

83rd SCIENTIFIC WORKERS' CONFERENCE 18.8.2017

RESEARCH IN REACH



83rd SCIENTIFIC WORKERS' CONFERENCE

(AGRICULTURE, HORTICULTURE, AGRICULTURAL ENGINEERING, FORESTRY AND SOCIAL SCIENCES)

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RESEARCH HIGHLIGHTS

DIRECTORATE OF RESEARCH
TAMIL NADU AGRICULTURAL UNIVERSITY
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CONTENTS


AGRICULTURE

CROP IMPROVEMENT

VARIETIES RELEASED THROUGH STATE VARIETY RELEASE COMMITTEE

RICE CO 52

CO 52 is a derivative of the cross, BPT 5204/CO(R) 50. It matures in 130 – 135 days. The new rice variety is with medium tall stature has efficient tillering capacity, long droopy panicles with a highly acceptable plant characters and is a good replacement for the rice variety BPT 5204 due to its high grain yield, superior grain quality. The variety recorded a mean grain yield of 6191 kg/ha with 11.29 per cent increase over BPT 5204 and is moderately resistant to plant and leaf hoppers, blast, sheath rot, brown spot and sheath blight. It produces medium slender white rice with intermediate amylose, soft gel consistency and moderate gelatinization temperature.

BARNYARD MILLET MDU 1

MDU 1 is a pure line selection of barnyard millet identified from Arupukkottai region. It is high yielder due to its high tillering capacity. It matures in 95-100 days and is suitable for *kharif, rabi* and summer seasons of Tamil Nadu. The average grain yield under irrigated condition is 2284 kg/ha which is 30% more over CO(Kv)2. Under rainfed conditions the grain

yield ranges 1500-1700 kg/ha. Fodder yield ranges from 3000-3300 kg/ha. The grains are yellowish grey in colour with good nutritional quality. The milling per cent is 70%. The variety is resistant to shoot fly, stem borer and smut.

REDGRAM CO 8

CO 8 Redgram variety is a hybrid derivative from the cross combination APK 1/LRG 41. It matures is 170-180 days and gives a yield of 1800 kg/ha under irrigated condition and 1600 kg/ha under rainfed conditions. It is superior to the existing varieties *viz*. CO 6 and VBN 2. The seeds are bold with 23.0% protein content. The variety is resistant to sterility mosaic virus (SMV) and root rot and moderately resistant to *Helicoverpaarmigera and Maruca.*

BLACKGRAM ADT 6

ADT 6 blackgram, a variety released for rice fallow conditions, is a cross derivative of VBN 1/VBN 04-006. It matures in 65-70 days by giving an average yield of 741 kg/ha, which is 13.8 per cent increased yield over ADT 3 (651 kg/ha). The culture possesses moderate resistance to

Mungbean Yellow Mosaic Virus (MYMV), leaf crinkle and powdery mildew diseases. The seed protein and arabinose contents are 21.6% and 5.7% respectively.

BLACKGRAM KKM 1

KKM 1 blackgram is another variety released for rice fallow conditions of Tamil Nadu. The variety having the parentage of COBG 643/VBN 3 gives an average yield of 607 kg/ha, which is 14.5 per cent increased yield over ADT 3 (530). It matures in 65- 70 days. The variety is moderately resistant to Mungbean Yellow Mosaic Virus (MYMV), powdery mildew disease and pod borer. It is resistant to root knot nematode (*Meloidogyne javanica*). The arabinose content in the seed is 6.7%.

SESAME VRI 3

VRI 3 is a hybrid derivative of SVPR 1/TKG 87 cross. The high yielding bold white seeded sesame matures in 75-80 days. The average yields are 995 and 1055 kg/ha under *rabi* and summer.

CASTOR YRCH 2

YRCH 2, the new castor hybrid having the parentage ofM 619 -1/SKI 215 gives an average yield of 2089 kg/ha, which is 18.4% more than the yield of YRCH 1. The seed oil content is 49.0%. The new hybrid is red stemmed and semispiny and comes under the triple bloom category. The plant type is non-lodging with basal branching and non-shattering capsules. The hybrid is specifically known for high proportion of female flowers more than 95 percent. The hybrid is meant for sole crop and is also suitable for intercrop cultivation. The hybrid YRCH 1116 is resistant to wilt. It is tolerant to insect pests *viz*. semilooper, spodoptera, leafhopper and capsule borer.

COTTON K 12

K 12, a new *Karunganni* cotton(*Gossypium arboreum*) is a hybrid derivative of K 11/K 9. This variety is released for the rainfed vertisol tracts of Tamil Nadu. The variety is drought tolerant with superior medium staple cotton and gives an average seed cotton yield of 1193

kg/ha as against 1066 kg/ha of K 11. The variety has higher boll weight (2.7 g) and superior fibre quality.

SUGARCANE CoC 25

CoC 25 sugarcane is the derivative of Co 85002/HR 83-144. It gives a cane yield of 153.65 t/ha, which was 12.20 % increase in over the check CoC (Sc) 24. The sugar yield of the variety is 19.54 t/ha with 12.85 % commercial cane sugar (CCS). The plant type is tall with good ratooning ability. The variety is moderately resistant to red rot.

CULTURES IN PIPELINE FOR RELEASE

RICE: AD 09367

AD 09367 is the hybrid derivative of BPT5204 and Improved White ponni developed by the Tamil Nadu Rice Research Institute with duration of 158 days and medium slender grains. The average yield of AD 09367 was 6720 kg/ha across 112 locations. This culture was found to be resistant to blast and bacterial leaf blight and moderately resistant to stem borer, leaf

folder, brown plant hopper, white backed plant hopper and sheath blight based on the screening under controlled conditions.

Table 1. Performance of AD 09367 from 2009 to 2016

Name of the Trial	No. of Locations	Grain yield (kg/ha)			Duration (days)		
		AD 09367	CR 1009	ADT 50	AD 09367	CR 1009	ADT 50
On-Station trial (2009 - 2012)	7	6796	5897	5923	153	152	148
MLT (2012-2014)	9	7242	6778	6609	152	154	148
ART (2014-2015)	47	6449	6337	6055	146	150	146
ART under DoA (2015-2016)	30	6434	5991	5395	148	149	148
ART under KVK (2014 -2016)	24	6206	5713	5741	152	157	148
OFT (2014 -2016)	70	6773	5673	-	160	158	-
Large scale demonstrations	4	6933	6156	6118	156	159	146
Overall Mean	191	6690	6077	5974	154	155	147
% increase over the checks			11.1	11.2			

RICE: AD 07073

AD 07073 is a hybrid derivative of ADT 43 and JGL 384 suitable for *kuruvai/navarai* seasons with duration of 114 days. It gave an average yield of 6110 kg/ha. The culture has field tolerance to brown Spot, blast, sheath rot, sheath blight and white backed planthopper.

Table 2. Performance of AD 07073 from 2009 to 2015

Name of the Trial	No. of Locations	Grain yield (kg/ha)		
		AD 07 073	ADT 43	CO 51
On-Station trial(2009 - 2012)	4	5812	4839	-
MLT (2013)	12	5758	5179	-
ART (2013-2015)	130	6090	5916	5946
OFT 2015	10	6780	5817	5932
Overall Mean	156	6110	5438	5939
% increase over the checks			16.5	8.4

CUMBU: TNBH 08804

TNBH 08804 is hybrid between ICMA 99555 and PT 6067 having a duration of 85-90 days. It is with Compact earhead having bold and grey coloured grains. It is resistant to downy mildew and rust diseases. It has an yield advantage of 15-20 % over the existing hybrids CO 9 and NBH 1717.

Table 3. Performance of TNBH 08804

Trials	No. of trials	TNBH 08804	CO 9 Hybrid	NBH 1717
Station Trials	3	5495	4677	4478
MLT	20	3729	3400	3423
OFT	30	4147	3538	3353
ART	69	2118	1899	1891
Total / Mean	122	3872	3379	3286
% increase over			14.6	17.8

BLACKGRAM: COBG 10-05

COBG 10-05 is a cross derivative of VBN 5 and *Vigna mungo* var. *silvestris* with a duration of 60-65 days. The average yield of the culture is 877 kg/ha which is 10.20 and 12 percent increased yield over the check varieties CO 6 and VBN 6, respectively. The culture is resistant to yellow mosaic virus (YMV).

Table 4. Performance of COBG 10-05

Trials	No. of locations	Grain yield (kg/ha)		
		COBG 10-05	CO 6	VBN 6
Station trials	6	997	872	-
MLT (*Kharif*)	7	790	716	883
MLT (*Rabi*)	4	709	718	622
ART	125	850	799	796
OFT	20	1105	839	957
Weighted Mean	162	880	800	785
% increase over checks			10.0	12.1

COWPEA: VCP 09 – 013

VCP 09 - 013 is a cross derivative of TLS 38 and VCP 16-1. The average yield is 915 kg/ha which is 11.72 percent increase over CO (CP) 7 and 12.68 percent over VBN 1. The duration is

70-75 days. It is bold and brown seeded with determinate plant type with synchronized maturity.

Table 5. Performance of VCP 09 – 013

Trials	No. of locations	Yield (kg/ha)		
		VCP 09-013	Vamban 1	CO (CP) 7
Station	3	1758	978	1313
MLT	9	919	-	848
ART	121	963	836	837
OFT	16	1392	1094	1072
Weighted Mean	149	1022	869	873
% increase over checks			17.6	17.0

SUGARCANE: G 2005 -019

G 2005-019 is a hybrid derivative of HR 83-144 X CoH 119. It gives a cane yield of 131.1 t/ha and sugar yield of 17.09t/ha. It is non-lodging and moderately resistant to red rot disease. It is suitable for jaggery production.

Table 6. Performance of G 2005 019 in ART 2012-2014 seasons in Sugar Mills of Tamil Nadu

Clone/ Standard	Plant Crop			Ratoon Crop		
	Cane yield t/ha	CCS %	Sugar yield t/ha	Cane yield t/ha	CCS %	Sugar yield t/ha
G 2005 019	138.91	13.09	18.14	129.39	13.15	16.98
Co 86032	118.27	13.00	15.38	109.56	12.75	13.97
CoC 24	123.49	12.61	15.57	116.00	12.59	14.57
% increase over Co 86032	17.45	0.65	17.95	18.10	3.12	21.51
% increase over CoC 24	12.48	3.77	16.51	11.55	4.43	16.53

Table 7. Performance of G 2005 019 in OFT 2014-2016 seasons in salt affected soils

Variety/ clone	Plant Crop				Ratoon Crop			
	Cane yield t/ha	CCS %	Sugar yield t/ha	Jaggery yield t/ha	Cane yield t/ha	CCS %	Sugar yield t/ha	Jaggery yield t/ha
G 2005 019	131.74	13.05	17.19	14.49	120.21	13.01	15.64	13.28
Co 86032	98.98	12.85	12.72	10.24	91.68	12.82	11.76	9.52
Co G 94077	94.63	12.81	12.12	9.70	89.44	12.80	11.44	9.21
Co G 95076	96.42	12.50	12.05	9.88	93.25	12.35	11.51	9.55
% increase over Co 86032	33.09	1.56	35.14	41.50	31.12	1.48	32.99	39.49
% increase over CoG 94077	39.22	1.87	41.83	49.38	34.40	1.64	36.71	44.19
% increase over Co G 95076	36.63	4.44	42.66	46.66	28.91	5.34	35.88	39.06

PROMISING CULTURES UNDER ON-FARM TRIALS

The performance of the following cultures of different duration groups will be assessed under large scale on-farm trials in farmers' holding during 2017-2018.

Table 8. Performance of promising cultures under ART

Culture	Locations	Duration (Days)	Yield (kg/ha)	Special feature
AD Bio 09518	81	114	5704	Resistant to BLB Marker Assisted Breeding
AD 09219	82	112	5718	High Zinc and Iron Content
TM 10085	73	110	6249	Erect plant type
TM 09132	52	115	3586	Suitable for rainfed conditions
TR 05 031	84	135	5714	Suitable for saline soils

AD Bio 09518


AD 09219


TM 10085 TM 09132

CULTURES UNDER EVALUATION IN ADAPTIVE RESEARCH TRIALS

RICE

Culture name	Parentage	Duration (days)	Yield (kg/ha)	Special feature
Cultures already under ART				
AD 09219	ADT 45/ACK 03002	115	6147	Good cooking quality
CB 10553	BPT 5204/CB 05501	119	6099	Long slender grains
CB 11107	BPT 5204/CO 50	137	5188	moderate cooking quality
CB 12588	CB 04110/CB 05501	118	5955	Resistant to blast disease
TM 09135	Selection from IR82639-B-B-115-1	118	3848	Rainfed cultivation
TM 10085	ADT 43/CO 47	118	5961	Resistant to blast disease
TR 05031	ADT 39 /CO 45	135	5433	Salt tolerant
TR 09030	Mutant of TRY 2	108	3842	Salt tolerant
VG 09006	ADT43/*Jeeraga samba*	127	4695	Short slender grain
TNTRH 40	TNAU 95 S/CB40	135	6321	Bold grains
CB MAS 14065	I.whiteponni/Apo	132	4968	Short slender grains
CB MAS 14142	I.whiteponni/Apo	128	4695	Long slender grains
I.white ponni *Saltol*	(I.whiteponni/ FL478)/I.whiteponni	131	4108	Salt tolerance
Cultures proposed for ART during 2017-2018				
AD 12132	ADT 39/Konark	125	5608	Moderately resistant to blast
TP 08053	ADT 36/ ADT 42	125	5464	Moderately resistant to blast
AD 13116	CR 1009/ADT 49	145	6032	Resistant to RTD

SORGHUM

Culture name	Parentage	Duration (days)	Yield (kg/ha)	Special feature
Cultures proposed for ART during 2017-2018				
TNS 648	APK 1/M 35-1	100	2305	Dual purpose
TKSV 1036	ICSB 518/SPV 1489	100	2102	Dual purpose
TNFS 213	CO 26/M 35-1	60	27 t/ha	Fodder purpose

CUMBU

Culture name	Parentage	Duration (days)	Yield (kg/ha)	Special feature
Cultures already under ART				
TNBH 08804	ICMA 9955/ PT6067	87	2415	Downy mildew resistance
TNBH 10885	ICMA 92777/ PT 6069	92	2605	Downy mildew resistance
Cultures proposed for ART during 2017-2018				
TNBH 121235	ICMA 01666x PT6303	92	2676	Downy mildew resistance

RAGI

Culture name	Parentage	Duration (days)	Yield (kg/ha)	Special feature
Cultures proposed for ART during 2017-2018				
TNEc 1281	Sel. from TNAU 900	109	2128	Uniform maturity
TNEc 1285	TNAU 900/CO (Ra) 14	110	2256	Bold grains

SAMAI

Culture name	Parentage	Duration (days)	Yield (kg/ha)	Special feature
Cultures proposed for ART during 2017-2018				
TN Psu 176	CO(Samai) 4/IPM 113	-	1205	Drought tolerant
TN Psu 177	CO(Samai) 4/TNAU141	-	1323	Bold grains

REDGRAM

Culture name	Parentage	Duration (days)	Yield (kg/ha)	Special feature
Cultures already under ART				
CRG 10-12	Co (Rg) 7/BSMR 853	180	1880	Resistant to sterility mosaic disease and indeterminate

BLACKGRAM

Culture name	Parentage	Duration (days)	Yield (kg/ha)	Special feature
Cultures already under ART				
COBG 11-02	VBN 4/*V. mungo* var *silvestris*	65	748	Resistant to YMV
VBG10-010	VBN 2/VBG 04-003	65	1095	Resistant to YMV
VBG 11 – 016	VBN 3/VBG 04-001	69	1137	Resistant to YMV

GREENGRAM

Culture name	Parentage	Duration (days)	Yield (kg/ha)	Special feature
Cultures already under ART				
VGG 05-009	VBN(Gg)2/VRM(Gg)1	75	882	Moderately resistant to YMV
Cultures proposed for ART during 2017-2018				
VGG 10 - 008	PDM 139 x BB 2664	75	961	Moderately resistant to YMV

COWPEA

Culture name	Parentage	Duration (days)	Yield (kg/ha)	Special feature
Cultures already under ART				
VCP 09 – 019	TY 860/CO(CP) 7	75	1370	Moderately resistant to YMV

GROUNDNUT

Culture name	Parentage	Duration (days)	Yield (kg/ha)	Special feature
Cultures already under ART				
ICGV 06146	ICGV 92069/ICGV 93184)/ICGV 96246/92 R/75	110	2040	Spanish bunch type
ICGV 07245	ICGV 92069/ICGV93184)/ SIL 4/(ICGS44/ICGS 763	120	2170	Virginia bunch type
ICGV 07247	ICGV 92069/ICGV 93184)/SIL 4/(ICGS 44/ICGS 763)	120	2133	Virginia bunch type
TVG 0856	VRI 6/R 2001-2	103	2130	Spanish bunch type
ICGV 07222	ICGV 92069/ICGV 93184)SIL 4/(ICGS 44 x ICGS 76)	115	2028	Spanish bunch type
BSG 0912	VRI 2 x TVG 0004	105-110	2670	Spanish bunch type

SUNFLOWER

Culture name	Parentage	Duration (days)	Yield (kg/ha)	Special feature
Cultures already under ART				
CSFH 12205	COSF 6A/IR 6	90	2010	High seed yield and high oil content.

COTTON

Culture name	Parentage	Seed cotton yield (kg/ha)	Duration (days)	Span length (mm)	Bundle strength (g/tex)	Special features
TCH 1819	Khandwa 2/ LH 2220	2310	135	27.3	19.7	High yield, compact genotypes suitable for HDPS
TCH 1822	Khandwa 2/ African I-2	2331	135	27.5	19.5	High yield, compact genotypes suitable for HDPS
TKH 1185/I/3	KC3/ NDLH 1938	1159	140	26.7	21.8	Drought and leaf hopper tolerant
TSH 0533	Surabhi/ H 99	1967	150	30.0	23.4	Leaf hopper tolerant

SUGARCANE

Culture name	Parentage	Cane Yield (t/ha)	CCS (%)	Sugar Yield (t/ha)	Special Features
		Early			
C 29 090	Co 85002/Co 775	135.50	12.92	17.50	High yielder, MR to red rot and borers
C 29 229	81 V 48 GC	127.10	13.05	16.60	MR to red rot and borers.
Si 08 005	CoSi (Sc) 6 GC	134.70	12.90	17.40	Suitable for water logged condition.
G 07 017	Co 8371/Co 1148	132.85	12.85	16.90	Suitable for jaggery making
		Mid late			
C 29442	Co 86032 GC	134.00	12.91	17.30	MR to red rot & Non lodging type
Si 08 006	CoG 93076 GC	132.00	12.87	17.00	MR red rot
G 07 023	Co 8371/Co 1148	132.50	12.90	17.10	MR red rot disease.

BREEDER SEED PRODUCTION AND DISTRIBUTION DURING 2016-17 (in kgs)

Crop	Indented Quantity 2015-16				Distribution of breeder seeds			
	State	GOI	Private	Total	State	GOI	Private	Total
Paddy	18780	2670	81053	102503	21060	2670	81053	104783
Millets	896	158	300	1354	962	158	300	1420
Pulses	9726	510	2956	13192	7983	510	2956	11449
Oilseeds	52288	0	62	52350	54078	0	62	54140
Cotton	30	0	52	82	2	0	52	54
Forage Crops	0	200	0	200	0	200	0	200
Vegetable Crops	0	6	40	47	1	6	40	48
Total	81720	3544	84464	169728	84086	3544	84464	172094

BREEDER SEED PRODUCTION PLAN FOR THE YEAR 2017-18 (in kgs)

Crop	State	GOI	Seed Hub	Private	Total
Paddy	11500	3405	0	114590	129495
Millets	1622	261	0	60	1943
Pulses	8220	1930	646	10644	21440
Oilseeds	28700	5500	0	190	34390
Cotton	40	4	0	110	154
Forage Crops	0	866	0	0	866
Vegetable Crops	0	0	0	18	18
Total	50082	11966	646	125612	188306

NEW INITIATIVES

REVITALIZATION OF MILLETS FOR NUTRITIONAL SECURITY AND ENHANCED PRODUCTIVITY

The State Planning Commission has sanctioned a new scheme entitled Revitalization of millets for nutritional security and enhanced productivity during 2016 under Tamil Nadu

Innovation Initiatives (TANII), with a budget of Rs 187.80 lakhs for three years. The principal objective in the promotion of millet cultivation and utilization in Tamil Nadu by exploiting the already evolved high yielding millet varieties through better processing technologies machineries and value addition methods. Formation of millet clusters at block level will be facilitated for sustained millet cultivation in order to have continuous supply of millets to the entrepreneurs/ consumers.

ENHANCING COTTON PRODUCTION

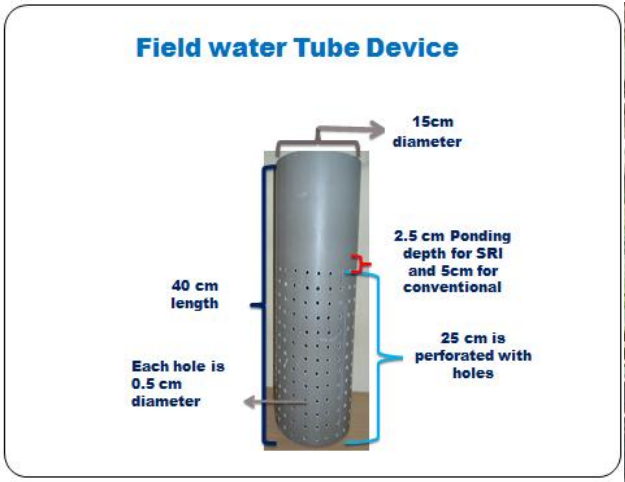
Under the ongoing scheme sanctioned by the Tamil Nadu Cotton Cultivation Mission during 2014-2015, compact plant types suitable for High Density Planting System are being evaluated. TCH 1819, one of the promising cotton genotypes is being evaluated under rice fallow situation in Cauvery Delta Zone.

An experiment to arrive at a holistic package for the High Density Planting System suitable culture TCH 1819 is initiated. Evaluation of mechanized cotton cultivation from seed to seed is also in progress.

CROP MANAGEMENT

Alternate Wetting and Drying (AWD) in irrigated rice

Alternate Wetting and Drying (AWD) in irrigated rice, a water saving technology evolved at the International Rice Research Institute (IRRI), reduces water use by 30 %. The technology has been validated across rice growing countries including India.This technology has been integrated with rice cultivation under heavy and light soils**.** When AWDis adopted, water for irrigation is applied, a few days after the disappearance of the ponded water. The number of days of non-flooded soil between irrigations can vary from 1 to more than 10 days depending on the number of factors such as soil type, weather, and crop growth stage. A practical way to implement safe AWD is to monitor the depth of ponded water on the field using a Field Water Tube (FWT) made of PVC with 15 cm diameter and length 40 cm. This tube is perforated with 0.5 cm diameter holes in the bottom 25 cm and the top 15 cm portion is non-perforated. Above the perforated portion, markings are made for 5 cm so that the irrigation at 5cm depth could be done.



One Field Water Tube (FWT) is required for adopting the AWD in an area of 1 acre. The FWT is installed in the field using mallet and it is inserted up to the perforated portion burried inside the soil. The soil inside the tube is to be removed. This FWT may be installed near the field levies so that the water level inside the FWT could be monitored easily.The results of On-Farm Trials (OFT) conducted to validate the AWD across Tamil Nadu for the past six years (2011-2017), indicated that AWD can be a technology for reducing water use in rice cultivation.

Demonstration of Non-puddled Machine Transplanted Rice (NPTR) technology

A large scale demonstration of transplanted rice cultivation without puddling was done at the Tamil Nadu Rice Research Institute. The main objective of this trial was to conserve the water during rice cultivation. The traditionally followed transplanted rice cultivation requires

1200-1400 mm water, of which puddling consumes 250 mm water. In the proposed technology puddling is replaced with dry ploughing (using cultivator and rotator), followed by laser levelling and wetting. The soil is allowed to settle for 12- 24 hours and before transplanting very light irrigation is given again to maintain a uniform depth of 1 cm of standing water.Machine transplanting was adopted in the wetted rice soil. Two long duration entries *viz*. CR1009 and AD 09367 were involved in the experiments conducted at Aduthurai, Thanjavur, Bhavanisagar and Killikulam during 2016- 17. In the experiments conducted with three systems rice cultivation *viz.,* Non-puddled transplanting, Direct sowing and Puddled transplanting. Nutrient and weed management methods were similar to that of puddled transplanted rice. Alternative wetting and drying method was followed for water management. Though there was a yield reduction ranging from rom 0.9 % at Aduthurai to 31% at Thanjavur, under non-puddled transplanting, there was considerable water saving, under non-puddled transplanting *i.e.* from 120 to 245 mm. No significant influence in the crop establishment was observed under non-puddled transplanting. Higher level of water use efficiency (WUE) ranging from 3.74 –4.70 kg ha^{-1} $mm^{-1}$was observed across locations, under non-puddled transplanting during *kuruvai* season. Further improvement in the crop management techniques, for this system of planting is expected to increase the yield level.

Dry ploughing followed by laser leveling

Wetting

Machine transplanting

Non-puddled machine transplanted rice

Efficient weed management in irrigated groundnut

Pre emergence application of pendimethalin @ 1.0 kg /ha on 3 DAS along with tank mix application of imazethapyr @ 37.5 g /ha + quizalofopethyl @ 25 g/ha, as early post emergence on20 DAS are recommended for efficient weed management and for getting higher yield (1950 kg/ha), net return (Rs. 53,632/ ha) and B: C ratio (1.75) in irrigated groundnut.

Optimization of spacing and fertilizer requirement for TCH 1819 under High Density Planting

Adopting a plant spacing of 100 x 10 cm with 125 % of the recommended dose of fertilizers (100:50:50 NPK kg/ha), registered higher seed cotton yield of 1650 kg/ha, with higher net return (Rs.29134 /ha) and B:C ratio (1.60).

Evaluation of drip fertigation in CumbuNapier hybrid grass CO (BN) 5

Adopting paired row drip system in cumbunapier hybrid grass CO (BN) 5, with a spacing of 60/90 cm x 50 cm and application of drip irrigation at 100% PE with N fertigation at 125% RDN recorded higher green fodder yield of 346 t/ha/yr with B:C ratio of 3.47 and water saving of 27.7 % as compared to surface irrigation.

Sprinkler irrigation on different Blackgram varieties under summer irrigated condition

For summer irrigated blackgram, sprinkler irrigation at 100% PE registered water saving of 14.5 % compared to surface irrigation method. Blackgram variety ADT 5 recorded higher grain yield at Aduthurai, Thanjavur and Bhavanisagar centres, whereas at Madurai, variety VBN 6 performed better than ADT 5. At all the centres, water productivity was higher (2.44-2.74 kg/ha/mm) under sprinkler irrigation at 100% PE than surface irrigation method (1.96-2.24kg/ha/mm).

Mechanised semidry rice cultivation and weed management

Sowing of seed by multi crop planter (Happy Seeder) under dry condition @ 40 kg/ha, Application of Pretilachlor@0.45 l/ha on 5 DAS and two machine weeding(power weeder) on 30 and 45 DAS, Alternate Wetting and Drying (AWD) method of irrigation up to the harvest of the crop along with recommended fertiliser dose of 120: 50: 50 NPK kg/ha is important to achieve higher number of productive tillers and number of grains per panicle and highest grain yield of 7.91 t/ha, with a net income of 71746 Rs/ha.

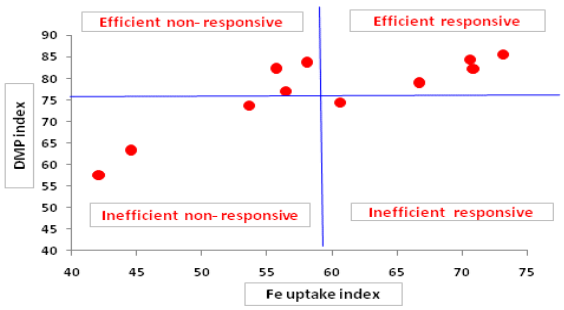
Pre emergence application of pretilachlor 0.45 l/ha on 5 DAS along with two hand weedings (30 and 45 DAS), under continuous submergence with higher seed rate (60 kg / ha), in mechanised semi dry rice cultivation reduced the weed density and dry weight (12 Nos / m^2 and 4.3 g/ m^2) at 60 DAS and increased weed control efficiency (77 %) for getting higher rice yield.

Optimization of split application of nitrogen and potassium for Anna (R) 4 rice variety

For achieving higher yield of Anna (R) 4 rice variety in Ramanathapuram and Sivagangai districts, application of full dose of Phosphorus (25 kg/ha) + 1/4th N (19 kg/ha) and K (9 kg/ha) as basal and top dressing of 3/4th N (56 kg/ha) and K (28 kg/ha) on 25, 45 & 65 DAS in three equal splits is recommended.

Screening and evaluating maize hybrids for lime induced Fe chlorosis in calcareous soils

Genotypic variation for Fe efficiency and resistance to lime induced Fe chlorosis in calcareous soil was studied by conducting a pot culture experiment with five maize hybrids *viz,* CO 6, CO 7, CO 8, CO 9 and CO 10 along with their parents UMI 1200, UMI 1201, UMI1205, UMI 1210, UMI 1220 and UMI 1230. Three different soils having varied intensity of calcareousness were used for growing the genotypes along with two levels of $FeSO_4$ (0 and 50 kg ha^{-1}) upto 40 days and harvested. Dry matter production and growth parameters of the genotypes were recorded, besides testing the soil and plant samples for Fe availability, content and uptake. Increasing soil calcareousness decreased the DMP of all the maize hybrids and their parents and the mean values varied from 2.53 to 39.7 g pot^{-1}. The visual chloratic rating increased with increasing calcareousness leading to poor DMP of all hybrids and parents. The maize hybrids CO 6, CO 8 and CO 7 were highly Fe efficient and responsive to added $FeSO_4$ in calcareous soils, thus indicating their tolerance to lime induced Fe chlorosis. The efficiency was well correlated with photosynthetic efficiency, chlorophyll content, active Fe content and uptake. Among the parents, UMI 1230 and UMI 1220 registered very poor dry matter production in all the three soils and the values varied from 2.53 to 9.84 g pot^{-1}, which indicated their susceptibility to lime induced Fe chlorosis. Further FTIR analysis of root exudates also revealed that, the efficient maize hybrids CO 6, CO 8 and CO 7 have produced more number of functional groups (>10), with more number of peaks and frequency for alkyl halides, carboxylic acid, alkanes, alkenes, nitriles, nitro compounds etc. The inefficient inbreds, UMI 1230 and UMI 1220 produced lesser number of organic functional groups (<6).

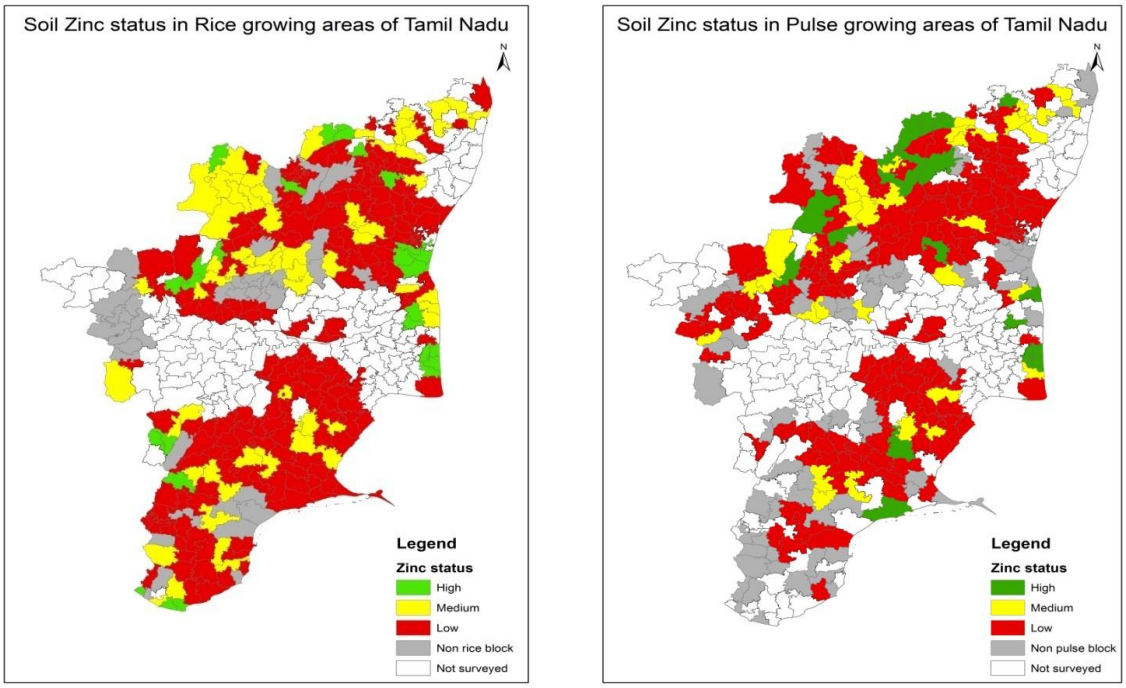


Based on DMP and Fe uptake efficiency (49.2 to 90.5 % and 32.2 to 81.2 % respectively) the maize hybrids CO 6, CO 8, CO 7 and CO 10 were found Fe efficient and responsive while CO 9 was Fe inefficient. The parents UMI 1200, UMI 1201 and UMI 1210 were found Fe efficient, while UMI 1230, UMI 1220 and UMI 1205 were highly Fe inefficient, indicating their susceptibility to lime induced Fe chlorosis.

Mapping of Zn deficiency in rice and pulse growing soils of various districts in Tamil Nadu

Zinc deficiency in rice and pulse growing soils of Tamil Nadu was assessed to prepare thematic maps to depict the extent of Zn deficiency in the rice and pulse growing tracts of Tamil Nadu. The data on DTPA- Zn status in the surface soils samples collected already from 22 districts of Tamil Nadu were utilized for this purpose. The data from rice and pulse growing soils in each district at block level were categorised into low, medium and high based on the critical limit of Zn (< 1.20 ppm = Low; 1.20 to 1.8 ppm – medium ; > 1.8 ppm – High).

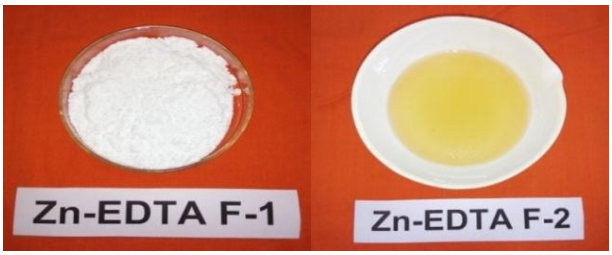
Out of the 36,746 nos. of GPS based soil samples collected from 22 districts, about 13,181 (35.9 per cent) and 7336 (20.3 per cent) soil samples collected were from rice and pulse growing areas respectively. About 61.5 % of the rice growing soils and 64.1% of the pulse growing soils are deficient in Zn. Madurai, Ramnad, Trichy, Tirunelveli and Namakkal districts showed more than 75 % Zn deficiency, while rest of the districts showed 40 to 75 % Zn deficiency.



Thematic map showing Zn deficiency in the rice and pulse growing soils of Tamil Nadu

Development, characterization and evaluation of new chelated zinc and iron formulations for Maize croZinc-EDTA chelates

Two Zn EDTA chelate formulations *viz.,* Zn-EDTA F1 and Zn-EDTA F2 were developed with the Zn Content of 9.4 % and 7.4 % respectively. Preliminary evaluation with maize crop in pot culture revealed that newly developed Zn-EDTA formulations performed well.



Iron citric acid chelates

Four different formulations of Fe-citric acid with Fe content of 12.2, 9.39, 6.14 and 5.45 % were developed. Among the four, in three formulations entire Fe was found to in chelated form (Fe Citric acid B, C and D).

Fertiliser prescription under Integrated Plant Nutrition System (IPNS) for cotton under drip fertigation

Fertiliser prescription equations (FPEs) under IPNS for cotton under drip fertigation were developed for Periyanaickenpalayam soil series (VerticUstropept - mixed black calcareous soils) and the FPEs are furnished below:

Fertiliser Prescription Equations

$$FN = 8.51\ T - 0.47\ SN - 0.73\ ON$$

$$FP_2O_5 = 4.41\ T - 2.25\ SP - 0.75\ OP$$

$$FK_2O = 6.59\ T - 0.18\ SK - 0.66\ OK$$

where, FN, FP_2O_5 and FK_2O are fertiliser N, P_2O_5 and K_2O in kg ha^{-1} respectively; T = seed cotton yield target in q ha^{-1}; SN, SP and SK are available N, P and K in kg ha^{-1} respectively; ON, OP and OK are N, P and K supplied through FYM in kg ha^{-1}.

These equations were validated through five verification trials - one in TNAU farm, Coimbatore (2012-13) and four in farmers' holding of Salem district (2014-16) with hybrid cotton. The increase in seed cotton yield due to STCR-IPNS 4.0 t ha^{-1} over blanket (RDF+FYM@12.5 t ha^{-1}) and farmer's practice was to the tune of 24.8 and 42.4 per cent respectively, besides recording relatively higher mean response ratio (5.06 kg kg^{-1}) and BCR (2.55). During 2016-17, the validated fertiliser prescriptions were verified through two trials in Salem district (Periyanaickenpalayam series) and one in Perambalur district (Peelamedu series), with cotton variety MCU 13. The results of the on farm trials revealed that STCR-IPNS-3 t ha^{-1} under drip fertigation has increased the seed cotton yield upto 21.7 per cent over blanket (RDF+FYM@12.5 t ha^{-1}) with higher BCR (2.07) and soil fertility status.

CROP PROTECTION

RICE

Stem borer and leaf folder

- Among the various rice insect pests, the incidence of stem borer and leaf folder was predominant. Unexpectedly the dark head stem borer, *Chilo polychrysus* is gaining significance along with dominant yellow stem borer, *Scirpophaga incertulas* and pink stem borer, *Sesamia inferens*.
- The role of *Trichogramma japonicum* as a major natural egg parasitoid of yellow stem borer is over ruled by other egg parasitoids, *Tetrastichuss chenobii* followed by *Telenomus remus*.
- The newer compounds flubendiamide 480 SC @ 50ml/ha and rynaxypyr 20 SC @ 150ml/ha were effective in management of leaf folder and stem borer.

False smut

- When, the incidence of false smut disease in rice was correlated with weather parameters,a positive correlation was observed between the incidence of false smut and temperature, RH, Rainfall and wind velocity.
- Foliar spray of difenconazole 25 EC @ 1.0 ml/l, was found to be effective in reducing the false smut incidence.

Bacterial leaf blight

- Seed treatment with *Pseudomonas fluorescens* Pf.1 @ 10 g/kg of seeds + foliar spraying with streptomycin sulphate + tetracycline combination 300 g + copper oxy chloride @ 1.25 kg/ha at 30 and 60 days after transplanting, recorded the least per cent disease incidence of 1.26 (bacterial leaf blight) and 1.08 (bacterial leaf streak), as compared to control, which recorded 7.64 (bacterial leaf blight) and 6.98 (bacterial leaf streak) per cent disease incidence.

Leaf blast

- Application of tricyclazole 20% + tebuconazole 16% SC @ the rate of 2.25ml/l was found to be effective in reducing leaf blast disease (10%), with increased yield (4633 kg/ha) compared to control (29.3%; 3200 kg/ha).

Sheath rot

- Seed bacterization (10 g/kg) + seedling root dip (2.5 kg/ha) + foliar spray (2.5 kg/ha) of endophytes (*Pseudomonas fluorescens*) at milky and boot leaf stages have recorded the minimum sheath rot incidence (12%) and maximum yield (5750 kg/ha) compared to control (24.39%; 4710 kg/ha).

- Foliar spray of tricyclazole20% + tebuconazole 16% SC @ 2 ml/l recorded minimum sheath rot incidence (PDI: 13.33), with higher yield (5685 kg/ha) compared to the control (PDI: 40.30).

Brown leaf spot

- Seed treatment with *Streptomyces* sp. @ 10 g/kg + soil application @ 2.5 kg/ha provided the maximum control of brown spot disease (PDI: 18.36) and recorded higher yield of 5566 kg/ha, while control recorded a PDI 36.46 and yield of 4147 kg/ha.

Sheath blight

- Three isolates of *Bacillus* spp. such as SrRB2, TpRB1 and TrRB3 were more effective in inhibiting the mycelial growth of *Rhizoctonia solani* and improving the growth of rice seedlings under *in vitro* conditions. Also effective in reducing sheath blight incidence (PDI: 51.1) and increasing yield (6793 kg/ha) of rice under *in vivo* condition when they were applied as consortia through seed, soil and foliar compared to control (PDI: 79.3; Yield 4073 kg/ha).
- Direct sown rice receiving plant growth promoting bacteria through seed, soil and foliar, recorded reduced sheath blight of 45.2 per cent, which is on par with the chemical treatment as against control which showed a maximum of 71.85per cent disease.

Sheath blight and brown spot

- Spraying tebuconazole 25% @ 1.5 ml/l recorded minimum sheath blight incidence (PDI: 12.22) and brown spot incidence (PDI: 13.32) with a grain yield of 6020 kg/ha, compared to control (sheath blight PDI: 43.32; brown spot PDI: 51.10; yield: 4252 kg/ha).

Grain discoloration

- Seed treatment with *Pseudomonas fluorescens* (Pf 1)@ 10 g/kg + seedling dip with (Pf 1) + two foliar sprays with liquid formulation of *P. fluorescens* (Pf 1) @ 5ml /l was found to be effective in reducing grain discolouration (PDI: 19.25), followed by seed treatment with *P. fluorescens* (Pf 1) @ 10 g/ kg + seedling dip with (Pf 1) + two foliar sprays with 10% leaf extract of *Coleus forskholii* (PDI: 21.00) compared to control (PDI: 36.35).
- Seed treatment with *P. fluorescens* (Pf1)@ 10g/kg + seedling dip with (Pf1) + two foliar spray with carbendazim + thiram + mancozeb (1:1:1) 0.2% recorded minimum disease incidence of 14.15 per cent followed by seed treatment with *P. fluorescens*(Pf1)@ 10g/kg + seedling dip with (Pf1) + two foliar spray with hexaconazole5% EC (0.2%) as against 36.35 per cent in control.

SORGHUM

- Among the TNAU entries screened for resistance against sorghum shoot fly, the per centage of dead heart was significantly the lowest (9.09 %) in resistant check, IS 18551 and TNS 667 (10.0 %) followed by TNS 648 (18.26%) and TNS 671(18.33%) during *rabi*,2016, while in summer, TN 648 and TNS 671 had the lowest dead heart of 5.75 and 7.83 per cent, respectively followed by TNS 667 (8.61%) and TNS 664(9.0 %).
- In resistance entries, trichome density ranged from 0.00 to 19.33 nos/mm^2 in different sorghum entries the highest being in IS18551 (12.33 mm^2) followed by TNS 667 (7.75 mm^2) and TNS 671 (6.08 mm^2).
- Sorghum stem borer damage was the lowest in TNS 667, TNS 623 and TNS 648 both in *rabi* (6.0, 6.25 and 6.25%) and summer (2.67, 2.67 and 4.0%), respectively.

REDGRAM

- Application of acephate 75 SP @ 750 g a.i./ha or acetamiprid 20 SP @ 20 g a.i./ha was found to be effective in minimizing the pod fly seed damage.
- Among the pod fly pheromone blends, blend-II (esters of phenyl acetate) attracted more flies (66 no/trap/60 days) followed by blend-III (53 no/trap/60 days) and blend-I (52no/trap/60 days). Comparatively male flies were more attracted than the females.
- Sequential application of chlorantraniliprole 18.5 SC, flubendiamide 480 SC and dimethoate 30 EC was effective in controlling pod borer complex in pigeonpea with higher yield of 1600 kg/ha.
- Pod borer, *Maruca vitrata* were less when redgram was intercropped with bajra (11.2/50 rachis) followed by intercropped with maize (13.2/50 rachis) and with sorghum (13.6/50 rachis) as against redgram sole crop, having 15.8 webs/50 rachis. Coccinellid beetle and spiders were more in intercropped redgram than the sole crop.
- Two rounds of spraying with fenpyroximate 5 EC @ 1 ml/l at 25 and 40 days after sowing, reduced the sterility mosaic disease incidence by 82.5 per cent and recorded the highest yield of 905 kg/ha

BLACKGRAM

- Whitefly population was less in the blackgram crop sown in September, October and December months, while less *Maruca* damage in August and December sown and pod bug in October and November sown crops.
- Diafenthiuron 50 WP @ 312.5 g a.i/ha was found to be effective in reducing the population of whiteflies followed by thiamethoxam 25 WG @ 25 g a.i/ha (and seed treatment with thiamethoxam 35 FS + thiamethoxam 25 WG (1.91/plant)).
- IPM plots (resistant variety, seed treatment with imidacloprid, maize as barrier crop, yellow sticky trap, and NSKE 5% spray) had less white fly population (0.87/plant),

Maruca larvae (4.40/plant) and cumulative pod damage (2.87%) as against the non IPM plots wherein white fly population (2.51/plant), *Maruca* larvae (9.80/plant) and cumulative pod damage (4.01%) were more than the IPM plots.

- Black gram intercropped with sorghum at 4:2 ratio followed by 6:2 ratio were found to be superior in suppressing stem fly (*Ophiomyia phaseoli*) and leaf folder incidence. Among the insecticides, chlorantraniliprole 18.5 SC @ 20 g a.i./ha was effective for controlling leaf folders and pod borers

GREENGRAM

- IPM module consisting of seed treatment with imidacloprid17.8 SL @ 5ml/kg of seed + *Trigoderma viride* 4g/kg, growing two rows of maize as barrier crop, installing yellow sticky trap @ 50/ha, spraying neem oil soap @1% on appearance of whitefly on yellow sticky trap, and application acetamiprid 20 SP @ 20 g a.i. /ha was found effective for management of whitefly in greengram.

COTTON

- Three species of thrips*(Thrips tabaci, Thirps palmi* and *Scirtothrips dorsalis)* were identified causing damage in cotton.
- Virus acquired thrips were found to be highly mobile, fast moving and voracious by feeding four times more than uninfected thrips.
- Three rounds of spraying flonicamid 50 WG @ 75 g a.i./ha at 15 days interval after the occurrence of thrips incidence was found effective, in reducing thrips population.

GROUNDNUT

- Two rounds of spraying with ponneem 3 ml/l and azadirachtin 3% (3ml/l)on 30 DAS and 15 days after first spraying were found to be effective in reducing *Spodoptera litura* damage. Intercropping groundnut + cumbu (6:1 ratio) combination was effective in reducing thrips population in *kharif* and *rabi* seasons. Natural enemies like coccinellids (3.8/plant) and spider (2.3/plant) population were also more in groundnut + cumbu and other cereals like sorghum, maize combination in both the seasons.
- Seed treatment with tebuconazole @ 1.5 g/kg seed + spray of tebuconazole 50% + trifloxystobin 25% WG @ 1.32g/l (0.035%) at 40 and 65 DAS, recorded lower disease severity of late leaf spot (LLS), rust and *Alternaria* leaf blight diseases with 34.58 , 30.83 and 27.50 PDI, respectively as compared to untreated control with the disease severity of LLS (93.75 PDI), rust (67.92 PDI) and *Alternaria* leaf blight (43.75 PDI). The treatment also recorded higher pod yield of 2344 kg/ha with ICBR of 3.36.

SESAME

- Seed treatment with *Trichoderma asperellum* @ 10 g/kg + application of *Trichoderma asperellum* 2.5 kg/ha enriched in 100 kg of FYM @ 250 kg/ha + foliar spray of

myclobutanil @ 1 g/l were effectively reduced the disease incidence of powdery mildew and *Alternaria* leaf spot recording 9.65 and 13.72 PDI respectively with yield of 657 kg/ha.

SUNFLOWER

- Seed treatment with *Pseudomonas fluorescens* (Pf1) @ 10g/kg seeds followed by foliar spraying of hexaconazole @ 0.1% at 45 DAS and *Pseudomonas fluorescens* (Pf1) @ 1.0% at 60 DAS were found to be effective in managing *Alternaria* leaf spot of sunflower. The technology will be tested as multi location trials at three locations *viz*., TNAU, Coimbatore, ARS, Bhavanisagar and AC & RI, Killikulam. The Treatments are T1- Seed treatment with *Pseudomonas fluorescens* (Pf1) @10g/kg seeds followed by spray of hexaconazole @ 0.1% at 45 days and *Pseudomonas fluorescens* (Pf1) @ 1.0% at 60 days after sowing; T2- Seed treatment with *Pseudomonas fluorescens* (Pf1) @10g/kg seeds followed by spray of propiconazole @ 0.1 % at 45 days and *Pseudomonas fluorescens* (Pf1) @ 1.0% at 60 days after sowing and T3-Two foliar spray of mancozeb at 0.2% at 45 and 60 DAS and T4- Control.

Alternaria leaf spot in sunflower

CASTOR

- Spraying buprofezin25 SC @ 0.8ml/l reduced the whiteflies population upto 62.30 per cent, followed by profenophos 50 EC @ 2 ml/l upto 60.90 per cent while thrips upto 64.10 per cent with an yield increase of 85.95 per cent over control
- Clothianidin 50 WDG @ 0.1g/l reduced the leafhopper population upto 60.30 per cent, while flonicamid 50 WG @ 0.2g/lit reduced the thrips population upto 57.40 per cent closely, followed by profenophos 50EC @ 1 ml/l (57.0 %).
- IPM module [Cultivar YRCH-1, application of Btk @ 1g/l after noticing early instar larvae), keeping *Spodoptera* pheromone trap (4/acre) and need based application of flubendiamide 39.35 SC @ 0.2 ml/l for *Spodoptera* and profenofos 50 EC @ 1 ml/l for capsule borer and or leafhopper, when damage is reaching 10%] in castor was found effective in reducing the population and damage of semilooper, leaf caterpillar, hairy

caterpillar, capsule borer, leafhopper and thrips compared to unprotected and farmers practice plots.

SUGARCANE

- Soil drenching of imidacloprid17.8 SL @ 250 ml/ha in root zone of affected cane was very effective in reducing white grub population to a tune of 91.82 per cent and recorded the highest cane yield of 96.10 t/ha with cost benefit ratio 2.56.
- Soil application of *Metarhizium anisopliae* 4 x 10^9 cfu-5 kg was significantly effective with the highest per cent reduction of white grub (79.69) and recorded the highest cane yield of 92.03 t/ha .
- Application of imidacloprid 17.8 SL @ 300 ml / ha through drip irrigation was found superior against borer pests than other treatments with the highest per cent reduction of shoot borer incidence (67.05 %), internode borer (40.75 %), and recorded the highest cane yield of 104.11 t/ha.
- Removal of infested leaves and application of imidacloprid 17.8% SL @ 100 ml/ha along with 5% extra N recorded higher mortality of whitefly nymphs and puparia (98.83 %) over control with cane yield of 101.78 t/ha.
- Thirteen Cuddalore clones *viz.,* C 14066, C 14077, C 14098, C 14109, C 14110, C 14192, C 14208, C 14222, C 14310, C 14347, C 14353, C 14408 and C 14411; ten Sirugamani clones *viz.,* Si 2012- 47, Si 2012-62, Si 2012-64, Si 2012-70, Si 2012-78, Si 2012-328, Si 2012-329, Si 2012-368, Si 2012-375 and Si 2012-393; six Melalathur clones *viz.,* 14G 005, 14G 036, 14G 042, 14G 050, 14G 062 and 14G 0120 were identified as moderately resistant genotypes to red rot disease.
- Among the bacterial antagonists tested against nematodes by sett treatment, significant reduction (74 %) in the nematode population in plots treated with the application of *Pseudomonas fluorescens* Pf1 @ 2.5 kg/ha, was recorded accompanied with higher cane yield (124.4 t/ha) compared to other treatments.
- Among the fungal antagonists tested against nematodes by sett treatment, significant reduction (70.5 %) in the nematode population was noticed in plots with the application of *Paecilomyces lilacinus* @ 2.5 kg/ha, which also recorded the higher cane yield of 124.8 t/ha compared to other treatment.
- Release of egg parasitoid (*Trichogramma chilonis)* @ 25 cc/ha from 4^{th} to 6^{th} months at fortnightly interval + installation of INB sex pheromone trap for monitoring and mass trapping @ 20 Nos. / ha + destrashing at 5^{th} and 7^{th} month after planting are effective for the management of internode borer in sugarcane. The technology will be tested as on farm trial at three locations *viz*., Sugarcane Research Station, Cuddalore, Sirugamani and Melalathur.


HORTICULTURE

CROP IMPROVEMENT

VARIETIES RELEASED THROUGH STATE VARIETY RELEASE COMMITTEE

Snakegourd Hybrid COH 1

Snakegourd COH 1is the product of Kethanur Local and CO 2. The fruits of the hybrid culture is short (33.5cm), spindle shaped and dusty white with prominent white stripes. The average fruit weight is 380g. The hybrid yields 69.0 t/ha (in a period of six months 15-17 harvests) which is 44.4 % more than check BSS 694. The plants should be trained as a single stem till it reaches the bower. It can be successfully grown in June-July and January-February under irrigated conditions in the districts *viz*. Coimbatore, Tirupur, Cuddalore, Virudhunagar, Dindigul, Thirvannamalai, Kancheepuram, Vellore, Villupuram, Theni, Erode, Madurai, Thoothukudi, Tiruchirapalli, Thirunelveli, Thanjavur, Namakkal and Pudukkottai.

Bottlegourd PLR 1

PLR 1 is a selection from Siruvanthadu local types maintained by inbreeding. The selected line possesses long viny (5-6m) growth habit. The fruits are medium sized (35-40 cm) possessing light green skin with mottles and tapering at the base with straight neck at the top. The variety comes to first harvest in 55 days after sowing and yields upto 32.4 t/ha

in a period of 135 days. It is moderately resistant to powdery and downy mildew diseases and fruit fly.

French Bean Ooty 3

French bean Ooty 3 is a pure line selection from Thoothurmattam local in the Nilgiris. It is pole type variety yielding 1,651.28g/plant. The pods are fleshy, long and straight without any curvature. The variety is resistant to powdery mildew and whitefly. The variety yields 39.8t/ha, which is 18.10 % higher than Ooty 1 in a duration of 90 days and is suitable for Ooty, Coonoor, Kotagiri and Gudalur block of the Nilgiris and other hilly areas in Tamil Nadu.

CULTURES UNDER PIPELINE

FRUIT CROPS

High yielding banana hybrid H 212 (AB)

Parentage: Karpooravalli (ABB) x Pisang Lilin (AA)
Resembles Ney Poovan in taste
Bunch weight: 13.0 kg
No. of hands: 11 hands
No. of fingers: 160 / bunch
Yield: 39 t /ha
Tolerant to *Fusarium* wilt and nematodes.

VEGETABLE CROPS

Cassava accession Me 681

Erect, tall growing plants.
Inter nodal length is shorter and the leaf size is bigger with sufficient canopy.
Tubers are long, cylindrical with pinkish white skin.
Rind colour is also pink with creamy white.
Flesh is white in colour.
Mean tuber yield per plant is 7.61 kg with the starch content of 29.80 %
Resistant to cassava mosaic virus
Duration 10 months.

High yielding tomato hybrid CTH 1

Parentage: LE 127 (Natural variant identified in PKM 1 population) x LE 239 (Athani Collection)
Flat round fruits
Fruit weight – 71.3 g
No. of fruits / plant – 38.5
High yield - 96.0 t/ha (22.6 % increase over Hybrid CO 3 & 26.3 % increase over Lakshmi)
Moderately resistant to leaf curl
TSS – 6.30 ^{o} brix
Ascorbic acid – 30.43 mg/100 g

Onion Aca 15 (Puttarasal Selection)

Seed setting type
Yield -20.81 t/ha
TSS – 17.11 ^{o} brix
Pyruvic acid - 2.88 mg/100 g
Duration - Bulb to bulb 65-70 days
Duration - Seed to bulb - 90 days
Seed yield - 300 kg/ ha

Brinjal Hybrid IC 374928-1/ABSR-2

Parentage: IC 374928-1 x ABSR-2
Plant height: 132.5cm
Fruit length: 9.1cm
Fruit weight: 76.8g
No. of fruits per plant: 54
Fruit yield per plant: 4.20 kg
Shoot borer infestation: 12.1%
Fruit borer infestation: 13.0%

Brinjal HD 10 - 6- 5- 3

Parentage: Singampunari Local/ Annamalai Local
No. of fruits per plant: 39.14
Average weight of fruit: 47.50 g
Yield / plant (kg): 2.12

Ridge gourd hybrid CRgH 1

Parents: IC 410147 x IC 373361
Fruit shape: Cylindrical
Fruit length: 30.5 cm
No. of Fruits: 26.7/ vine
Fruit weight: 274.5 g
Fruit colour: Pale green
Crude fibre: 0.50 mg/100 g
Yield: 27.0 t/ha
Special attribute: Short fruited type

Bottle gourd LS 44

Selection from Uchhimedulocal
Fruits are round in shape
Fruits can be harvested from 50-55 days
Duration: 130-135 days
Single fruit weight 0.8-0.9 kg
No. of fruits per vine: 11-12
Fruit yield /vine is 9-10 kg
High yielding - 41.9 t/ha

Garlic Accession *As* – 72

Selection from germplasm (Adasolai village)
Bulb weight: 34.66 g
Equatorial diameter :45.38 mm
Polar diameter : 42.39 mm
No. of cloves : 15.76 / bulb
TSS : 47^{o} Brix
Allicin : 3.87 µg/g
Polyphenol : 3.08 µg/g
Bulb yield : 19.5 t/ha

SPICES AND PLANTATION CROPS

Turmeric BS 9

Multi Locational Trial (MLT) on a high yielding turmeric culture BS-9 from ARS, Bhavanisagar was conducted at two centres during 2016-17
The MLT data of the two centers revealed that the culture BS-9 registered the highest fresh rhizome yield (52.08 t/ha)

Coriander CS 38

Selection from Rajasthan local
Leaf yield - 4238 kg/ha
Duration - 38 to 45 days
23 per cent yield increase over the check variety CO (CR) 4

FLORICULTURE & LANDSCAPING
Jasmine *(Jasminumnitidum)*Acc.Jn-1 (MTP)

Clonal selection with year-round flowering
Good keeping quality, attractive bold buds
Mild fragrance, higher consumer preference
Attractive plant architecture - ideal as decorative ornamental also

MEDICAL AND AROMATIC CROPS

Sn 19-Kalipalayam local Solanumnigrum

Promising accession Kalipalayam local

Recorded 454 g fresh herbage and 90 g of dry herbage/plant.

The accession Kallipalayam local (*Sn* 19) recorded 15 per cent increase in fresh herbage yield (g/plant) and 23.04 per cent increase in fresh herbage yield (kg/plant) over check.

CROP MANAGEMENT

Rapid multiplication of turmeric using single bud rhizome sprouts in protrays

A protray based production of turmeric seedlings using single bud rhizomes was developed. This method requires only lesser quantum of planting materials (600–750 kg/ha). Since the planting materials are propagated in portrays, there is good establishment of seedlings with better establishment capacity in a shorter period of time (30 days). The establishment of seedlings in the field is to the extent of 98-100 percent and is better than conventional method of planting.

Brinjal grafting

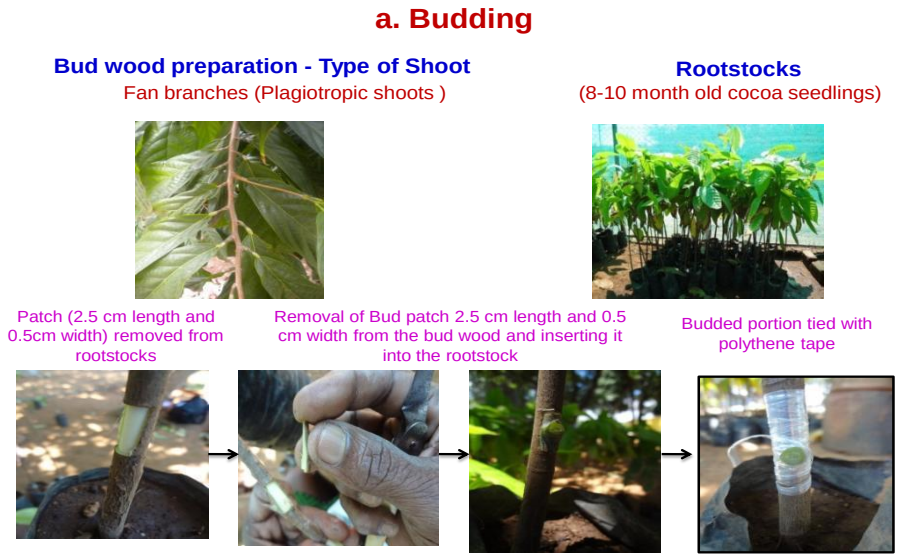
Brinjal grafting technology has been standardized, where the choice variety / hybrid is cleft grafted on the *Solanumtorvum* rootstock to boost plant growth, development and yield by increasing the uptake of nutrients and also have resistance to dry root rot and nematode. The main crop can be maintained for 6 months followed by one or two ratoon

crops. By adopting this technology, the brinjal plants are capable to yield 115 t/ha in 10 months duration. (One main and one ratoon crop).

Standardization of vegetative propagation in Cocoa

Patch budding and soft wood grafting techniques have been standardized with 65-70% and 70-80% success respectively.

Through patch budding and soft wood grafting



Through cuttings

Single node semi hardwood cuttings treated with IBA in sand medium recorded significant effects on traits like rooting percentage (14 per cent), number of roots (14.00) length of roots (16.87 cm), number of leaves sprouted (5.37), length of sprout (7.70 cm), fresh weight of roots (0.42 g) and dry weight of roots (0.13 g). Similarly, in two node and

long cuttings, two node cutting treated with IBA in sand medium influenced the sprouting, fresh weight and dry weight of roots. Even though the factors like media, growth regulator and type of cuttings had a role in increasing the rooting ability of cuttings, the success rate recorded in this study was far below and this can be applicable only for research purpose.

Standardization of potting media for Cocoa

Studies on efficacy of different pot mixtures on seedling establishment of cocoa revealed that Red Soil + Sand + FYM (2:1:1) + Super phosphate (5 kg/ton) was found to be the best treatment as adjudged by the seedling characters *i.e*. seedling height, number of leaves, leaf length, leaf breadth, root length and root fresh weight.

Standardization of fertigation schedule for cocoa

Application of 100 per cent RDF (100:40:140kg of N, P2O5 and K2O) as WSF through fertigation by drip irrigation recorded the highest number of pods per tree (31.74 and 25.97, 32.41 and 26.18) during first and second season in 2012-13 and 2013-14 respectively. Fertigation with 100 per cent recommended dose of water soluble fertilizers recorded the highest dry bean yield per tree per year of 3433g and 3817g during first and second year which was on par with 75 per cent recommended dose of water soluble fertilizers.

Improvement of fruit quality in Banana cv. Matti (AA)

Spraying of 1.5 % SOP once during the last hand opening and second spray on 30th day after the first spray to the entire foliage and bunches recorded the highest bunch weight (12.40 Kg) as against control (8.20 Kg) and finger weight of 39.30 g against 26.80 g in control. The quality parameters viz., bunch appeal, flavour, TSS (22 ^{o} brix), reducing sugars (13.43 g/100 g), non-reducing sugars (8.52 g/100 g) and total sugars (21.96 g/ 100 g) were also the highest with 1.5 % SOP spray.

Integrated nutrient management in Papaya

In papaya, application of 100 per cent recommended dose of fertilizers + AM fungi(50g/plant) + Phosphate Solubilizing Bacteria (25g/plant) + *Azospirillum* (50g/plant) + *Trichoderma harzianum* (50g/plant) recorded the highest fruit yield of 38.34 kg /tree and 73.27 kg/plant/year in Co.7 and Co.8 papaya respectively.

Improving the storage life of papaya seeds

Studies regarding standardization of protocols for medium term storage of papaya seeds (*Carica papaya* L.). var. Co. 8revealed better performance of seeds stored with 8% moisture content in trilaminatedaluminium package with higher germination (76.10 %), germination index (8.83), healthy seedlings (73.50), shoot length (16.04 cm), root length (2.50 cm), dry matter (148.30 mg) and vigour index (1421.85). It also registered minimum number of days taken for germination (8.73) and lowest per cent of dead seeds (11.04 %).

High density planting and canopy management in guava cv. Lucknow 49

At HC&RI, Coimbatore, a trial of HDP and canopy management in guava cv. Lucknow 49 is being conducted with various spacing and nutrient doses. The results revealed that the combination of spacing 3×1 m and nutrient dose of 75:75:75 g of NPK / plant was the best to get higher productivity (50.63 t/ha) along with better quality parameters.

Turf grasses for salinity tolerance

Among three grass species *viz*., *Zoysia* grass (*Zoysia japonica*), Bermuda grass (*Cynodondactylon* x *Cynodontransvaalensis*) and Seashore paspalum (*Paspalumvaginatum*) evaluated, Seashore Paspalum (*Paspalumvaginatum*) was observed to possess higher salinity tolerance upto 15 d Sm^{-1} and Zoysia grass (*Zoysia japonica*) had acceptable turf quality for salinity treatment of 10 d Sm^{-1}.

Water saving in foliage plants using Pusa hydrogel

Incorporation of 40 g of hydrogel/5 kg potting media for *Schefflera arboricola* was found to be superior by reducing the frequency of irrigation (5.43 days) and the quantity of water required (11.42lit.**)** by saving 5.12 litre of irrigation water, when compared to control which required an irrigation level of 16.56 litre.

Fertigation for tuberose

Drip irrigation of tuberose (var. Prajwal) with 125% WR_c and fertigation with 75% WSF + 25% straight fertilizer along with foliar spray of 0.4% humic acid under black polythene mulching system recorded improved flower yield (19.06 t/ha & 653 g/ plant), bulb yield (14.4 Nos./clump), earliness in flower spike emergence (68.16 days), increase in flowering duration (26.16 days), rachis length (27.21 cm) and floret number/spike (55.6 Nos.). The BCR was the highest (3.08) in this treatment.

CROP PROTECTION

VEGETABLES

- Cabbage tested for different intercropping systems, the cabbage-coriander system had less number of major pests and more of natural enemies later.
- Isolation of native *Bacillus thuringiensis* from 16 district soil yielded 38 isolates of *Bacillus*.
- Imidacloprid 17.8 SL applied at @ 50 g a.i/ha dissipated to below detectable level on fifth day after spraying and the half-life was 1.84 days, while, half life of lambda cyhalothrin 5 EC @ 15 g a.i/ ha was 1.83 days and bifenthrin 10 EC @ 50 g a.i/ha was 0.89 days.
- Thiamethoxam 25 WG @ 50 g a.i/ha, acetamiprid 20 SP @ 20 g a.i/ha, chlorpyriphos 20EC @ 200 g a.i/ha and quinalphos 25 EC@ 250 g a.i/ha dissipated to below detectable level on 7^{th}, 5^{th}, 10^{th} and 10^{th} days, respectively with half life period of 1.62, 1.28, 3.27 and 2.92 days, respectively.
- A multi residue analysis method was developed and validated for detecting neonicotinoid group of insecticides in tomato. Out of 5 samples screened till now, two samples were found contaminated with thiamethoxam residues (0.17 and 0.007 µg/g).
- In tomato, foliar spray of propiconazole (0.1%) on 30 and 50 days after planting recorded lower incidence (PDI: 1.33) of early blight and maximum fruit yield of 32.45 tones/ha.
- As an alternate to chemical management, *Pseudomonas fluorescens* - Pf1 talc product (0.5%) spray on 30 and 50 days after planting recorded lesser incidence of early blight (6.07 PDI) with higher fruit yield of 30.86 tones/ha.

Tomato early blight symptom

Alternaria solani

- Seed treatment with carbendazim (2g/kg) + propiconazole (0.1%) spray on 60, 75 and 90 days after planting recorded lower incidence (10.30 PDI) of chilli anthracnose when compared to control (27.70 PDI).
- Application of *Purpureocillium lilacinum*(*Paecilomyces lilacinus*)as seed treatment @ 10g/kg of seed followed by soil application @ 50g/m^2 reduced the root knot nematode *Meloidogyne incognita* population infesting tomato in soil by 41.1% and root knot index by 42.2 % and increased the tomato yield by 37.2% compared to untreated control. The treatments *viz.*, application of *Purpureocillium lilacinum*@10 g/kg seed and soil application @ 50g/m^2, *Trichoderma harzianum*@10 g/kg seed and soil application @ 50g/m^2, carbofuran@ 1kg a.i./ha and untreated control will be reconfirmed as on farm trails at Coimbatore and Paiyur.

Integrated nematode management of root knot nematode,

- Bio-fumigation with mustard followed by application of neem cake @ 625 kg/ha along with *Purpureocillium lilacinum* @ 5kg/ha significantly reduced the root knot nematode *Meloidogyne hapla* in carrot by 64.43 per cent and increased the tuber yield by 20.15 %. The technology will be tested as on farm trials at three locations *viz*., Ooty, Kothagiri and Kodaikanal with treatments consisting of mustard bio-fumigation + neem cake application @ 625 kg/ha +*P. lilacinum* @ 5kg/ ha, carbofuran 3G @ 1 kg a.i./ha and untreated control.

Bio-fumigation of carrot field with mustard

FRUITS

- Three sprays of propiconazole (0.05%) + mineral oil (1%) at 25 days interval after noticing the symptoms of banana sigatoka leaf spot disease recorded the least disease severity index of 12.15 as compared to untreated control (23.44). The treatment recorded higher bunch weight (31.36 kg/plant), number of hands / bunch (12.16), pseudostem height (197.50 cm), pseudostem girth (67.00 cm) as compared to untreated control (10.80,22.77 kg/plant, 8.33, 176.67 cm and 60.17 cm, respectively)

Symptoms of Sigatoka leaf spot

- Aonla trees mainly suffered from ten insect pests. Of which, the infestation of apical twig gall maker, *Betousa stylophora* (Thyrididae: Lepidoptera) adversely affected the apices of growing twigs. With a maximum (21.50%) incidence during second fortnight of September in 2016. The mealy bug, *Nipaecoccus vastator* (Pseudococcidae: Homoptera) infesting leaves and tender shoots was found active throughout year.
- *Bactrocera correcta* Bezzi was found to be the major fruit fly species in guava in Tirunelveli district with a maximum incidence (46%) during the first fortnight of November. Mean maximum temperature showed a significant positive correlation while relative humidity exhibited a significant negative correlation. But rain fall had no effect on fruit fly incidence.
- Organic mulch was the most advantageous and statistically superior over plastic film mulch and non-mulch environments in terms of reduced pest intensity with increased number of natural enemies observed under high density planting of guava.
- Citrus red mite, *Panonychus citri,* citrus bud mite, *Eriophyes sheldoni and* citrus rust mite, *Phyllocoptruta oleivora* are the predominant mite species that devastate the acid lime crop in summer months.
- Guava orchards of Tamil Nadu were facing sudden decline and sampling revealed the incidence of root knot nematode. The species was identified using morphometry and with the help of Polymerase Chain Reaction (PCR) common 18S primer as *Meloidogyne enterolobii* and further confirmed by partial sequencing using 18s rRNA gene. The sequence had 99% similarity with *Meloidogyne enterolobii* sequence previously available in NCBI database which was submitted and provided with Gene bank accession number (KX611608.1).
- Survey conducted in Tamil Nadu, Andhra Pradhesh and Telangana states revealed that the propagating materials such as ground layers, grafts , root stocks used for grafting, clones and rooted cuttings are themselves infested with root knot

nematode, *M.enterolobii* in guava and *M.incognita* in pomegranate, and act as sources for dissemination of these nematodes into main field. Use of air layers and sterilized soil media or adopting soilless media (vermiculite and coir pith), can keep the nematodes from entering the root system at nursery stage.

- All the commercial guava varieties were susceptible to root knot nematode, *M. enterolobii.* Application of bioagents *Purpureocillium lilacinum @* 75g/tree, once in six months recorded the lowest reproductive rate of *M. enterolobii* in guava (0.39) and the highest fruit yield (39.8 kg/tree) in three years old guava tress (cv. L 46).

Pomegranate ground layer with minute galls

Guava rooted cutting with microscopic galls

Guava ground layer with galls that are seen only on zooming

COCONUT

- Incidence of a new invasive spiralling whitefly (*Aleurodicus rugioperculatus*)was noticed in coconut as early as August 2016, in several villages of Anaimalai block, Coimbatore Dt., Tamil Nadu. The species was identified and confirmed as Rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin. Several plants such as bhendi, sapota, custard apple, lemon, hibiscus, nutmeg, banana and guava were recorded as alternate hosts. Observations on the natural enemy fauna in the infested gardens revealed that a diverse array of coccinellids and an aphelinid parasitoid, *Encarsia guadeloupae* were noticed subsequently leading to excellent biosuppression of the RSW. Periodical awareness programme and sensitization campaigns were organized jointly by Coconut Research Station, Aliyarnagar and Dept. of Agrl. Entomology, TNAU, Coimbatore, NBAIR, Bengaluru and CIPMC, Trichy. Non-chemical approaches were insisted to the participating farmers and pesticide holiday has been declared in Tamil Nadu against RSW on coconut. Farmers are advised not to spray any insecticides for the management of RSW.
- Among five new coconut hybrids of location specific crosses combinations evaluated, COD x ALR 1 showed the highest mean damage up to 95.83 % by spiralling whitefly,

while, Tall x Tall coconut hybrids BGR x ADOT showed moderate level of damage up to 25.00 % as against no significant damage in WCT x TPT and LCOT X ADOT hybrids.

Egg spirals on the under surface of the leaves

Nymphal stage

Adult stage

RSW life stages on the under surface of fronds

Sooty mould on the upper surface of fronds

Sooty mould on the lower most whorls

- Rugose spiralling whitefly on coconut can be managed by setting up of yellow sticky traps/ sheets to monitor the RSW population.

- Forcible water spray on the under surface of the leaves
- Spraying maida flour paste @ 25g/l to flake out the sooty mould
- Release of *Chrysoperla zastrowisillemi* eggs @ 1000/ha

Chrysopid egg

Chrysopid larva

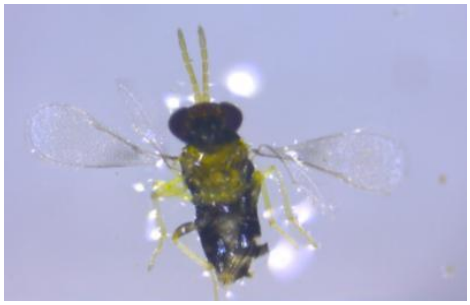
Chrysopid pupa

Chrysopid adult

- Stapling leaflets containing parasitized cocoons on the under surface of the infested leaflets
- Conservation of natural enemies particularly Coccinellid adults and *Encarsia*

Coccinellid adults

Pupal stage of RSW parasitised by *Encarsia guadeloupae*



Encarsia guadeloupae

- Placing chlorpyriphos 1.5%DP or chlorantraniliprole 0.4% GR along with 100-150 gram of sand at two-months interval significantly reduce the leaf and spindle damage in the leaf by coconut rhinoceros beetles.
- Root feeding with tebuconazole @ 2ml + 100 ml water thrice at three months interval was effective in reducing the intensity of leaf blight in coconut.

FLOWER CROPS

- Survey conducted in rose, carnation, gerberra, and chrysanthemum revealed that gerberra had 81.0 per cent damage by leafminer followed by chrysnathimum (68%) and carnation (47.5%) in Dharmapuri and Krishnagiri districts. But in the Nilgiris district, the damage was high in chrysanthemum (68 %), followed by gerbera (48%).
- Peak activity of leaf miner occurs just after sunrise in warm weather. The most abundant species found in cut flowers under protected cultivation are *Chromatomyia horticola* and *Chromatomyia nigra.* The incidence of *Liriomyza trifoli* is less.
- Foliar spray of picoxystrobin @ 0.15% or *Bacillus amyloliquifaciens* @10^8cfu/ml at fortnight intervals was effective for lilium Botrytis blight

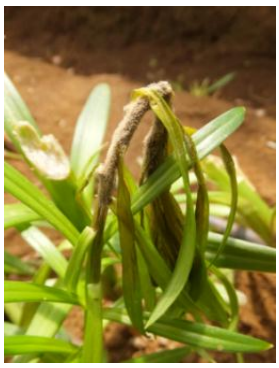
Water soaked brown lesion

Enlarged blighting pattern

Disease progress and infection

Sporulation on entire infected plant

Sporulation on buds



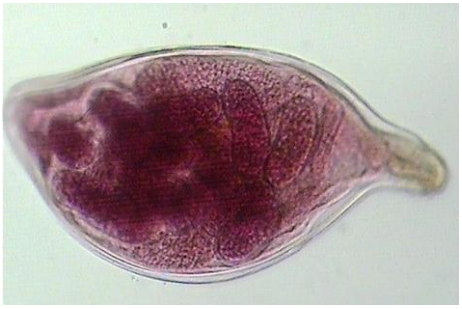
Sporulation on infected areas

MEDICINAL PLANTS

- Out of 98 plant species maintained in the glass house of HRS, Yercaud 38 plant species were found free of insect pests. The mealy bug species *Ferrissia virgata, Paracoccus marginatus* and *Orthezea insignis* were found to attack medicinal plant species. The white fly species, *Bemisia tabaci* and *Trialeurodus vaporaiorum* were found to damage

the medicinal plants. The mites *Tetranychus urticae* and *Tetranychus ludeni* were found to feed on clitoria, sage, aswagantha and karuoomathai.

- Dipping the tubers of gloriosa in talc based formulation of *Bacillus subtilis* (0.2%) followed by drenching with *Bacillus subtilis* (0.2%) on 30th day after planting recorded the lowest root rot incidence of 18.9 per cent with maximum seed yield of 533 kg/ha as against 32.7 per cent disease incidence and a seed yield of 376 kg/ha in control.
- In gloriosa spraying talc based formulation of *Bacillus subtilis* (0.2%) on 30 and 60days after planting recorded the lowest alternaria leaf blight severity of 16.2 per cent disease index (PDI) with a higher seed yield of 564 kg/ha as against 29.6 PDI and 385 kg/ha seed yield in control.
- In India, red clover cyst nematode, *Heterodera trifolii* Goffart was earlier recorded at Kangra region of Himachal Pradesh by Kaushal*et al.,* (2008). Now it was recorded on white clover in The Nilgiris at an altitude above 1200 MSL. It was observed to infest the roots of *Trifolium* sp. a pasture legume along with the grasses. *H. trifolii* was observed at Nanjanadu cole grain farm and Sandynalla. Its occurrence and spread to other legumes are being monitored.



Adult female with eggs

Cyst

AGRICULTURAL ENGINEERING AND HOME SCIENCE

AGRICULTURAL ENGINEERING AND HOME SCIENCE

RELEASES MADE DURING 2016-17

Continous Aonla deseeder

Removal of seed from aonla is a pre-requisite for the processing of aonla fruit into different value added products. At present the seed is being removed with the hand operated equipment of capacity 10 kg/h which is a cumbersome process and also time consuming. In order to eliminate the drudgery in the removal of seed and to increase the capacity, a continuous aonla de-seeding machine has been developed.

The unit essentially consists of a feed hopper, singulating unit, metering mechanism and seed removal unit. The aonla fruits dropping through the feed hopper are singulated by means of guide plates and endless flat belt. The metering mechanism keeps the fruits on the fruit seater of the base plate smoothly. The seed from aonla is removed by piercing rod which is actuated with cam and gear mechanism. The unit is powered by a 2 HP electric motor.

Special features of the equipment

Capacity	:	100Kg/ h
Power required	:	2 HP
Efficiency	:	95 %
Damage	:	5%
Labour required	:	1 person
Cost of operation	:	Rs 3/ kg
Cost of the unit	:	Rs. 60,000

Biomass hot air generation system integrated with solar tunnel dryer

Suitable for drying copra, turmeric, chilli, medicinal and food products. Solar heat collected through UV stabilized polyethylene. Biomass hot air generation system consists of combustion chamber, heat exchanger and air distribution ducts in the drying chamber. Auto-control system maintains desired temperature throughout drying period, enhancing product quality.

Drying capacity : 2 tonne/batch of copra and turmeric.

Solar mode can be used during sunshine hours and biomass mode can be used during off-sunshine and rainy periods.

Coconut husk and coconut shell can be used as biomass fuel in this dryer

Reduced drying time for copra, 48 hours (2 days) in solar-biomass dryer, which is 4-5 days in solar tunnel drying and 6-8 days in open sun drying. Drying time for turmeric is 96 hours (4-5 days), which is 70 % lesser than open sun method (12-15 days). Cost of drying is Rs.1762/tonne of copra and pay back period is 3.59 years.

System for controlled level of puddling

The system of controlled puddling by using laser controlled external hydraulic system was developed with 2WD tractor (MF 1035). The tractor was modified to have double acting external hydraulic cylinder that can be easily connected to the hydraulic control of the laser leveller. The system has potential to save water requirement for puddling and also reduce the energy required.

The advantages envisaged are

- Constant depth of puddle, which can be maintained accurately as per the plant requirement (typically 150 mm), thus reducing the tillage energy expended by deep puddling.
- Reduce water requirement for puddling
- When controlled puddling is practiced, there is a possibility of establishment of a strong sub soil layer that will reduce deep percolation
- Controlled puddling will ensure a perfectly level surface layer and subsurface layer. Thus a perfectly levelled surface will be available for transplanting the rice seedlings.

Tractor operated cluster onion harvester cum collector

The mechanization of digging cluster onion had been made possible by the adoption of drip irrigated crop cultivated in raised beds. The cluster onion harvester has a special profile of blade to ensure shallow cut of soil and riddle conveyer for separating the soil from the onion bulbs. The distinguishing feature is the provision of cross conveyer and elevating conveyer. Hence the onion can be collected in the bags provided. Extensive field trials have been conducted.

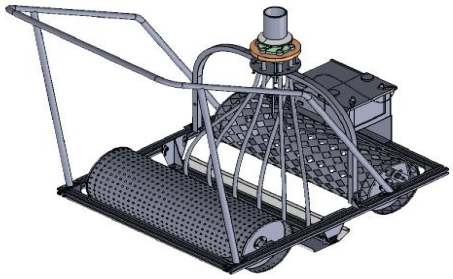
Tapioca De-topper

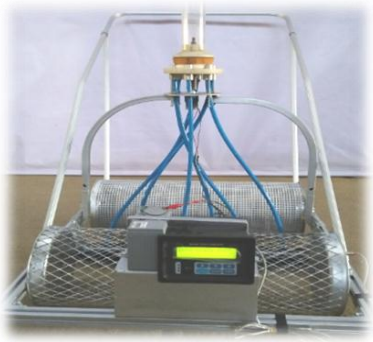
A tapioca de-topper for cutting and conveying the tapioca stems ahead of the digger was developed as a front mounted attachment to the tractor. The de-topper is driven by tractor hydraulics. The cutting cum conveying unit is raised and lowered by a hydraulic cylinder. This makes it possible to vary the height of cut. The cutter-heads can be

independently moved along the frame to accommodate variation in row spacing. This attachment to tractor can be used in conjunction with the cassava harvester.

Manually operated carrot seeder

A manually operated six row seeder for sowing pelletized carrot seeds was developed. This seeder uses a novel metering device. This conical foam pad metering mechanism was developed for metering pelletized seeds in the range of 2 to 4mm. The seeder is suitable for sowing small seeds. The seeds are to be pelletized for use in this seeder. The seeder can sow carrot seeds at row to row spacing of 100 mm. The seeder drills the seeds along the row and the plants are to be thinned after emergence. The weight of the seeder is 19 kg and has a 12V battery for operating the metering mechanism.





The field capacity of the carrot seeder was 0.008 ha h^{-1}. The cost of planting by the machine is around Rs.4900 ha^{-1}, compared to Rs 6000 by manual method.

Biochar production

Biochar is a stable form of Carbon which is produced from pyrolysis of biological materials. Biochar was produced using slow pyrolyzer at 400–450°C using *Prosopis sp*., Casuarina and Coconut shell species and various characteristics such as bulk density, particle density, porosity, elemental ratios, major and minor nutrients, pH, EC, CEC, SEM, FTIR, XRD, total carbon content were analyzed and compared for carbon sequestration applications.

The biochars differed much in their physical, chemical, nutrient, thermal and biological characteristics of biomass.The carbon content of the biochars were enriched from 48.09 per cent (biomass) to 96 per cent. The coconut shell and casuarina biochars had a very high C content (96 per cent). The pH and EC of the biochars were varied from 9.20 to 9.80 and 0.50 to 1.70 ds m^{-1} respectively. The Cation Exchange Capacity of biochars was varied from 7.40 to 16.70 cmol kg^{-1} and the higher CEC content was found in *Prosopis glandulosa* biochar.

Biochars from different biological substrates

The quantity of biomass produced per annum in the form of agricultural residues alone is about 500 million tonnes (MT) and it is estimated that the potential carbon through biochar conversion is about 90 MT yr^{-1} and it could sequester for about 324 MT of carbon in the atmosphere per year.

Biochar can be used as an alternate material for solid fuels, low cost adsorbents in waste water treatment plants and as a soil conditioner in the agricultural fields to mitigate greenhouse gas emissions in the atmosphere.

Turmeric washer

The essential postharvest operations employed in turmeric are washing, boiling, drying, polishing and storage. The existing postharvest operations are tedious, time consuming and also lead to quality and quantity loss. As mandated by the All India Co-ordinated Research Project, efforts were made to design postharvest machinery for turmeric, the highlights of which are given beow:

Capacity - 290kg/hr; Mechanical washing efficiency - 88%

Presently the farmers do not wash the turmeric and directly go for steaming. The problems of this practice are that lot of dirt enters the processing and steaming efficiency is also reduced. Keeping these in view, a continuous type batch type mechanical washer was developed for turmeric.

The main components of newly designed turmeric washer are feed hopper, cylindrical rotary drum, water spray assembly, washed turmeric outlet, motor, pump, frame and water collecting tray. The washing drum is 180 cm long and 60 cm diameter. The drum is made of stainless sheet punched with rectangular holes of 6 mm x 25 mm to give a total perforation of 60% the total surface area. The rotating drum was covered by a stainless steel hood. The feed hopper of 10 kg capacity was mounted on front end of the drum. A water spray assembly is installed inside the drum and is made of GI pipe of 210 cm length. On the pipe, totally 17 holes of 4 mm diameter were drilled at an interval of 10 cm. A gate valve was provided to control the water flow rate into the drum. A rectangular tank of 300 L water capacity was fixed below the rotating drum for collecting the sprayed water from the rotating drum. The collected waste water will be filtered and re-circulated with the help of a pump. A one hp single-phase variable speed DC motor (10-1400 rpm) was provided to rotate the drum. The power from the motor was transmitted by a 6.25 cm diameter pulley to 15 cm diameter pulley for variable speed, which then transmits the power to helical gear assembly of the rotating drum. The washed turmeric was received at a trapezoidal shaped collection chamber where the excess wash water was drained from the surface of washed turmeric. At the end of this outlet tray, cleaned turmeric rhizomes were collected in separate boxes.

Improved boiling system for turmeric

Curing is essentially a process of cooking the raw rhizome in water just sufficient to cover the bulk. The surface layers open up and the main component namely the starch gets gelatinized. Boiling destroys the vitality of the rhizomes, avoids raw odour, reduces drying time, and yields a uniformly colored end product. Conventionally farmers are cooking turmeric in mild steel barrels covered with gunny bags on top which leads to high steam losses and increased cooking time and is a time consuming and laborious process. Currently the capacity of drum used by the farmers is 200 L which can hold 100 kg of turmeric.

Keeping this in view and to improve the ease of handling, a mobile cooking vessel was designed. The capacity of the vessel was 100 kg. To avoid heat loss the vessel was insulated by PUF. For easy transportation in rough soil it was provided with four wheels and a handle of sufficient length for easy handling. A steam trap was provided at the bottom so that dry steam can be passed into the vessel. To get uniform boiling two perforated pipes were provided and field trials were conducted. In the improved vessel to open the lid with ease a screw rod with a wheel was mounted on the top of lid. A handle was provided on the side, up on release will tilt the vessel after cooking**.** Experimental trials using improved vessel were conducted in farmers' holding at Thamarapalayam of Erode District, Tamil Nadu.

- Using the improved cooking vessel 100 Kg of turmeric can be boiled in 10 min compared to 15 min as in the case of conventional cooking vessel.
- Turmeric boiled using improved vessel can be dried in lesser time compared to the samples boiled using conventional method.

  Further testing and evaluation of the machine is in progress.

Mechanical dryer for turmeric

Presently farmers resort to sun drying after steaming. It takes about 13 days to dry a batch of turmeric and sun drying on open yards brings lot of dirt into the processed turmeric and thereby affecting the quality of end product. A mechanical dryer was considered to be a dire need so as to save drying time and preserve quality. A rotary dryer which can run on slow speed (6-15 rpm) was considered to be suitable for drying spices and designed. Preliminary testing of the dryer was done at Thamarapalayam village of Erode district and later near Periyanayakkan Palayam of Coimbatore district.

In the drying trials, the turmeric rhizomes were dried from a moisture level of about 41.3% (d.b.) to 9% (d.b.) in about 30 h. The biomass fired furnace was initially allowed to run for 30 min without load so as to heat the air to the required temperature. About 500 kg of turmeric rhizomes were loaded which had occupied 75 % of drum volume. Experiments were conducted at air temperatures of 50, 60 and 70^{o}C, air velocities of 2 and 3 ms^{-1} and drum speeds of 6 and 9 rpm.

- The drying time for a batch of the turmeric rhizomes ranged between 33 to 48 h and it could save nearly 80% of time when compared to sun drying.
- Quality of turmeric like curcumin, oleoresin, colour and starch content was found to be the best when dried at 50^{o}C, 9 rpm and 3 m/s.

Further testing and evaluation of the machine is in progress.

Dust proof turmeric polisher

A dust proof turmeric polisher was designed to overcome the problem of dust release into the atmosphere. The developed polisher was evaluated in the farmers' field at Kodumudi, Erode District. A collapsible hood was provided at both the upper and lower side of the polishing drum to control dust emission. The percent reduction in dust emission when compared to conventional turmeric polisher was estimated. On an average of 500 kg of raw turmeric rhizomes was fed into the machine in every trial, out of which 345 kg of polished turmeric was retrieved. Dust recovery amounted to 31% (144.5 kg) in these trials. The observed polishing efficiency of the dust free turmeric polisher was 93%. By using the newly developed dust free turmeric polisher in the place of conventional polisher, it is possible to save about 40% of time for polishing finger and mother rhizomes. It has resulted in lesser air pollution around the polisher operating area and thereby protects the workers and public in the vicinity of polisher operating area from health hazards. There was 99% reduction in the emission of the dust from the newly improved dust free turmeric polisher. The collapsible cover is light in weight and also trapped dust from the machine. Further testing is in progress.

Polishing efficiency - 93 %; Polishing loss - 31%, 99 % reduction in the emission of the dust

Studies on the effect of boiling, drying and storage on the biochemical constituents of turmeric rhizomes

Effect of various postharvest operations on the recovery of curcumin, essential oil, oleoresin and starch contents in the turmeric during processing was determined. Freshly harvested rhizomes of PTS 10 and CO2 varieties were subjected to different boiling methods

namely water boiling, cowdung slurry boiling, steam boiling and pressure boiling followed by drying in solar drying and sun drying methods. The processed rhizomes were then subjected to storage in different packaging materials namely, jute gunny bag, polythene lined jute gunny bag and polythene gunny bag.

Maximum curcumin (5.21%), essential oil (5.80%) and oleoresin (14%) contents were obtained in pressure boiled solar dried PTS 10 rhizomes. The study also disclosed the effect of packaging material on the retention of quality of rhizomes during storage. The minimum change in colour (ΔE) upto six months of storage was obtained when stored in polythene lined jute gunny bag (1.05 to 3.46). Polythene lined jute gunny bag was found to retain maximum quality compared to other packaging materials. The pressure boiled rhizomes showed no incidence of pest till six months of storage. The percentage of incidence of pest by cigarette beetle (*Lasioderma serricorne*) was lower in polythene lined gunny bags compared to other packages.

Boiling of PTS 10 rhizomes at a pressure of 0.5 $kgcm^{-2}$ for 5 min and drying it in a solar drier (35 h) resulted in better quality dry rhizomes and stored in polythene lined jute gunny bags retained maximum quality when measured in terms of curcumin (5.17%), essential oil (5.76%) and oleoresin (12.50%) contents during storage up to six months.

Therapeutic Ready to cook millet products

Ready to cook millet products based on millet flour, millet grits with the incorporation of fenugreek leaves powder (10%) and drumstick leaves powder (10 %) were developed. The developed products had higher mineral content, dietary fibre and complex carbohydrates. The product had a shelf life of four months with highly acceptable sensory qualities.

Value Added Products from Sapota

Sapota jam

Ripened sapota fruits were taken, washed, peeled, deseeded and macerated to a pulp and was double filtered. Sugar was added to the pulp (1:1), followed by addition of citric acid @ 1% / kg .The entire mass was concentrated in a steam jacketed kettle till it attained 65^0bx and cooled to 50^oC and sodium benzoate @ 200 ppm/kg was added. The jam was then filled in bottles and stored at ambient conditions. The product had highly acceptable organoleptic qualities retaining the characteristic flavor of sapota. It had a shelf life of six months under ambient conditions.

Sapota Candy

Sapota fruits well ripened, sound and firm were selected. It was washed, peeled, deseeded and cut longitudinally into equal pieces. The cut slices were pretreated in a solution of 0.5% citric acid for 10 minutes. The fruit pieces were then put in sugar syrup (60^obx) and heated for 10 minutes and soaked in the syrup for 18 h to facilitate osmotic process. The fruit pieces were then drained from the syrup and dried in a cabinet drier at a temperature of 50°C for 5h. The product had a shelf life of four months, with highly acceptable organoleptic qualities.

Ready to use coconut chutney

The method for the development of ready to eat coconut chutney was standardized. Fresh coconut scrapings, roasted bengalgram, ginger, garlic, green chilies, coriander leaves, tamarind and salt was ground to uniform slurry. The slurry was packed in retort pouches and sealed. In pack sterilization was done at a temperature of 120^{o} C for 5 min in a retort. The product had a shelf life of three months in refrigerated conditions with highly acceptable organoleptic qualities.

Ready to use Coconut milk powder

Standardized the method for the development of ready to use coconut milk powder. The nuts were split, kernels separated, washed, steam blanched (3 min) and converted into small gratings. The gratings were then made into slurry with water and pressed to extract the milk. To the extracted milk, maltodextrin (15%) was added and mixed. The mixture was then spray dried at a temperature of 140^{o} C. The shelf life of the product was three months under ambient conditions.

Tamarind Syrup

Tamarind pulp was soaked in water (50^0C containing 15 % salt) for 30 minutes. It was then macerated to uniform thin slurry and filtered. The slurry was concentrated to syrup, in a steam jacketed kettle at a temperature of 80^0C till the mass attained a final brix of 25^0 bx. The syrup was bottled and in bottle sterilization was done for 15 minutes. The product had highly acceptable sensory qualities retaining its characteristic flavor and taste. The product had a shelf life of three months under ambient conditions.

Processing and evaluation of probiotic fruit yogurt

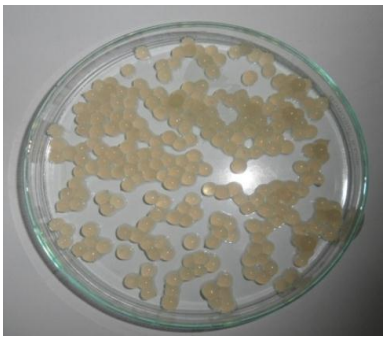
Probiotic yogurt was standardized using commercial yoghurt culture NCDC 260 and probiotic culture *Lactobacillus casei* inoculated @ 2 per cent in toned milk (fat-3%, SNF - 8.5 %, @ 1% & 2 % level) and incubated at 40 ± 2^0C for the preparation of yoghurt. To this, fruit pulp of banana, papaya, sapota or custard apple @ 5, 10 and 15 per cent and 6 ml of sugar solution (TSS- 62^0 Bx) was individually added and were evaluated for sensory attributes using 9 point hedonic scale. The overall acceptability was found to be higher for of probiotic banana fruit yoghurt with 10 % fruit incorporation. The probiotic count of probiotic banana yoghurt was 45 x10^{12} on the initial day of storage and it was recorded as 21 x10^8 at the end of storage. Yeast and mold count was found to be nil. Probiotic fruit yoghurt had a shelf life of 14 days at refrigerated condition.

Spray dried pomegranate powder

Spray drying of pomegranate (*Punica granatum*) juice was carried out using mridula red variety of pomegranate possessing uniform red arils. Fruit juice extracted filtered was tested for its TSS (14^0 Brix) acidity (0.4 %) and pH (6.0). The drying conditions followed are specified below: Inlet air temperature: 120 to 180 ^{0} C, Outlet air temperature: 42 to 75 ^{0}C, Feed rate: 1.2 to 1.7 ml / minute. The recovery of spray dried pomegranate juice was 13.30±0.03 % (without the use of additives). This product was used for making ready to use juice and squash. Food additives such as maltodextrin can also be used to improve the yield and colour retention. Pomegranate is a valuable source of ascorbic acid (24.21 mg / 100g), total carotenoids (0.218 mg / 100g), total polyphenols (148.61 mg / 100g), total flavonoids (209.83 mg / 100g) and tannin content (1620.45 mg /100g).

Development of non dairy probiotic ready-to-serve juices

Fruit and Vegetable blended RTS



2% sodium alginate beads

Probiotic encapsulated beads

Blending of fruit juices with vegetable juices is one of the new emerging trend in processing industry and its gaining more popularity. Also, it has become a convenient alternative for utilization of fruits and vegetable in order to have some value added drinks which are of high quality in respect of both sensory and nutritional aspects. Blending of two or more fruit pulp/vegetable juices can supplement their beverages blends with vitamins and minerals, besides improving their colour and appearance, flavour, taste, mouth feel and overall acceptability. The suitability of five different blended fruit and vegetable juice (Orange and Beetroot, Muskmelon and Carrot, Pineapple and cucumber, Pomegranate and

White pumpkin, Watermelon and Tomato) as a raw material for production of RTS using probiotic cultures with and without encapsulation was evaluated. The organoleptic score showed the acceptable combinations of fruit and vegetable blended RTS are Pineapple-Cucumber RTS and Watermelon-Tomato RTS (75: 25 ratio), Orange-Beetroot RTS and Muskmelon-Carrot RTS (50:50 ratio).

Formulation and storage stability of noni fruit juice blended squash

Two techniques *viz*., hot process and cold process were studied to extract the fresh juice by non-fermentation (non-traditional) method. In the hot process method the ripened fruit was steam blanched (90ºC) separately for a period of 2, 4, 6, 8 and10 minutes respectively and cooled at room temperature. The fruits were crushed manually and the juice was extracted by filtering in nylon net. In the cold process method the ripened fruit was packed in a closed plastic container and placed in the freezer (-18ºC) for a period of 6, 12, 18, 24 and 30 hours respectively. The frozen fruits were thawed at room temperature (32±2°C). The fruits were crushed manually and the juice was extracted by filtering into nylon net. It was found that in the cold processing treatment that is by keeping the noni fruit in the freezing temperature for a period of 24 hrs followed by thawing showed the highest physical and chemical characteristics. The noni fruit juice blended squash were prepared by using amla juice (NA), sathukudi juice (NS) and grape juice (NG) in different combinations. Each fruit blended noni squash was prepared by adding the selected fruit juices with noni juice at different levels and the squash was prepared as per FSSAI (2006) specification. a) noni juice - 80% and amla juice 20%, b) noni juice - 80% and sathukudi juice -20% and c) noni juice -85% and grape juice -15 % obtained the maximum score for colour and appearance, flavour, body, taste and overall acceptability.

Development of neoxanthin rich fruit powder from egg fruit (*Pouleria compechiana*)

The egg fruit powder was prepared by foam mat drying technique. The egg fruit pulpwas mixed with different foaming agents such as 3 per cent guar gum, 3 per cent glycerol mono stearate and 10 per cent egg albumen. The pulp was whipped using an electrical egg beater until maximum stable foam was formed. The maximum expansion of foam (163 ml) was observed at 3 per cent incorporation of guar gum for 20 min whipping time. For processing of egg powder, the guar gum at 3% with 20 minutes whipping time and drying at 60ºC for 6 hours was standardized. In the foam mat dried egg fruit powder, the

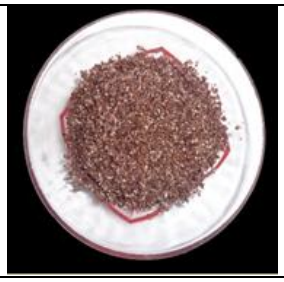
chemical, nutritional, total antioxidant activity, polyphenolic compounds, microbial load and sensory qualities were assessed. The foam mat dried egg fruit powder was incorporated in ice cream mix and cake mix at 30 and 20 percent respectively. The developed mix, were assessed for changes in quality characteristics in three different packaging materials *viz*., LDPE (P_1), HDPE (P_2) and metalized polypropylene pouches (MPP) (P_3) during storage. Among the packaging materials, metallized polypropylene retained maximum amount of nutrients and bioactive compounds. The predominant polyphenolic compounds present were gallic acid (15.35 mg and quercetin 14.78 mg/100g %).Sensory quality of egg fruit incorporated ice cream and cake had an acceptable scores even after 180 days of storage. The unit cost of production for 100g of egg fruit powder incorporated ice-cream mix and cake mix were Rs.48.50 and Rs. 40.00.

Standardization of instant puttu mix using Kavuni rice

Instant puttu mix was standardized from the partially gelatinized flour of the selected pigmented rice (TKM 9 Red rice and Kavuni) and white rice (ADT 43) varieties. The standardized formula for the preparation of instant puttu mix from red rice and kavuni rice is rice flour -100g, salt – 2g and water-30ml. The selected rice samples were cleaned and soaked in water for 1 hour and cooked for 30 minutes with salt. The cooked rice samples were dried for 6 hours at 60^0 C (13% m.c.) and pulverized to pass through BS 40 mesh sieve to obtain uniform size particles. The instant *puttu* mix was stored in polyethylene and polypropylene bags (100g). The instant *puttu* mix (100g) could be rehydrated for immediate consumption by reconstitution with hot water (80 – 90^oC). Hot water (30 ml) was sprinkled on the *puttu* mix, mixed well to obtain a crumbled texture and tempered for 12 minutes. The pigmented rice (red rice and kavuni rice) *puttu* was subjected to organoleptic evaluation using the score card with 9 point hedonic rating scale and compared to the control samples.

The glycemic index of the test food (*puttu* developed from instant *puttu* mix) from the selected rice (White rice, Red rice, and Black kavuni rice varieties) were evaluated and compared with that of the reference food (white bread). Ten subjects, all adult females (age range from 35 to 45 years, BMI 27-32 and fasting plasma glucose 114 mg/dl at baseline) were selected for the study. The glycemic index was maximum for the instant *puttu* mix prepared from white rice (79) followed by black rice (57) and lowest for red rice (48).It can

thus be concluded, that the red rice variety falls under the category of low GI food, black rice as intermediate GI food and the white rice falls under the category of high GI food.

Instant Puttu Mix		
		
Puttu from Instant Mix		
		
White rice	Red rice	Kavuni rice

Development of pulses based gluten free noodles

The formulation for gluten free noodles was optimized by Response Surface Methodology (RSM) and the product ingredients were lentil and barnyard flour. The farinograph characteristics namely water absorption (%), dough development time (min.), stability (min) and mixing tolerance index (BU) for the formulations were also studied. Based on the experimental trials, the optimum formulation for gluten free noodles was lentil flour-63g, barnyard millet flour-13g, corn flour-20g, xanthan gum-2g and salt – 2g. The optimum formulation was assesssed based on the response factors *viz.,* hardness (0.96 N), bulk density (0.627 g/cm^3), diameter (1.62 mm), lateral expansion (162 %), water absorption index (4.55gel/g), water solubility index (6.10%), overall acceptability (8.8/9.0), cooking time (8.11min.), water absorption (268.3%) and cooking loss (14.89%). The developed formulation also had high protein (13.6±0.22g/100g) and fiber content (2.89±0.04g/100g), and recorded low fat content (0.44±0.23) compared to 4.52±0.12 g/100g protein, 0.52±0.01 g/100g fiber and 1.33±0.02g/100g fat content in the control product. The gluten free noodles are recommended for patients suffering from celiac disease, who have intolerance for gluten.


Pulses based gluten free noodles

Amaranthus seed flour incorporated pasta products

Celiac disease (CD), or gluten sensitive enteropathy, is an autoimmune response to dietary wheat gluten or similar proteins of barley or rye. Celiac disease is reported to affect as many Indians as their western counterparts. Patients suffering from celiac disease have to exclude gluten containing cereals from their diet. Keeping this in view the gluten free pasta products are developed from different combinations such as (Whole wheat flour), (50% Rice flour: 50% Amaranth flour), (50% Corn flour: 50% Amaranth flour), (50% Tapioca: 50% Amaranth flour), (50% Potato: 50% Amaranth flour). The gluten replacer added to the gluten free pasta products was xanthan gum 2%. Among the different proportions, the amaranth flour (60%) and corn flour (40%) was found to be the best combination and had the higher acceptability score value of 8.0.

Manually operated hand held sapling transplanter

From several studies across the state and national level, transplanting and weeding operations were found to be most drudgery prone activities based on the physiological parameters, postural stress and drudgery index. To address this issue, use of manually operated hand held sapling transplanter to transplant the vegetable saplings was conducted.

Conventional method

Using transplanter

The findings of the study revealed a reduction in the physiological load of women and relieved them to a greater extent from the postural stress. The physiological parameters such as resting, working and recovery heart rate of the farm women involved in the transplantation of saplings were recorded using heart rate monitor. The mean work load rating as per the heart rate observed was found to be in the range of moderate (3.54) and light (2.81) for conventional and improved method respectively. The improved method of transplanting was acceptable among the farm women due to the reduced physiological stress when compared with that of the conventional method of transplanting.


FORESTRY

Industrial Forestry

The rapid industrial development along with human and cattle population explosion have increased the demand for both domestic and industrial requirement which resulted in over harvesting and rapid degradation. The wood requirement for pulp and paper industry alone is estimated to be around 45 million m^3; plywood industry 28 million m^3; construction industry 22 million m^3; splints and match box 4 million m^3; furniture 7 million m^3 etc. The overall projected demand for short rotation species is estimated to 87.7 million m^3 and for long rotation species 65.10 million m^3 during the year 2020 indicating a overall wood requirement 152.80 million m^3. Though there is an increase in wood requirement for all sectors of development, there is no concomitant plantation development programme which resulted in uncertainty in the entire industrial wood supply chain. These growing demands have compelled the Government of India to issue policy guidelines through National Forest Policy and National Agroforestry Policy (2014) to different stake holders to inculcate the agroforestry programme through industrial and farmer's participation. However, the industrial wood plantation activity has not gained serious attention for want of suitable institutional mechanism and also the existence of traditional constraints like lack of high yielding varieties, non-availability of quality planting materials coupled with multi-partite supply chain system and poor price support mechanism delimit the agroforestry plantation development program. Against this backdrop, the Forest College and Research Institute of Tamil Nadu Agricultural University has conceived an organized Value Chain model for Industrial Agroforestry and resolved the issues flagged above through technological, organizational and marketing interventions.

Constraints and Problems identified in Industrial Agroforestry

The Forest College and Research Institute has made elaborate survey and discussion with several stake holders involved in the entire Production to Consumption System (PCS). The stake holders represented farmers, wood based industries, financial institutions and research organizations. The discussions and the interactions with the different stake holders have identified the following constraints which demanded serious interventions for successful development of industrial agroforestry.

Production Constraints

The following constraints are identified as the serious setback for establishment, development and promotion of industrial agroforestry plantations in the state of Tamil Nadu.

- Lack of high yielding and short rotation varieties
- Non availability of quality planting material
- Non availability of institutions for mass multiplication
- Low productivity from unimproved seedling progenies
- Alternate genetic resources not explored and exploited
- Poor adoption of precision silvicultural packages
- Lack of profitable and multi-functional agroforestry model

Processing Constraints

The base line study identified the following processing constraints which demanded strong intervention.

- Lack of mechanization
- Poor understanding on harvest and post-harvest management
- Un and underutilization of plantation residues
- Inventory on alternate utility of woody biomass.

Consumption Constraints

The success or failure of many plantation programme is widely questioned. The reasons for failures are many but the key reasons identified are unorganized supply chain and uncertainity in market. The research group has identified the following constraints in the consumption sector.

- Existence of Multi partite supply chain
- Lack of price support mechanism
- Nonexistence of contract tree farming
- Lack of credit facilities
- Non availability of insurance for plantation protection

Technological intervention

Miniclonal Technology

A mini clonal technology has been developed for Casuarina and Melia which is one of the pioneering attempts in the country for these two industrial wood species.

Clonal Garden establishment

The clonal garden was established at a size of 10 x 1 x 0.6 m / 5 x 1 x 0.6 m / 3 x 1x 0.6m using cement trough / GI trough. The bed was filled with 20 mm stones upto 25 cm and over which finely sewed river sand is filled. The raised beds were covered with 100 micron UV stabilized polyethylene film on the top and covered with insect proof mesh to protect the plants and to ensure its freeness from pest and diseases.

Fertigation

The clonal garden was maintained with irrigation at an interval of every one hour and supplemented with Urea (300-400 g/m^2), SSP150(175 g/m^2), KCL (175-250 g/m^2) and Micro nutrient mixture (100 g/m^2). The nutrients were applied twice or thrice depending on the rate of growth of plants.

Clonal Management

The plants are allowed to grow upto 60 days by applying the required nutrient composition. After 60 days, the plants are pruned at required size preferably at half of the plant to induce new shoots. With continuous irrigation and nutrient management, the cuttings start producing shoots from 8-10 days onwards and after 15-20 days, the cuttings are collected and treated with 2% carbendazim solution.

Clonal Treatment

The newly induced shoots were separated from the plants and treated with or without 1500 ppm IBA (liquid formulation) and planted in 90 cc root trainers filled with decomposed coir pith. The rooting started in 15 days and 25 days old rooted plants are ready for hardening.

Green House Conditions

The root trainers are kept under greenhouse conditions with a temperature regime of 32 – 35°C and a relative humidity of 85-95%. Periodical watering once in every 30 minutes is preferred.

Acclimatization and Hardening

The rooted plants are hardened in a shade house condition with 50% shading for 7-15 days and maintained with adequate irrigations. After hardening chamber, the plants are lifted to open nursery for 30 days. Watering is done 2 times a day and the fertizer of all 19 (N:P:K) was applied at the rate of 5g/plant. During this hardening, application of carbendazim (2g/l) or triazophos (2ml/lr) is recommended based on the incidence of diseases and pests.

Advantages

Under this method, rooting efficiency and the uniformity has been increased significantly which resulted in uniformity in establishment, growth and development of clones. The mini clonal garden is maintained upto 5 years. With minimal space, time, labour requirement, easy handing and management coupled with uniform rooting ensures higher

productivity and avoid epigenetic variation which proved superior to the existing macro clonal technology.

Development and Promotion of High Yielding Short Rotation Clones

The TNAU has developed high yielding short rotation varieties one each in Casuarina (TNAU Casuarina MTP 2), Eucalyptus (TNAU Eucalyptus MTP1) and *Melia dubia* (TNAU Malai vembu MTP1) which are amenable for harvest from 18 months onwards. The yield and rotation 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

Species	Variety	Rotation	Yield/ha	Utilizing industry
Casuarina Hybrid	TNAU Casuarina MTP 2	3 Years	150 tonne	Paper, Pole and Construction industries
Eucalyptus camaldulen	TNAU Eucalyptus MTP 1	3-5 Years	150 tonne	Paper industry
Melia dubia	TNAU Malai vembu MTP 1	18 to 24 Months	150 Tonn	Paper Industry
Melia dubia	TNAU Malai vembu MTP 1	5 Years	250 tonne	Veneer, plywood an splints industry

Inventory and Development of Alternate Industrial Wood Genetic Resources

The another major intervention is the identification of alternate pulpwood species where in a fast growing clone in *Melia dubia* has been identified with a pulp recovery of 50% and a kappa number of 19% coupled acceptable strength properties *viz.,* tear (10.1 $mN.m^2g$), tensile (86 Nm/g) and burst index (5.8 $kPa.m^2/g$). Similarly in *Dalbergia sissoo* (Cellulose content - 73.6%, Kappa Number – 20.2), *Leucaena leucocaephalla* (Cellulose content - 70.2%, Kappa Number – 20.7) and Eucalyptus – EC 48 (Cellulose content - 75.2%, Kappa Number –19.30) potential clone have been identified and incorporated in the promotional activities for pulp and paper industries.

For match industries, 4 species *Ailanthus triphysa*, *Anthocephalus cadamba*, and *Albizzia falcataria* have been identified as potential genotypes with a stick recovery of 18000 per kg, 17000 per kg, and 16500 per kg respectively. All these species *Ailanthus triphysa, Anthocephalus cadamba* and *Albizzia falcataria* have proved superior in terms of density, fissility, colour and splint recovery. Hence these species have been incorporated in the matchwood promotional programme.

Industrial Wood Species

Casuarina MTP 1

Casuarina MTP 2

Eucalyptus MTP 1

Malai Vembu MTP 1

Leucaena leucocephala (LL15)

Neolamarckia cadamba (AC7)

Dalbergia sissoo (DS 18)

Gmelina arborea

Precision Silvicultural Technology

Optimizing tree density

One of the major factor identified for yield gap is the plant density per ha of plantations. Hence studies were conducted and it was identified that population density of 4400 – 5000 per ha (4 ft x 4ft and 5 ft x 5 ft) has yielded higher returns compared to the traditional planting of 8000 – 10000 plants / ha.

Irrigation and Fertilizer requirement

The irrigation and fertigation studies to augment the productivity of Casuarina clone further indicated that the following three treatments *viz.,* Fertigation with 125% WSF viz., 1.85g MAP, 1.39g polyfeed and 1.58g potassium nitrate per week per plant along with 8 L of water per day (or), Fertigation with 100% WSF viz., 1.48g MAP, 1.11g polyfeed and 1.26g potassium nitrate per plant per week along with 8 L of water per day (or), Fertigation with 125% CF viz., 1.51g urea, 1.39g MOP per week per plant along with 8 L of water per day along with soil application of SSP@ 117.1g once in 3 months per plant (totally 4 splits per year) have been found ideal for productivity improvement of Casuarina.

Profitable Agroforestry Model

The cogeneration of wood and food has been found amenable with Casuarina clonal plantations. The intercropping studies identified cowpea and groundnut crops as suitable intercrops for this model. This agroforestry model exhibited the benefit cost ratio of 3.78 when sold for pulpwood and 5.01 when sold for pulp and pole market. This model attracted many farmers towards cogeneration of wood and food particularly black gram and ground nut with TNAU Casuarina MTP 2.

Value Addition Technology

The plantation residues of Casuarina which were so far unutilized, have been successfully value added into briquettes. This value addition has created new industrial supply chain and attracted many rural industries. The economic analysis indicated that the value addition of residues into briquettes has generated an additional income of Rs. 1750 / tonnes of briquette produced.

Semi Mechanized Harvesting System

The project has significantly contributed by introducing semi mechanized harvesting system using power chain saw. The economic analysis indicated that felling efficiency of semi mechanized harvesting has been improved to 30 tonnes / 8 hours compared to 8

tonnes / 8 hours for manual felling. This felling efficiency and reduction in cost of felling attracted one of the industrial partner (TNPL) who have purchased over 100 power chain saws and given to potential farmers at free of cost and they were successfully involved in felling operation. This has resulted in creation of over 200 felling groups which thereby attest the successful intervention of organized felling system.

Organizational Intervention

The Tamil Nadu Agricultural University has resolved the multi-partite supply chain into an organized value chain model. TNAU has conceived the consortia mode organized farming system which is furnished below.

Consortium mode Organized Tree Farming

The TNAU has strongly intervened in the existing multipartite supply chain system and successfully introduced organized bi, tri and quad partite model value chain models which have been attracted and adopted by many wood based industries. In this organized value chain model, farmers, research institutes, wood based industries and financial institutions have participated as a consortium and played a significant role in resolving the issues through technological, organizational and marketing interventions

Marketing Intervention

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 successful price supportive system implemented and practiced is furnished below.

Price supportive system

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 2).

Tree Insurance Scheme

The 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 3. 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 should be replicated across the country for all the farm grown tree species.

Table 2. Price support for various industrial wood species

Species	Market	Price support per metric tonne	
		Pre intervention During 2008	During 2016
Casuarina species	Pulp and paper	Rs.2000	Rs.5350
Casuarina hybrid clone	Pole	Rs.3000	Rs.8500
Eucalyptus species	Pulp and paper	Rs.2000	Rs.4500
Leucaena leucocephala	Pulp and paper	Rs.1600	Rs.4400
Ailanthus excelsa	Match Splints	Rs.2200	Rs.6500
Melia dubia	Paper	No Price	Rs. 4400
Melia dubia	Plywood	No Price	Rs. 7500
Tectona grandis	Timber	Rs.8000-12000	Rs.20000

Table 3. Insurance premium rates for agroforestry plantation

Name of plantation	Premium rate (Rs./acre)									
	1st YR	2ND YR	3RD YR	4TH YR	5TH YR	6TH YR	7TH YR	8TH YR	9TH YR	10TH YR
Casuarina	NO COVERAGE									
a) seedling plantation		337	407							
b) clonal plantation		590	758							
Eucalyptus		365	485	618	695	779				
Melia dubia		646	829	941	1053	1138				
Ailanthus		730	927	1046	1138	1222				
Gmelia		414	611	730	843	864	892	920	941	1053
Leucaena		885	906	1025	1145	1264				
Dalbergia sissoo		548	576							

Consortium of Industrial Agroforestry

In order to sustain the activities of industrial agroforestry, the Forest College and Research Institute of Tamil Nadu Agricultural University has established an institution called Consortium of Industrial Agroforestry which has brought all stakeholders in one platform. As of now, the consortia has enrolled 138 members which involved wood based industries, scientists, potential farmers, rural industries, nursery growers, felling and marketing group, plantation developers and financial institutions. The consortium meet annually and identify the problems faced in industrial agroforestry production, processing, consumption system and identified strategies to resolve the issues. This consortium also established industry linked research and development projects which will cater to the needs of farmers and other stakeholders.

MTPCP18: A promising silk cotton clone for agroforestry

A clonal evaluation programme has been conducted during the last 10 years deploying 14 clones selected from across the state. Among 14 clones evaluated, the superiority of clone MTPCP 18 was evidenced due to higher pod and floss yield.

- Method of Breeding - Clonal selection
- Plant density - 277 ha^{-1}
- Average Height(10 years) - 16.52 meters
- Average Basal diameter (10 years) - 50.27 cm
- Average Pod yield - 264 – 300 pods / tree
- Pod length - 29.1 cm
- Green pod weight - 214.23 grams
- Pod Yield at 10 years after planting - 73128 pods ha^{-1}
- Floss yield - 365 $kgha^{-1}$

Potential Fodder Trees

The Forest College and Research Institute has identified 21 fodder tree species and assembled as a potential fodder trees amenable for varied agroclimatic region. These species are amenable for management under hedge garden in order to meet the fodder needs during lean seasons. The fodder hedge model was established at FCRI in 20 m x 1m size plot. The fodder quality parameters indicated the suitability of the species for fodder utility during offseason as a green as well as dry fodder.

Tree Fodder Quality Analysis

Crop	DM (%)	Crude Protein (%)	Crude Fibre (%)	Crude Fat (%)
Leucaena leucocephala (Subabul)	43.00	21.70	16.50	3.02
Leucaena diversifolia (Subabul)	37.28	20.34	16.00	2.35
Holoptelea integrifolia (Aaya maram)	44.72	11.90	15.00	3.03
Melia dubia (Malai vembu)	32.06	19.43	16.00	2.69
Sesbania grandiflora (Agathi)	21.07	21.35	16.50	1.67
Pithecellobium dulce (Kodukkaipuli)	50.61	20.16	20.00	3.36
Thespesia populnea (Puvarasu)	34.45	13.06	10.50	2.68
Morus indica (Mulberry)	45.38	12.04	16.50	2.01
Neolamarckia cadamba (Vellai Kadambam)	26.27	16.35	11.00	2.60
Bauhinia variegata (Sem-Mantharai)	46.29	12.71	32.00	2.34
Hibiscus tiliaceus (Malai Puvarasu)	40.00	12.60	21.00	2.70
Dalbergia sissoo (North Indian Rosewood)	42.93	16.52	18.50	4.39
Gliricidia sepium (*Gliricidia*)	23.80	16.14	12.50	1.34
Albizia lebbeck (Vaagai)	45.30	17.08	24.50	3.03
Ficus benghalensis (Banyan tree)	44.60	9.07	25.00	2.68
Moringa oleifera (Drumstick)	32.57	20.62	12.50	2.68
Ceiba pentandra (Kapok)	35.85	9.66	22.50	3.71
Terminalia arjuna (Maruthu)	48.89	8.92	14.00	4.05
Ficus religiosa (Peepal tree / Arasu)	40.28	10.82	22.50	4.70
Melia composita (Malai vembu)	43.90	15.02	14.50	3.02
Pterocarpus santalinus (Red sandal)	57.43	11.66	26.50	2.00

Non-timber Forest Product: Naval Powder

Syzygium cumunii (Naval) fruit one of the Non-Timber Forest Product from the forest known for its edible value. The fruits are highly perishable in nature. They cannot be stored for more than 3 to 4 days under ordinary conditions.. The technique for conversion of Naval fruits into powder form (Spray drying) was developed by Forest College and Research Institute. The proximate analysis of the powder form was analysed.

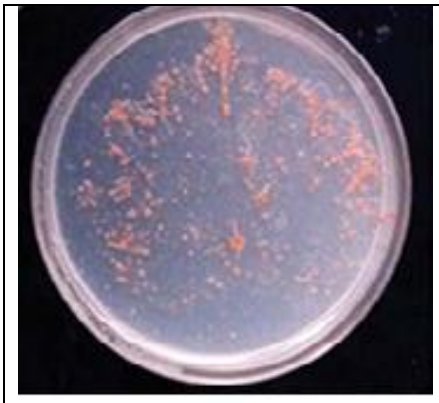
Parameters analysed	Result
Protein (%)	1.75
Fat (%)	0.70
Fiber (%)	1.10
Carbohydrate (%)	82.39
Ash (%)	4.64
Moisture (%	9.42
Energy (Kcal)	342.86
Vitamin C (mg/100gm)	810.00


TECHNOLGIES FOR ADOPTION
AND COMMERCIALIZATION

TECHNOLOGIES FOR ADOPTION AND COMMERCIALIZATION

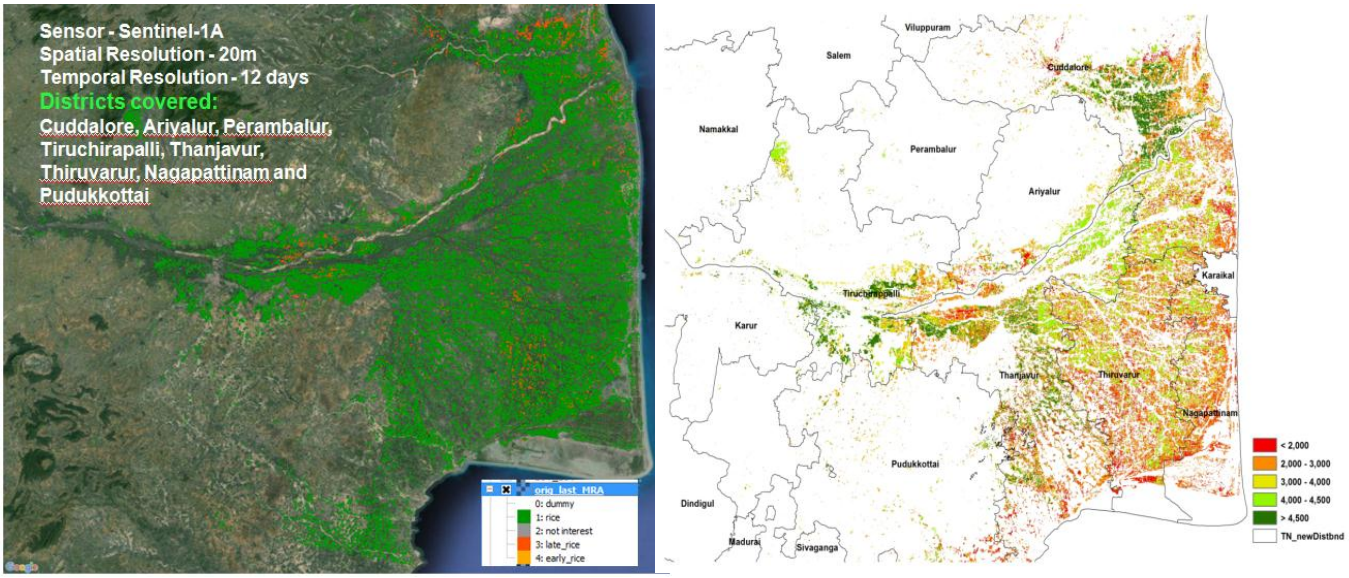
TNAU CROP BOOSTERS		
TNAU Coconut Tonic 	TNAU Coconut Tonic has nutrients and growth regulators for coconut, increases chlorophyll content and greenness of leaves, improves photosynthetic efficiency, decreases button shedding and increases nut yield up to 20 per cent.	Root feeding of the tonic @ 200 ml / palm twice a year at six months interval. **Quantity distributed during 2015-2017: 22351 litres**
TNAU Pulse Wonder 	A booster with nutrients and growth regulators for pulses, decreases flower shedding and increases yield up to 20 per cent apart from improving drought tolerance.	Foliar spray @ 2.0 kg/acre (which should be dissolved in 200 litres of water) at peak flowering time. **Quantity distributed during 2015-2017: 61346 kgs**
TNAU Groundnut Rich 	A booster with nutrients and growth regulators for groundnut, enhances flower retention, improves pod filling and increases pod yield up to 15 per cent with better drought tolerance.	Foliar spray @ 2.0 kg/acre (which should be dissolved in 200 litres of water) at peak flowering and pod development stages. **Quantity distributed during 2015-2017: 4223 kgs**
TNAU Cotton Plus 	A booster with nutrients and growth regulators for cotton, reduces flower and square shedding, improves boll bursting, increases seed cotton yield up to 18 per cent and improves drought tolerance.	Foliar spray @ 2.5 kg/acre (which should be dissolved in 200 litres of water) at flowering and boll formation stages. **Quantity distributed during 2015-2017: 2780 kgs**

TNAU Maize Maxim 	A booster with nutrients and growth regulators for maize, improves grain filling, increases grain yield up to 20 per cent and improves drought tolerance.	Foliar spray @ 3.0 kg/acre (which should be dissolved in 200 litres of water) at tassel initiation and grain filling stages. **Quantity distributed during 2015-2017: 312 kgs**
TNAU Sugarcane Booster 	A booster with nutrients and growth regulators for sugarcane, enhances cane growth and weight, improves internodal length, increases cane yield up to 20 per cent and enhances drought tolerance.	Foliar spray @ 1, 1.5 and 2.0 kg / acre (which should be dissolved in 200 litres of water) at 45, 60 and 75 days after planting respectively. **Quantity distributed during 2015-2017: 1717 kgs**
Liquid formulations of biofertilizers		
	Liquid formulation of biofertilizers are made available to the farmers to overcome the problems associated with carrier based biofertilizers.	Seed treatment – 500 ml each *Azospirillum* and Phosphobacteria per ha seeds; Seedling dip – 500 ml each *Azospirillum* and Phosphobacteria per ha seedlings; Soil application - 500 ml each *Azospirillum* and Phosphobacteria per ha seedlings; Tree crops – 100 ml each *Azospirillum* and Phosphobacteria per tree once in six months. Biofertigation: One ml per lit of water mix in the fertigation tank (Capacity: 60 lit) trice at 30 days interval.

	Fasten seed germination and seedling growth Accelerate vegetative growth Increase leaf area index and chlorophyll content Earliness in flowering, fruit set and maturation Improves fruit quality, color and seed weight Yield increase by 10% Mitigate drought	Spraying of PPFM at 500 ml/ha with 500 litres of water thrice at active growth stage of crops with 15 days interval.

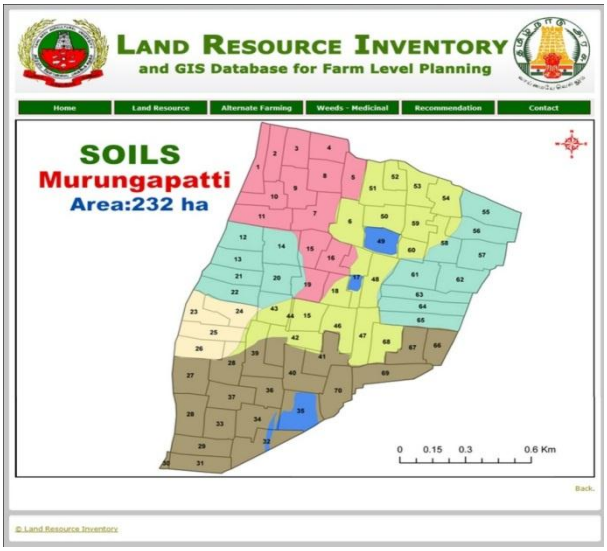
RIICE Technology for Remote Sensing Based Crop Monitoring and Yield Estimation

With latest advances in remote sensing and crop yield modeling, it is now possible to provide precise information on crop acreage, crop health, yields, damages and losses during floods and drought. Various maps *viz*. area map, seasonality map, seasonal map and phenology map were developed using Multi-year and seasonal Synthetic Aperture Radar (SAR) data viz., CosmoSkymed, TerraSAR-X and RISAT. The crop growth simulation model ORYZA was used to estimate yield involving remote sensing products in addition to the usual meteorological, soil, and plant parameters. Early estimation of the yield by Remote Sensing Based Crop Monitoring is expected to facilitate the policy makers in the event of natural calamities without waiting for the data on Crop Cutting Experiments (CCEs).



Samba Rice area and yield map 2015-16

Web Based Fertlizer Recommendation System Using Cadastral Level Soil Maps



Detailed soil survey was made for more than 1,10,000 acres of entire Rasipuram, Valapadi and Veerapandi blocks soil for a period of three years. Based on various parameters obtained from the soil survey data, web based software was developed for fertilizer recommendation to the respective fields. A farmer by knowing his survey number in the mapping unit and can click on his survey number, the software will display the erosion detail of the survey number, colour, depth, pH, calcareousness details and available macro and micro nutrient status of particular survey number of the farmer. It also shows the list of highly suitable crops, moderately and marginally suitable crops of the particular survey number. From the list farmer can select the crop and the details of area of cultivation is to be entered through the interface. The software will provide fertilizer recommendation for the selected crop. The fertilizer recommendation is based on its soil available nutrients status. It also explores the problem, viz., soil reclamation, soil conservation, and if the soils are problem in nature and the software also provides details about suitable crops for saline, alkaline and calcareous soil. This application is now available in all the primary Agriculture Co-operative Societies, Agricultural Extension centers of concerned three blocks and through the url: https://sites.google.com/a/tnau.ac.in/rsgis/maps.

Enhanced Freshness Formulation (EFF) technology

The Enhanced Freshness Formulation (EFF) technology has been released for adoption as a fruit preservative. Pre-harvest spray of 2% EFF twice (15 and 30 days before harvest) reduced the post-harvest losses by 10-15% in major varieties of mango. Fruits harvested from the sprayed trees had a extended shelf-life of 2-3 weeks under storage conditions besides retention of fruits on trees by

another three weeks. Due to the delayed harvest and extended shelf-life, this technology helps the farmers to gain lucrative price in the market due to the late arrival.

Pre-harvest spray of EFF

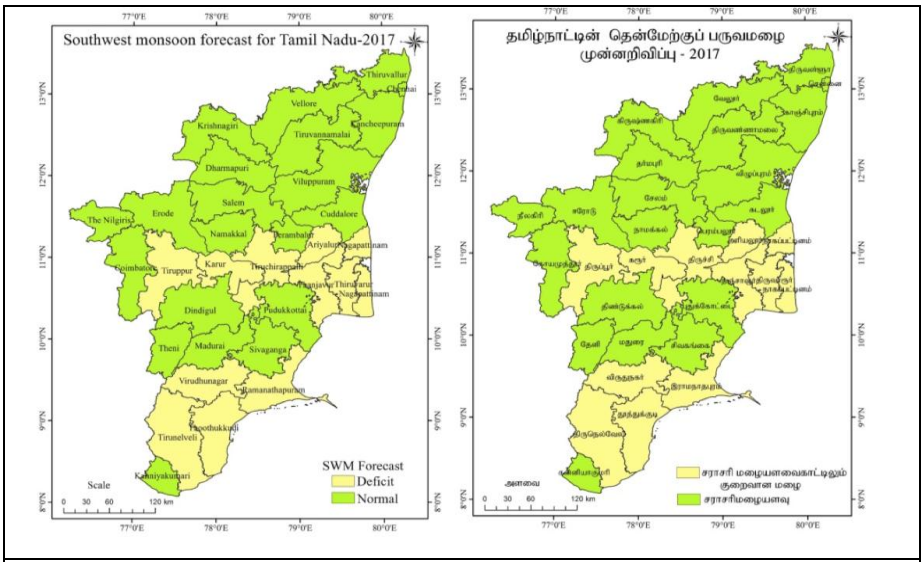
Increased Shelf life after post-harvest dip

- The post-harvest dipping of fruits (mango and banana) and vegetables (cucumber and tomato) in 2% EFF extended shelf-life by 12-18 days under ambient storage conditions.
- Electrospun nano-fibre matrix fortified with hexanal (Sticker) and β cyclodextrin inclusion complex (Sachet) have been developed to minimize the post-harvest fruits damage during transport. The cost of technology hardly exceeds Rs. 5 per piece to protect the fruit box carrying 2-3 kgs.

Seasonal Climate Forecast for South West Monsoon and North East Monsoon

Weather based farm decision making helps in reducing the production cost, climatic risks on crop production and improves yield and farm profit. Since 2013, district level rainfall forecast over Tamil Nadu for the ensuing monsoon is being prepared at Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore as Seasonal Climate Forecast (SCF) bulletin. The SCF for South West Monsoon is given by last week of May and North East Monsoon is given by last week of September along with agro advisories on precautions and suitable crops. This could be utilized for modifying both on-farm as well as off-farm decisions with proper understanding and assessing its impact on crop production and income

maximization. Rainfall expected during Southwest monsoon 2017 with 60 per cent probability is given in Fig.1. Sixty five per cent of the State will be receiving the normal rainfall during this South West Monsoon season 2017.



Seasonal Climate Forecast for South West Monsoon 2017

Medium range weather forecast (MRWF)

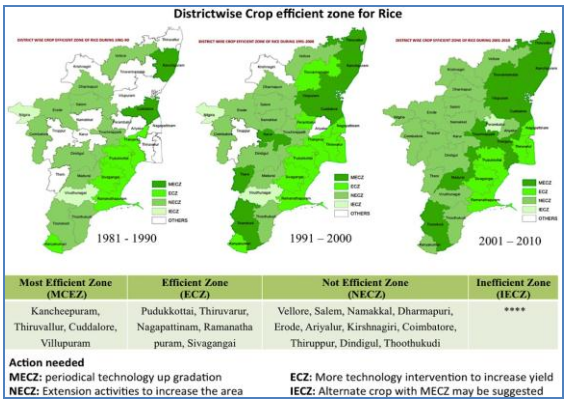
Medium Range weather forecast is highly useful for farmers to plan their next few days' cultural operations at farm level and to take necessary precautionary measures against extreme events. Since 2009, Agro Climate Research Centre, Tamil Nadu Agricultural University is providing block level medium range weather forecast for nine parameters *viz.,*rainfall, maximum and minimum temperature, morning and evening relative humidity, wind speed and wind direction. The weather forecast is being uploaded every day by 10.00AM as data and chart, with a lead time of next six days in public domain "tawn.tnau.ac.in". Both block wise data and charts for overall Tamil Nadu are given for easy understanding both in Tamil and English language.

IWeather based agro advisory bulletins and mobile SMS

In collaboration with India Meteorological Department, under Gramin Krishi Mausam Sewa (GKMS) scheme, weather based agro advisory bulletins in both Tamil and English languages are being prepared on every Tuesday and Friday. Studies indicated that the bulletin created awareness on weather based agro advisory among the farmers and more than 75 of farm operations are decided by using these agro advisories. Agro advisory in both Tamil and English languages are being sent to 8.67 lakh farmers for every Tuesday and Friday. Timely advisories help them in reducing risk and increasing input productivity.

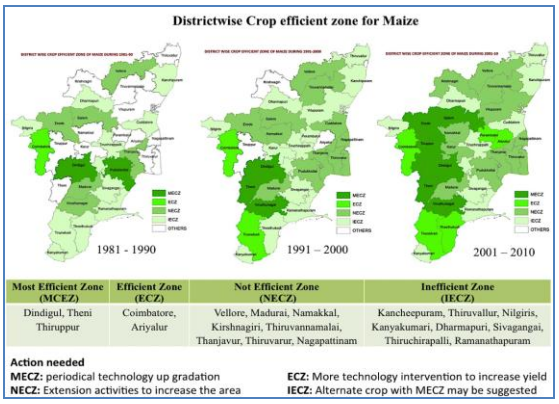
Districtwise crop efficient zone for rice, maize, sorghum and cumbu

Recent past, many of native crops have been replaced with newly introduced crops. But the productivity of most of newly introduced crops is less due to introduction without concerning the soil and climatic requirement of the new crops. Even for the native crops, the yield is declined due to change in climate and soil factors. Hence, it is necessary to identify the crop wise efficient zones for better productivity and profitability. Relative Yield Index (RYI) and Relative Spread Index (RSI) are simple and efficient tool to identify the crop efficient zones. This is also an adoption activity could reduce the climate change risk. A study was conducted at Agro Climate Research Centre during 2016 – 17 under University Research Project and identified district level crop efficient zone for rice, maize, cumbu and sorghum (Fig. 2 - 5). The crop efficient zone categories could be interpreted as below.



Most Efficient Zone (MCEZ)	Efficient Zone (ECZ)	Not Efficient Zone (NECZ)	Inefficient Zone (IECZ)
Kancheepuram, Thiruvallur, Cuddalore, Villupuram	Pudukkottai, Thiruvarur, Nagapattinam, Ramanatha puram, Sivagangai	Vellore, Salem, Namakkal, Dharmapuri, Erode, Ariyalur, Kirshnagiri, Coimbatore, Thiruppur, Dindigul, Thoothukudi	****

Action needed
MECZ: periodical technology up gradation
NECZ: Extension activities to increase the area
ECZ: More technology intervention to increase yield
IECZ: Alternate crop with MECZ may be suggested



Most Efficient Zone (MCEZ)	Efficient Zone (ECZ)	Not Efficient Zone (NECZ)	Inefficient Zone (IECZ)
Dindigul, Theni Thiruppur	Coimbatore, Ariyalur	Vellore, Madurai, Namakkal, Kirshnagiri, Thiruvannamalai, Thanjavur, Thiruvarur, Nagapattinam	Kancheepuram, Thiruvallur, Nilgiris, Kanyakumari, Dharmapuri, Sivagangai, Thiruchirapalli, Ramanathapuram

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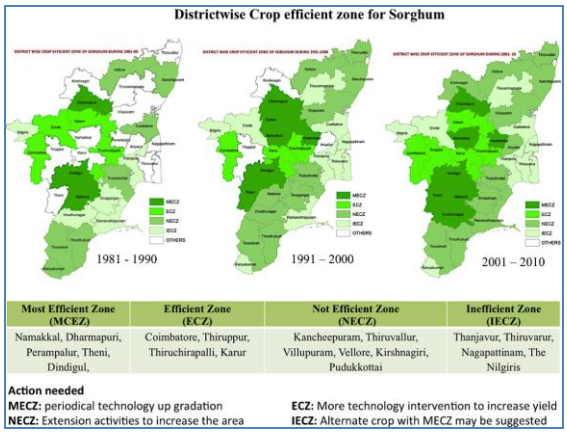

Most Efficient Zone (MCEZ)	Efficient Zone (ECZ)	Not Efficient Zone (NECZ)	Inefficient Zone (IECZ)
Namakkal, Dharmapuri, Perampalur, Theni, Dindigul,	Coimbatore, Thiruppur, Thiruchirapalli, Karur	Kancheepuram, Thiruvallur, Villupuram, Vellore, Kirshnagiri, Pudukkottai	Thanjavur, Thiruvarur, Nagapattinam, The Nilgiris

Action needed
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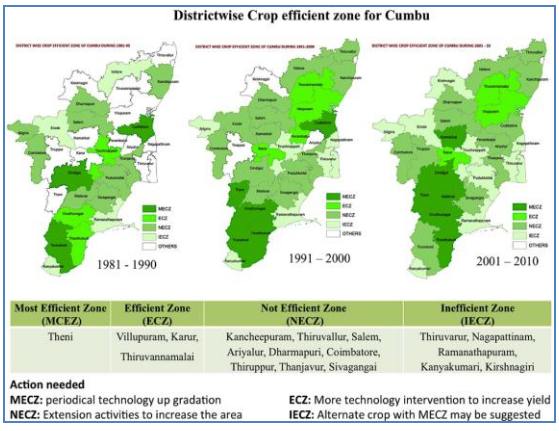

Most Efficient Zone (MCEZ)	Efficient Zone (ECZ)	Not Efficient Zone (NECZ)	Inefficient Zone (IECZ)
Theni	Villupuram, Karur, Thiruvannamalai	Kancheepuram, Thiruvallur, Salem, Ariyalur, Dharmapuri, Coimbatore, Thiruppur, Thanjavur, Sivagangai	Thiruvarur, Nagapattinam, Ramanathapuram, Kanyakumari, Kirshnagiri

Action needed
MECZ: periodical technology up gradation
NECZ: Extension activities to increase the area
ECZ: More technology intervention to increase yield
IECZ: Alternate crop with MECZ may be suggested

Most Efficient Cropping Zone has higher yield and crop area, hence periodical technology up gradation is necessary to sustain the same. In Efficient Cropping Zone, technology intervention has to be done to increase the yield, where the area under the crop is high with low crop productivity. In Not Efficient Cropping Zone, Extension activities may be initiated to increase the area, where there is good yield potential with minimum spread. In

Inefficient Cropping Zone, alternate suitable cropping system may be promoted, where both the area and yield is low.

Management of Root Knot Nematode Wilt Disease Complex in Guava and Pomegranate

Tamil Nadu farmers have been facing decline of guava and pomegranate orchards wherein three to four year old trees show yellowing and wilting followed by shedding of leaves, reduction in fruit size followed by complete death of trees. The guava nematode wilt complex was first intercepted from Ayakudi village of Dindigul district and that of pomegranate at Sivagiri, Erode district. Oflate, the problem has been observed in almost all the guava and pomegranate growing districts of Tamil Nadu.

Symptoms of Root Knot Nematode Wilt Disease Complex in Guava

Morphological and molecular confirmation of the root knot nematode species in guava and pomegranate proved them to be *Meloidogyne enterolobii* in guava and *M.incognita* in pomegranate. On inspection it was observed that guava root stocks used for grafting, grafted seedlings and layered cuttings (ground layers) purchased by farmers from various nurseries themselves harbored root knot nematodes which inturn get introduced into orchards. Wide awareness was given to farmers and extension officials through media such as newspapers (English and Tamil dailies) and as newsflashes in TV and AIR. Newsflashes were given on 'New nematode in guava' and 'Nematodes of guava and pomegranate' in DD PODIGAI TV Channel, and in Dinamalar.com as 'youtube' on the necessity to randomly check for galls in the roots of planting material they purchase to ensure they are nematode free, to take prophylactic measures to manage the nematodes using egg parasitic fungi such as *Purpureocillium lilacinum* and *Pochonia chlamydosporia,* available in the Department of Nematology, TNAU, Coimbatore. Training programmmes were imparted to fruit growers and extension officials across the state. 'Nematode Awareness Campaigns', 'Scientists-Farmers interactive meet' and 'Kisan Mela' were organized under the AICRP on Nematodes in Cropping Systems, ICAR, New Delhi to address the growers on assuaging the situation. A trilingual (English, Tamil and Hindi) video documentary funded by AICRP on Nematodes has been prepared on 'Management of root knot nematodes in guava and pomegranate' to create awareness on identification and management of these

nematodes, and is being widely circulated among the scientific and farming community. A workshop has been proposed for horticulture officers incharge of State Horticulture Farms, Quarantine officials and Nursery people dealing with fruit crops on 'Field diagnosis and management of plant parasitic nematodes in horticultural crops' in which the techniques of producing nematode free planting material, their detection and de-nematisation methods will be delivered by means of theory and practical sessions.

ROLE OF KVKS IN TECHNOLOGY TRANSFER AND ADOPTION OF TNAU TECHNOLOGIES

Krishi Vigyan Kendras (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, 3 KVKs under the control of TANUVAS, 2 KVKs with Deemed Universities and the remaining 11 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 farm 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.

Accomplishments of KVKs

On Farm Testing [OFT]

On Farm Testings 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 265 OFTs were conducted in an area of 625 ha.

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 farmers field to assess their performances. The successful technologies of the OFTs will be converted as FLDs. A total of 830 FLDs were organized in an area of 2395 ha directly benefitting 6568 farmers in various districts of Tamil Nadu. The year wise accomplishments of the OFT/ FLD along with lists of technologies disseminated are presented in Table 1.

Skill Teaching by Trainings

To create awareness, knowledge, skill and adoption of TNAU technologies a total of 1786 trainings were organized benefitting 68128 farmers, 638 sponsored training programmes benefitting 30312 farmers. To develop farmers as entrepreneurs 111 Vocational training programmes were organized benefitting 3674 farmers. The year wise accomplishments of the trainings are presented in the table 1.

Exhibitions/Mela and other Extension activities

To create awareness and to popularize TNAU technologies, exhibitions, mela, field day, farmers day and campaigns were organized by KVKs at the District and State level. A total of 538 programmes were organized benefitting 219035 farmers during the period 2014 to January 2017. Besides, KVKs have organized various Extension activites /programmes for the benefit of farming community in transfer of technology during Farmers day (2014 to 2016), Agri Intex at TNAU, Coimbatore.

Table 1: Accomplishments of TNAU KVKs (2014-2017)

S.No.	Year / Particulars	2014 - 15	2015 - 16	2016-17	Total
On Farm Trial					
1	OFT (Nos.)	82	66	117	265
2	OFT (Area in ha)	151	189	285	625
3	OFT beneficiaries (Nos.)	465	380	498	1343
Front Line Demonstration					
1	FLD (Nos.)	211	256	363	830
2	FLD (Area in ha)	696	906	793	2395
3	FLD beneficiaries (Nos.)	2124	2207	2237	6568
Trainings					
1	Trainings On Off – (Nos.)	818	487	481	1786
2	No. of farmers – On and Off campus trainings	30996	20466	16666	68128
3	Vocational training	54	27	30	111
4	No. of farmers – Vocational trainings	2023	2784	2867	7674
5	Sponsored training (Nos.)	266	296	276	838
6	No. of Beneficiaries (farmers) of sponsored training	9844	15339	15129	40312
Exhibition/Farmers Day/Field day/ Mela					
1	Exhibition/Farmers Day/Field day/ Mela (Nos.)	277	154	207	638
2	No. of farmers participated	62018	77364	79653	219035

Directorate of Agri-Business Development

The Directorate of Agri-Business Development remains as the nodal point commercializing the Varieties and Technologies developed by the scientists of Tamil Nadu Agricultural University. The following are the activities carried out by the Directorate of Agri-Business Development.

Name of the Technology	Agency to which commercialized	Technology Transfer Fee in Rupees
TNAU – SRI Power Weeder	M/s. Sharp Garuda Farm Implements Pvt. Ltd.,	5,00,000
TNAU – Downdraft Gasifier	M/s. Excess Renew Tech (P) Ltd.	1,00,000
Solar Crop Drier (Tunnel Type)	M/s. Excess Renew Tech (P) Ltd.	1,00,000
TNAU Maize Hybrid CO7 & CO8 (F1 Commercial Seed)	M/s. Karnataka State Seed Corporation limited (KSSC)	No License fee
TNAU – Liquid based Biofertilizer	M/s. Devi Biotech Pvt Ltd	5,00,000
Seed Pelleting of Sesame seeds using seed pelleting Mixture for Sesame	M/s Reliable Corporation, Chennai	3,00,000
Rice Hybrid CORH-4	M/s. Trimurti Plant Sciences Private Limited, Hyderabad, Telangana	5,00,000
TNAU Maize Hybrid COH (M)8	M/s. Trimurti Plant Sciences Private Limited, Hyderabad, Telangana	5,00,000
Sugarcane Juice Bottling Technology	M/s. Skysis Foods and Beverage Private Limited.Sonipat, Haryana	2,00,000
Consultancy on Palmyrah	M/s. Bihar Agricultural University, Sabour, Bihar	30,50,000

SEED PRODUCTION AND DISTRIBUTION

SEED PRODUCTION AND DISTRIBUTION 2016 -17

The Seed Centre is coordinating seed programme in TNAU based on adoption of single window system with the following mission and mandate.

Mission

- Quality seed production and effective seed distribution network.
- Capacity building in seed science and augmenting seed production hubs.
- Orientation of research that commensurate with advancement.
- Public – Private – People Partnership for technology development

Mandate

- Educate the students in seed science and seed quality regulations.
- Engage in advanced and innovative research in seed science.
- Entertain outreach activities.
- Enhance production of quality seeds of crop varieties.
- Ensure timely delivery of seeds to farmers.
- Encourage institutional networking.

Seed Centre of TNAU is actively involving in seed production component with 175 varieties of 47 principal crops and 1647.07 q of foundation seeds and 3267.04 q of TFL seeds in various crop varieties and 28.93570 lakh numbers of planting materials were produced and distributed to the Department of Agriculture, progressive farmers, GOI and various public and private agencies during the year 2016-17. Because of the existence of efficient seed supply system in TNAU the newly developed improved varieties are reaching the doorstep of farmers in a shorter period to derive the benefit of improved varieties for the benefit of farming community so as to attain food security through seed security.

The details of production and distribution of foundation as well as TFL seeds in various crop varieties during 2016-17 is furnished below:

ABSTRACT

Units in Quintals

Crop	Foundation		TFL	
	Target	Production	Target	Production
Paddy	1775.00	1597.30	3342.90	2617.70
Millets	-	-	81.50	59.71
Pulses	35.00	49.77	242.00	276.81
Oilseeds	-	-	138.00	79.21
Cotton	-	-	2.00	2.98
Forage crops	-	-	11.40	11.40
1. Vegetables Crops	-	-	190.05	189.53
2. Green manure Crops	-	-	60.00	29.70
Total	1810.00	1647.07	4067.85	3267.04

CROP WISE PRODUCTION AND DISTRIBUTION

I. PADDY

Units in Quintals

S. No.	Variety	Foundation seed		Truthfully labelled seed	
		Target	Production	Target	Production
1	ADT 36	0.00	0.00	0.00	10.00
2	ADT 39	0.00	0.00	220.00	178.21
3	ADT 43	300.00	301.50	460.00	283.00
4	ADT (R) 45	525.00	350.00	70.00	249.20
5	ADT (R) 46	0.00	0.00	280.00	49.52
6	ADT (R) 49	0.00	0.00	80.00	25.50
7	ADT (R) 50	0.00	0.00	75.00	0.00
8	ASD 16	0.00	0.00	350.00	216.95
9	CO (R) 50	0.00	0.00	130.00	195.20
10	CO (R) 51	650.00	476.00	310.00	359.06
11	I.W.Ponni	300.00	261.90	140.00	47.49
12	CR 1009	0.00	149.10	335.00	332.00
13	CR 1009 Sub 1	0.00	0.00	80.00	56.00
14	MDU 5	0.00	0.00	40.00	0.00
15	MDU 6	0.00	0.00	40.00	3.90
16	TPS 3	0.00	0.00	50.00	0.00
17	TPS 5	0.00	0.00	50.00	24.70
18	TRY 1	0.00	0.00	40.00	12.98
19	TRY 3	0.00	58.80	100.00	44.40
20	TKM 13	0.00	0.00	360.00	415.44
21	Anna (R) 4	0.00	0.00	25.00	76.45
22	PMK (R) 3	0.00	0.00	7.90	0.00
23	Paiyur 1	0.00	0.00	100.00	37.70
	Paddy Total	**1775.00**	**1597.30**	**3342.90**	**2617.70**

II. MILLETS

Units in Quintals

S. No.	Crop	Variety	Truthfully labelled seed	
			Target	Production
1	*Maize*	COH (M) 6	25.00	24.62
2	*Fingermillet*	CO (Ra) 14	5.90	2.80
		CO (Ra) 15	2.40	3.37
		Paiyur 2	5.00	10.42
3	*Barnyard millet*	CO(Kv) 2	8.00	3.19
4	*Samai*	CO 4	4.20	1.49
5	*Kodo millet*	CO 3	6.50	7.84

6	*Italian millet*	CO (Te) 7	19.00	1.85
7	*Panivaragu*	CO (Pv) 5	5.50	4.13
		Millets Total	**81.50**	**59.71**

III. PULSES

Units in Quintals

S. No.	Crop	Variety	Foundation seed		Truthfully labelled seed	
			Target	Production	Target	Production
1	*Redgram*	BSR 1	0.00	0.00	5.00	3.54
		VBN (Rg) 2	0.00	0.00	9.00	7.30
		VBN (Rg) 3	0.00	0.00	7.00	6.49
		LRG 41	0.00	0.00	0.00	2.24
		Total	**0.00**	**0.00**	**21.00**	**19.57**
2	*Blackgram*	ADT 5	30.00	44.62	0.00	2.76
		VBN (Bg) 6	0.00	0.00	114.00	117.80
		VBN (Bg) 8	0.00	0.00	37.00	72.52
		MDU 1	0.00	0.00	12.00	4.48
		Total	**30.00**	**44.62**	**163.00**	**197.56**
3	*Greengram*	VBN 2	0.00	0.00	5.00	4.59
		VBN (Gg) 3	0.00	0.00	5.00	6.70
		CO (GG) 8	0.00	0.00	35.50	24.44
		Total	**0.00**	**0.00**	**45.50**	**35.73**
4	*Cowpea*	CO (Cp) 7	5.00	5.15	0.00	0.00
		VBN 1	0.00	0.00	2.00	1.00
		Total	**5.00**	**5.15**	**2.00**	**1.00**
5	*Horsegram*	Paiyur 1	0.00	0.00	2.50	4.28
		Paiyur 2	0.00	0.00	0.00	7.01
		Paiyur 3	0.00	0.00	0.00	2.54
		Total	**0.00**	**0.00**	**2.50**	**13.83**
6	*Mothbean*	TMV 1	0.00	0.00	8.00	9.12
		Pulses Total	**35.00**	**49.77**	**242.00**	**276.81**

IV. OILSEEDS

Units in Quintals

S. No.	Crop	Variety	Truthfully labelled seed	
			Target	Production
1	Groundnut	VRI 8	12.00	16.07
		TMV (Gn) 13	75.00	9.56
		Total	**87.00**	**25.63**
2	Gingelly	VRI Sv.1	5.00	4.41

		VRI Sv.2	5.00	3.89
		SVPR 1	5.00	3.83
		TMV 7	6.00	5.45
		Total	**21.00**	**17.58**
3	Castor	YRCH 1	30.00	36.00
		Oilseeds Total	**138.00**	**79.21**

IV. COTTON

Units in Quintals

S. No.	Crop	Variety	Truthfully labelled seed	
			Target	Production
1	**COTTON**	SVPR 2	1.00	1.80
2		SVPR 4	1.00	1.18
		Cotton Total	**2.00**	**2.98**

V. Forage crops

Units in Quintals

S. No.	Crop	Variety	Truthfully labelled seed	
			Target	Production
1	*Desmanthus*	Velimasal	10.40	10.40
2	Lucerne	CO 2	1.00	1.00
		Forage crops Total	**11.40**	**11.40**

VI. Vegetable crops

Units in Quintals

S. No.	Crop	Variety	Truthfully labelled seed	
			Target	Production
1	Tomato	PKM 1	3.60	20.85
		COTH 3	0.25	0.04
		Total	**3.85**	**20.89**
2	Chillies	K 1	0.27	10.42
		PKM 1	0.25	0.00
		PLR 1	0.20	0.00
		CO 1 Hybrid	0.25	0.02
		Total	**0.97**	**10.44**
3	Ridge gourd	MDU 1	0.30	0.06
		PKM 1	0.40	0.20
		CO 1	6.00	2.32
		Total	**6.70**	**2.58**
4	Ash gourd	CO 1	5.00	0.08
5	Snake gourd	PLR 1	1.25	12.01

		PLR 2	0.15	0.06
		PKM 1	0.20	0.00
		CO 2	3.00	3.60
		Total	**4.60**	**15.67**
6	Brinjal	PLR 2	3.00	3.26
		Annamalai	1.00	1.40
		Total	**4.00**	**4.66**
7	Bitter gourd	CO 1	7.55	16.93
8	Bottle gourd	CO 1 Hybrid	5.00	0.46
9	Cluster bean	MDU 1	1.10	0.21
		PNB	21.25	17.99
		Total	**22.35**	**18.20**
10	Bhendi	CO Bh H1	7.50	1.81
		CO 4	15.00	12.09
		Arka Anamika	1.50	3.63
		Total	**24.00**	**17.53**
11	Onion	CO (On) 5	4.55	31.46
12	Bushtype Lab Lab	CO (GB)14	35.00	12.93
13	Pumpkin	CO 1	0.30	6.55
14	Brinjal	MDU 1	0.05	0.00
		CO 2	0.05	12.33
		PLR 1	0.25	0.78
		Total	**0.35**	**13.11**
15	Amaranthus	CO 3	20.00	1.20
		CO 1	20.00	4.79
		CO 2	15.00	0.05
		PLR 1	1.00	5.02
		Total	**56.00**	**11.06**
16	A. Moringa	PKM 1	4.08	5.30
		PKM 2	0.05	0.08
		Total	**4.13**	**5.38**
17	Veg. Cowpea	PKM 1	5.50	1.60
		Vegetable Total	**190.05**	**189.53**

VII. Green manure crops

Units in Quintals

S. No.	Crop	Variety	Truthfully labelled seed	
			Target	Production
1	Sunnhemp	CO1	60.00	29.70

VIII. Planting materials (setts/ Rhizome)

Units in Quintals

S. No.	Crop	Variety	Truthfully labelled seed	
			Target	Production
1	Sugarcane	-	997.50	1050.16
2	Turmeric	-	336.00	348.93
		Total	**1333.50**	**1399.08**

IX. Planting materials/ tissue culture plants

(in numbers)

Crop	Target	Production
Planting material		
Mango	59850	60875
Sapota	1575	1960
Amla	420	488
Guava	15750	16227
Cassava	43472	43628
Acid lime	4944	5040
West Indian cherry	137	169
Pomegranate	137	163
Ornamental plants	7350	7651
Cashew	82680	84298
Jack	14648	15092
Coconut seedling	135720	137918
Tree seedlings	3914	4780
Sugarcane	476280	519020
Cumbu napier	1762530	1813796
Guinea grass	103898	104787
Fodder grass	77112	77678
Total	**2790415**	**2893570**

In addition, around 3.00 lakhs packets of vegetable and flower seeds are distributed through Automated Seed Vending Machine to encourage roof gardening in Urban areas

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