeds was observed in more than 88 % of the samples tested and its level ranged from 5.4 to 125.4 µg/kg and 31 samples out of 51 samples tested contained AFB1 above 20 µg/kg.

b. Management of post harvest decay of carrot

Boiled bark extract of Cinnamon 10% was found to be effective against post harvest decay of carrot. Similarly, the cinnamon oil + lemograss oil + thyme oil combination @ 0.1% concentration was also found to be effective in reducing the post harvest decay in carrot.

AC&RI, Eachangkottai

S.No	Particular	Rate (kg/litre) (Rs.)	Quantity (kg or litre)	Amount (Rs.)	Revenue generated (Rs.)
Bioinnoculants					
A.	**Biocontrol agents**				**Rs. 2,25,717.00**
	Trichoderma viride talc	168/-	1240 kg	208320/-	
	Pseudomonas fluorescens talc	168/-	20 kg	3360/-	
	Pseudomonas fluorescens liquid	448/-	4 lit	1792	

NEMATOLOGY

Two major nematode problems were recorded during the reporting period. The first one is guava root-knot nematode, *Meloidogyne enterolobii* and the second one is in polyhouse root knot nematode, *Meloidogyne incognita.*

Management of root-knot nematode, *Meloidogyne enterolobii* infestation in guava

Status of root-knot nematode infestation in guava in Tamil Nadu

This species is considered to be aggressive with high reproduction rate, capable of inducing severe root galling and plant decline. Preliminary infection causes bronzing and yellowing of leaves, stunted growth and galling of roots. The nematode interacts with *Fusarium* sp. which leads to wilt disease complex results in sudden death of the plants.

The incidence though first observed in Ayakudi village of Dindigul district is now intercepted from guava growing areas of Erode, Villupuram., Tiruvannamalai, Dindigul, Salem, Virudhunagar, Dharmapuri and Krishnagiri districts.

Management

- Selection of healthy propagating materials
- Application of 5kg/ha of *Purpureocillium lilacinum* or *Pochonia chlamydosporia* along with 250 kg of Farmyard manure / vermicompost around the rhizosphere region.
- Growing of marigold around the tree basin.

Guava root knot nematode symptom	Growing of marigold at basin	Application of bioagents at basin
 		

Management of root-knot nematode, *Meloidogyne incognita* infestation in protected cultivation

Status of *Meloidogyne incognita* infestation in protected cultivation

- Nematode infestation in protected cultivation has become major issue due to conducive microclimate. The symptoms include yellowing of leaves, stunted growth, day wilting and large sized compound galls in roots. This results in reduction of fruit size and yield.
- A survey was carried out in crops like Gerbera, Carnation, Rose, Capsicum, Cucumber and Paprika grown under polyhouses at Thally, Mathagondapalli, Saragapalli, Vanamangalam of Denkanikottai Taluk, Krishnagiri District. The crops grown in polyhouses were found to be infested with *M. incognita*.

Management

- Soil solarization with transparent polythene sheet (25 microns) for a period of 2-3 weeks during peak summer.
- Incorporation of *Pupureocillium lilacinum / Pochonia chlamydosporia* + *Bacillus subtilis* enriched with FYM @ 2.5 kg/acre at the time of transplanting

- Application of liquid formulation of *P. chlamydosporia* @ 1 liter / acre at the time of planting and thrice at 30 days interval.

Nematode problem in crops grown under polyhouse conditions		
		
Yellowing of leaves on cucumber	Severe root galling on cucumber	Root-knot nematode infestation in gerbera

Nematode management in polyhouse condition			
			
Soil solorization	Mixing bioagents with FYM	Soil application of bioagents at the time of planting	Application of liquid formulation of *P. chlamydosporia*

Dr. S. Panneerselvam
Director, Water Technology Centre,
TNAU, Coimbatore

Water Technology Centre (WTC) at Tamil Nadu Agricultural University (TNAU) is one among the three such centres in the country which was established during 1982 to cater to the needs of the Southern region in relation to research, extension and teaching. It plays a key role in making an assessment of the available resources of water and economic utilization for maximizing agricultural production with suitable on-farm water management practices developed for different situations. Over the years, the centre has grown up in terms of infrastructural facilities, staff positions, research and training activities and it stands foremost among the institutions devoted for water management issues.

The Water Technology Centre which encompasses five inter-disciplinary units viz., Agronomy, Agricultural Engineering, Agricultural Economics, Crop Physiology and Soil Science & Agricultural Chemistry are involved in developing a package of practices with the main focal theme on increasing Water Use efficiency **(**WUE) with simultaneous increase in crop production. Some of the major thrust areas given due recognition are: cropping system and water management, micro irrigation and fertigation, watershed management, conjunctive use, water quality and waste water recycling, agricultural drainage and water policy. Besides, the Centre is handling State Government aided plan schemes, international collaborative schemes, Government of India schemes, ICAR schemes and private agency funded schemes.

Research Highlights (2017-2020)

Tamil Nadu – Irrigated Agriculture Modernization Project(TNIAMP) funded by the World Bank is a follow on project of Tamil Nadu - Irrigated Agriculture Modernization and Water-Bodies Restoration and Management (TN-IAMWARM) Project which was successfully implemented during 2007-2013. TNIAMP is a multidisciplinary project with Water Resources Department (WRD), PWD as Nodal Agency supported by line departments *viz.,* Department of Agriculture, Department of Agricultural Engineering, Department of Agricultural Marketing and Agribusiness, Department of Horticulture, Department of Animal Husbandry, Department of Fisheries, Tamil Nadu Agricultural University (TNAU), Tamil Nadu Fisheries University (TNFU) and Tamil Nadu Veterinary and Animal Sciences University (TANUVAS). The total outlay is Rs. 2962crores to improve irrigation service delivery in 66 sub-basins, covering 5.43 lakh ha of ayacut area, 4778 tanks and 477 anicuts. The project gives special emphasis on enhancing crop production to have better market access, crop diversification, value addition and climate resilient agriculture in the sub-basins.

TNAU is one of the line departments with Director of Water Technology Centre as Nodal Agency implementing through KVK / Research Stations across Tamil Nadu through interventions likeProductivity Enhancement in Rice through safe Alternate Wetting and Drying (AWD) and Pulse Production by way of producing good quality seed and area expansion and value addition by forming Commodity Groups in the sub-basins. Focus is also given to increase productivity of Redgram. Major thrust is given for micro irrigation to improve the water use

efficiency and income of farmers through cultivation of high value crops. Crop diversification with Maize is promoted in Cauvery Command as a climate resilient activity. IT based solutions and sensor based applications in irrigation water will also be studied. The total budget outlay is **Rs. 8746 lakhs**. The project is sanctioned for a period of seven years (2017-2024).

As focus is shifted from production centric agriculture led by farm technologies and innovations to the market oriented agriculture because of rapid urbanization, rise in income levels, change in consumer preferences etc., the farm profitability is dictated by markets. Still, 66.14 per cent of the rural households in Tamil Nadu has to depend upon farming as the main livelihood supporting activity. The proposedTN-IAM project would give special emphases on enhancing crop production to have better market access, crop diversification, value addition and climate resilient agriculture in the sub basins of Tamil Nadu. Tamil Nadu Agricultural University (TNAU) would address all these tasks with the following interventions for the crops grown in the river sub basins of Tamil Nadu.

- **Productivity enhancement in Rice**
- **Promotion of Pulse production in sub basin**
- **Value chain analysis in pulses**
- **Revival of oilseeds cultivation in sub basins**
- **Precision farming**
- **Sustainable sugarcane initiative (SSI)**
- **Promotion of pesticide free vegetable production and organic farming**
- **Introduction of new technology in fruit crops**
- **Domestic and export market intelligence**

Tamil Nadu Agricultural University (TNAU) is one of the implementing agencies concentrating on upscaling and implementation of water saving technologies in farmer's fields of sub-basins. The Water Technology Centre, Tamil Nadu Agricultural University (TNAU), Coimbatore as Nodal office is implementing the Tamil Nadu Agricultural University component of TNIAM Project.

Prospects of Rice Activities in Tamil Nadu

In spite of the initial scepticism from people all over the area, GM-SRI, AWDI has established its roots entrenched in various sub basins of Tamil Nadu. It is incredible that it has created such a remarkable consciousness among the rice growers of the State. The widespread adoption of all rice activities has put aside to many more theoretical queries about its adoption at field level. Above all, GM-SRI, AWDI has revived the interest of many rice growers of the project area those who were with the intention of receding rice cultivation earlier.The rice farmers of Tamil Nadu almost gave up rice cultivation for the last 3 - 4 years due to labour scarcity and less net income. Introduction of GM-SRI, AWDI, Tamil Nadu Agricultural University, under TN-IAMP revived their interest in rice cultivation. Nearly 2500 rice growing farmers from various districts of Tamil Nadu have visited nearby villages in last six months to see the success and to understand and experience SRI at field level. The innovative upscaling measures dealt by TNAU should have definitely aided them in

efficient execution of the technology. It was planned to cover an area of **15,000 ha** during the project period with a budget outlay of **1,500 lakhs**.

Impact of this technology to farmers also practiced all the components of TNIAMP perfectly. Hence they realized the benefits like healthy and strong plant, higher numbers of tillers per plant, more numbers of grains per panicle etc. They recorded 30-35 numbers of productive tillers per hill against 12-15 tillers under normal planting. They also obtained an additional yield of 900 kg per acre due to tis technology than normal planting.

PROMOTIONOFPULSEPRODUCTIONINSUB-BASINS:

In the river basins, pulses grown next to rice as allow crops are the new important commodity group for giving special focus. They are the main source of plant protein for achieving the nutritional security of the rural households and also act as the soil-nutrient enhancer by the way of fixing atmosphericnitrogen. Current yield levels are merely a 50 percent of the potential yield attainable and the State is a net importer of pulses. There is huge scope for improving the productivity levels of major pulse crops as poor seed replacement rate, timely availability of quality seeds, zero mineral nutrition, improper pest management practices, poor post-harvest practices etc., are the major constraints to increase the productivity. TNAU will intervene with production and supply of quality seeds under farmer's participatory approach and adoption of improved production technologies *viz.,* advocating optimum plant population along with nutrient spray. Further, evolving appropriate value chains to improve both forward and backward linkages to improve the production and

marketing effi ciency, providing scope for secondary agricultural activities, proper branding, formation of pulse commodity groups, involving public-private partnerships in the pulses value chain, etc., are the major interventions proposed by TNAU to ensure eff ective use of inputs for better farm profits, additional gainful employment, quality produce for processing and final consumption, accommodating small and marginal farmers to have better market linkages and to achieve food and nutritional security of the State. TNAU was planned to cover an area of **9,000 ha** during the time of period (2017-2024) with a budget outlay of **510 lakhs**.

TAMIL NADU AGRICULTURAL UNIVERSITY
DETAILS OF PHYSICAL AREA

S. No	Interventions	Phase-I									Phase-II		
		I-Year (2018-19& 2019-2020)			II-Year (2019-2020)			Total			I-Year (2019-2020)		
		Target as per G.O (ha)	Achievement (ha)	Impact (ha)	Target as per G.O (ha)	Achievement (ha)	Impact (ha)	Target as per G.O (ha)	Achievement (ha)	Impact (ha)	Target as per G.O (ha)	Achievement (ha)	Impact (ha)
1	**Productivity enhancement of Rice** Green Manure –System of Rice Intensification-Pulses, Dry Seeded Rice, Unpuddled rice, SRI-Semi Dry Rice, Alternate Wetting and Drying	1568	1568	4860	2095	2095	4142	3663	3663	9002	1556	1534	2436
2	**Pulses** TFL Seed Production, Area Expansion, Red gram Cropping Sequence	881	881	2026	1157	1157	1778	2038	2038	4064	761	695.1	1481
3	**Crop Diversification** Oil seeds (Ground Nut, Sesame & Castor) Maize	322	322	902	460	335	1117	782	657	2019	299	259.2	745

Crop Diversification

In Cauvery Command, growing of rice in the first season (June-September) is uncertain due to delayed release of water. Research results shows that growing of maize and sesame as first crop can increase cropping intensity with less water consumption. Hence, crop diversification in Cauvery Command will be attempted by introducing new cropping patterns/promoting hybrid maize production. In the Cauvery basins, maize is grown mostly with traditional varieties. Now, it is proposed to shift from traditional varieties to hybrids to increase the yield potential by conducting Improved Production Technology Maize Crop Demonstrations incorporating: (i) Use of high quality, high yielding hybrid seeds;(ii) Crop diversification from paddy to maize to increase water productivity; (iii) Spraying with maize growth promoter (TNAU Maize Maxima); and (iv) Adopting the technologies like Integrated Nutrient Management (INM), Integrated Weed Management, Integrated Water Management (IWM)–including the use of drought mitigation substances and Integrated Pest Management (IPM) for Fall Army Worm. It was planned to cover an area of **5,000 ha** during the time of period (2017-2024) with a budget outlay of **500 lakhs**.

All the farmers were benefited in this cluster have expressed their happiness on the performance of maize as an alternative crop during kuruvai. Maize fetches more price than rice; doubling the income through maize around Rs.91750/ha compared to rice (Rs.45000) with a saving of 50 per cent irrigation water. Farmers from Nagapattinam sub basin recorded green cob yield of 67500 nos./ha with 5 Nos. of irrigation which consumed approximately 550 mm of irrigation water. It was sold out through direct selling of Rs. 1.0 - 2.5 per cob and obtained the gross income of Rs. 121750 per ha with cost of cultivation of Rs. 30000 per ha, besides the BC ratio of 4.06.

Precision Farming

Micro irrigation is an effective tool for conserving water resources and studies have revealed significant water saving ranging between 25 and 50 per cent by drip irrigation compared with surface irrigation, with yield increases as high as 100 per cent in some crops under specific locations. World Bank assisted TNIAM Project (Tamil Nadu Irrigated Agriculture Modernization Project) was formulated with the objective to improve irrigation service delivery and productivity of irrigated agriculture with effective integrated water resources management in 25 river basins of Tamil Nadu. Micro irrigation technologies especially drip fertigation was demonstrated in crops viz., sugarcane, banana, tapioca, vegetables and flowers. Through this programme farmers were supplied with elite seedlings or hybrids of crop and inputs viz., water soluble fertilizers. The drip fertigation system was installed at subsidized rate for demo farmers. TNAU was planned to cover an area of **3,650 ha** during the time of period (2017-2024) with a budget outlay of **3,850 lakhs**.

Results indicated that drip fertigation increased the crop yields from 30 to 100 per cent over conventional practice and resulted in B.C ratio of 3.84 besides saving of irrigation water (20 to 50 per cent). Micro irrigation technology helped to conserve the ground water for irrigation along with increased crop productivity. Fertigation provides Nitrogen, Phosphorus and Potassium as well as the essential trace elements directly to the active root zone, thus minimizing the loss of expensive nutrients, which ultimately helps in improving productivity and quality of farm produce. Nutrients are delivered to the restricted root zone (wetted soil) in a readily available form and frequent delivery of water and nutrients replenish the small volume of soil in the active root zone, nourishing the crop throughout the entire growing season.

Conclusions

The adoption of TNIAM project as the first milestone in the development of water saving technologies (SRI, SSI, precision farming, and improved cropping technologies etc.,) for different crops under varying agro climatic conditions of the State. All the farmers benefited in this project have expressed their happiness on the performance of TNIAM Project. The benefited farmers informed that there was less pests and disease incidence and the crop was always green even under moisture stress. It also recorded less consumption of irrigation water when compared to conventional method of cultivation. The TNIAM project has created lot of awareness among the stakeholders about importance of irrigation water and need of water saving technologies. Most of the crop fetches more price than conventional method of cultivation crops with lesser water; 73 per cent higher income in improved production technologies as compared to rice with saving of 54 per cent irrigation water. The gross cultivated area has increased by two to three times of net area by raising two to three crops in a year through judicious use of available water resources. Water starved areas in irrigation commands are getting shrunk and thereby drastic reduction in gap area acreage.

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The Faculty of Horticulture was established during the year 1971 with the formation of Tamil Nadu Agricultural University. The PG and Doctoral Programmes were also introduced during the year of inception. The undergraduate programme B.Sc. (Horticulture) was started during the year 1972 and later in 1990, the Programme was shifted to the Horticultural College and Research Institute, Periyakulam. At the time of formation of the University during 1971, the Departments of Fruit Crops, Flower Crops and Spices and Plantation Crops were established. Later, the Department of Vegetable Crops and Department of Medicinal and Aromatic Crops were started during the year 1979 and 2010 respectively. Earlier, a common PG and Ph.D. programme was offered and later four separate PG and Ph.D. programmes are being offered from each department.

After the formation of various Departments at HC & RI, TNAU, Coimbatore, intensive education, research and extension activities are pursued to promote the various branches including fruits, vegetables, spices, plantation crops, floriculture, landscaping, medicinal and aromatic crops with respect to crop improvement, production and post harvest management. Outcome of the research conducted at HC & RI, Coimbatore, resulted in the release of 12 fruit crop varieties, 59 vegetable crop varieties, nine spices and plantation crop varieties, nine flower crop varieties, one medicinal crop variety and improved production technologies for various crops. Besides the Faculty of Horticulture at Coimbatore, the Dean (Horticulture) of HC & RI, Coimbatore is entitled to direct administrative control over the Horticultural Research Stations at Ooty, Yercaud, Palur and Coconut Research Station at Aliyar, Veppankulam, Agricultural Research Station, Pattukkottai and technical control of the Regional Research Station at Paiyur, Agricultural Research Station at Bhavanisagar and Tapioca Research Station at Yethapur.

The Institute's mandates are Education, Research and Extension. With respect to education, courses on crop improvement, crop production and post harvest management pertaining to fruits, vegetables, spices, plantations, floriculture and landscape gardening, medicinal and aromatic crops are taught in a comprehensive manner for various Post Graduate and Doctoral students. Research on crop improvement and crop management of the above crops is carried out with the objective of improving yield and quality, by way of releasing improved varieties and new technologies**.** In order to achieve the objective of 'lab to land' dissemination, extension tools such as Farmers' mela and Exhibitions, Trainings, Seminars, Media (AIR and Paper), Farm Advisory Services *etc*., are being effectively used. Besides these tools, efficient dissemination of the released varieties and new technologies is achieved through regular updating of the TNAU website which enables reaching out to a wider group of stakeholders including the general public.

Research Highlights (2017-2020)

Snake gourd Hybrid COH 1 (2017)

Salient Features

- Fruits are short (35-37 cm), dusty white (RHS 142D) with prominent white stripes
- Fruits are spindle shaped with a weight of 380-390 g
- Average fruit yield per plant is 27.5 kg with an yield of 70 t/ha

Impact

The area of Snake gourd Hybrid COH 1 was extended to 26 ha in Tamil Nadu *viz.,* Coimbatore, Tirupur, Cuddalore, Virudhunagar, Dindigul, Thiruvannamali, Kancheepuram, Vellore, Villupuram, Theni, Erode, Madurai, Thoothukudi, Trichy, Thirunalveli, Thanjavur, Namakkal and Pudukkottai districts.

French beans Ooty 3 (Pole type) (2017)

Salient Features

- Pure line selection from Nilgiris local (Thoothoormattam)
- Plants are trailing in nature and require staking.
- Pods are in cluster (7-9/cluster) and very tender
- Medium maturing crop (90 days)
- First harvest starts on 70 days after sowing. Harvesting done 7 times with 3 days intervals.
- Pods are very long, straight, light green in colour, smooth, shiny, attractive, fleshy, robust,
- Broad and less fibre and has good market value and consumer preference.
- The shelf life is 7 days in hills and 4 days in plains.
- Very good nutritive value and pods are rich in Protein (1.51 %), Vitamin C (2.26 mg/100g),
-

- Carotene (1.92 mg/100g) with very high antioxidant activity (2625 µg/g).
- High yielder 39.81 t/ha, which is 18.1 % higher than the check
- Moderately resistant to Powdery mildew and whitefly
- Suitable both for planting under irrigated and rainfed condition
- Suitable to high, middle and lower elevations of 1200 – 2200 m above MSL of Nilgiris and similar areas.

Impact

Area of adoption 5ha

Bottle gourd PLR 1 (2017)

Salient Features

- Inbred line selected from Siruvanthadu, Villupuram District
- Ideal variety for salad preparation.
- It is high yielding variety (32.4 t/ha)
- Duration:130-135 days
- Medium – long fruits with average weight of 450g
- Moderately resistant to fruit fly and mildews

Impact

- Totally 169.15 kg seeds were produced from 2018 to till date
- It was distributed to farmers, stakeholders, NGO's, KVK's and research institutes for commercial production , home garden and research purpose throughout Tamil Nadu (including Cuddalore, Villupuram, Thiruvannamalai, Aduthurai, Nagapattinam, Kallakurichi, Trichy, Vellore, Perambalur, Thiruvallur, Kanyakumari, Salem and Ramanathapuram) and nearby state Pondicherry.

Ridge gourd Hybrid COH 1 (2018)

Salient Features

- Hybrid is very early (days to first harvest is 30-35) and a prolific bearer (33.7 t/ha).
- The fruits can be harvested for 15 – 17 times in 4 months duration.
- Single plant yields 25 - 30 fruits with an average yield of 10.57 kg/plant.

Impact

- The area of Ridge gourd Hybrid COH 1 was extended to 296 ha in Tamil Nadu states *viz.,* Coimbatore, Erode, Tirupur, Namakkal, Velore, Thiruvannamalai, Thiruvallur, Villupuram, Karur, Pudukottai, Dindigul, Madurai, Theni, Virdhunagar and Thirunelveli districts

Garlic variety Ooty 2 (2019)

Salient Features

- Clonal selection from Nilgiris local near Godalatty
- Plants are robust, erect growth with dark green waxy coated leaves
- Medium duration of 115- 125 days
- Bulbs are larger, oval shape with 4-5 layers outer shiny skin with attractive pinkish colour and has good market value and consumer preference
- Each bulb has 15-18 bold cloves
- The shelf life is 7- 8 months in plains and 3 months in hill

- Moderately resistant to purple blotch disease and thrips
- The cloves are of good quality with high allicin content (3.87 µg /g), TSS (47 ^{O} brix) and Polyphenol (3.5µg/g)
- Suitable for high, mid and lower elevations of 1200 to 2600 m above MSL of Western Ghats regions of Nilgiris, Kodaikanal, Thalavadi and equivalent elevation ranges
- Suitable for cultivating in both irrigated (March-April and Oct-Nov) and rainfed (June - July) conditions in Nilgiris.
- Highest yield obtained 16.94 tonnes / ha

Impact

Area of adoption 10ha

Bottle gourd PLR 2 (2019)

Salient Features

- Inbred line selected from Uchimedu, Cuddalore District
- Round shaped fruit like traditional bottle gourd types
- Short necked and mottle less light green fruits
- Average weight of single fruit is 950g
- 12-15 fruits per vine
- Moderately resistant to powdery and downy mildews
- High yield (42 t/ha)

Impact

- Totally 105.1 kg seeds were produced from 2018 to till date
- It was distributed to farmers, stakeholders , NGO's, KVK's and research institutes for commercial production , home garden and research purpose throughout Tamil Nadu (including Cuddalore, Villupuram, Thiruvannamalai, Aduthurai, Nagapattinam, Kallakurichi, Trichy, Vellore, Perambalur, Thiruvallur, Kanyakumari, Salem and Ramanathapuram Districts) and nearby state Pondicherry.

Star Jasmine - CO.1 (*Jasminum nitidum*) (2019)

Salient Features

- Year-round flowering (12 months); flowers will be available during lean season/off-season (Nov-Feb)
- Attractive bold buds
- Good keeping quality (buds remain unopened for 12 hrs under room temperature and for 60 hrs under refrigeration)
- Mild fragrance
- Easy to pluck and highly suitable for string-making due to bold buds with long corolla tube

- Higher consumer preference
- Attractive plant architecture - ideal as decorative ornamental also
- The variety is suitable for all jasmine growing regions namely, Madurai, Erode, Coimbatore, Thiruvallur, Krishanagiri, Dindigul, Salem, Thirunelveli, Thiruchirapalli, Vellore and Villupuram.

Impact

- Area under large scale demonstration of the variety - 2.0 acres (Dindigul, Karur, Salem, Tindivanam, Tuticorin)
- **Area of adoption 3ha**

Flower buds and open flower

Banana CO2 (2020)
Salient Features

- Progenies derived from the cross Karpooravalli (ABB) x Pisang Lilin (AA) (resistant source for nematode)
- Crop duration (360 - 390 days)
- Tolerance to nematodes and lesser incidence of *Fusarium* wilt
- Yield potential of the variety is 32 tonnes/ha
- Average bunch weight is 12-13 kg with 12-14 hands/bunch and 150-160 fingers / bunch.
- Fingers adhere firmly in bunch even after full ripening
- Recommended for cultivation in Coimbatore, Erode, Theni, Trichy and Kanyakumari districts of Tamil Nadu.

Banana CO2

Manila Tamarind PKM2 (2020)
Salient Features

- Clonal Selection from germplasm (Acc-MT-02)
- Regular and cluster bearing habit (3-4 fruits/cluster) red aril
- High yield (90 kg/tree/year (13.50 tonnes/ha))
- Harvest starts from 3rd year and economic yield obtained from 5th year onwards
- Ascorbic acid (138 mg/100g of FW), anthocyanin (25.2mg/100g) and TSS (13.7° Brix)
- Shelf life 4-5 days after harvest (80% maturity)
- Suitable for dry land cultivation, problematic soil and water logged conditions

<u>Tomato Hybrid CO4 (2020)</u>
Salient Features

- Tomato Hybrid CO4 fruits have green shoulder at breaker stage which turns to red colour at ripening.
- Fruits are borne in clusters of 5-6, with an average fruit weight of 75.3 g.
- Hybrid has long harvesting period with 20-22 harvests in 150 days with a yield of 2.94 kg per plant.
- Yield is 92.3 t/ha (27.31 % increase over TNAU tomato hybrid CO3 and 40.91% over Lakshmi).
- Moderately resistant to leaf curl virus (10.5 PDI)

Impact

- The seeds are distributed to six acres for carrying out frontline demonstrations (FLD) in Tirur, Tiruppur, Salem, Pudukottai, Coimbatore and Karur district.

CO6 Onion (2020)

Salient Features

- It is a free flowering and seed setting type.
- Bulb yield :19.10 tonnes / ha ; Seed yield: 250- 300 kg/ ha
- It recorded 20.94 % increase over the check CO(On) 5.
- The bulbs are bolder in size with attractive pink in colour.
- Each clump has 5 - 7 bulbs and each clump weighs 90-100 g.
- Seed to bulb it takes 130 days and bulb to seed it takes 140 days duration.
- The bulb has a TSS of 15.4 ^{0} brix and ascorbic acid content of 10.8 mg/100 g.
- CO6 onion is adaptable to fertile loamy soils of Tiruppur, Perambalur, Namakkal Cuddalore, and Coimbatore districts of Tamil Nadu under irrigated condition.

Impact

- The seeds are distributed to five acre for carrying out frontline demonstrations (FLD) in Perambalur, Theni, Dindigul, Coimbatore and Sandhiyur district.

Cassava YTP 2 (2020)

Salient Features

- Plants are erect (170-190 cm), medium growing and top branching type
- The tubers are long, cylindrical with pale white skin and pink rind
- Flesh colour is white
- Yield:6.28 kg/plant; 46.20 t/ha
- Duration : 270 - 300 days
- Starch content : 29.62 %
- HCN content in tuber: 368.58 ppm
- No visible symptom was observed for Cassava Mosaic Disease incidence
- Suitable for Plains (irrigated conditions): Salem, Namakkal, Erode, Cuddalore, Villupuram, Perambalur, Ariyalur, Dharmapuri and Trichy districts
- Suitable for Hills (rainfed conditions): Karumandurai of Salem district, Kolli hills of Namakkal district and Pachamalai hills of Perambalur district.
- Dual purpose variety suitable for edible purpose and industry

Impact

- Multiplication of the planting materials is being done at TCRS, Yethapur and also at farmers field at various districts viz., Salem, Namakkal, Erode, Dharmapuri, Kallakurichi, Perambalur and Cuddalore through participatory approach under Venture Capital Scheme on "Production of cassava planting materials".
- It is also distributed to KVKs, stake holders and state department farms for multiplication and area spread and awareness is being created through farm advisory services, KVKs, State department meetings, and multi location audio conference and farmers.
- At present the area coverage is upto 10 hectare which will be distributed to five times of area this year.

Manathakkaali –CO.1 (2020)
Salient Features

- Selection from germplasm collection
- Propagation : Seed
- Duration : 160-180 days
- Green herbage yield : 30-35 t/ha
- Total alkaloid content : 0.38 %
- Rich in ascorbic acid (21.66 mg/g) and iron content (6.10 mg /100g)
- 19.05 % increase in herbage yield over check.

Technologies

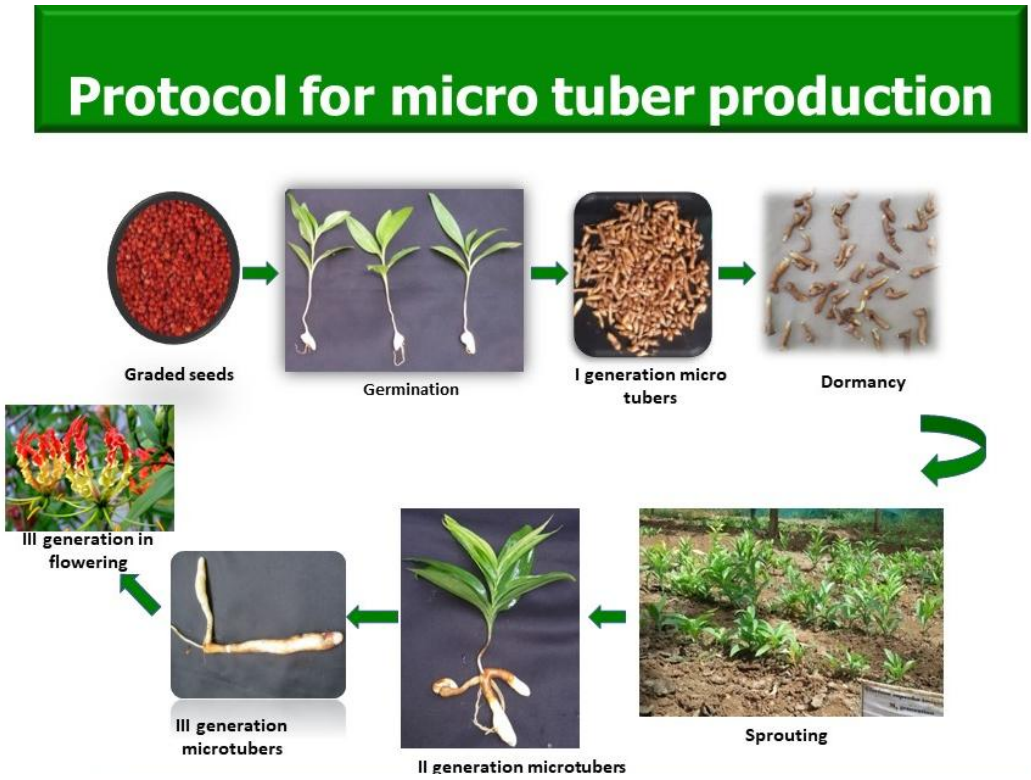
Cassava Booster

- Cassava Booster technology was released during 2020 at Tapioca and Castor Research Station, Yethapur. Production and sale of Cassava booster has been started from June 2020 and at present 500 bags in hand. The sales is under progress, which will be accelerated during the ensuing season. Awareness on Cassava booster is being created through farm advisory services, KVKs, State department meetings, and multi location audio conference and farmers from various parts of Tamil Nadu are approaching to buy the product.

Microtuber production in Glory lily

- Microtuber production protocol in *Gloriosasuperba* was standaridsed and released during 2020.The micro tubers evolved were advanced for three generations until the tubers bulked to 40-45 g weight which is the acceptable

form to farmers. This technique is useful for generation of quality planting material (tubers) on sustained basis, saving in the cost of tubers upto Rs.1.0 lakh per acre and uniformity in crop growth leading to higher seed yield when compared to the conventional practice



HC&RI, Periyakulam

Technologies

S. No	Year	Name of the Technology	Technology details	Feed back
1	2019	Effect of micronutrients on yield & quality of mango **(ICAR-AICRP (F))**	Application of RDF (1.0:0.5:1.0 NPK basin apply) + 100 g Zinc sulphate + 50 g Copper sulphate + 50 g Borax (Soil application in basin after harvest) + Foliar spray of 0.2% Zinc sulphate + 0.1% Copper sulphate + 0.1% Boric acid (2 sprays at just before flowering and marble stage) recorded the highest fruit weight (232.61 g), fruits/ tree (278.78), fruit yield (6.15 t/ha),TSS (22.92 ^{o} Brix) and fruit shelf life (11.98 days).	FLD has been conducted for dissemination of technology in 5 districts (Theni, Dindigul, Madurai, Dharmapuri and Krishnagiri)
2	2019	Management of seed borer in sapota **(ICAR-AICRP (F))**	The four alternate applications of profenophos (0.075%) @ 1.5ml/lit. followed by *Bt* @1 g/lit. or profenophos (0.075%) @ 1.5ml/lit. followed by indoxacarb (0.007%) @ 0.5ml/lit. Were found effective in reducing sapota seed borer fruit damage.	· Demonstration on dissemination of technology has been conducted in Madurai, Dindigul & Virudhunagar. ToT through distribution of leaflets and Pamphlets
3	2017	Regulation of flowering in Acid lime **(ICAR-AICRP (F))**	Acid lime trees sprayed with GA 3 50 ppm in june + Cycocel 1000 ppm in September + KNO3 2% in October recorded the highest number of fruits tree^{-1} (1003), weight of fruit (48.60g) and average fruit yield (28.96 kg tree^{-1}). The same treatment registered the highest value for juice content (32.13 %), TSS (7.29° Brix) and ascorbic acid content (32.56 mg/100 ml)	· Recommended for crop production guide 2020 · Technology dissemination through FLD by ATARI, Hyderabad (KVK's)
4	2018	UHDP in Guava **(TNAU-TANII Project)**	In guava under UHDP system, 2222 plants / ha were accommodated with a spacing of 3m x 1.5m. By adopting this technology, farmers could harvest two to three times higher yield of 40 tonnes /ha (BCR: 1:5.4) against 14 tonnes/ ha under conventional planting system with spacing of 5 x 5m (400 plants /ha; BCR: 1:2.6).	Recommendation for crop production guide 2020

Horticultural College and Research Institute for Women, Tiruchirapalli

Research Highlights (2017-2020)

1.From the studies on Collection, maintenance and evaluation of flower (Annuals & Perennials) and filler crops under salt affected Soils, the following flower crops are recommended for the salt affected soils:

Flower crops: *Jasminum sambac, Jasminum auriculatum, Jasminum grandiflorum, Nerium oleander, Ixora coccinea cv. Native Red, Polianthestuberosa var.* Prajwal

Foliage crops: *Chrysalidocarpuslutescens* (Areca palm), *Caryotaurens* (Fish Tail Palm), *Pritchardiathurstonii, Cyperusdiffusus* (Umbrella plant), *Dracaenas spp.* (Song of India, Song of Jamaica) *and Pandanus utilis* (Screw Pine)

2. The studies on Bio-ecology and Management of Pest Complex in Guava (*Psidium guajava* L.) indicated that addition of organic mulch to 15.0 ±5.0 cm height in orchard floor, timely pest management action synchronizing with the occurrence of respective pests and need based application of foliar sprays using spinosad 2.5SC @15g a.i./ha >or fenazaquin 10EC @ 125g a.i./ha > fipronil 5SC @ 75g a.i./ha in the order mentioned are proposed as additional IPM tools for management of pest complex in high density planting system of guava.

3. The Studies on integrated management of wilt disease in guava revealed that The bio-intensive IDM module comprising the following components viz., soil application of neem cake, AM fungi, Azophos, *P. fluoresces, I viride, P. Lilacinum* and marigold planting in tree basins recorded the lowest incidence of *Fusarium* wilt and the highest per plant fruit yield

4. The studies on Standardization of fertigation schedule in high density planting of Guava cv. L-49 under alkaline soil indicated that Application of 50 % of the recommended dose of fertilizers (300:150:150gN: P_2O_5 and K_2Og/plant/year – CISH recommendation) through fertigation was found to be best in obtaining higher yield (10.22 tonnes/ha) in HDP of guava cv. L.49.

5. Fifty genotypes of small fruited bitter gourd (Mithipakal) collected from different districts of Tamil Nadu were evaluated under the project "Collection, evaluation and screening of small fruited bitter gourd, *Momordicacharantia* L. var. *muricata*(Willd.) Chakrav. (Mithipakal) for high yield and anti-diabetic compounds under salt affected soil". The studies

indicated that the number of fruits per plant ranged from 30.17 to 45.83. The significantly higher number of fruits per plant was recorded in MCM 1 (45.83) which is on par with MCM 16 (45.06), MCM 14 (45.22), MCM 17 (43.78), MCM 33 (43.67), MCM 13 (43.56), MCM 12 (41.72), MCM 34 (41.39), MCM 21, MCM 32 (41.17), MCM 19 (40.89), MCM 15 (40.67) and MCM 10 (40.34).Identification of phytochemicals in bitter gourd fruits of accessions, MCM 1 and MCM 37 were done using GC-MS. The anti-diabetic compoundsviz.,stigmasterol and sitosterol were identified in MCM 1 and Stigmasterol in MCM 37

			
MCM 1	**MCM 10**	**MCM 13**	**MCM 15**
			
MCM 19	**MCM 24**	**MCM 27**	**MCM 29**
			
MCM 31	**MCM 34**	**MCM 46**	**MCM 48**
			
MCM 37	**MCM 41**	**MCM 45**	**MCM 11**

Variability in fruits of small fruited bitter gourd, *Momordicacharantia* L. var. *muricata*(Willd.) Chakrav. (Mithipakal)

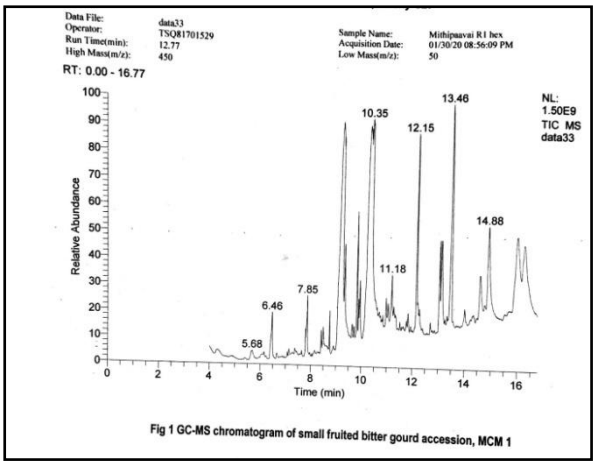


Fig 1 GC-MS chromatogram of small fruited bitter gourd accession, MCM 1

GC MS Chromotogram of MCM 1

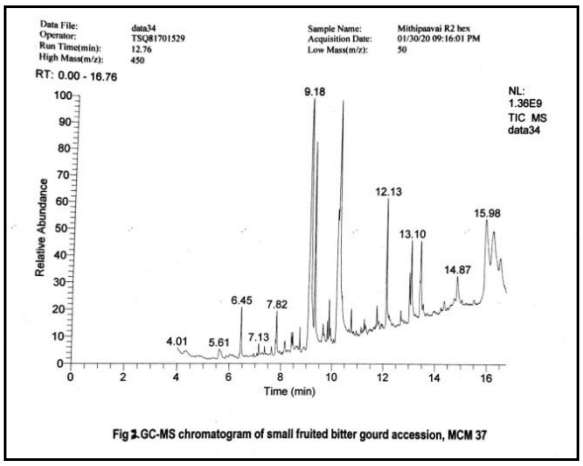


Fig 2 GC-MS chromatogram of small fruited bitter gourd accession, MCM 37

GC MS Chromotogram of MCM 37

6. In Screening of bhendi entries K /varieties and evaluation botanicals / Newer insecticidal molecules for management of bhendi fruit borer complex, Out of 55 bhendi entries screened during 2016-20 in four consequent seasons revealed that, the entries viz., IC 27821-A, IC 31850-A, IC 42531, IC 22237-C, IC 42485-B, IC 43743, IC 43746-D, IC 45728 and IC 45804 were identified as tolerant sources against the bhendi fruit borer Earias sp.,, which registered the Earias fruit borer damage of <30 per cent with average fruit length (15-18cm) and girth(5-7cm).

7. Sodicity is one of the major constraints in crop production. Phytoremediation is a biological approach proving the efficiency of plants to desalanise the soil. Soil phytodesalinisation is based on the capacity of some halophytes to accumulate enormous sodium quantities in their shoots.

The study on the Evaluation of three underutilized leafy vegetables along with amaranthus in salt affected soils for leaf yield and phytoremediation effect at HC&RI (W), Trichy revealed that all the leafy vegetables grown in sodic soil viz., Portulaca, chenopodium, Tetragonia and Amaranthus performed well indicating the potential of growing these underutilized leafy vegetables in sodic soil. Among them Tetragonia and *Chenopodium album* recorded an estimated yield of 12.6 tonnes per ha in sodic soil condition.

The reduction in pH and EC content of the soil in the Portulaca and chenopodium grown field indicated their phytoremediation effect. Repeated cropping of these crops until the soil reaches acceptable levels will help the farmers to utilize their lands for regular crops

Dr. B. Shridar, Dean, AEC&RI, TNAU, Coimbatore
Dr. V. Thirupathi, Dean, AEC&RI, TNAU, Kumulur

Agricultural Engineering College and Research Institute, Coimbatore is offering four year degree programs in B.Tech. (Food Technology), B.Tech. (Energy and Environmental Engineering), B.Tech. (Agricultural Engineering), Masters' and Doctoral degree in the fields of Farm Machinery and Power Engineering, Renewable Energy Engineering, Processing and Food Engineering and Soil and Water Conservation Engineering. The Agricultural Engineering College and Research Institute with the new paradigms in teaching and research is constantly redefining strategies and focusing new destinations. As an integrated strategic planning process, faculty of the institute played a key role in focusing and refining the directions of the institute for the future and the Institute is now refining its operations and seeking methods to enhance the discipline. The institute is committed to provide an excellent environment where students can reach their full potential with an academic experience of "thinking, learning and doing".

Research Highlights (2017-2020)

Farm mechanization is considered to be one of the several pathways of agricultural development. In modern agricultural practices, mechanization of farm is needed from the view point of profitability of agriculture. A farming system cannot sustain with the traditional machinery. The mechanization of farm is also inductive to the diversification of the cropping system. Farm mechanization has seen a rather slow progress over the years. The demand of important agricultural equipment like tractors, power tillers, combine harvesters, irrigation pump sets, diesel engines, has shown an increasing trend. The progress of farm mechanization in terms of demand of agricultural equipment is estimated at about 1 to 1.5% per annum.

During last 53 years the average farm power availability in India has increased from about 0.30 kW/ha in 1960-61 to about 2.02 kW/ha in 2013-14. Over the years the shift has been towards the use of mechanical and electrical sources of power, While in 1960-61 about 92.30% farm power was coming from animate sources, in 2013-14 the contribution of animate sources of power reduced to about 11.80% and that of mechanical and electrical sources of power increased from 7.70% in 1960-61 to about 88.20% in 2013-14. In Tamil Nadu, the availability of power is estimated at 0.78 kW/ha. Out of this about 90% comes from tractors, engines and motors. For adoption of higher level of technology to perform complex operations within time constraints and with comfort and dignity to the operators, mechanical power becomes essential. Thus, the extent of use of mechanical power serves as an indicator of acceptance of higher level of technology on farms. It is visualized that the additional requirement of food grains in future will be met, to a great extent from the demand of mechanical power sources and matching farm equipment.

In view of this, research activities are conducted under AICRP on Farm Implements and Machinery and AICRP on Ergonomics and Safety in Agriculture schemes of the Department of Farm Machinery and Power Engineering, Agricultural Engineering College and Research Institute, Coimbatore. The research output from the department for the period 2017 to 2020 is as follows:

Sowing pelletized rice seeds

A four row seeder for direct sowing of rice pellets in field was developed. The seeder consists of two 680 mm long and 120 mm wide skids. The skids provide floatation in soft puddle rice field. Propulsion is achieved by a single 30 W DC motor with spur gear reduction. The 12V 30W DC geared motor providing 3.1Nm of torque. The torque was further amplified by a chain drive to 8.6 Nm in the drive wheel. The wheel drive plate is swivelly mounted to a hinged drag bar. Thus the drive wheel can swing up and down to enable the lugs to get traction from the subsoil layers. Steering of the seeder is effected by a linear DC actuator. The steering arm is designed to give a rotation of ±30 degrees. The lugged traction wheel has a outer diameter of 400mm.

The seed metering device was designed as a vertical rotor type, for simplicity of design and improved cell fill. The cell plate was designed with hemispherical cavities in the periphery of a circular disc. A 120mm seed plate with 12 cells was designed. The seed plate hub was mounted with friction clamping element to have a flush geometry at the hub. The design of this improved seed plate showed that 98 percentage single pellets could be metered by the 120mm seed plate.

The control of the propulsion, steering and seed metering were done by three separate motors. The control of all the three motors is done through multi-channel telemetry control. The ground speed is measured by an encoder wheel and the seed disc is driven at proportional speed. The seed metering can be switched on and off by the telemetry controller. The rice seeds are bonded into multiple seed aggregates with two or three seeds and the seed aggregates are pelletized. The cost of the unit is Rs.50,000. The field capacity of the seeder is 0.08 ha/h.

Design and development of a self propelled corn cob harvester

A single row self propelled corn cob harvester as an attachment to existing mini tractor was developed. The harvester consists of snapping rollers, gathering chain, chain elevator with slots and cob collection box. The harvesting unit comprised of two counter rotating snapping rollers and gathering chain. The drive for these two mechanisms is provided by a gear box. Both are driven by the bevel gear box having four sets of bevel gears mounted on ball bearing and lubricated by oil bath. The ratio of the speed of the snapping roller to the gathering chain drive shaft is 1:3. The drive to the side mounted picker head is through a Hydraulic motor of 50 cc/rev. The motor is close coupled to a hydraulic pump which is mounted on the front of the tractor and it is primed by the engine power. The snapping rollers are of 80 mm in diameter with tooth provision on the circumference. The front end is fitted with a conical double start scroll for feeding the crop

into the snapping rollers. The clearance between the rollers can be adjusted to suit crop condition. The gathering chain is of 25.4 mm pitch and fingers are mounted to the chain for gathering the crop. The complete assembly mounted on an auxiliary frame is fitted below the tractor and this forms the main frame for mounting the harvester head and hydraulic tank. The harvester head is offset at 400 mm from the outer edge of front wheel.

As the machine moves forward in row of maize crop, the plants are pulled by counter rotation of the snapping rollers. During the progress of the plant in between the rollers, the cobs are separated from the plants by the striking plate. The separated cobs are moved towards the elevator by the counter rotating chains. The elevator consisted of "L" angle plates fitted to the chain. A rectangular structure of 2420 x 270 mm size and chain guides were provided to support the chain elevator. The cobs are lifted by the plates, conveyed and dropped in to the collection box through chute. The collection box is hydraulically operated, which can be lifted sideways for unloading the collected cobs by the operator.

The snapping roller pulled 100 per cent of plants from the field and out of which 94 per cent of cobs were removed from the plants. The actual field capacity of the cob harvester is 0.16 ha/hr. The cost of the unit is Rs.2.50 lakhs and whereas the cost of harvesting is Rs.5000/ha.

Tractor operated high clearance weeder

Weeding is one of the most laborious, time consuming operation and most expensive operations in crop growth. Hence, a tractor operated weeder was developed by keeping in mind the various agronomical requirement of crop, *viz.,* spacing of crop about 45- 90 cm, height of the crop about 45 - 60 cm from the ground level during the first 60 days of crop growth. Based on the average height of the crop during 60 days of sowing, the height of the weeder frame was fixed as 70 cm, which can be easily moved in between the rows without damaging the crop. The weeder consists of three frames, out of which the centre frame is of size 1645 x 1330 x1360 mm that includes a standard three point hitch frame for attaching to the tractor. The dimensions of each auxiliary frame are 785 x 1330 x 1340 mm. The height of main frame of the weeder was made to have a high clearance of 700 mm below the frame and also it has provision to mount the weeding elements at required spacing based on the spacing of the crop. The overall dimension of the prototype weeder is 3220 x 1330 x 1360 mm. During the field operation, the auxiliary frames are locked in horizontal position, while during transport; the auxiliary frames can be folded on to the middle main frame. Fifteen number of the clamping type tynes with sweeps were fabricated. Those can be fitted on to the frame according to the crop rows spacing and number of rows. The weeding efficiency, plant damage and field capacity were 88 %, 3 %, and 0.65 ha h^{-1}, respectively. The cost of the weeder is Rs.90,000/-.

Development of a tractor operated planter for tissue culture banana

A tractor operated planter suitable for planting tissue culture banana being raised in polybag was developed. The planter consists of the main frame, chisel type furrow opener, furrow enlarger, plants dispensing unit, earthling up assembly and press wheels. Provision was made on the main frame for attaching with tractor three point linkages. Chisel type furrow opener opens the furrow to a depth of 300 mm. The furrow enlarger made up of sheet metal wings, enlarges the furrow for the width of 120 mm and depth of 200 mm behind the chisel. The seedlings grown in the grow-bag of 60 mm diameter and 150 mm height are placed in the spoon type valve arrangement by a person after removing the grow-bag. The lever provided at one end is operated by the cam and it actuates the spoon to oscillate backwards which in turn drops the seedling in the furrow and then the spoon type valve returns to its original position wherein the seedling feeding person can place the another banana seedlings.

The valve is designed to open automatically at fixed plant to plant spacing of 1.52 m through ground wheel measuring system with the help of cam and lever. Seedlings are earthed up by a suitable shovel mounted on the vertical pipe which is attached to horizontal pipe by means of scaffolding clamp for the easy adjustment of depth, width and forward inclination of shovel. Finally, the soil around the plant is compacted by the set of press wheels. The provision for adjusting the depth as well as width of pressing is also made in the press wheel. The width of pressing can be adjusted from 100 mm to 200 mm. The machine can plant the tissue culture banana in a single row at recommended spacing of 1.52 m. The field capacity of the machine is 1.5 ha/day. The machine resulted in 50 % saving in time and 90 % saving in labour. The cost of the machine is Rs. 50000 and the cost of operation of machine per hectare is Rs.3500.

SSI Sugarcane Seedlings Tranplanter

The automatic SSI transplanter is an electro-pneumatic system. The basic functions of the pick and placing mechanism adopted for the transfer of seedling from the tray to the planter chute consisted of three axes of motion and a gripper arrangement. The tray is incrementally fed by a DC motor driven belt conveyer. The clamping of the plant, to pull out the plant from the tray was done by a pair of fingers that are pivoted and operated by a pneumatic cylinder. The pulling out action was implemented by a parallogram mechanism that was activated by a pneumatic cylinder. The entire clamping and pulling arrangement was designed to ensure lesser weight in order to reduce inertial forces. The traverse of the plant from the cell location to the drop chute was done by an electrically driven ball screw. The ball screw was operated by a stepper motor and controlled by a PLC to ensure accurate positioning. The entire cycle of

operation was automated by a PLC and hence it can be flexibly adopted for different protrays and seedling. Presently one pick and plant mechanism had been designed and developed. The mechanism is targeted to achieve a planting speed of 2kmph and hence a field coverage of 0.2ha/h.

Automatic vegetable protray seedling transplanting mechanism

A pneumatically operated automatic vegetable seedling transplanting mechanism was developed. The pneumatically operated prong fingers of 185 mm length and made of 2.5mm diameter spring steel was used for picking and transplanting the seedlings from the protray. The upper end of the prong was pivoted to the central hub attached to the picking cylinder. The gripping and ejection of the seedlings was done by a separate cylinder. The picking cylinder implements the picking action and the removal of the seedling from the protray cavity. This cylinder is mounted on linear guides. The carriage is driven by a stepper motor. The drive was given by a 5A stepper motor. A PLC with microcontroller was used to control the stepper motor to position the picking cylinder above the protray cavity. The optimal machine operation parameters were examined for picking up of tomato, chilli and brinjal seedlings at different levels. With the maximum speed limit for the stepper motor, the transplanting rate was 6 seedlings / minute. When picking tomato 25 days old seedling, the success rate of up to 90.69 % was recorded at 18.84 ±2 moisture content. Similarly for chilli and brinjal, of 40 days old seedling, the success rate of 92.47 % and 91.32 % respectively were recorded.

The research output from the Department of Farm Machinery and Power Engineering, AEC&RI, Kumulur for the period 2017 to 2020 is as follows:

Combined Inter and Intra Row Weed Control Mechanism in Cotton

Weed control is laborious and expensive operations in crop production, which accounts for around 25 % of total labour requirement and one-third of the cost of cultivation. Due to the competitiveness of weeds, delay and negligence in weeding operation affect crop yield up to 30 to 60 %. By keeping these facts, an attempt was made to develop a sensor activated spraying system to apply herbicide in between plants in intra row area for avoiding the problems of removing intra row weeds mechanically as well as manually and also to reduce the application of chemical and thereby soil and environmental pollution.

While combining the mechanism used in inter row mechanical weeding and intra row weeding mechanism a single unit to control weeds in both inter and intra row was developed. The major components of the developed inter and intra row weeding mechanism were sweep attached with helical type pulverizing roller assembly, spraying pump assembly, sensors activation spraying system, power transmission system and three-point linkage system. The developed inter and intra row weeding mechanism was evaluated in cotton field with spacing of 900 × 600 mm by setting the different components according to the plant height, plant width and row-to-row spacing.

The weeding efficiency, plant damage and effective field capacity of developed unit was 87.52, 13.12 % and 0.037 ha h^{-1} respectively. The droplet size of the spray deposition ranged from 765 to 785 µm. The length and volume of chemical delivered in between plants in intra row by the developed unit was found to be 372 mm and 7.24 ml, which confirmed to the volume of chemical to be applied at the recommended length and dose of 400 mm and 7.62 ml per 0.12 m^2 respectively. There was a saving in chemical by 75 %. The savings in cost of weeding in intra row with developed intra row weeding mechanism was 22.77 %. The cost of operation of the machine was Rs. 6667.14 ha^{-1}.The savings in cost of weeding with developed inter and intra row weed control device was 45.82 %, respectively.

Tractor Drawn Cassava Sett Planter

Cassava is cultivated in about thirteen states of India with major production in southern states of Tamil Nadu and Kerala. Cassava crop offers immense scope as food, feed, and industrial raw material. Cassava planting is conventionally done by manual methods.

A tractor operated prototype belt with bucket type cassava planter was developed and evaluated for its performance in actual field condition. The performance of belt with bucket type cassava planter was compared with manual planting. The belt with bucket type cassava planter recorded minimum draft of 2235 N and fuel consumption of 3.42 l/h during the field operation. The belt type cassava planter registered 66.67 % of single sett per hill, 12.27 per cent of double setts per hill. 9.75 % of more than two setts per hill, 11.30 % of missing hills maintaining the recommended plant population of 4 plants per m^2 and at 0.9× 0.9 m plant spacing.

The use of belt type cassava planter for planting cassava sett resulted in 27.37 and 95.42 % saving in cost and time respectively as compared to the conventional method of manual planting. The cost of planting by the machine was Rs.2832.42 ha^{-1} and breakeven point, payback period and benefit-cost ratio of the cassava planter were 7.93 ha yr^{-1}, 2 years and 1.76: 1, respectively.

Dr. K. Parthiban
Dean, Forest College and Research Institute,
TNAU, Mettupalayam

The Forest College and Research Institute (FC & RI) is located at Mettupalayam in the sylvan surroundings of Jakanari Reserved Forest, about 40 km north of Tamil Nadu Agricultural University (TNAU) main campus, Coimbatore. It is situated over a sprawling expanse of 200 ha of reserved forest, located of the foothills of Nilgiris on the Kotagiri road. The college is perched at an altitude of 300 m with a longitude of 11.19'N, latitude of 77.56'E and enjoys an annual rainfall of 830 mm. The mean maximum and minimum temperature are 32.2°C and 23.2°C respectively.The Forest College and Research Institute (FC & RI) is located at Mettupalayam in the sylvan surroundings of Jakanari Reserved Forest, about 40 km north of Tamil Nadu Agricultural University (TNAU) main campus, Coimbatore. It is situated over a sprawling expanse of 200 ha of reserved forest, located of the foothills of Nilgiris on the Kotagiri road. The college is perched at an altitude of 300 m with a longitude of 11.19'N, latitude of 77.56'E and enjoys an annual rainfall of 830 mm. The mean maximum and minimum temperature are 32.2°C and 23.2°C respectively

Research Highlights (2017-2020)

CURRENT STATUS OF INDUSTRIAL AGROFORESTRY IN TAMIL NADU

Introduction

Agroforestry in India in general and in the state of Tamil Nadu in particular is gaining significant attention and attraction due to growing importance of doubling the productivity and mitigating the climate change. The vagaries of monsoon, labour shortages due to migration, erratic rainfall pattern coupled with uncertainty in supply chain have all attracted alternate land use system to augment the productivity and profitability. Increasing wood demand for wide range of industrial demand in the State of Tamil Nadu, particularly timber, pulp and paper industries, plywood, packing cases, biomass industries have increased the attention towards industrial agroforestry. It is estimated that the state would need between 60 and 80 lakh MT /annum of raw material requirement to meet industry raw material, Industrial energy and other domestic utility. However, the actual production is less than 20lakh MT which necessitated massive import of wood and wood products in the state of Tamil Nadu. Under such circumstances, there is a need to expand the area under Agroforestry with High Yielding Short Rotation (HYSR) varieties, precision silviculture technology, Multifunctional Agroforestry System and the associated organized supply chain to assure buy back and marketing. Against this backdrop, Forest College and Research Institute has conceived a Consortium mode Industrial Agroforestry and implemented in association with wide range of industries. The major achievements that had happened during the last three years are furnished below.

I. Development and Deployment of HYSR clones

The TNAU has developed high yielding short rotation varieties in Casuarina (TNAU Casuarina MTP 2), Eucalyptus (TNAU Eucalyptus MTP1) *Melia dubia* (TNAU Malai vembu MTP1 & MTP2) and Kadam (TNAU Kadam MTP 1) which are amenable for harvest from 18 months onwards. The yield, rotation and utility details are furnished. These high yielding clones were deployed in all industrial agroforestry plantation activities through organized contract tree farming (Table 1).

Table 1. List of varieties released and demonstrated

S.No.	Species	Variety	Rotation	Yield / ha	Utilizing industry
1.	*Casuarina Hybrid*	TNAU Casuarina MTP 2	3 Years	150 tonnes	Pulp & paper, Pole and Construction industries
2.	*Eucalyptus camaldulensis*	TNAU Eucalyptus MTP 1	3-5 Years	150 tonnes	Pulp & paper industry
3.	*Melia dubia*	TNAU Malai vembu MTP 1	18 to 24 Months	150 Tonnes	Pulp & paper Industry,
4.	*Melia dubia*	TNAU Malai vembu MTP 2	5 Years	250 tonnes	Veneer, plywood and splints industry
5.	*Neolamarckia cadamba*	TNAU Kadam MTP 1	3 yrs - Pulp 5 yrs -Ply 6 yrs for Match	175 tonnes	Pulp, Plywood and Match wood industries

II. Mini Clonal Technology for mass multiplication

Mini clonal technology has been developed for a wide range of tree species such as, Melia, Casuarina, Eucalyptus, Teak, Toona, Kadam etc., which is one of the pioneering attempts in the country for these industrial wood species, and ensures availability of quality planting material as envisaged in the National Agroforestry Policy (2014).

III. Development of alternate and improved industrial wood genetic resources

During the last three years, Industrial Agroforestry has received a fillip due to the development of new and improved genetic resources amenable for various industrial utility.

Table . 2. Alternate and improved tree genetic resources

Sl.No	Species	Utility
1	*Casuarina* (CJH 27 -01)	Higher pulp yield
2	Subabul (FCRILL15)	Higher pulp yield
3	*Acacia* (AM 19)	Higher Pulp and plywood yield

4	*Dalbergia sissoo* (MTP DS18)	Higher Pulp yield
5.	Teak (MTPTK07, MTPTK16, MTPTK 21)	Timber
6.	White teak (FCRIGA08)	Timber and plywood
7.	Red sanders (TNRS01)	Timber
8.	*Jatropha* (CJH 13&CJH 05)	Bio fuel

These new and alternate industrial wood species are at varied stages of adoption.

IV. Development of new clone for face veneer production

The plywood industries in India in general and in the State of Tamil Nadu in particular depend predominantly on the imported face veneer to manufacture their plywood products. The imported face veneer increases the cost of plywood production and predominantly obtained from only one species namely *Dipterocarpus turbinatus.* To resolve this issue FC&RI TNAU has identified a new clone in Melia (MD 44) which has been identified as one of the potential species for face veneer production and the clone is deployed in agroforestry promotional programs.

V. Design and Development of Multifunctional Agroforestry system for small farmers

The State of Tamil Nadu witnessed more than 70% of small farmers and their land productivity exhibited static conditions. The government both at State and Central level directs the researchers to develop alternate land use system to double the productivity and triple the income of the farmers. Under such circumstances FC&RI TNAU has designed and developed a comprehensive Multifunctional agroforestry model incorporating industrial wood species, floriculture, fodder crops, vegetables etc,. which ensures the daily income of Rs. 550 - 950 and satisfies the government direction towards augmenting productivity and profitability.

VI. Promotion of Organised Contract Farming

To create self reliance in raw material security and attract farmers towards agroforestry, TNAU has developed Bi, Tri and Quart partite model contract farming system in association with wide range of wood based industries. This contract farming has witnessed development of 5000 acres of organized agroforestry plantation per annum in association with various wood based industries which are furnished below:

Table 3. CIAF linked wood based industries for marketing

Sl.No	Sector	Wood based Industry	Species
1	Pulp & Paper	➢ **Tamil Nadu Newsprints and Papers Limited (TNPL), Kagithapuram, Karur** ➢ **Seshasayee Paper and Boards Ltd., (SPB), Pallipalayam, Erode**	*Casuarina, Eucalyptus Melia*
2	Plywood	➢ **Century Plyboards (I) Ltd, Chennai** ➢ **Ambiply Panels and Doors, Mettupalayam** ➢ **Maxbond Plywoods** ➢ **Jai Maruthi Plywood** ➢ **Asian Timbers**	*Melia dubia* (18 inches and above) *Eucalyptus* (18 inches and above)
3	Timber	➢ **Suresh Timbers, Elumalai, Madurai Dt.**	Teak (30-45inches and above), *Gmelina* (25 inches and above)
4	Match wood	➢ **Vasan Match Works, Vellore** ➢ **The Ideal Splints and Veneers , Coimbatore**	*Ailanthus excelsa* (24 inches and above)
5	Biomass	➢ **Pavo Energy, Chennai** ➢ **K.G.Denim Limited, Coimbatore** ➢ **Senthil Group of Companies, Coimbatore**	All agroforestry tree species
6	Packing Cases	➢ **Bharathi Package and Furniture, Coimbatore**	*Melia dubia, Albizia* spp. *Acrocarpus fraxinifolius*

VII. Price Supportive System

The Forest College and Research Institute of TNAU has initiated price supportive system for farm grown industrial wood species particularly pulp and paper, plywood, matchwood, dendro power and timber species. The consortium mode value chain approach has witnessed fixation of prices for various industrial wood species. The following price supportive mechanism has been extended to farmers by the industries which attracted many farmers towards tree husbandry and resolved the marketing problems faced by the farmers (Table 4).

Table 4. Price support for various industrial wood species

S.N	Species	Potential Market	Price support per metric tonne	
			Pre intervention	During 2020
1.	*Casuarina* species	Pulp and paper	Rs.2000	Rs.5350
2.	*Casuarina hybrid clone*	Pole	Rs.3000	Rs.8500
3.	*Eucalyptus* species	Pulp and paper	Rs.2000	Rs.4500
4.	*Leucaena leucocephala*	Pulp and paper	Rs.1600	Rs.4400
5.	*Ailanthus excelsa*	Match Splints	Rs.2200	Rs.6500
6.	*Melia dubia*	Paper	No Price	Rs. 4400
7.	*Melia dubia*	Plywood	No Price	Rs. 7500
8.	*Tectona grandis*	Timber	Rs.8000	Rs.16000-37,500
9	*Neem*	Timber	Rs. 2500	Rs.6000-8500
10	*Subabul*	Timber	Rs.2500	Rs.5000-6500
11	*Kumizh*	Timber	Rs. 5000	Rs.8000-12000

VIII. Tree Insurance Scheme

TNAU has conceived a comprehensive tree insurance scheme in association with United India Insurance for seven major tree species promoted through industrial agroforestry value chain model. The species included are *Casuarina, Eucalyptus, Melia, Ailanthus, Gmelina, Dalbergia sissoo* and Subabul and the insurance premium for each species is furnished in table 5. The insurance programme has fixed the lowest premium of 1.25% of the input cost and the perils included are flood, cyclone, fire, riots, wind fallen, lightening etc. This has attracted several farmers and industries and resulted in insurance coverage of over 5000 acres of clonal plantations. This needs to be extended for other tree species and the model extend a greater scope of its replication across the country for all the farm grown tree species.

Table 5. Details of tree insurance scheme

Prioritized` Tree Species	Common name	Premium	Risk Coverage
Casuarina	Casuarina	• **1.25 % and 1.60 %** • **Rs. 300 – 800 / acre/year**	Forest fire Lightning Animal Damage Flood Storm Cyclone Riot Pests & Diseases
Melia dubia	Malabar Neem		
Eucalyptus	Eucalyptus		
Ailanthus excelsa	Indian Tree of Heaven		
Leucaena leucocephala	Subabul		
Gmelina arborea	Gamhar		
Dalbergia sissoo	Sisham		

IX. Consortium of Industrial Agroforestry (CIAF)

To strengthen the developments of industrial agroforestry not only in Tamil Nadu but also throughout the country and to sustain the activities of production, processing and consumption issues, the Forest College and Research Institute of Tamil Nadu Agricultural University has created a Consortium of Industrial Agroforestry (CIAF) during 2015 which has brought all stakeholders in one platform. This consortium has 271 registered members which includes wood based industries, nursery growers, farmers, Farmers Producer Organization, NGOs, Scientists, financial institutions, Line department, small and medium scale industries and entrepreneurs.

The consortium identifies the problems and constraints that exists in the entire Production to Consumption System (PCS) in Agroforestry and resolves the issues through suitable technological, Organizational and marketing interventions. This Consortium is one of the pioneering attempts in the Country and attracted almost all stakeholders and extends greater scope of replication across the country.

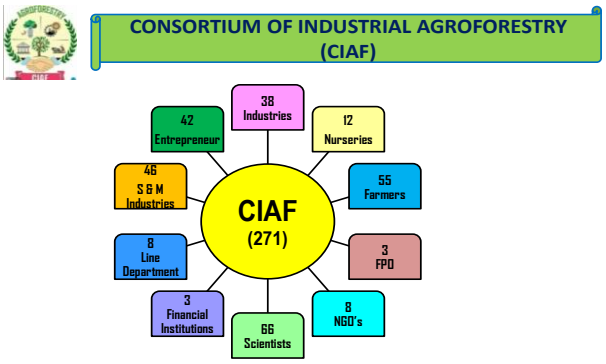


Fig : 1. Members of Consortium of Industrial Agroforestry

X. Business Incubator

To translate agroforestry research into a business enterprise TNAU has established India's first Agroforestry Business Incubator and involved in development of entrepreneurial skill among the students, farmers and unemployed youth towards creation of Startup and new business enterprises. During the last one year of inception the incubator has enrolled 44 new business hubs and involved in creation of decentralized employment and income generation activities besides catering to the needs of Government vision on Make in India Program.

Way Forward

Agroforestry promotion in the State of Tamil Nadu has witnessed paradigm shift from unorganized system to an organized Consortia mode Agroforestry. This consortia mode agroforestry is continuously involved in assessing the problems witnessed at various levels of Production to Consumption System (PCS) and resolving the issues through suitable technological, organizational and marketing interventions. This innovative approach is able to promote over 5000 acres of agroforestry establishment per annum and ensures self reliance in raw material security besides augmenting the income and employment generation activities. These activities need to be strengthened further through continued and systematic Research and Development mechanism in order to identify new and alternate species, develop models for increasing productivity and creating forestry based business opportunities. This need a comprehensive participation of all stakeholders at all levels of agroforestry system, which will benefit the farmer, Wood based industries, raw material availability, income generation and will satisfy the climate change mitigation and adaptation process.

Dr. S. Amutha
Dean, Community Science College and Research Institute,
TNAU, Madurai

The Community Science College and Research Institute, Tamil Nadu Agricultural University, Madurai has its origin as Department of Home Science in 1980 at Agricultural College and Research Institute, Madurai offered B.Sc. Home Science degree. The Food Technology unit at TNAU, Coimbatore started during 1972, later was renamed as Department of Food Science and Nutrition in 1982, which was shifted to AC&RI, Madurai during 1984 to strengthen the B.Sc. (Home Science) degree program. The Institute also offers Masters Degree in Food Science and Nutrition from 1981 which is now offered as M.Sc (Community Science) Food Science and Nutrition and Doctoral programme in Food Science and Nutrition from 1988 onwards. During the year 1999, the three year B.Sc. (Home Science) degree programme was upgraded as a four year professional degree course. The two departments namely Department of Home Science and Food Science and Nutrition functioned at AC&RI, Madurai till 2000. Continuing its path of progress in tune with the latest developments and technologies, it was developed into a full fledged institute named as Home Science College and Research Institute in Madurai during 2000 and presently renamed as Community Science College and Research Institute during 2017 as per the recommendation of the Fifth Deans' Committee of the ICAR. This institute has emerged as a nodal centre for Education, Research and Extension in five specialized disciplines of Community science namely; Food Science and Nutrition, Human Development and Family Studies, Family Resource Management and Consumer Sciences, Textile Science and Design and Extension Education and Communication Management. In addition, the Department of Differently Abled Studies was established in 2014 as per the UGC guidelines. During 2015, the B.Sc. (Food Nutrition and Dietetics) was introduced based on the ICAR Fifth Deans' Committee recommendations and to take advantage of the growing prospects in food processing and value addition and for its promising business opportunities. During 2019, two departments namely Food Policy and Public Health Nutrition & Apparel Designing Management has been established.

Research Highlights (2017-2020)

1. Micronutrients (Iron and Zinc) enriched Kavuni rice with anti diabetic properties

Parent varieties (Kavuni and CO-50) and 22 cultures were assessed for nutrient and therapeutic properties. The percentage of carbohydrate (64.00 g/ 100g), amylose content (23.12g/100g) and total soluble sugars (57.58 gm per 100gm) was found to be lowest in kavuni, which was on par with cultures having black colour genotypic traits. Based on the physicochemical characteristics, nutritional composition and therapeutic properties, the culture 145-3 have maximum scores when compared to other cultures. The antioxidant property of culture 145-3 (164 mg c3g equivalent/100g) was similar to the kavuni parent (223.76 mg c3g equivalent/100g) based on the antioxidant activity analysis. *In vitro* bioavailability results suggest that 145-3 rice lines having highest solubility of selected minerals and therapeutic compounds such as calcium, iron (1.57ppm), zinc (3.28 mg/100g),

total flavonoids (65.21 mg CAE/100g) and total anthocyanin (164 mg C3g/100g). Suitability of 145-3 rice line for traditional foods (pongal, pittu), extruded foods (idiappam and noodles) other breakfast foods (rice uppma, rice flakes and kali) was found to be highly acceptable

		
Puttu		**Flakes**
		
Vermicelli		**Rice analogue**
		
Sweet Pongal		**Noodles**

2. Development of multigrain simulated rice analogues

The multigrain formulation for simulated rice analogues were optimized by Simplex Lattice Design of RSM viz., kodo millet (10-20%), little millet (5-10%), barnyard millet (30-40%), foxtail millet (30-40%) and pearl millet (5-10%). Extrusion cooking was carried out using a twin screw extruder at optimised extrusion parameters such as barrel temperature: 35, 60 and 35^{o}C for zone 1 to zone 3, die diameter of 3mm and screw speed of 180 rpm. Finally, the extruded rice shaped analogues obtained were dried to 11% moisture content at 65^{0}C for 4 hours. The developed simulated rice analogues had 8.64g of protein, 2.84g of fat, 2.40g of zinc, 2.34mg of iron, 18.05mg of calcium, 268.22mg of phosphorous, 0.37mg of thiamine, 22.46mg of β-carotene, 4.68g of fiber and 5.54% of resistant starch. The simulated rice analogues were observed to have 0.59g/ml of bulk density, 4.25g/g of Water Absorption Index, 15.7g/g of Water Solubility Index and 147.39g of Hardness. The organoleptic characteristics of the cooked rice analogues and variety rice (coconut rice, tamarind rice, pepper rice and mint rice) prepared from the rice analogues were highly acceptable. The rice analogues are quick cooking (5 minutes) on rehydration with water (1:1.25) under open boiling method and alternatively can be presoaked in water for 30 seconds to 16% m.c. and steamed for 5 min. The product has a shelf life of six months, with an overall sensory acceptability of 8.5/9.0 and cost of: Rs. 68.50 per Kg. The rice analogues have low glycemic index (38.51) and glycemic load (14.82) making it a ideal food in management of diabetes mellitus and obesity. The rice analogues have potential to be promoted as nutritious convenience foods and micronutrient enriched food to address micronutrient malnutrition. The technology is versatile and lends for blending with pulses, vegetables and other foods to further improve taste and nutrient content.

Multigrain simulated rice analogues

3. Vitamin B_{12} Enriched functional millet beverage

Among 138 GRAS propionibacteria isolated from various food products, only 25 isolates was confirmed as *Propionibacterium freudenreichii* by 16s rRNA sequencing. Among 25 isolates, only 18 isolates were known to produce vitamin B_{12} which ranged between 0.108 to 1.302 µg/ml. The high vitamin B_{12} producing culture, MM21 (1.302 µg/ml) was used as starter culture for in *situ* active vitamin B_{12} biofortification for the development of millet based beverage using all the five minor millets. All the millet based vitamin B_{12} enriched drinks has good organoleptic scores and it was found that the product can be stored up to 1 month under refrigerated condition. The complete physicochemical and nutritional composition of the developed product was analysed which included TSS, viscosity, pH, acidity, carbohydrate, protein, fat and fibre content, total antioxidant activity,

total phenol content, flavanoids, minerals (Mg, Ca, Zn, Fe, Na & K), B vitamins (folic acid, thiamine, riboflavin, pantothenic acid & pyridoxine), amino acid profile and volatile compounds. In addition, antinutritional factors *viz*., phytates and tannins was also found to be reduced due to fermentation. The efficacy and toxicity of the fermented vitamin B_{12} rich millet drink was evaluated. Anemia induced albino wistar rats were fed with vitamin B_{12} enriched drink, one group served as control with normal diet, one positive control group treated with vitamin B_{12} capsules and one served as negative control fed with vitaminB_{12} deficient diet throughout the study period. Among the treatment groups, the positive control group and vitamin B_{12} rich millet drink fed groups has significant recovery in level of hemoglobin, plasma folate and plasma vitamin B_{12} level. The cost of production of the vitamin B_{12} enriched fermented millet beverage was Rs. 12.65, Rs. 12.82, Rs. 12.80, Rs. 12.76 and Rs. 12.82/200ml for the respective foxtail millet, little millet, kodo millet, proso millet and barnyard millet beverages.

4. Development of Millet based Functional Milk Beverage

Kodo millet was steeped in water for 12 hours, germinated for 36-48 hours at room temperature. Water was added to the malted grains in the ratio of 1:7 and milk was extracted. Sugar 20 g and cardamom 2 g were added as a flavoring substance. Total Soluble Solids was increased to 15° brix. The milk yield was recorded as 475 ml / 100 g. The protein content of the milk was 1.75 g%, starch 5.73%, reduced sugar 1.79%, total sugar 3.26 g %, fat 1.21g% and calcium content 1.63 mg%. The shelf life of the malted millet beverage added with preservative was acceptable up to three months. The microbial load was acceptable limit as per FSSAI standards. The cost of the millet milk Rs. 25/ 200 ml.

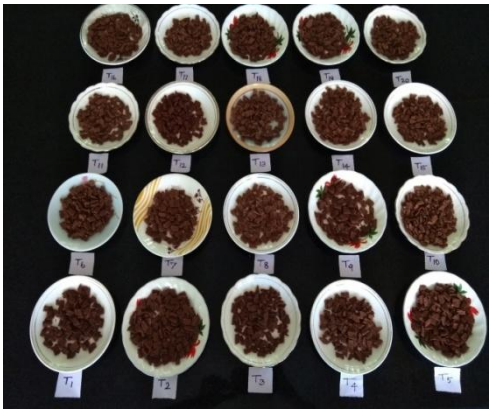
5. Millet fruit bar

One of the promising snack item that could be created using millets is millet bars. Whole puffed sorghum, flaked and gritted bajra and finger millet grits were utilized for producing an acceptable millet bar. To enhance the nutrient content in terms of protein and fat roasted whole bengal gram, roasted and coarsely gritted groundnuts were incorporated in the millet bar. The palatability and nutrient content of the millet bar was improved by adding intermediate moisture fruit product – mango bar. The ingredients were mixed quickly with jaggery syrup to a hard crack consistency. They were then spread on the trays and shaped and cooled. The bars were packed in metallized polyethylene covers and stored. . The protein content of the fruit bar was 3.65 g%, fat content was 1.68g%, calcium and iron content were 1.73 and 35.15mg% respectively. The energy content of the millet fruit bar was 137 kcal per 100g. The millet fruit bars could be stored in metalized polyethyle packages upto 2 months. The cost of 25 g of the millet fruit bar was calculated as Rs.9.00.

6. Millet based breakfast cereal

The sorghum K12 and CO 30 varieties were used for the preparation of millet breakfast cereals. Ready-to-eat breakfast cereals (flakes) was developed with popped sorghum flour optimized by using Response Surface Methodology (Minitab 16). The optimization scores for development of Ready-to-eat breakfast cereals were 20.63 g protein, 3.04 mg iron and 9.0 overall acceptability scores, corresponding to the optimum condition of popped sorghum flour - 41.84 g as X_1, jaggery 23.09 g as X_2 and 35.94 ml of water as X_3 out of twenty set of variables and responses.

To optimize the technology for the preparation of semolina based bajra incorporated vermicelli, the responses, the Protein, Fiber and rehydration ratio were selected on the basis that these responses had direct effect on the acceptability and quality of vermicelli. To consider all the responses simultaneously for optimization, multiple regression was used to get compromise optimum conditions and it has found that the scores were 22.43 g, 0.96 g and 2.96g for protein and fiber and rehydration ratio respectively.



Sorghum Breakfast Cereals (Flakes)

Bajra Vermicelli

7. Ready to Serve soup from horsegram extract with potential hypolipidemic activity

Hyperlipidemia is considered to be major risk factor for premature atherosclerosis, and the confirmatory clinical trials revealed the antihyperlipidemic effect of horsegram extracts. This is particularly promising for promotion of therapeutic value of horse gram in health foods. Based on the health benefits of the horse gram extract, technology was standardised for functional beverage - ready to serve (RTS) soup from horse gram extracts with potential hypolipidemic activity. Ready to serve horse gram soup mix was developed from Payiur 2 variety. The process involved soaking horse gram (100g) in excess water for 12-18 hours (1:5), followed by cooking (60 min.) and draining the cooked water (horsegram extract). The horse gram extract was used for the preparation of the RTS soup. For the spice mixture for the soup, oil was heated and pepper, cumin, garlic, turmeric powder were added, sauteed, cooled and pulverized to fine powder. For preparation of horse gram soup, oil was heated and sautéed with mustard seeds, fenugreek seeds and cumin seeds. Chopped tomato and salt were added to the sautéed spices and cooked till done. To this was added the spice mixture and the horse gram extract and simmered on low flame for 10 min. The horse gram extract was packed in glass bottles, pasteurized and stored under refrigeration condition for shelf life study (3-5^{o}C). The sensory changes during storage and microbial load revealed that the product had an acceptability of 60 days on storage under refrigeration condition. The product had shelf life of 60 days under refrigerated condition. Cost: Rs. 90.0/Litre.

8. Texturized Vegetable Protein blending Mushroom and Underutilized Pulses

Extrusion processing has been carried for development of mushroom analogues by combining mushroom (oyster, milky mushroom) with underutilized pulses (horse gram, cowpea). The pulses (50-75%) and mushrooms (25-50%) formulation were made in different ratios. The formulation was extruded with feed moisture content 12%, extrusion temperature 120°C and screw speed of 150rpm. The analogues formed were collected, dried in cabinet tray drier at 50°C for 30 minutes to achieve 3-5% moisture content in the final product. The average value of Water Absorption Index and Water Solubility Index varied from 3.25 - 5.28 (g/g) and 22.78 - 32.43 % respectively. The expansion ratio values of analogues were in the range of 1.15 to 1.86. Increase in the mushroom flour concentration significantly increased the bulk density from 0.127-0.287 g/ml of sample. The protein concentrates showed higher emulsifying properties or gel formation which will improve the texture of the extruded product by forming 3D structure with higher water absorption. Incorporation of mushroom flour improved protein(24.56%), fiber content (7.78%)and antioxidant properties (11.91-12.46 mg GAE/g) of the analogues. The processed TVP utilizing mushroom and underutilized pulses had good organdeptic properties and the TVP could be used for product diversification such as TVP 65, biriyani and gravy. The cost of the mushroom TVP is Rs.56/100g including the fixed, variable and total processing cost.

Texturized vegetable Protein (TVP) chunks

Rehydrated TVP

9. *Dolichos labla t*empeh

Tempeh was prepared with fresh *Dolichos lablab* and and fresh *Arachis hypogaea* in the ratio of 75:25 using sub cultured *Rhizopus oligosporus.* The frresh tempeh had moisture content of 50.03g%, fat 4.48g%, protein 19.38 g%, crude fiber 3.11g%, dietary fiber 3.56 g%, carbohydrate 20.50g% and calcium 98mg%. Sensory characteristics of the tempeh revealed that it may be an alternative and eventually an option for non vegetarian preparations

10. Groundnut germ meal maida /millet cookies

Groundnut germ is a major by – product in groundnut processing and contributes 5-6% of the total weight of the processed groundnut which is underutilized. The refined wheat flour, sodium bicarbonate and by-products flour blends were sieved using BS 80 mesh sieve. Vanaspati and powdered sugar were creamed and blended with respective flour combinations and made into dough, rolled and cut using biscuit cutter. Cookies were baked at 170ºC for 15 minutes, cooled and packed. The groundnut germ millet cookies has a protein content of 12.5 g, fat content of 22.08g and also very rich in micro nutrients like calcium 37.52mg, iron 5.43 and Zinc 3.86mg / 100g of cookies. The cost of Groundnut germ meal maida and millet Cookies was 10.71 and 14.58 per 100g.

11. Protein enriched papaya RTS

Papaya fruits were cleaned, peeled, edible portions were cut and pulped. The juice was extracted from pulp. Sugar syrup (9° bx) 0.3g% acidity was prepared and mixed with the pulp. it was found that 10 per cent soy protein isolate (T_2 S) incorporated RTS was highly acceptable. The TSS of protein enriched RTS beverage was 14.7° bx, pH was 4.9, with 9.8 g of protein and 670μg of β carotene in 100 ml . The shelf life of the protein enriched papaya RTS is 60 days. The cost of 200ml of RTS is Rs16 / 200 ml.

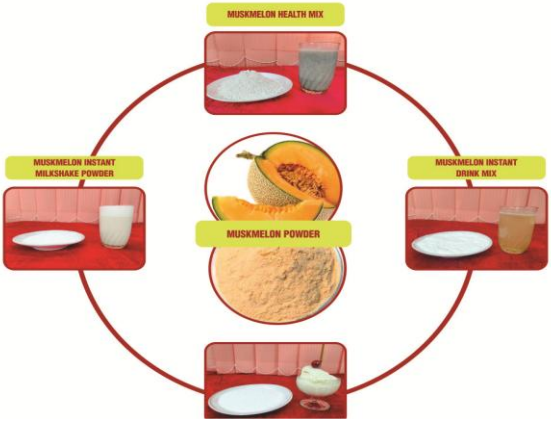
12. Banana pseudostem RTS beverage

Banana pseudo stem RTS was prepared with ginger as a flavouring agent. The banana pseudo stem was cleaned and washed thoroughly. Inner portion was cut into smaller pieces and blanched at 65°C for 3 mins. The juice was extracted mechanically by crushing and filtered using muslin cloth. Sugar and ginger extract for flavour was added separately. Then pseudo stem beverage was pasteurized at 71- 75°c for 5 mins and filled in sterilized glass bottles, corked and stored at refrigerated condition. The TSS of the beverage

was 12°bx, acidity 0.34%, protein 3g, total sugar 14.75 g, reducing sugar- 6.34 g, starch22.41 g and phenols 52.04mg /100g. The pseudo stem beverage prepared with natural ginger flavour had high acceptability and had a shelf life of forty five days of storage in refrigeration with minimal changes in the quality attributes.

13. Processing of fruit powder from muskmelon

Muskmelon fruit powder was prepared using spray drying at a temperature of 180°C with a TSS of 25°bx of the juice. The freshly processed muskmelon fruit powder contained moisture - 4.19 per cent, pH - 5.39, acidity - 0.1 per cent, TSS - 55°brix, total sugar - 25.07, reducing sugar - 11.82 per cent, β - carotene - 988.99 µg/100g, ascorbic acid - 97.62 mg/100g and total antioxidant - 14.34 µg/g. The shelf life of muskmelon powder was 180 days. Instant drink mix, instant milk shake powder, instant ice cream mix and instant health mix was formulated by utilizing muskmelon fruit powder for commercialization.



Processed Products From Muskmelon

14. Osmo dried cashew apple candy (*Anacardium occidentale* L.)

Osmo dried cashew apple slices was processed with palm sugar syrup at a temperature of 50°C, in 60% palm syrup concentration with an immersion time of 2 hrs. The red and yellow fleshed varieties were taken for processing. The acidity of the osmo dried cashew apples were 046 and 0.56, TSS was 38 and 34° bx, vitamin C 122.12 and 133.5 mg/100g , poly phenols 282.3 and 280.0 GAE mg/100g, 80 and 94 CE mg/100g and antioxidant activity 485 and 510 mg/100g for red and yellow fleshed candies.

Cashew apple candy (Yellow flesh)

Cashew apple candy (Red flesh)

15. Banana flour based health mix

Freshly harvested fully matured green fresh banana fruits var.`Chakkai` (A clone of Monthan) and Nendran were washed in tap water, surface dried, steamed (15 min), peeled out manually and cut into circular slices of 3 mm thickness, dried at 60 $\pm$ 5°C in a cabinet drier for 6 to 8 h, milled/ ground, sieved, packed and stored at room temperature for the preparation of health mixes. Development of banana health mixes using banana flour (40%), sprouted bajra flour (20%), sprouted green gram flour (25%) / sprouted bengal gram (25 %) flour and cashew nut (15%) has been found to be highly acceptable in sensory characters. The moisture content of the health mix was 6.7%,. The health mix had 14.8g of protein , 3g of fat, 347 kcal energy, 175mg of phosphorous and 520mg of potassium per 100g of health mix. The unit price of the banana health mixes (200g) was found to be Rs. 81 .

16. Appropriate Processing technology for extending the shelf life of palm tender fruit

Tender palm fruit is a seasonal fruit. Processing of tender palm fruit with appropriate technology will support the palm farmers. The tender palm fruit was precleaned and filled in cans. Sugar syrup at 60°bx was used as filling agent and the can was exhausted for 6 min. This was followed by steaming and processing at a temperature of 121°C for 25 min followed by cooling and storing. This canned product had a shelflife of 5 months.

Peeled and precleaned palmyrah tender fruit endosperm

Canned palmyrah tender fruit

For freeze drying the peeled and precleaned tender fruits was frozen at a temperature of about -20°C for 2 hrs. The frozen tender palm fruits were freeze dried at -18°C for 6hrs at vacuum of 40 mm and stored in HDPE packaging materials.

Freeze dried palmyrah tender fruit

Palmyrah tender fruit in retort pouch

The peeled and pre cleaned tender palm fruits were processed in aluminium and transparent retort pouches and processed at a 20Psi for 2.54 min.

17. Antimicrobial Food Packaging Material: A Green Technology

Chitosan film was prepared at 1.0 and 1.5% concentration. For preparing film, 1 % chitosan solution was prepared by dissolving 1 g chitosan in 100 ml of 1% acetic acid solution. The resultant chitosan solution was filtered using Whatman No. 3 filter paper. The essential oil like Basil oil, Lemon grass oil and Thyme oil was added separately to the chitosan film forming solution at three different concentrations of 0.1, 0.2 and 0.3 % . Tween 80 (0.05 % v/v of the film forming solution) was used as an emulsifying agent and Glycerol was added at 0.1 % v/v as plasticizer. The solution (250 ml) was then homogenized using a magnetic stirrer before casting. Then the solutions were casted into a Teflon tray (9 x 12 cm) and were air dried for 48 h. The films are peeled off and conditioned in a Dessicator until further use. Biodegradable packaging material can be made using Chitosan@1% and 1.5% level. Biodegrable films incorporated with essential oil had good stability and strength suitable for packing papaya and tomato.

Chitosan + PVA

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CARDS is the first Multi-disciplinary Centre in Tamil Nadu Agricultural University established in 1978 with the mandate to promote Teaching, Research, Extension and Policy Advocacy in the area of Agriculture and Rural Development. CARDS has three Constituent Departments.

1. Agricultural Economics (1961)
2. Agricultural Extension and Rural Sociology (1962)
3. Agricultural and Rural Management (2000)

In order to make the students to understand the issues related to Agricultural and Rural Development and Transfer of Technology, the constituent Departments of the CARDS offer various courses at undergraduate and post-graduate levels. At post-graduate level, the specialization in each discipline equips the students to meet the demand of stakeholders and also policy makers engaged in welfare of farming community. The continuous perseverance on bringing the structural changes in the curricula and syllabi could help the students to gain confidence to meet the challenges arising in agricultural sector. The constituent departments of CARDS offers 40 UG courses,51 PG courses and 47 Ph.D courses in the disciplines of Agricultural Economics, Agricultural Extension and Rural Sociology and Agricultural and Rural Management.

I. Research Highlights (2017-2020)

The Centre for Agricultural and Rural Development Studies (CARDS) is involved in policy oriented research in thematic areas. The CARDS has received research grants from different international, national and state level funding agencies. CARDS and its constituent departments are actively associated with State and National organisations on policy related studies and dialogues. Recent activities include Government of Tamil Nadu Policy on Farmer Producer Organizations, Government of Tamil Nadu Policy on Export and Import, Preparation of District Human Development Report of Coimbatore District and preparation of Perspective Plans under State Balanced Growth Fund (SBGF).

The Department of Agricultural Economics is involved in conducting policy oriented research on different domains viz., agricultural production, marketing and international trade, natural resource and environmental issues, farm finance and rural credit, intellectual property rights, price forecasting etc to cater to the needs of the society. The major research programmes currently being implemented are the Cost of Cultivation Scheme, Endowment Chair in Agricultural Marketing, Impact of Watershed Development Programmes, DEMIC and Price forecasting, impact of e-NAM, Artificial Intelligence and Big data Analytics (AI&BDA), documentation of IPRs etc. The department has dedicated Intellectual Property Management Cell (IPMC) for facilitating thes c i e n t i s t s , f a r m e r s a n d entrepreneurs in filing the newinventions. So far 77 patents have been filed and 11 patents weregranted. A s a nodal agency for impact evaluation, the department is involved in evaluation of watershed development programmes being implemented by the state agencies and NABARD. Around 2500 watershed were evaluated.

The Department of Agricultural Extension and Rural sociology is involved in conducting research in agricultural education, administration, extension teaching methods, leadership, programme evaluation, rural youth, migration, entrepreneurship, ICTs in technology transfer, training of farmers and extension workers, empowerment of tribal women and impact assessment of MGNREGA. Regarding extension activities, model village was adopted by ng farmers' income (DFI) scheme of TNAU to uplift the socio-economic status of farming community through technological interventions.

The department of Agricultural and Rural Management is involved in conducting research on Management of Agribusiness and Entrepreneurship, Institutions for Agribusiness Development and Supply Chain Management and Value Chain Analysis. Department is currently undertaking the projects on creating database on millets in India and assessing the demand and supply pattern of industry human capital in agribusiness sectors.

1.An Economic Analysis of Protected Vegetable Cultivation in Tamil Nadu

- Among protected cultivation methods, the poly house was used to a larger extent of 97 for vegetable production followed by shade net house.
- The major reason for greenhouse construction is high profit in less area; cultivate high value crops and offseason crops which have good export potential and also attractive government subsidy.
- Vegetables produced in larger area under poly house in Tamil Nadu are capsicum, cucumber and chinese cabbage.
- 92 per cent of the farmers belong to medium and large holdings with income of more than 2 lakh / annum
- The establishment cost for one acre of poly house is Rs. 33,76,000.
- There is 95 per cent efficiency in input usage and 73.33 per cent of the greenhouse capsicum growers is in the most efficient category in productivity (91 to 100 per cent)

2.Promoting Rural entrepreneurship and empowerment of rural young women self-help groups (SC / ST)

- Majority of the women SHG members performed the roles *viz*., labourers in MNREGA programme, agricultural labourers and other allied activities *viz*., beedi making, match box making, coconut leaf thatching, incense stick making, tailoring, household work, candle making etc.,From the training imparted, the SHG women members had acquired adequate skill or production of bio-inoculants and gained confidence to start bio-inoculant production units

3.Constraint analysis of jasmine (Madurai Malli) growers

- Cent per cent of the farmers adopted the ruling variety. Gundumalli and 85 per cent of the farmers adopted recommended plant propagation and planting methods.There existed 1.3 t/ ac of Yield gap-I and 0.45 t/ac of Yield gap-II. Scarcity of water, lack of proper pruning, high temperature, improper fertilizer application and pest and diseases were the major contributing factors for yield gap as expressed by the farmers.

4.Analysis of Declining trend in area under Groundnut in Tamil Nadu

- Groundnut farmers were using their own seeds since the cost of seed is high.
- The major groundnut varieties grown in the sample farms during Kharif 2015 were TMV-7 VRI- 2 and TMV -2.
- Attainable yield gap in groundnut was 0.60 and 0.77 in Kharif 2015 and Kharif 2016, respectively revealed that yield can be increased by 60 to 77 per cent during Kharif season.
- The average yield of sesame was -373 kg/ha in kharif 2015 and 345 in kg/ha2016 In Sesame the Yield gap- II was 315 kg/ha in kharif 2015 and 442 kg/ha in rabi 2015-16 This clearly indicates the existence of potential to increase farm level yield of sesame by 46 to 56 per cent.

5.Socio-Economic Aspects of Seed System, Cropping System and Value Chain

Farmers predominantly cultivated H226 in drip irrigation system, Kungumarose in ridges and furrow irrigation system and H165 in rainfed hill system due to higher yield and starch content. Other characteristics considered in selecting cassava varieties are drought tolerance, short duration, good keeping the quality of tubers, easiness to harvest, whiteness of the pulp of the tuber and less fibre (for sago production). The majority of industries prefer Thailand variety (white and black) due to the highest starch content. Majority of the farmers used their own planting material or sourced the planting material from farmers in same village or other nearby village and from relatives. CMD incidence is reported in all most all the cassava farms surveyed in north Tamil Nadu and in 78 per cent of the farms in south Tamil Nadu. Other major diseases found in north Tamil Nadu are brown leaf spot (36 per cent) and root rot (25 per cent). In south Tamil Nadu brown leaf spot is reported in 37 per cent of cases. The major pest in north Tamil Nadu is white fly which is the vector of CMD reported in all the farms. Other important pests in the region are spiraling white fly (61%), mealy bugs (40%), mite (33%), scales (13%) and rodents (11%). The average yield of cassava in north Tamil Nadu is 32.19 t/ha in drip system, 27.54 t/ha in flood irrigated system, 22.30 in rainfed plains and 21.19 in rainfed hills. The total cost of cultivation per hectare ranges from Rs.59214 in rainfed hills to Rs. 108744 in drip irrigated cassava production system. The net income was Rs. 1.20 lakh in drip system, Rs. 1.02 lakh in flood irrigated system, Rs. 0.69 lakhs in rainfed plains and Rs. 0.57 lakhs in rainfed hills.Price instabilityis the major constraint in cassava marketing. Nearness to the factory, time of harvest and market conditions also influences the price of the tuber. During the study period the average price varied from Rs. 7092 to 5491 per tonne. Value chain relationships and linkages along the industrial cassava value chain are mapped.

Tapioca cultivation in the study area registered a negative growth of 8.2 per cent during 2006-07 to 2015-16. Long Term Trends in the Area cultivated of the important crops in the study area for 20 years from 1996-97 to 2015-16 shows that the instability in the cassava area is moderate (around 25 per cent) compared to the instability of other crops. The long-term shift in cropping pattern shows the rice area has declined at an annual average rate of 5.23 per cent and groundnut area declined at an annual average rate of 7.35 per cent. In the last 20 years maize area has grown by an annual average rate of 20.64 per cent and cholam area increased by 3.71 per cent. But the instability, which indicates the year to year variation in area cultivated, is high in the case of maize and cholam cultivation.

6.Performance of Crop Insurance Schemes in Madurai District

- Implementing Agency (PMFBY) for Madurai District is Agricultural Insurance Company (AIC)
- Madurai district is included in CLUSTER – I (with indemnity 80%) Medium risk
- Drought or Deficit Rainfall is the major risk factor in the district
- Among the loanee farmers, 30% of them claim the insurance for more than three times in the past five years and 70% of them claimed twice during the same period.
- Though adequate awareness was created among the farming community about the PMFBY, still 24 per cent of farmers were not aware of prevented sowing and exempted clauses of this scheme.
- Overall, the farmers were satisfied with the PMFBY compared to NAIS as it provided large amount of claims in general.
- InadequateIndemnity, High premium rates (need more subsidy), Loan by PACS is limited to part of the land holding and Claims are used to clear old debts were the problems faced by farmers.
- Constraints faced by AIC were huge claims due to assessment at village level, data discrepancies in area under crops: Lending agencies, Dept. of Agriculture &Dept. of Statistics (Area Conversion Factor), Adverse selection (more number of insurers during high risk year), Lack of technical man power and increasing work load and lack of awareness of crop insurance schemes among farmers
- Policy Implications
- Though the existing premium rates are low compared to previous schemes; premium for small and marginal farmers may be still lowered.
- In recent times, payment of premium and settlement of claims are done online with clear deadline for different activities which avoids errors in data.

7.Enhancing the Livelihood of Tribal Women through Technological Interventions of Trainings on Non-Wood Forest Products (NWFPs)

Created (100%) awareness on sustainable harvest of non-wood forest products (Without damaging the plant parts and tree branches) by which the tribal's got awareness on forest conservation.

Tribal women (50 %) have increased the collection of Non- wood forest products - Amla, (Phyllanthusemblica), Shikakai(Acacia concinna), Tamarind(Tamarindusindica), Echam leaves (Phoenix loureirii),Soap nuts(Sapindusserginatus), Arappu(Albiziaamara), Jamun (Syzygiumcumini)and Sundakkai(Solanumtorvum) due to the arrangment market linkage in the tribal settlement

Self-life of perishable harvested produce is increased due to knowledge building (100%) in value addition/semi processing, which helps tribal women to timely marketing of their produces.

Tribal people had indigenous skill in harvesting honey from rock bees (Apisdorsata) from the steep rock cliffs, tall trees and they lacked knowledge of filtering of honey to remove impurities, which adversely affected the fetching of a good price. Knowledge building (100%) on mid-rib cutting and draining method for harvesting honey, filtering out impurities, reducing the water content of honey etc., this optimized the yields, reduced the impurities in the collected honey and enhanced the keeping quality.

Policy Recommendations:

Location specific training centers may be established
Financial assistance from the nationalized banks for starting small
Market linkage with private agencies may be arranged

8.Monitoring and evaluation of medicinal plants cultivation during 2013-14 to 2015-16 for Farmers level survey on medicinal plants cultivation in the state of Tamil Nadu

- NMPB supported through the Department of Horticulture & Plantation Crops for cultivation of medicinal plants by organising the farmers in cluster approach.
- Majority of the farmers partially converted their land holding for medicinal plants cultivation and also it is interesting fact that, farmers turned out to medicinal plants cultivation from traditional cash crops like paddy, cotton, ground nut, pulses, vegetables and flower crops. Very few farmers have totally turned for medicinal plants cultivation.
- State Departments and Research Station have helped the farmers by extending the technical support through various means *viz*., awareness programmes, training, demonstrations, field visits etc.

- **Outcomes and Recommendations**

- Promotion of clusters through formation of new clusters may be encouraged.
- Establishment of processing facilities like threshing floor, processing centres, tarpaulin and storage structures like godowns etc.
- More extension programmes like training may be offered to the farmers on production systems especially pollination mechanisms / strategies and plant protections measures which is being one of the important problems to the farmers.

9.Resource Use Planning for sustainable agriculture in Tamil Nadu

The optimal plan revealed, the gross cropped area has declined from the existing area of 43.84 lakh ha to 38.39 lakh ha under scenario I (technologies such as SRI, SSI, Bt cotton and tissue culture banana) and 38.93 under scenario II (drip irrigation technology). The net income has increased by 43 percent increase from Rs.218.64 billion rupees to Rs 313.22 billion rupees under scenario I and 315.12 billion rupees under scenario II. Decline in area under cereals, pulses and oil seeds are replaced by commercial crop and vegetables.

Wider adoption of yield increasing and water saving technologies help in increased income. Hence, technologies such as SRI, SSI, tissue culture banana, BT cotton etc are to be promoted in a larger scale. Efforts have to be taken particularly in CD and NE zone to increase the productivity of pulses and oilseed through water saving and yield enhancing technologies like sprinkler irrigation system. In all the optimal plans area under vegetables had increased and per ha net return also increased. Use of more hybrid seed production and necessary technology for protected vegetable cultivation of vegetable may be promoted on the selected districts. Tailored made technology and credit support programmes may be formulated to increase net return per unit area of land

10.Supply and Demand for Urban Public Goods – The Case of Municipal and Environmental Services from Urban Lakes (Tanks) in Coimbatore District

The study examinedthe resident preferences for lake restoration in Coimbatore, India, a 'Smart City' selected to be part of a national urban development program. In particular, women reported lower willingness to donate than men, despite being as concerned about the status of the lakes and urban environmental quality overall. The half of the sample randomly assigned to receive messaging focusing on both the ecological and recreational benefits of lake restoration also reported significantly lower values than those told about the recreational benefits only. These responses appear to reflect contextual issues, such as expectations about government responsibility for public goods provision, cash constraints, and women's limited access to household funds. Thus, engaging the public in urban environmental planning and action will require attending to varied cultural norms regarding the role of the government versus private organizations and households and the gendered nature of transactions.

11. A Study on Participatory Behaviour of Rural Households in Neem Seed Collection in Tamil Nadu

- The peak bearing period is three months from June, July and August, when the rural people actively involved in collecting neem seeds.
- During the peak months, on an average 15 days to 26 days per month the rural people engaged in neem seed collection.
- The neem seed collectors could be able to collect 4 to 8 kgs of neem fruits/seeds per day.
- The annual income earned by the rural population during the peak season period varies from Rs. 6237/annum in Singampunari to 28 Rs.13100/annum in Pennagaram block.

- It is evident that the rural people engaged 97 days in year for neem seed collection which accounts for 41 per cent to the total number of days employed. However, they could earn only Rs.7468/annum which accounts only around 5 per cent of the total income.
- The analysis confirms that agriculture based households members generally involved in neem seed collection. Hence, these households in the rural areas may be identified and supported for their livelihood.
- It is expressed by most of the neem seed collectors that the collection of neem seeds will be increased by thirty percent with better transport facilities.
- As neem seed collection is a time consuming, laborious and needs good health conditions, support in the form of transportation and health insurance may be ensured.

12.Study on Present Extension System in Tamil Nadu – A Critical analysis

- SWOC analysis among the extension functionaries were organized among Department of Agriculture, Department of Horticulture, Department of Agrl Marketing and Agri Business, Agricultural Engineering and Seed Certification in Salem, Namakkal, Sivaganga, Madurai and Coimbatore districts to find the training needs, officials constraints and their suggestion to overcome the problem in the department.

- SWOC analysis also organized among the department of agricultural marketing and agri business of Trichy and Villupuram districts.

13.Spread And Acceptance of TPS 5 Paddy Variety in Kanyakumari District

- Most of the respondents belonged to old age (60%) and illiterate category (40%). followed by agriculture as a primary occupation (60%).
- Majority of the farmers (63.33 %) had by more than 5 acres of rice cultivation area followed by 2.5 acres – 5.00 acres (23.33 %).
- Meager percents of the respondents adopted (26.66 %) recommended basal and NPK fertilizer application, weed management practice and application of foliar spray.
- More than fifty per cent of the respondents adopted recommended pest control measure for leaf folder and stem borer.
- Cent per cent (100.00 %) of the respondents adopted timely harvest. Eighty per cent of them adopted paddy harvester for harvesting.
- Marketing Behavior
- Gunny bags were used for package material (100%)
- Tempo van used for transport of rice (73%) followed by tractor (26.66%).
- Sold their produce in nearby towns (73.33 %) followed by village itself (20.00%).
- Sold their produce through wholesale merchant (53.33 %) followed by commission agents (26.66%).
- Higher price and immediate payment (73.33 %) as the main criteria for the selection of market
- Suggestions offered
- Training cum demonstration to be given to the farmers on technologies viz., application of soil test based recommended fertilizer
- Creating awareness cum training for usage of pre emergence herbicide application
- Arrangement to supply the quality seed for the farmers in time by officials, Seed Production Department and KVK

14.Assessing the Technological Gap in the cultivation of Major Vegetable Crops in Madurai District

- Majority of the respondents in the study area are using hybrids. The research station yield for hybrid tomato is 38.4 t/ac. The average farmers yield is 32 t/ac.
- The yield gap prevails for the tomato hybrid is 6.4 t/ac. The technology index of tomato is 6.25. The extension gap is 4t/ac.
- With regard to brinjal the research station yield is 32 t/ac and average farmers yield is 22.5 t/ac. Hence the average yield gap I is 9.5 t/ac.
- In the case of Bhendi, the yield gap I come around 3t/ac. The technology index is more in case of brinjal and bhendi (21.87 and 24.0)
- Major technological gaps are due to lack of knowledge to utilize High yielding varieties available, Soil testing and SHC recommendations, application of foliar spray / micronutrient spray/ growth regulators (100.00%) followed by non adoption of IPM Packages (77.77%).
- Improved nutrient-use efficiency, use of organic manures, bio fertilizers, bio-agents, mulching with crop residues, IPM practices, knowledge on pesticide usage, vegetable value addition, education on climate change are the approaches needed for the sustainable production.

15.Identification and documentation of ITKs among the tribes of The Nilgiris.

- The maximum number (4) of ITKs on Agriculture were indentified and documented
- Among the identified ITKs the traditional weedicide was adopted by nearly 85 per cent of the respondents
- The weedicide was prepared with the available weeds available in the field and sprayed to the main crop. The actual plants used and the AI to be explored for scientific validity.
- Perception of the Tribals on Conservation of ITKs was measured in terms of Conservation of seeds of traditional crops, Cultivation of traditional crops Livelihood sustainability through *ITK* conservation, Improvement in standard of living and Government policies
- Educational status, farming experience, decision making behavior and Progressiveness were the factors influencing the attitude of the tribals on documentation and conservation of ITKs.
- Policy implication
- Location specific environmental education modules to be identifies for creating awareness on the importance of ITK and its conservation
- Involvement of farmer's organization, KVK, Zonal Research Stations and SAUs in different strata are important for proper documentation, validation and development of environment friendly, location specific technology and commercialization of ITK

16.Assessment of the Cost and Returns and Marketing of Organic Vegetables in Tamil Nadu

Research Intervention.

- Conserve traditional vegetable varieties seeds
- Take up research on organic vegetables farming for its promotion
- Quality control of organic inputs

Extension Intervention

- Provide training and method demonstration on production of organic inputs for organic vegetable production
- Develop a model village of organic vegetable farming as whole village concept.

Production Intervention

- Provide production subsidy for organic vegetables seeds production and procure the same and sell to other organic vegetable farmers with subsidised rate.
- Provide subsidy for purchase for purchase of livestock or give to organic vegetable farmers at free of cost
- Simplifying certification procedures, reduced cost of certification and encouraging group certification
- Formulate and implement organic farming policy

Processing Intervention

- Develop organic vegetable processing centres at block level in the study areas
- Provide hands-on training on processing and value addition in organic vegetables
- Supply of organic vegetable processing machineries at subsidised rate.

17.Developing Agribusiness Models Linking Farmers Groups and FPOs to Markets through Value Chain Management

- Small and marginal farmers were higher in proportion with the SFAC supported and self-promoted FPCs. On the other hand, the number of medium farmers participation was higher in the self-promoted FPCs.
- FPCs provided the inputs for member farmers at a price lower than the market price. The benefit farmers obtained was the reduction in cost by buying inputs from the FPCs, reducing the role and cot associated with middle men and transportation.
- Poor to Fair Performing FPCs: Credit availability at right time and enhanced income were the driving forces. Loan procedures and risk in repayment were the restraining forces.
- Good and very good performing FPCs: Quality, labelling, product differentiation and brand image were the driving forces. Lack of knowledge on branding by the farmer members and branding cost were the restraining forces.

II National Agricultural Development Project (NADP)

The Centre for Agricultural and Rural Development Studies (CARDS) is the nodal agency for implementing NADP projects in TNAU. The projects with development oriented are being implemented in TNAU. The highlights of the different projects implemented during 2017 to 2020 are presented here.

SALIENT FINDINGS FROM 2016-17 TO 2018-19

1.Mango Research Centre at RRS, Paiyur (2016-17)

- Under the NADP scheme of the Govt. of Tamil Nadu, 'Mango Research Centre' was established with the budget outlay of Rs.200 lakhs at the Regional Research station, Paiyur. The main objectives of the scheme are construction of a training hall and laboratory to conduct training and research activities in mango, production of quality planting materials, to develop units for the demonstration of the latest production technologies viz., HDP, UHDP, Drip irrigation, Grafts production, training, pruning, rejuvenation of old trees, scientific ripening technique and bio intensive plant protection in mango.
- Establishment of Training hall and Laboratory: An amount of Rs.100 lakhs was utilised for the construction of one training hall (340.32 sq.m) and one laboratory (333.21 sq.m) at RRS, Paiyur.
- Laboratory equipments*viz.*,Atomic absorption spectrophotometer Portable Photosynthesis system, Flame photometer, UV Spectrophotometer, N Analyser, Chlorophyll meter, Electronic top pan balance were purchased for an amount of Rs.63 lakhs for carrying out macro and micro nutrient analysis, photosynthetic efficiency and ensuring scientific high tech mango cultivation in farmers field.
- Establishment of MRC Farm unit: An area of 12 acres at RRS, Paiyur was earmarked for carrying out theresearch and development activities in mango. This comprises of Mango germplasm, clonal orchard and nursery, High density planting unit, Ultra high density planting unit, ripening chamber and Field Laboratory.

- A poly house (5000 sq. ft) was constructed with a budget outlay of Rs.3.63 lakhs and is being utilised for the propagation of mango varieties and training to farmers.
- Equipmentsviz.,Telescopic tree pruners (manual and power operated), Mist blower, Chain saw, Fruit harvester were purchased for an amount of Rs.9.08 lakhs and being demonstrated to the farmers through trainings for increasing mango production.
- Activities & Utility: Farmers mela, Trainings, Demonstrations, production of quality grafts in the field of mango are being conducted besides research work.
- Quality planting materials of mango approach grafts of the varieties like Alphonsa, Bangalora, Neelum, Sendura 9357 Nos. were produced in the clonal orchard and distributed to the farmers of Krishnagiri district during 2017 and 3249 Nos. during 2018. A total of 3728 Nos. of Softwood grafts and 12500 Nos. of mango rootstocks were also produced and distributed.

2.Diversified Agricultural Cafeteria with the State of the Art Technologies for Third Generation(2016-17)

The project funding was used for creation of facilities that have strengthened the agricultural models at the College premises. The state of art technologies in housing constructions for different livestock species *viz*., cattle, sheep, goat (Slatted Floor) and poultry with milking machine and power back up is worth mentioning and attracts interested farmers. This has been serving as a platform for giving demonstrations while training the participant groups. However, social impact of such models may be witnessed in the long run as these have been relatively newer to this region. As rearing of cattle is women centered in villages particularly in the category of marginal and small farmers, selection of trainees was done with due recognition for women farmers.

Organic crop cafeteria with millets created under this project gave the visiting participants a realization to know the need for quality and residue free millet production. The real usefulness of millets to perform better with relatively less water availability was the carry home message. Seeds produced under this project viz., paddy, black gram, Cumbu Napier grass(Slips) which were distributed to the farmers was of worth Rs.2.0 lakhs during the year 2019-20. Sale of milk obtained from the 4 milch cattle during the month of March amounted to Rs. 46200/-. Similarly, the value of off springs of sheep and goat was about Rs 1,40,000. From the perception of farmers, milch animal rearing has been a better alternative to crop husbandry as well as the first choice for integration with the crops, because of its daily revenue generation. In the days of increasing consumption of meat among the public, there is a felt need among the interested youth and farmers to go in for sheep/goat rearing along with crop cultivation. Nursery at the College campus was enriched with herbal and medicinal plant species (79 Nos.) and around 90 different forest tree species were assembled for the purpose of study, identification and species preservation. High value tree species were also assembled for preservation and economic value.

The farmers particularly the trainees of Chennalpatti village stated that recycling their own farm waste for production of vermicompost was found to be a better alternate to use of chemical fertilizers. This reduces the cost of chemical fertilizers, improves soil nutrient status thus would sustain soil nutrient content. Similarly, the participants in the training conducted for Azolla production technologies started recognizing the usefulness of the same as bio-fertilizers.

There is scope that the farmers and other stakeholders have been benefitted and will be benefitted with the demo units, agro-forestry models, IFS model, Mushroom unit, waste recycling unit, and all state of art technologies for farm mechanization.

3.Construction of Farmers Trainees Hostel at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirapalli(2016-17)

- Fully functional during 2020. Two trainings were conducted. Sofar, 82 beneficiaries used this infrastructure (58 male + 24 female). Revenue generated so far was Rs. 75,000/-

4.Promotion of organic cultivation for quality black pepper production from Kolli Hills of Tamil Nadu(2016-17)

- Supply of quality planting materials resulted in expansion of area under black pepper in Kolli hills (795 ha under black pepper)
- Capacity building through training and demonstration for organic production of black pepper resulted in adoption of improved organic practices, increased use of organic inputs, bio inputs etc. This resulted in increased productivity of organic black pepper.
- Farmers have started practicing hygienic processing methods and are willing to mechanize the processing methods in order to produce clean and quality black pepper and white pepper organically. Previously, the farmers manually separated the black pepper berries from the spikes. Peeler cum washer and spike thresher were supplied and demonstrated to the growers. They were put in use by the other black pepper growers also.
- Farmers have started their own nursery for production of quality planting material.
- Capacity building of the farmers in Kolli hills resulted in sale of organically grown black pepper and value added products.
- Branding of Kolli hills Black pepper:The black pepper produced from Kolli hills have high pungency and good medicinal values. By knowing the importance of black pepper produced from Kolli hills and also farmers get the premium price for their organically produced black pepper at Kolli hills, the branding for the product should be needed. For that, the meeting was conducted for "Branding of Kolli hills Black pepper "on 11. 07. 2018.

5.Establishment of Pulses-based inoculants production units for sustainable pulse productivity of Tamil Nadu (2017-18)

- Eight one day trainings were conducted in different districts of TamilNadu in collaboration with the respective KVKs. In each training awareness about seed treatment technology and its importance in plant growth and development were given to 20 farmers.
- The Groundnut, Maize, Ragi and Red gram trials were conducted in the farmer's field especially in rainfed condition . The seed treatment demonstration was conducted in front of farmers and the treated seeds were sown directly in the field. The newly developed bioinoculant formulation for *Rhizobium*, VAM, *Pseudomonas* and Phosphobacteria were used as consortium for seed treatment. Totally 35 trials were conducted in different regions of Tamil Nadu for evaluation and popularization.
- The Groundnut yield variation is high among the districts which ranges from 1200 kg /ha in Villupuram district to 4575 kg/ha in Theni district in the uninoculated fields. The treated fields showed a minimum of 16% yield increase to 34% increase over unionculated control plots (farmers practice). The maximum yield obtained was 6250kg/ha in Cuddalore district (34%) followed by Theni district (5875 kg/ha).
- The field trial shows the bioinoculant treated fields had increased yield over the uninoculated treatments (farmers practice). The average maize yield ranged from 2000kg /ha to 8625 kg/ha in uninoculated control fields whereas in treated fields yield varies from 3500kg/ha to 13000kg/ha. The maximum yield of 13000kg /ha was recorded in Pollachi taluk of Coimbatore district which is 36.5% increase over the farmers practice. On an average the percentage of yield increase varies from 17% in Coimbatore and Salem district to a maximum of 43% in Sivagangai district. The variation in the yield may be due to variation in climatic condition and nature of soil.
- In redgram two trails were conducted in Dharmapuri and Pudukottai district. The inoculated trials had better yield response than the farmers practice. The yield increase was 18 % and 15% respectively with maximum yield of 675kg/ha was harvested in Vamban, Pudukottai district.
- One trial was initiated at Thalavaditaluk of Erode district. The crop response studies showed 19% increase in ragi grain yield in treated field when compared to control (625kg/ha).
- Based on the FLD results the recommendation for maize, groundnut, ragi and redgram the concentrated cells 25g ha^{-1} (10^{12}cfu g^{-1} of carrier) of *Azotobacter*, *Rhizobium*, VAM and *Pseudomonas* can be recommended along with 25ml of biosticker / biopolymer.

6.Establishment of Pilot Water Soluble Fertilizer Production Units for facilitating farmers for stage wise crop nutrition(2017-18)

- Construction of Housing Structure and steel truss structure has been completed.
- Purchase of machineries following TNAU tender norms has been completed.
- Installations of machineries are in progress.
- Coordination cell for inventory, monitoring and marketing of product to farmer's at all three centres will be established.
- Skill development Training to Farm science graduates will be conducted.

7.Remote sensing based information for crop coverage, yield estimation, and drought monitoring(2017-18)

- Rice, Maize and cotton area maps, Seasonality and yield maps
- Maps and Statistics for drought indices *viz.,* SPI, NDVI, NDWI and MAI ensuring drought preparedness in Tamil Nadu.
- GAJA cyclone damage assessment on coconut plantation was done during 2018 using drones and satellite imageries.
- Identified villages under Prevented/Failed Sowing/total crop failure for crop insurances.
- No. of Farmers benefitted :537598; Claim Settled: Rs. 2340.84 Cr.; Remote Sensing analysis for dispute resolution helped in getting payouts of Rs. 422 Cr during 2017-18 in Ramanathapuram district

8. Popularization of MGR 100 Rice in Tamil Nadu (2018-19)

- As per the programme, all the 100 demonstrations and 10 field days were completed. The average processed seed yield obtained in these front line demonstration was 4600 kg/ha, and the minimum and maximum seed yield was 4130 and 5870 kg/ha respectively.
- Awareness on new rice variety MGR 100 (CO 52) which is an alternate variety for BPT 5204 and I.W.Ponni has been created among the farmers.
- Farmers are slowly shifting their choice of cultivating MGR 100 Rice variety in the place of BPT 5204 for samba cultivation.
- Production of 289.5 mt quality seeds under this project has resulted in area coverage of 9600 ha under MGR 100 rice variety.
- Now farmers are demanding for MGR 100 seeds. Seed growers also giving importance to produce foundation and certified seeds by indenting breeder seeds from TNAU.
- From the seed production, total quantities of 289.5 mt of seeds were procured from the farmers in which 205.62 mt were distributed so far to 6854 farmers for commercial cultivation. In addition, seed production in 10 ha is also planned during Rabi (Samba) 2019 and these seeds will also be distributed for commercial cultivation.

9.Demonstration on Quality Seed Production and Arresting Seed Deterioration during Storage in Groundnut"(2018-19)

- The project has been implemented in four districts of Tamil Nadu *viz.,* Villupuram, Cuddalore, Salem and Namakkal by the TNAU research stations *viz.,* ORS, Tindivanam, RRS, Vridhachalam, TCRS, Yethapur. Under this project, 150 demonstrations on quality seed production technologies for groundnut were conducted in the selected farmers' fields.

- 37 demonstrations & 40 trainings were conducted; 5000 Groundnut production manuals were prepared and distributed. 40 tons of quality seed was produced and made available to the farmers under this project. Production potential of improved varieties TMV 13 and VRI 6 and key technologies were demonstrated
- Groundnut pods stored in super bag without calcium chloride or stored in gunny bag with calcium chloride @ 250 gram for 30 kg of groundnut pods maintained the required germination standard upto 6 months. This technology will help to preserve the viability until next planting season.

10.Restoration of Agriculture in Prosopis cleared farm lands through Agri-Silvi-Pasture system for rainfed farmers of Ramanathapuram District (2018-19)

- Guava (var. Lucknow-49) layers, Sapota (var. PKM-1), Amla var. NA-7 grafts, which are being comes up very well in the dry tracts have been distributed to the identified beneficiaries.
- Multi cut Fodder Sorghum var. CO(FS)29 seed to satisfy the fodder requirement for the goat and cattle maintained by the farmers and PPFM for drought mitigation have also been distributed to the identified beneficiaries.
- About 108 numbers of trainings on proven dryland technologies have been given to 5390 farmers from 10 blocks of Ramanathapuram District.
- As an impact of demonstrations and trainings, farmers are clearing their lands by removing Prosopis and starting to plant seedlings of dryland fruit trees and cultivating millets, fodders and intercrops like pulses by utilizing stored farm pond water in a large scale as recommended by both the main and sub-centres.
- More numbers of farmers are following techniques like seed hardening, cultivating drought tolerant varieties and PPFM spray to mitigate the drought. Soil breeding (tank silt application, in situ incorporation of green manures and use of bio-inoculants) is being adopted by the rainfed farmers throughout the district.

11.Promotion of Advanced Technologies to the flower growers of Kanyakumari District"(2018-19)

- 5000 numbers of cuttings of jasmine and tuberose were supplied to the growers.
- Training and supply of *Dendrobium orchid* (500 numbers) were given to the schedule tribes of khodhayar region of Kanyakumari district.
- Pruning technology in jasmine was advocated in the farmers field of Th.Nagarajan, Thovalai region.
- *Jasminumnitidum* cuttings were supplied to Th.Murugan of Kolikottupothai.
- Quality planting materials (corms) of Tuberose / Prajwal was supplied to flower growers around Thovalai block of Kanyakumari district.

Dr. J. Venkata Pirabu
Director, Planning and Monitoring,
TNAU, Coimbatore

Achievements in TANII

- The Directorate was established in the year 2003.
- Processes new action research scheme proposals for receiving funds for infrastructure development from the Government and takes steps for facilitating implementation of various schemes.
- Involved in consolidation and reporting the monthly progress of various schemes funded by the GoI. Preparation of Hon'ble Governor's address, Budget Speech, Citizen's charter, Policy Note, Submission and follow up action on Government announcements
- The Planning and Monitoring Directorate strives to compile differential data for the need based institutions/ Government on demand highlighting the entire university accomplishment/achievements/contribution in Teaching, Research and extension.
- To infuse confidence and to enhance research project, the **Tamil Nadu Innovation Initiative projects (TANII**) have been processed and mobilized funds to the tune of 47.02 crores for upscaling, marketing and policy formulations.
- To enrich the professionalism and to heighten the intellect of the Teaching fraternity, **Faculty Development Cell** was launched with slew of trainings on the ethical standards, quality teaching, augmented learning, ICT based teaching, quality research, intellectual writing etc.,
- To promote the quality consciousness and for the holistic development, the **Internal Quality Assurance Cell (IQAC)** has been launched and the activities like guest lecture/ workshops were planned.
- To promote the tribal welfare and development in order to sustain the natural resources and contribution to biodiversity, the **Special Area Development Programme (SADP)** funded by SPC was proposed and obtained 60.40 lakhs.
- Ranking of the university, to rope in admission secure more funds/ hall mark achievements/ for which ICAR / NIRF / THE /QS Asia /QS India by the institutions and it projects the performance by the institution.
- To enlighten the achievements awards determine the benchmark and performances, for which the FICCI / Mahindra Samridhi awards are applied regularly and the awards are secured in the year 2016 for Overall Excellence in FICCI and secured cash award from Mahindra groups as Krishi Shisti Samman Award.

2017-18

1. Establishment of Infrastructures to develop Nutritionally Enhanced Premium Quality and Stress Resilient Rice Varieties for Tamil Nadu

Objectives

- To develop superior rice varieties with high micronutrients, protein with low glycemic index.
- To develop rice varieties with superior milling properties along with resistance to major pests and diseases prevalent in Tamil Nadu.
- To characterize traditional rice varieties for biochemical properties associated with their therapeutic values.
- To create a world class laboratory for pursuing breeding programmes that require nutritional, cooking and eating quality assessments through grain analysis.

Outcome

Theme 1: Development of Nutrition rich rice varieties

- The germplasm was screened for high Zinc and Iron content. Accordingly, the landraces Varisuriyan , Mallampunjan and Kavuni were identified as donors for Zinc, Iron and Protein respectively
- Karuppu kavuni and Mallampunjan were crossed with CO 51.The F2 populations were raised. Plants advanced as SSD method.
- 113 native landraces were collected and raised for documentation of phenotypic and nutritional traits.
- The landrace collection of TRRI were assessed for amylose (Juliano method), Zinc and Iron (XRF method)

Theme 2. Development of Super fine Rice Vareity with improved resistance to major pest and diseases

- A high yield culture AD 13253 which is a derivative of AD 01246 / CO 49 maturing in 134 days has been found to have a grain length of 6.2 mm and breadth of 3.1mm.
- The LER is 1.40 and BER is 0.90 after cooking. It has recorded 11.5 % higher yield than ADT 49 in station trials and hence, nominated in the MLT 2018.

Disease screening

Blast:

The advanced cultures have been sent to Gudalur. for blast screening during 2017-18. Out of 27 cultures evaluated. Three cultures viz., AD 09493, AD 12173 and AD 12191 were found resistant to blast with a score of 1.

Bacterial Leaf Blight:

Eleven resistant cultures possessing different resistant alleles viz., Improved Samba Mahsuri, PR 114, Xa 33, Xa 23, HWR 23 and other IRBB lines have been screened artificially using leaf clip method. The genotypes IRBL 29, Xa 33 and ISM had shown resistant reaction with very low lesion length. Crosses were effected using this donor lines.

Details of Up scaling

Popularization of the new enriched cultures / variety among farmers and traders

- Identification of new enriched cultures is under progress.
- A field was organized on 06.01.2020 with 35 progressive farmers for participatory varietal selection of the newly developed enriched cultures.

2. Production and supply of quality vegetable seedlings of major vegetable crops – An innovative approach

Objective

1. To produce the quality vegetable grafts through robotics and faster production
2. To produce and supply quality vegetable seedlings
3. To serve as a training cum demonstration unit to entrepreneurs

Outcome

Production of grafts details

S.No	Crop	Production	Revenue (Rs.)
I	**Grafted Brinjal (A)**		
1	2017-18	6006	30030
2	2018 -19	23179	108395
	Sub total	**29185**	**138425**
II	**Vegetable seedlings (B)**		
1	2018-19	4,443	2,741
	Sub total	**4443**	**2741**
III	**Protray filling charges (C)**		
1	2018-19	25342 trays	1,52,052
	Sub total		**152052**
IV	**Delivery charges (D) 2018-19**		
	Income from delivery charges	4680 kms	37,440
	Sub total		**37440**
	Grand Total (A+B+C+D)		**330658**

From 1.4.2019 onwards, the scheme was merged into the scheme Seed Production in vegetable crops on contract basis and production of vegetable seedlings and grafts under ICAR Revolving fund.

Production and Revenue generated (2019-2020)

S.No	Crop	Production (Nos.)	Revenue (Rs.)
1.	Grafted Brinjal (A)	78564	566123
2.	Vegetable seedlings (B)	30050	18030
3.	Protray filling charges (C)	17400	104400
4.	Delivery charges (D)	4832 kms	38656
	Grand Total (A+B+C+D)		**727209**

Demonstration plot at HC&RI, TNAU, Coimbatore

Technology Dissemination at orchard, TNAU, CBE

Details of Upscaling

- Demonstration plot on grafted brinjal was maintained in this department for the benefit of farming community.
- Trainings and demonstrations were given for up scaling the technology
- Regularly news was given to the newspapers for popularizing the technology
- The grafting technology is being popularized to the farming community through the extension activities.
- Large scale demonstration should be carried out in every block level to promote this technology.
- It is being communicated to the state department officials for forecasting the availability of grafts.

Dr. S.D. Sivakumar
Director, Agri Business Development,
TNAU, Coimbatore

The Directorate of Agribusiness Development (DABD) was established in 2007 with the major mandate of supporting startup companies in agriculture and also commercializing the technologies developed by the University. The DABD strives to serve as a one stop solution to all the business needs of agribusiness firms and entrepreneurs who are interested in agriculture and allied activities. DABD encourages students, youth, farmers and women individually or in teams to make use of the services provided by this Directorate to realize their vision in life. People with inclination to innovate, start new agribusinesses, expand existing business could approach DABD for mentoring, support and business services. The journey of innovation and entrepreneurship requires persistence, networking, optimism and purpose. DABD facilitates clients to stay on target, offer handholding and grow with the clients.

Research Highlights (2017-2020)

a). Technologies commercialized

S No	Name of the technology	**Department from which the technology developed**	Name of the Firm	Duration	Tech.Tr. fee (Rs.)	Royalty (%)
2018						
1.	TNAU- Seed Coating Formulation	**Dept. of Seed Science Technology, TNAU, Coimbatore**	M/s. Vriksha Agro ventures, Coimbatore	15.03.2018 to 14.03.2021	10,00,000	**2**
2019						
2.	TNAU-Liquid Bio – Pesticide- *Trichoderma viride*	**Dept. of Plant Pathology, TNAU, Coimbatore**	M/s. HIL (India) Limited	01.02.2019 to 31.01.2020	5,00,000/-	**2**
3.	TNAU-Liquid Bio – Pesticide- *Pseudomonas fluorescens*	**Dept. of Plant Pathology, TNAU, Coimbatore**	M/s. HIL (India) Limited	01.02.2019 to 31.01.2020	5,00,000/-	**2**
4.	TNAU Sweet Flag 6 % EC	**Dept. of Entomology, TNAU, Coimbatore**	M/s. Bhuvicare Private Ltd., Tirunelveli	03.03.2020 to 02.03.2025	25 lakhs (payment of Rs. 5 lakhs each year as upfront fee	**2**

b). Machineries commercialized

S No	Name of the technology	**Department from which the technology developed**	Name of the Firm	Duration	Tech.Tr. fee (Rs.)	Royalty (%)
2017						
1.	TNAU-Millet Dehusker	**Department of Post Harvest Technology Centre, AEC&RI, TNAU, Coimbatore**	**M/s .Perfura Technologies India pvt.ltd**	18.4.2017 to 17.04.2020	**3,00,000**	**2**
2.	TNAU-Dhal mill	**Dept. of Food and Agrl. Process Engg., AEC&RI, TNAU, Coimbatore**	**M/s. Perfura Technologies India Pvt.Ltd**	27.7.2017 to 26.7.2020	**50,000**	**5**
3.	Compost pelletizer	**Dept. of Food and Agrl. Process Engg., AEC&RI, TNAU, Coimbatore**	**M/s Biogen Fertilizers India Pvt. Ltd.**	15.11.2017 to 14.11.2020	**50,000**	**5**
2018						
4.	TNAU – Solar Tunnel Dryer	**Dept. of Bio-energy AEC&RI, TNAU, Coimbatore**	M/s. Focusun Energy Systems	20.11.2018 to 19.11.2021	1,00,000/-	**5**
2019						
5.	Wetland Laser lever	**Dept. of Farm Machinery and power Engineering**	M/s. Farm Implements (India), Pvt. Ltd., Chennai	18.03.2020 to 17.03.2030	2 lakh	**5**

c). Hybrids Commercialized

S. No	Name of the Crop & Hybrids	Department from which the technology developed	Name of the Firm	Duration	Amount (Rs.)	Royalty (%)
1.	Rice- CO 4	Department of Rice, TNAU, Coimbatore.	M/S. Dinkar Seeds Pvt Ltd., Gujarat.	14.09.2017 to 13.09.2022	5,00,000 /-	4
2.	Maize- COH(M) 9	Department of Millets, TNAU, Coimbatore.	M/S. Rasi Seeds Pvt Ltd., Attur, Salem.	27.05.2019 to 26.01.2024	5,00,000 /-	4
3.	Maize- COH(M) 8	Department of Millets, TNAU, Coimbatore.	M/S. Proline Seeds Company (India) Pvt Ltd., New Delhi.	04.09.2019 to 03.09.2024	5,00,000 /-	4

Ms. Bhuvi Care Pvt. Ltd., signing MoU to Commercialize "TNAU SWEETFLAG 6% EC" on 03.03.2020.

MS. Rasi Seeds Pvt. Ltd., Attur, Salem signing MoU to Commercialize "Maize hybrid COH(M) 9" on 04.09.2019

MS. Proline Seeds Company (India) Pvt. Ltd., New Delhi signing MoU to Commercialize "Maize hybrid COH(M) 8" on 04.09.2019

Ms. Farm Implements (India), Pvt. Ltd., Chennai signing MoU to Commercialize "Wetland laser leveler Component" on 18.03.2020. (1)

Dr. M. Jawaharlal,

Director of Extension Education,

TNAU, Coimbatore

The Directorate of Extension Education was started in the year 1972 for the planning and execution of programmes of extension work based on the results of research and work in cooperation with the technical Directorates of the University. The Directorate of Extension Education facilitates and executes the Extension Education activities of the University. The Director of Extension Education is the Member Secretary of the Extension Education Council and formulates and present to Extension Council, policies and programmes of Extension Education activities of the University. This Directorate coordinates with the directorates and departments of the University and provides the developed research findings to various stakeholders. The Directorate of Extension Education activities coordinates the through Department of Training Division, 14 ICAR Krishi Vigyan Kendras of TNAU, Educational Media Centre, e-Extension Centre, Community Radio Station, TNAU Press and through Tamil monthly magazine *Uzhavarin Valarum Velanmai.* This Directorate is responsible for organizing State level Farmers' Day, Large scale demonstrations, Farmers Mela, Exhibitions, Training programmes and Awareness programmes in coordination with the University centers.

Research Highlights (2017-2020)

Role of KVKs in Technology Transfer and Adoption of TNAU Technologies

Krishi Vigyan Kendras (KVKs)

KVKs have been recognized as effective institutional links between Agricultural Research and Extension system in the country. KVKs are one of the effective and well-tested Frontline Extension System, which is exemplary and admired all over the world. At present, KVKs are the Frontier Frontline Extension System at the district level which functions with the mandate of "Technology assessment, refinement and demonstration of technology/products".

Tamil Nadu has a total of 30 KVKs of which 14 KVKs are under the control of TNAU, 4 KVKs under the control of TANUVAS, 2 KVKs with Deemed Universities and the remaining 10 KVKs are under the administrative control of NGOs.

The KVKs in Tamil Nadu are instrumental in transfer of technologies of National Agricultural Research System (NARS) including TNAU technologies and impacted in the adoption of frontier technologies in agriculture and allied sector.

The specific activities of KVKs:

- On-farm testing to identify the location specificity of agricultural technologies under various farming systems.
- Frontline demonstrations to establish its production potentials on the farmers' fields.

- Training of farmers to update their knowledge and skills in modern agricultural technologies, and training of extension personnel to orient them in the frontier areas of technology development.
- To work as resource and knowledge centre of agricultural technology for supporting initiatives of public, private and voluntary sector for improving the agricultural economy of the district.
- In order to create awareness about improved technology, a large number of extension activities will be taken up.
- The seeds and planting materials produced by the KVKs will also be made available to the farmers.
- Identifying the training needs of the farming community and organizing need based short term and long term training programmes for various target groups in the district.
- Developing and organizing non-formal educational programmes by way of field days, diagnostic field visits, farmers fair, radio talk, Farm Science clubs etc. as the follow up information support to training courses.
- Identifying the Farmer Teachers, Agripreneurs, Seed producers and IFS model farmers and recognizing them by using them as para extension professionals in the district.

The KVKs of TNAU are involved in demonstration of TNAU technologies through various interventions. The accomplishments of KVKs are given below:

Accomplishments of KVKs [2017-18 to 2019-20]

1. On Farm Testing [OFT]

On Farm Tastings' are conducted to find out new varieties and technologies emanated from research systems of State and Central Institutes/ stations which are suitable to the district concern. In order to facilitate the transfer and adoption of TNAU technologies a total of 264 OFTs were conducted in an area of 428 ha.

2. Front Line Demonstrations [FLDs]

The KVKs played a significant role in demonstration of varieties/ hybrids, management practices / crop production practices, plant protection technologies, Value addition and post harvest technologies, Agriculture engineering technologies. FLDs are conducted in the farmer's field to assess their performances. The successful technologies of the OFTs will be converted as FLDs. A total of 525 FLDs were organized in an area of 1708 ha directly benefitting 5188 farmers in various districts of Tamil Nadu. The year wise accomplishments of the OFT/ FLD along with lists of technologies disseminated are presented in the table 1 & 2.

3. Skill Teaching by Trainings

To create awareness, knowledge, skill and adoption of TNAU technologies a total of 2707 trainings were organized benefitting 124910 farmers, 528 sponsored training programmes benefitting 20418 farmers. To develop farmers as entrepreneur's 293 Vocational training programmes were organized benefitting 6038 farmers. The year wise accomplishments of the trainings are presented in the Table 1.

4. Exhibitions / mela and other Extension activities

To create awareness and to popularize TNAU technologies, exhibitions, mela, field day, farmer's day and campaigns were organized by KVKs at the District and State level. A total of 1040 programmes were organized benefitting 118687 farmers during the period 2017 to January 2020. Besides, KVKs have organized various Extension activities /programmes for the benefit of farming community in transfer of technology during Farmers day (2017 to 2020), Agri Intex at TNAU, Coimbatore.

Table 1: Accomplishments of TNAU KVKs (2017-2020)

S.No.	Year / Particulars	2017-18	2018-19	2019-20	Total
On Farm Trial					
1	OFT (Nos.)	73	94	97	264
2	OFT (Area in ha)	136.67	124.97	165.74	427.38
3	OFT beneficiaries (Nos.)	429	536	818	1783
Front Line Demonstration					
1	FLD (Nos.)	169	164	192	525
2	FLD (Area in ha)	600.8	597.44	510.34	1708.58
3	FLD beneficiaries (Nos.)	1717	1688	1783	5188
Trainings					
1	On Campus Training (Nos.)	420	393	552	1365
2	No. of farmers	21558	17313	23488	62359
3	Off Campus Training (Nos.)	306	486	550	1342
4	No. of farmers	10791	21189	30571	62551
5	Vocational Training (Nos.)	40	96	157	293
6	No. of farmers	1174	1767	3097	6038
7	Sponsored training (Nos.)	75	162	291	528
8	No. of Beneficiaries (farmers) of sponsored training	3219	4895	12304	20418

Exhibition/Farmers Day/Field day/ Mela					
1	Exhibition/Farmers Day/Field day/ Mela (Nos.)	281	329	430	1040
2	No. of farmers participated	24760	39984	53943	118687

The TNAU Varieties /technologies demonstrated by KVKs for adoption by farmers during the period 2017-2020 are listed below.

Table 2 : **Demonstration of TNAU Varieties/Technologies by KVKs for Adoption**

The varieties demonstrated by KVKs during 2017-20 are given below:

Barnyard millet CO (KV) 2	Rice CO (R) 52, 53, VGD 1, TRY 3	Bottle gourd - PLR 1
Barnyard Millet MDU1	Rice TKM 13	Coriander Co (cr) 4
Bhendi Hybrid COBH 4	Rice ADT 53	Cotton K12 (2018-19)
Black gram- ADT 6	Rice CSR 46	Cowpea VBN 3
Blackgram MDU -1	Gingelly VRI 3	Ragi variety CO 15
Blackgram VBN 6 & Vamban 8	Groundnut VRI 8	Fodder cowpea- CO 9
Lablab (Bush type)-Co(GB)14	Greengram VBN 4 and CO-8	Fodder crop-CoFS-31

Management technologies

- ✓ Fall Army Worm Management
- ✓ IPM in Cotton
- ✓ Management of Rugose White fly