CRITICAL TECHNOLOGIES

RICE

Critical technologies for improving rice production both for SRI and Normal method

Aim: To achieve good early vigour, desired plant population and superior plant health

Technologies - Purpose	SRI	Normal Method
To improve soil health	Green Manure/ Green Leaf manure – 5.0 tons/ha	Green Manure/ Green Leaf manure – 5.0 tons/ha
Cost	Rs 1400/=	Rs 1400/=
To improve water management	Proper leveling of lands (Laser/ Manual)	Proper leveling of lands (Laser/ Manual)
Cost	Rs 500/=	Rs 500/=
Choice of Varieties	Kuruvai / Kar / Sornavari: CO51, MDU6, ADT45, ADT47, TPS 5, CORH3 Samba / Thaladi : CR1009 Sub1, ADT50, ADT49, TKM 13, CO50	Kuruvai / Kar / Sornavari: CO51, MDU6, ADT45, ADT47, CORH3, TPS 5 Samba / Thaladi : CR1009 Sub1, ADT50, ADT49, TKM 13, CO50, Anna(R)4 (Rf)
Cost	NIL	NIL
To improve the early crop vigour	Bio-priming of seeds with 6% *Pseudomonas fluorescence* @ 180 g in 3.0 lit of water for 3.0 Kg of seeds	Bio-priming of seeds with 6% *Pseudomonas fluorescence* @ 1800 g in 30.0 lit of water for 30 Kg of seeds
Cost	Rs 20/=	Rs 200
	Planting of <16 days old seedlings at a spacing of $(22.5)^2$ to $(25.0)^2$ manually or 30 x15 cm using mechanical means	Kuruvai: Planting of <20 days old seedlings at 20 x 10 cm spacing Samba/ Thaladi: Planting of <25 days old seedlings at 20 x 15 cm spacing

Cost	NIL	NIL
Integrated Weed Management	Mechanical weeding: 2-4 times	Combination of pre-emergence herbicide + one hand weeding / mechanical weeding
Cost	Rs 1000	Rs 1000
Integrated Pest Management	Application of neem cake to the nursery – 1 Kg Avoiding PP chemicals upto 45 days after transplanting (to encourage natural enemy population) and need based sprays thereafter.	Application of neem cake in Nursery @ 5 Kg/ 8 cents for 1 ac Avoiding plant protection chemicals upto 45 days after transplanting (to encourage natural enemy population) and need based sprays thereafter.
Cost	Rs 100/=	Rs 500/=
Total Additional Cost	Rs 3020	Rs 3600
Expected additional Yield	500 Kg / ac	500 Kg / ac
Expected additional income	@ 500 x Rs 13 = Rs 6500	@ 500 x Rs 13 = Rs 6500

MILLETS

Millets are a group of crops which are hardy and grow well in dry zones as rainfed crops under marginal conditions of soil fertility and moisture. These are some of the oldest food grains known to human kind and possibly the first cereal grains to be used for domestic purposes. Millets are also unique due to their short growing season. The name "Millet" has been derived from the word "mil or thousand" referring to the large number of grains that can be produced from a single seed. However, the Hindi word "Kadann" has come from a Sanskrit word "Kadannam", which refers to foodgrains of the poor.

The list of crops covered under millets along with their botanical and common names is given below:

Sl.No.	Common name	Botanical name	Vernacular name
1	Sorghum	*Sorghum bicolor*	*Cholam*
2	Pearl millet	*Pennisetum glaucum*	*Cumbu*
3	Finger millet	*Eleusine coracana*	*Ragi*
4	Little millet	*Panicum sumatrense*	*Samai*
5	Kodo millet	*Paspalum scrobiculatum*	*Varagu*
6	Barnyard millet	*Echinochola frumentacea*	*Kuduraivali*
7	Proso millet	*Panicum miliaceum*	*Panivaragu*
8	Foxtail millet	*Setaria italica*	*Tenai*

India is the world's largest producer and consumer of millets. These crops form an important component of nutritional and livelihood security of resource poor farmers of India. They exhibit wide adaptation in marginal production and niche areas and provide farmers with best available opportunity for assured harvest, staple food, required nutrition and sufficient fodder in environments characterized by scanty rainfall. These crops are climate change compliant. Besides, these millets also provide raw materials for agro industries such as poultry and cattle feed, value added products, potable alcohol, starch, bio-fuel *etc*.

Millets are highly nutritious, non glutinous and non acidic foods. Hence, they are soothing and easy to digest. They are considered to be the least allergic and most digestible grains available. Millets are rich in protein, minerals, dietary fibre, B complex vitamins such as niacin, thiamin, riboflavin, essential amino acids like methionine and lecithine. They are also rich in phytochemicals including phytic acid which lowers cholesterol and helps to reduce the incidence of cardio vascular diseases and cancer. Owing to which these are called as ***"God's own grains* and *nutricereals"*** .

Status of Millets in Tamil Nadu

In all millet crops, the present area under cultivation has shown a gradual decline compared to the past but the productivity has increased.

Crop	Area(L.ha)		Production(L.T)		Productivity kg/ha	
	1980's	2012-13	1980's	2012-13	1980's	2012-13
Maize	0.19	2.92	0.20	9.46	1074	3252
Sorghum	5.40	2.12	8.86	1.74	852	830
Pearl millet	4.80	0.43	3.0	0.56	625	1316
Ragi	1.64	0.70	2.29	1.30	1396	1963
Other small millets	2.31	0.27	1.34	0.27	580	1007
Total	14.34	6.44	15.69	13.33	905	1674

Source: Directorate of Economics and Statistics

General strategies for increasing area and production of Millet crops

1. Creating awareness among the farmers on the importance of millets in the dietary requirement through training SHG/ farmers for production and value addition
2. Organizing field demonstrations to showcase the yield potential of the high yielding varieties/ hybrids
3. Introduction of millets in the nontraditional districts where millets are not grown
4. Increasing the area under small millets in the hilly areas
5. Bringing in unutilized land in to cultivation of millets under rainfed / drought situations
6. Self seed maintenance
7. Promotion of processing industries and value addition
8. Commodity group formation for higher market price
9. Fixing of minimum support price

Five critical technologies for millet crops

1. Improved varieties / Hybrids

- Introduction of hybrids and high yielding varieties
- Seed production and distribution
- Field demonstration with new varieties & hybrids
- Market availability of new varieties and hybrids
- Self seed maintenance

2. Seed and seed treatments

- Distribution of good quality seed with recommended quantity to maintain optimum plant population
- Seed treatment with fungicide or bio-control agent to prevent the pest and disease incidence during early vegetative stages of crop growth
- Seed treatment with biofertilizers to reduce the fertilizer requirement of crops
- Seed hardening with potasium dihydrogen phosphate 2 % for drought management

3. Nutrient management

- Application of recommended dose of fertilizer
- Split application of fertilizer at the critical stages
- Application of micronutrient mixture 12.5 kg/ha
- Foliar application of micronutrient with boom sprayer
- Utilization of bio inputs for organic millet production

4. Water and drought management

- Establishment water harvesting structure (Mini Farm Pond) based on the slope of the land
- Utilizing harvested rain water for irrigation by using Mobile sprinkler at the critical stages of crop growth
- Foliar application of 1 % KCL and 1 % PPFM with Boom sprayer under drought situations

5. Mechanization

- Introduction of seed drill sowing or line sowing
- Introduction of transplanting technologies with transplanter
- Introduction of multigrain thresher
- Introduction of mini millet mill

Critical technologies for Maize

S.No.	Name of the Technology	Recommendation
1	Improved varieties and hybrids	CO H (M) 6
2	Seed and seed treatments	20 kg/ha, *Pseudomonas* @ 10g/kg of seed or 2.5 kg soil application/ha,

		Azospirillum @ 600 g/ha and *Phosphobacteria* @ 600 g/ha.
3	Integrated nutrient management and weed management	135:62.5:50 kg NPK / ha and 100:30:30 kg NPK/ha RF, Mn mixture 12.5 kg/ha or Maize Maxim 7.5 kg /ha, Foliar nutrients spray with boom sprayer, Weed management – PE atrazine 0.25 kg/ha + one HW on 30 DAS.
4	Water and Drought management	1% KCL and PPFM spray with boom sprayers. Formation of mini farm pond based on the slope and use mobile sprinklers for pumping out water from the farm pond to mitigate the drought during critical stages of plant growth.
5	Mechanization	Drill sowing, using power weeder and multigrain thresher

Maize CO H (M) 6

Critical technologies for Sorghum

S.No.	Name of the Technology	Recommendation
1	Improved varieties	K 12 and CO (S) 30
2	Seed and seed treatments. Transplanting of sorghum seedling reduce the shoot fly and downy mildew incidence at the early stages and maintenance of 150 plants/10 sq feet is also possible	10 kg/ha Irrigated, 15 kg/ha Rainfed, *Pseudomonas* @ 10g/kg of seed or 2.5 kg soil application/ha, *Azospirillum* @ 600 g/ha and *Phosphobacteria* @ 600 g/ha, Potassium dihydrogen phosphate 2 % for seed hardening
3	Integrated Nutrient Management	90:45:45 kg NPK (Irrigated) and 40:20:0 kg NPK (Rainfed) Mn mixture 12.5 kg/ha

4	Weed, Pest and Disease Management	Shoot borer – Imidacloprid –250ml/ha or Phorate 10 G @25 kg/ha, Neck blast, Finger blast and Blight management with resistant varieties and seed treatment, Atrazine 500 g/ha on 3rd day for weed control
5	Water and drought management	1% KCL spray or PPFM 1 % spray with boom sprayers. Formation of mini farm pond based on the slope and use mobile sprinklers for pumping out water from the farm pond to mitigate the drought during critical stages of plant growth.


TNAU Sorghum Variety - CO 30

Critical technologies for cumbu - Pearl millet

S.No.	Name of the Technology	Recommendation
1	Improved varieties and Hybrid	CO (Cu) 9 and CO (H) 9
2	Seed and seed treatments	5 kg /ha, *Pseudomonas* @ 10g/kg of seed or 2.5 kg soil application/ha, *Azospirillum* @ 600 g/ha and *Phosphobacteria* @ 600 g/ha, Potasium dihydrogen phosphate 2 % for seed hardening
3	Integrated Nutrient Management	80:40:40 kg NPK Irrigated and 40:20:0 kg NPK Rain fed, Mn mixture 12.5 kg/ha and Utilization of bio inputs
4	Pest and disease management	Downy mildew – Metaloxyl 6g/kg of seed
5	Water and drought management	1% KCL and PPFM 1 % spray with boom sprayers. Formation of mini farm pond based on the slope and use mobile sprinklers for pumping out water from the farm pond to mitigate the drought during critical stages of plant growth.

Cumbu Variety - CO (Cu) 9

TNAU Cumbu Hybrid CO 9

Critical technologies for ragi - Finger millet

S.No.	Name of the Technology	Recommendation
1	Improved varieties	CO (Ra) 14, Paiyur 2 and CO (Ra) 15,
2	Seed and seed treatments	5 kg/ha for transplanting, *Pseudomonas* @ 10g/kg of seed or 2.5 kg soil application/ha, *Azospirillum* @ 600 g/ha and *Phosphobacteria* @ 600 g/h
3	Integrated Nutrient Management	60:30:30 kg NPK MN mixture 12.5 kg/ha Utilization of bio inputs
4	Weed, pest and disease management	Blast – Tricyclozole 2g/kg of seed, Stemborer – 4: 1 cowpea sowing, Butachlor or Pendimethalin 2.5 kg/ha, PE oxyflurofen 50 g/ha + one hand weeding on 30 DAS
5	Water and drought management	1% KCL spray and PPFM spray with boom sprayers. Formation of mini farm pond based on the slope and use mobile sprinklers for pumping out water from the farm pond to mitigate the drought during critical stages of plant growth.

CO (Ra) 14

CO (Ra) 15

Critical Technologies for Small Millets

S.No.	Name of the Technology	Recommendation
1	Improved varieties	Tenai – Foxtail millet - CO (Te) 7 Samai – Little Millet - CO (Samai) 4 Panivaragu – Proso Millet - CO (Pv) 5 Varagu – Kodo Millet - CO 3 Kudiraivali – Barnyard Millet - CO (Kv) 2
2	Seed and seed treatments	12.5 kg/ha, *Pseudomonas* @ 10g/kg of seed or 2.5 kg soil application/ha, *Azospirillum* @ 600 g/ha and *Phosphobacteria* @ 600 g/ha.
3	Integrated Nutrient Management	40:20:00 kg NPK, MN mixture 12.5 kg/ha, Utilization of bio inputs.
4	Water and drought management	1% KCL and PPFM spray with boom sprayers. Formation of mini farm pond based on the slope and use mobile sprinklers for pumping out water from the farm pond to mitigate the drought during critical stages of plant growth. Nearly 31.89 % yield reduced at 20-25 and 60-65 DAS of moisture stress.
5	Post harvest Mechanization	Introduction of multigrain thresher and mini millet mill for processing

CO (Te) 7

Panivaragu CO(Pv)5

Kuthiraivali – CO (KV) 2

Varagu – CO 3

PULSES

Strategies for increasing area and production of pulses

- Organizing awareness programme to the farmers and various stake holders to grow, manage and sale more pulses
- Making timely availability of quality seeds of high yielding varieties to the pulse growers
- Conducting critical technologies demonstration *viz*., Front Line Demonstration and Field Day programme at every panchayat/village level
- Introduction of short duration / synchronised maturing pulse crops and varieties as intercrops in all the dry land tracts of Tamil Nadu
- Promoting pulse based cropping systems as bio-intensification and resource conservation agro technologies in irrigated conditions
- Bringing in unutilized and fallow land into cultivation of pulses with supplemental irrigation facilities *viz*., farm pond construction and mobile rain gun irrigation facility
- Evolving efficient extension models like pulse-seed-village for dissemination of pulse based technologies for farmers and quality seed production
- Formulation of Pulse Grower Farmers' group for higher pulses production and realize higher market price for their produce
- Exploring mechanized cultivation in large scale area

Key technologies for pulses crops

- Use of quality seeds of season specific high yielding pulse crop varieties
- Seed treatment with suitable *Rhizobium* inoculants and bio-pesticide
- Timely weed management with integrated approach
- Nutrient management and foliar nutrition
- Control of sucking pests and pod borer complex
- Supplemental irrigation facilities in dryland tract (greengram & blackgram)

I. Variety

- Promoting season and location specific high yielding, early and synchronized maturity varieties
- Good quality seed production and distribution through certified pulse growers, state seed farms and university centers
- Frontline / field demonstration of newly released varieties at farmers' holding

II. Seed and seed treatments

- Supplying chemically pretreated good quality recommended seed rate per acreage
- Supplying required bio-pesticide for seed treatment to prevent the crop from pest and disease incidence
- Providing crop specific *Rhizobium* inoculants along with seed package both for seed treatment and soil application to maximize the root nodule formulation, minimize the N fertilizer requirement
- Providing phosphobacteria, potassium releasing microbial consortia both for seed treatment and soil application for effective utilization of soil available P_2O_5 and K_2O

III. Weed management

- Controlling of weeds for first 4-5 weeks after sowing either through herbicide or manual or integrated approach
- Pre-emergence application of Pendimethalin 30EC @ 1.0kg ha^{-1} + one hand weeding at 25-30 days after sowing (or)
- Early post emergence application of Quizalofop-ethyl 5EC @ 50 g ha^{-1} for grassy weeds (or) Imazethapyr 10SL @ 40g ha^{-1} for broad leaf weeds on 15 DAS
- Hand weeding at 15 and 30 DAS

IV. Nutrient management and foliar nutrition

- Indiscriminate/imbalanced fertilizer application detrimental for pulse production
- Soil test based fertilizer application or timely application of recommended dose of fertilizer for irrigated and rainfed condition
- Application of sulphur and zinc sulphate at recommended level
- Combined application of fertilizer NPK&S along with zinc sulphate increased pulse crops yield than individual application
- To maximise the pod formation and enhance the yield of pulses, foliar spray of DAP @ 2% (or) Urea @ 2% once at flowering and another at 15 days thereafter (or) Pulse Wonder @ 2kg/ac once at flowering

V. Control of sucking pest and pod borer complex

- Indiscriminate pesticides application is detrimental for pulse production
- Seed treatment with imidacloprid @ 5ml / kg for stem fly management
- Spray Dimethoate 30EC(200ml/acre) for sucking pests and Indoxacarb 15.8%SC (125ml/ac) for pod borers.

VI. Supplemental irrigation through rain gun

- Establishment of water harvesting structure (community / cluster based farm pond) based on the slope and acreage of the land
- Harvested rain water during rainy season may be utilized for supplemental irrigation by using mobile rain gun / mobile sprinkler at the critical stages of crop growth (or) at moisture stress conditions
- Foliar application of 1% KCL and 1 % PPFM with Boom sprayer under drought situations

Redgram

S.No.	Name of the Technology	Recommendation
1	Variety	Co(Rg) 7, VBN(Rg) 3, LRG 41, BSR 1 (Border and bund crop)
2	Seed and seed treatments	Seed rate : Long duration-3kg/ac; Short duration – 6kg/ac ; *Rhizobium* strains (CMR 9), PGPR and Phosphobacteria 30gm each /kg of seed using rice kanji as binder followed by *T. viride* (4gm/kg of seed) *or P. flourescense* (10gm/kg of seed)
3	Weed management	Pre-emergence: Pendimethalin 30EC @ 1.0kg ha^{-1} + one hand weeding on 30 DAS (or) Early post emergence : Quizalofop Ethyl 5EC@ 50g ha^{-1} (or) Imazethapyr 10 SL@ 75 g ha^{-1} on 15 DAS + one hand weeding
4	Nutrient management	10:20:10:8 kg/ac NPK and S - Irrigated 5.10:5: 4 kg/ac NPK and S - Rainfed Foliar spray of DAP @ 2% once at flowering and another at 15 days thereafter or Pulse Wonder @ 2 kg/ac once at flowering.
5	Control of sucking pest and pod borer complex	Spray dimethoate 30EC(200ml/acre) for sucking pests and indoxacarb 15.8%SC (125ml/ac) for pod borers.

Blackgram and greengram

S.N	Technology	Recommendation
1	Variety	**Blackgram** Cauvery delta : ADT 3 Other zones : VBN 6, CO 6, VBN(Bg) 5, VBN(Bg) 4, VBN 3 Summer irrigated : ADT 5 **Greengram** Cauvery delta : ADT 3 Other zones : VBN(Gg) 3, VBN 2, CO(Gg) 7, CO 8, CO 6
2	Seed and seed treatments	Seed : 8kg/acre, *Rhizobium* strains (COG 15 for greengram, BMBS 47 for blackgram), PGPR and Phosphobacteria 30gm each /kg of seed using rice kanji as binder followed by *T. viride* (4gm/kg of seed) *or P. flourescense* (10gm/kg of seed)
3	Weed management	Pre-emergence: Pendimethalin 30EC@ 1.0kg ha^{-1} + one hand weeding on 30 DAS (or) Early post emergence :Quizalofop ethyl 5EC@ 50g ha^{-1} (or) Imazethapyr 10SL @ 75g ha^{-1} on 15 DAS.
4	Nutrient management	10:20:10:8kg/ac NPKand S – Irrigated, 5:10:5:4 kg/ac NPKandS– Rainfed, Foliar spray of DAP @ 2% once at flowering and another at 15 days thereafter or Pulse Wonder @ 2 kg/ac once at flowering.
5	Control of sucking pest and pod borer complex	Spray dimethoate 30EC(200ml/acre) for sucking pests and indoxacarb 15.8 SC(125ml/ac) for pod borers.
6.	Supplemental irrigation through rain gun	Supplemental irrigation twice (Vegetative & flowering stages) using 40-60 mm through rain gun recorded 30-40% higher yield.

OILSEEDS

A. GROUNDNUT

In Tamil Nadu, groundnut is being cultivated in an area of 3.39 lakh ha with production and productivity of 7.85 lakh tons and 2314 kg/ha respectively. Following critical technologies are recommended to increase a minimum of 20 per cent of the present level of productivity.

1. Adoption of high yielding varieties

	TMVGn 13	**VRIGn 6**	**VRIGn 7**	**CO 6**	**CO 7**
Year of release	2006	2009	2008	2010	2013
Yield kg/ha	1613 (RF)	2050 (RF)	1865 (RF)	1915 (RF)	2300 (RF)
	2580 (Irri)	2600 (Irri)			2800 (Irri)
Duration (days)	100-105	105	120-125	125-130	100-105
Oil content (%)	50	50	48	49.5	51
Special feature	Tolerance to drought, red kernel	Tolerant to LLS, rust and PBND	Tolerance to drought	Tolerance to drought	Tolerance to drought


TMVGn 13


VRIGn 6


VRIGn 7


CO 6


CO 7

2. Seed drill sowing in groundnut

- Timely sowing with the use of available soil moisture immediately after receipt of rain
- Seed drill sowing in groundnut reduces the labour requirement (1 A + 2 B type labourers)
- Maintains optimum plant population and spacing which ultimately results in increased yield and reduction in cost of cultivation.
- Coverage 4.0 ha/day.

3. Split application of fertilizer for groundnut

New fertilizer recommendation - 25:50:75 kg NPK/ha for irrigated situation.

Split application: Basal : 100 % P + 50 % N & K
Ist Top : 25 % N and K at 20 DAS
II top : 25 % N and K at 45 DAS

4. **Micronutrient Management**

- Apply TNAU MN mixture @ 7.5 kg /ha (rainfed) and 12.5 kg/ha (Irrigated) as enriched FYM. Broadcast evenly on the soil surface immediately after sowing.
- To improve pod filling, spray nutrient solution. This can be sprayed on 25th and 35th day after sowing. This can be prepared by soaking DAP 2.5 kg, Ammonium sulphate 1 kg and borax 0.5 kg in 37 lit of water overnight. It may be diluted with 468 lit of water so as to made up to 500 litre to spray for one ha. Plano fix at the rate of 350 ml can also be mixed while spraying. (or)
- Two sprays of Groundnut Rich @ 5 kg/ha (for each spray) at 35, 45 DAS in 500 lit of water.
- Apply gypsum @ 400 kg/ha by the side of the plants on 40th day depending upon soil moisture.

5. **Weed management**

- Pre emergence pendimethalin @ 1.0 kg + one HW on 30 DAS (or) early-post emergence herbicide imazethapyr @ 75 g/ha at 15.20 DAS after sowing based on weed density (Irrigated).

6. Mechanizing stripping operation in groundnut

- The efficiency of groundnut stripper is 450-600 kg pods/hour
- Labour requirement: Two men and two women labourers.
- Cost of the stripper Rs.4 lakhs

B. SESAME

In Tamil Nadu, Sesame is being cultivated in an area of 33,000 ha with production and productivity of 17,000 tons and 518 kg/ha respectively. Following critical technologies are recommended to increase a minimum of 20 per cent of the present level of productivity.

1. Adoption of high yielding varieties

	VRI (SV) 2	TMV (SV) 7
Year of release	2005	2009
Yield (kg/ha)	726 (Irri)	820 (Irri)
	706 (RF)	750 (RF)
Duration (days)	80-85	85-90
Oil content (%)	51.9	50
Special feature	Brown seed	Brown seed

2. Application of recommended dose of fertilizer 23:13:13 kg NPK/ha (RF) / 35:23:23 (Irrigated) Kg NPK/ha
3. Thinning on 15 & 30th DAS
4. Weeding: Application of pre-emergence herbicide alachlor 1.5 kg/ha on 3 DAS and one hand weeding on 30 DAS
5. Application of 5 kg MnSo4 to avoid manganese deficiency

C. SUNFLOWER

In Tamil Nadu, Sunflower is being cultivated in an area of 11,000 ha with production and productivity of 11,000 tons and 1055 kg/ha respectively. Following critical technologies are recommended to increase a minimum of 20 per cent of the present level of productivity.

1. Adoption of high yielding hybrid: Hybrid CO 2

Parentage	:	COSF 1 A X CSFI 99
Duration	:	85 – 90 (Days)
Season	:	Kharif and Rabi / Summer
Yield (Kg/ha):		Kharif : 1950 Rabi / Summer: 2230
Special features	:	High oil content (39.8 %) High volume weight (48g/100ml)

2. Spacing: 60 x 30 for hybrids; 45 x 30 for varieties
3. Pre-emergence herbicide application of Pendimethelin @ 1.0 kg/ha on 3 DAS followed by hand weeding on 30-35 DAS
4. Thinning on 10 DAS
5. Sparying of Borax @ 0.2% at ray floret opening stage to improve seed set

D. CASTOR

In Tamil Nadu, Castor is being cultivated in an area of 5,000 ha with production and productivity of 2,000 tons and 311 kg/ha respectively. Following critical technologies are recommended to increase a minimum of 20 per cent of the present level of productivity.

1. Adoption of high yielding hybrid: YRCH 1

Year of release	2009
Yield kg/ha	1861 kg/ha under rainfed 3000 kg / ha under Irrigated
Duration (days)	150 – 160 days
Oil content (%)	49
Traits for resistance to biotic stresses	Resistant to green leaf hopper and tolerant to wilt

2. Pre emergence application of Pendimethalin @1 kg/ha followed by power weeding twice at 40 and 60 DAS
3. Spraying of Profenophos 0.05 % to control capsule borer
4. Spraying of Carbendazim (0.1%) on 45 and 60 DAS to control Botrytis grey mold

COTTON

Cotton is an important commercial crop. The area under cotton is around 1.2 to 1.4 lakh ha during this decade. The production is around 5.0 to 6.0 lakh bales with a productivity of 700 to 830 kg/ha. Cotton cultivation is labour and capital intensive. At present the availability of labour for agricultural operations is very scarce. Hence, the farmers are reluctant to take up cotton cultivation. Concerted efforts were taken to develop simple implements to mechanise the cotton cultivation. By using the implements large area can be covered quickly without losing the moisture. Few key technologies are listed to reduce the labour cost and enhance the yield.

1. Varieties

a) G. hirsutum variety SVPR 4 for summer irrigated to replace SVPR 2

- Medium Long staple cotton (fibre length 27.9mm)
- Tolerant to high temperature prevailing during summer season.
- Suitable for Madurai, Virudhunagar and Tirunelveli Districts.

b) G.hirsutum variety KC 3 for rainfed cultivation

- Medium staple cotton (Fibre length 26.4mm)
- Resistance to leaf hopper
- Tolerant to drought
- Suitable for Tuticorin and Tirunelveli Districts

2. Line Sowing for mechanised operations

- Perfect line sowing is must for mechanization.
- Seed drill (or) Tractor drawn implement to be used.

Tractor drawn implement

A detachable and adjustable type of cultivator. A small shoe like attachment to the cultivator tine will mark the line for sowing. A spacing of 100cm between the rows enables the movement of tractor for harrowing, earthing up and spraying.

Efficiency: 1.5 ac/hr.

3. Integrated Weed Management

- Application of Pre-emergence herbicide Pendimethalin 1.0 kg/ha + one HW on 30 DAS.

Tractor drawn implement

a. Blade harrowing

- A semi circular blade attached between the two cultivator tines will stir the soil and remove the weeds. Two harrowings may be done during 30 and 45 DAS.
- Efficiency: 1.5 ac/hr.

b. Ridge formation

- An adjustable ridger fitted with the cultivator arm will form the ridges and earth up the soil close to the plants. After top dressing of fertilizer during 45-50 DAS earthing up may be done.
- Efficiency: 1.5 ac/hr.

Operation	Cost involved (Rs/ac)		Saving Rs/ ac
	Manual	Tractor implement	
1st weeding (25 DAS)	2500	800	1700
2nd weeding (45 DAS)	1800	800	1000

4. TNAU Cotton Plus

- Dose: 6.25 kg/ha
- Two sprayings viz. flowering and boll formation stage

5. Integrated Pest and Disease Management Package

- Seed treatment with imidacloprid 70 WS (10 g/kg seed) (Sucking insect)
- Soil drenching with chlorpyriphos 20 EC (1.25 l/ha) on 10 days after sowing (Stem weevil)

- Soil drenching with *Bacillus subtilis (*BSC5) on 30 days after sowing (wilt, root rot)
- Foliar application of *B.subtilis (*BSC5) @ 0.1% (10g/lit) on 60 DAS (foliar diseases)
- Monitoring with yellow sticky traps (12/ha) (whitefly)
- Monitoring with pheromone trap (12 /ha) (boll worms)
- Need based application of insecticides – imidacloprid 17.8 SL (25g.a.i./ha) (Sucking insect)
- Need based application of fungicide 0.1% trifloxystrobin 25% + tebuconazole 50% WG or mancozeb 75 WP – 0.25% (foliar diseases)
- Raising of trap crop (castor and maize) along bunds (boll worms)

By adopting these technologies the yield can be increased by about 15-20 per cent.

SUGARCANE

Sugarcane (*Saccharum* sp) is part of the Poaceae family serves as a source of sugar since hundreds of years. Recently turned into a global commodity and important energy source, is being cultivated in more than 20 million hectares in tropical and subtropical regions of the world, producing up to 1.3 billion metric tons of crushable stems. Sugar produced from sugarcane accounting for almost two thirds of the world's production and has also gained increased attention because of ethanol an energy source.

India is the largest producer of cane sugar in the world and its share in the world sugar production is around 20 per cent. It is grown in all the states of our country except the hilly tracts. The Indian sugar industry, the second largest agro-based industry next to textiles plays a pivotal role in the national economy. The 526 sugar factories in operation in the country are providing employment to nearly 1.0 million persons. About 50 million Indian farmers and their families are engaged in the cultivation of sugarcane in addition a large mass of agricultural labour involved in sugarcane cultivation, harvesting and ancillary activities constituting 7.5% of the rural population. The sugar industry employs over 1.0 million skilled and unskilled workmen, mostly from the rural areas. Currently, it is cultivated in an area of 5.06 million ha with an average productivity 66.9 t/ha with the total production of 339 million tonnes of sugarcane and 25.0 million tonnes of sugar.

In Tamil Nadu, it is cultivated in an area of 3.83 lakh ha with an average productivity of 92.0 t/ha with the total production of 351 lakh tonnes of sugarcane and 21.46 lakh tonnes of sugar. Of the total area cultivated, 53% is planted and 47% is ratoon. Sugarcane is used for producing sugar, gur, jaggery, khandsari, ethanol and other products.

Critical technologies for increasing productivity in sugarcane

1. **Chip bud seedlings recommended in the conventional method of planting which will increase the population and productivity**

Reduced crop duration (upto 40 days): Since seedlings of 25-30 days are transplanted in the main field, the crop can be harvested by 11 months which is otherwise an annual crop of 12 months duration.

Possibility of grading of seedlings: Grading of the seedlings is done at two stages – in the nurseries and during transplanting. This ensures good vigour of the seedlings and is reflected in the crop stand in the field.

Increased yield: Chip bud method of seedling planting has an economic advantage over the conventional method of planting. Through this technology the average yield was 135 tons per hectare where as the yield from the conventional one was 118 tonnes per hectare,an increased cane yield of 14 % over conventional method.

2. Foliar spray of TNAU sugarcane booster @ 45, 60 and 75 days after planting respectively improves the cane yield up to 20 % (Dose : 2.5, 3.75, and 5 kg/ha in 500 litres of water with surfactant)

Sugarcane booster contains macro and micronutrients and growth regulators that promote better growth and development of sugarcane crop. It contains ingredients that are water soluble and facilitates complete absorption of nutrients.

Thus the benefits of spraying sugarcane booster are manifested in enhanced cane growth, cane weight, increased internodal length which are important yield attribute of sugarcane accounting increased yield (upto 20 %), increased sugar content and imparts resistance to drought.

3. Intercropping of blackgram/ green gram/ green manure in the sugarcane will pave way for additional income, enhance the soil fertility, control weeds and increase the income by 10-15%

Intercropping would help in increasing the land utilization efficiency, reducing the production cost, economizing the use of market purchased costly inputs and making plant-ratoon system sustainable. Land being inelastic, sugar industry can no longer stay with extensive cultivation of sugarcane for its future growth. Therefore, importance of intercropping and crop diversification has been recognized profitable and economical for combating the future problems. Rapidly increasing population, insufficient food, limited scope for extension of cultivation to new areas, diversified needs of small farmers for food and cash etc. have forced the adoption of intercropping systems. Sugarcane envisages the possibility of raising one more crop as intercrop in between the two cane rows. Generally, pulses *viz*., greengram / blackgram are raised as intercrops. In some places groundnut is also raised as intercrop. The intercrops in addition to fetching additional income, act as live mulch and conserves moisture. They also minimize the attack of early shoot borer. Besides enriching the soil by way of fixing atmospheric nitrogen, the bulky organic matter added to the soil after the harvest of the intercrop improves the soil fertility status. The success of intercropping, however, depends upon the selection of crops, their varieties, sowing time, planting geometry and fertilizer management apart from other practices.

Growing of sunhemp as intercrop with sugarcane recorded the maximum cane yield (113.3 t/ha) which is 7.50 % higher than the sugarcane alone (105.4 t/ha). Growing of sunhemp as intercrop (Rs. 32,731/ha) in sugarcane increases the net income by 17.4% and adds nitrogen 9.25 kg/ha than growing of sugarcane as sole crop (Rs. 27,872/ha) with higher B:C ratio of 1.66, followed by blackgram as intercrop (Rs. 32,544/ha) in sugarcane increases the net income by 16.7% with the B:C ratio of 1.64.

4. Integrated management of early shoot borer and inter node borer in sugarcane by installation of Sex pheromone @ 20 nos./ha

Among the borer pests of sugarcane, early shoot borer (ESB) and internode borer(INB) are considered as pests of economic importance in Tamil Nadu.

It has been computed that the shoot borer destroys 26-65 per cent mother shoots. Losses from 22-33 per cent in yield, 12 per cent in sugar recovery, 2 per cent in commercial cane sugar and 27 per cent in jaggery have been estimated.

Infested inter nodes suffer reduction in length and girth as compared to healthy canes. Actual field loss has amounted to 19.0, 16.3 and 8.6 tonnes per hectare respectively, when the mean percent canes damaged was 55.4, 42.4 and 40.0.

Among the integrated management package for ESB and INB, one of the component is the installation of sex pheromone trap @ 20/ha for monitoring of respective pests. It has been observed that, due to the installation of sex pheromone trap, the estimated cost of trap and lure for both the pests amounts to Rs. 4800 per hectare. The increased yield obtained due to the adoption of this technology was 2.00 t/ha.

The main advantages of this technology are ease of adoption, eco friendly and safer to natural enemies, low cost, trap is reusable, easy monitoring of pests and additional yield.

VEGETABLE CROPS

TOMATO

1. Use of high yielding hybrids

TNAU Hybrids: COTH 2 - TLCV resistant hybrid
COTH 3 - TLNCV and nematode resistant hybrid
Other F_1 hybrids from certified source

2. Quality seedling production (portray nursery)

- Protray seedling production
- Media : cocopeat 300 kg + 5 kg neem cake + *Azospirillum* and *Phosphobacteria* @ 1 kg each. Spraying 19:19:19 + MN mixture @ 0.5 % during nursery stage (15 DAS)

3. Field planting, population maintenance

- Broad bed system of planting 120 cm width and convenient length.
- Paired row planting 90 x 60 x 60 cm with the population of 23,334/ha

4. Drip fertigation and mulching

- Installation of drip system and placing drip laterals at the centre of each bed
- Fertigation using water soluble fertilizer @200:250:250 kg NPK /ha

Fertigation schedule

Stage	Crop stage	Duration in days	Fertilizer grade	Total fertilizer (kg/ha)	% of requirement		
					N	P	K
1	Transplanting to plant establishment stage	10	19:19:19 13:0:45 Urea	65.8 27.8 8.44	10	5	10
2	Flower initiation to flowering	30	12:61:0 13:0:45 Urea	41.0 222.2 100.3	40	10	40
3	Flowering to fruit set	30	12:61:0 13:0:45 Urea	65.8 138.9 63.9	30	5	30
4	Alternate day from picking	80	12:61:0 13:0:45 Urea	20.5 111.1 50.1	20	5	20
		150			100	25	100

Note: 75 % recommended phosphorus is applied as super phosphate as basal

- Mulching with black polythene sheet of 30 -50 micron

5. Application of growth regulator and foliar nutrients

- Growth regulator - Planofix @ 125 ml in 500 lit of water at 45,60, 90 DAP
- Spray Zinc sulphate @ 0.5 % at 10 days interval from 40 DAP
- 19:19:19 + MN mixture @ 1 % at 60 DAP

6. Staking for hybrids

- Staking with bamboo poles at two ends of ridges and connecting with polythene string at an interval of 0.5 m height

7. Integrated pest and disease management (IPDM)

Pests

i. Fruit borer

- Spray Azadirachtin 1.0 EC (10000ppm) @ 2.0 ml/lit or Indoxacarb 14.5 SC @ 8.0 ml/10 lit or Flubendiamide 20 WG@ 5 g/10lit

ii. White fly

- Spray Dimethoate 30EC @ 1.0 ml/l or Thiamethoxam 25WG @ 4.0 ml/10 l

Diseases

i. Damping off

- Drench with Copper oxychloride @ 2.5 g/l. Treat the seeds with *Trichoderma viride* @ 4 g / kg or *Pseudomonas fluorescens* @ 10 g /kg of seed 24 hours before sowing.

ii. Fusarium wilt

- Seed treatment with *Pseudomonas fluorescens* @ 10g/kg of seed. Soil application of *Pseudomonas fluorescens* @ 2.5 kg + 100 kg FYM / seedling dip with *Pseudomonas fluorescens* @ 5g/l. Soil drenching with Carbendazim 0.1% or Copper oxychloride @ 2.5 g/l

3. *Tomato spotted wilt virus/ Tomato leaf curl virus*

- Roguing out of virus infected plants upto 45 days of transplanting. Spray systemic insecticides like Methyl demeton 25% EC @ 2 ml/l or Dimethoate 30 % EC @ 1.0 ml/l

Nematodes

- Add FYM @ 25 t/ha. Seed treatment of *Pseudomonas fluorescens* 10 g/kg of seeds (or) Soil application of *Bacillus subtilis* @ 2.5 kg/ha.

COTH 2

Protray seedling

Paired row planting

BRINJAL

1. Use of hybrids

- TNAU F_1 Hybrid COBH1 and COBH2/ any hybrids of preference

2. Quality seedling production

- Protray seedling production
- Media sterilized nutrient enriched cocopeat @ 300 kg/ha is mixed with 5 kg of neemcake along with *Azospirillum* and *Phosphobacteria* each @ 1kg. Spraying of 19:19:19 + MN mixture @ 0.5% during nursery stage

3. Planting and population maintenance

- Broad bed system of planting 120 cm width and convenient length
- Paired row planting 90x60x75 cm with the population of 18,700/ha

4. Drip fertigation and mulching

- Installation of drip system and placing drip laterals at the centre of each bed
- Drip fertigation with water soluble fertilizers @ : 200:150:100 kg of NPK / ha

Fertigation schedule

Stage	Crop stage	Duration in days	Fertilizer grade	Total fertilizer (kg/ha)	% of requirement		
					N	P	K
1	Transplanting to plant establishment stage	10	19:19:19 13:0:45 Urea	39.47 5.50 25.65	10	5	10
2	Vegetative stage	30	12:61:0 13:0:45 Urea	24.5 88.89 142.4	40	10	40

3	Flower initiation to first picking	30	19:19:19 13:0:45 Urea	39.47 50.0 100.0	30	5	30
4	Harvesting	80	12:61:0 13:0:45 Urea	12.30 44.4 71.13	20	5	20
		150			100	25	100

Note: 75 % recommended phosphorus is applied as super phosphate as basal

- Mulching black polythene mulch (30-50 micron) in the field

5. Integrated pest and disease management

Pests

i. Shoot & fruit borer

- Spray any one insecticide Chlorpyriphos 20 % EC @ 1 ml/lit or Flubendiamide 20 WDG @ 7.5 g/10 lit or Quinalphos 20 % AF @ 1.7 ml/ lit starting from one month after planting at 15 days interval

ii. White fly

- Spray Neem oil 3% + Teepol 1 ml/lit or spray Thiamethoxam 25 % WG @ 4.0 g/10 lit.

Diseases

i. Damping off

- Drench with Copper oxychloride @ 2.5 g/l. Treat the seeds with *Trichoderma viride* @ 4 g / kg or *Pseudomonas fluorescens* @ 10 g /kg of seed 24 hours before sowing.

ii. Little Leaf

- Remove the affected plants in the early stages. Spray dimethoate 30 EC @ 1.0 ml/lit. to control the vector

Paired row system

CHILLIES

1. Use of high yielding hybrids

- Hybrids suitable for green / dry chillies: TNAU chilli hybrid CO 1 or other suitable F1 hybrids from certified source

2. Quality seedling production

- Pro-trays seedling production
- Media : Sterilized, nutrient enriched cocopeat + 5 kg neem cake + 1 kg each of *Azospirillum* and Phospobacteria

3. Field planting, population maintenance

- Broadbed system of planting (120 cm width and 15 cm height)
- Paired row system with the spacing of 90 x 60 x 45 cm (population of 29,000/ha)
- Installation of drip system

4. Drip fertigation, growth regulators application and mulching

i. Drip fertigation

- Drip fertigation with water soluble fertilizers @ 120 : 80: 80 kg of NPK / ha

Fertigation schedule

Stage	Crop stage	Duration in days	Fertilizer grade	Total fertilizer (kg/ha)	% of requirement		
					N	P	K
1	Transplanting to plant establishment stage	10	19:19:19 13:0:45 Urea	21.05 8.88 14.86	10	5	10
2	Flower initiation to flowering	30	12:61:0 13:0:45 Urea	13.11 71.04 80.72	40	10	40
3	Fruit set to fruit picking	30	19:19:19 13:0:45 Urea	21.05 44.4 56.91	30	5	30
4	Alternate day from picking	80	12:61:0 13:0:45 Urea	6.52 35.52 40.38	20	5	20
		150			100	25	100

Note: 75 % recommended phosphorus is applied as super phosphate as basal

ii. Application of Growth regulators and foliar nutrients

- Foliar spray of Triacontanol @ 1.25 ppm on 20, 40, 60 and 80th DAP
- Foliar spray of NAA @ 10 ppm on 60 and 90 DAP.
- Foliar spray of ZnSO4 @ 0.5 per cent thrice at 10 days interval from 40 DAP.
- Foliar spray of 19:19:19 @ 1 % at 60 DAP

iii. Mulching

- Mulching with black polythene mulch (30-50 micron)

5. Integrated pest and disease management

i. Thrips

- Treat seeds with imidacloprid 70% WS @ 12 g /kg of seed. Apply carbofuran 3% G @ 33 kg /ha or spray imidacloprid 17.8% SL @ 3.0 ml/10 lit or fipronil 5 % SC @ 1.5 ml/lit.

ii. Aphids

- Spray imidacloprid 17.8SL @ 3.0 ml/10 lit at 10 days interval.

iii. Yellow muranai mite

- Spray Propargite 57EC @ 2.5 ml/lit or dimethoate 30EC @ 1.0 ml/lit.

Diseases

i. Powdery mildew

- Spray Wettable sulphur @ 3 g/lit or Carbendazim @ 1 g/lit, 3 sprays at 15 days interval from the first appearance of symptom.

ii. Die-back and fruit rot

- Spray Mancozeb @ 2 g/lit or Copper oxychloride @ 2.5 g/lit thrice at 15 days interval starting from noticing the die-back symptoms.

iii. Chilli leaf curl

- Spray imidacloprid 17.8% SL @ 3.0 ml/10 lit at 15 days interval to control vector

TNAU Chilli Hybrid CO 1

Protray seedling


Paired row system of planting

BHENDI

1. Use of high yielding F_1 hybrids

- TNAU Hybrid : COBhH 1 or any other certified F_1 hybrid seed

2. Sowing, population maintenance strategy to enhance production

- Cultivation in broad bed system (1.5 m width and convenient length) 60 x45x45 cm paired row planting installed with drip

3. Drip fertigation, foliar nutrition and mulching

- Installation of drip fertigation
- Fertigation with water soluble fertilizers@ 200:100:100 kg of NPK/ha

Stage	Crop stage	Duration in days	Fertilizer grade	Total fertilizer (kg/ha)	% of requirement		
					N	P	K
1	Sowing to plant establishment stage	10	19:19:19 13:0:45 Urea	26.3 5.50 25.65	10	5	10
2	Flower initiation to flowering	30	12:61:0 13:0:45 Urea	16.39 88.88 144.52	40	10	40
3	Flowering to fruit set	30	19:19:19 13:0:45 Urea	26.30 55.55 103.87	30	5	30
4	Alternate day from picking	30	12:61:0 13:0:45 Urea	8.20 44.44 72.26	20	5	20
		100			100	25	100

Note : 75% of the P will be applied as basal dose as super phosphate as basal

Foliar nutrition

- 1 % urea (10 g/l) + 1% Muriate of Potash (10 g/l) on 30 and 45 days after planting.For hybrids, foliar application of water soluble fertilizer 19-19-19 grade three times @ 0.5% at 10 days interval from 30 days after planting.

Mulching

- Polythene mulch (30-50 micron)

4. Integrated pest and disease management

Pests

i. Fruit borers

- Spray Quinalphos 20 AF 1.5 ml/l or Emamectin benzoate 5SG @ 3.0 g /10 l.

ii. Leaf hopper

- Spray imidacloprid 17.8SL @ 2 ml/10 l. or Thiamethoxam 25WG @ 1.0 g /10 l.

Diseases

i. Yellow vein mosaic

- Spray systemic insecticides like Methyl demeton 25EC @ 1 ml /lit or Dimethoate 30EC @ 1.0 ml/l to kill the insect vector.

ii. Powdery mildew

- Dust sulphur 25 kg / ha or spray wettable sulphur 2 g / l immediately after noticing the disease and repeat after 15 days if necessary.

ONION

1. Use of high yielding seed propagated aggregatum onion varieties

- TNAU released CO (On) 5 (seed propagated)

2. Planting and population maintenance

- Broad bed system of planting 120cm width and convenient length
- Paired row planting 15 X 10 cm (7 rows within bed) with the population of 4,70,000 /ha

3. Drip fertigation

- Installation of drip system and placing drip laterals at the centre of each bed
- Fertigation with water soluble fertilizers @ 60: 60: 30 kg of NPK /ha

Fertigation schedule

Stage	Crop stage and No. of application	Duration in days	% requirement		
			N	P	K
1.	Sowing to establishment stage	10	10	5	10
2.	Vegetative stage	25	30	10	20
3	Bulb formation stage	25	30	5	30
4	Bulb development stage	15	30	5	40
	Total	75	100	25	100

Note: 75 % recommended phosphorus is applied as super phosphate as basal

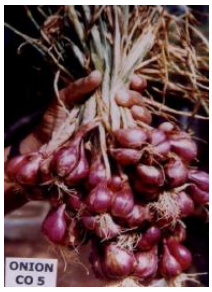
4. Weed management

Application of pre emergence herbicide pendimethilin 1.0 kg/ha or oxyflurofen 250 g/ha just after planting and one to two hand weeding

5. Integrated disease pest management practices

i. Onion thrips

- Spray with Neem oil 3ml/l + Profenofos 0.5 ml/l or Neem oil 3ml/l + Carbosulfan 1 ml/l at 15 days interval



ii. Purple blotch

- Three sprays of Mancozeb 0.2% or Hexaconazole 0.1% at the time of appearance of disease at 15 days interval

BITTER GOURD

1. Use of high yielding F1 hybrids

- F1 hybrids from certified source

2. Erection of pandhal/ bower system

3. Planting/Sowing and Population maintenance

- Broad bed system -1.2 m width and 0.15m height
- Spacing - 2 .0 x1.5 m
- Population - 3333 plants /ha

4. Use of growth regulators

- Spraying of ethrel @ 100 ppm for 3-4 times from 15 DAS, at weekly intervals.

5. Drip fertigation and mulching

- Installation of drip fertigation system
- Fertigation with water soluble fertilizers@ 200:100:100 kg of NPK/ha

Fertigation schedule

Stage	Crop stage	Duration in days	Fertilizer grade	Total fertilizer (kg/ha)	% of requirement		
					N	P	K
1	Crop establishment stage	10	19:19:19 13:0:45 Urea	26.81 11.00 29.03	10	5	10
2	Vegetative stage	30	12:61:0 13:0:45 Urea	12.28 66.00 109.00	30	7.5	30
3	Flower initiation to first picking	30	12:61:0 13:0:45 Urea	12.28 44.00 115.00	30	7.5	20
4	Harvesting stage	45	19:19:19 13:0:45 Urea	26.31 78.00 97.52	30	5	40
		115			100	25	100

75 % of P is applied as basal as super phosphate

- Polythene mulching with - 30 to 50 micron sheets

6. Integrated pest and disease management

1. Pests

Fruit fly

- Collect the affected fruits and destroy. Use of insect traps / fish meal trap with 5 g of wet fish meal and 1 g of dichlorvos in cotton, 50 traps are required per hectare. Neem oil @ 3.0% as foliar spray as need based.

2. Diseases

i. Powdery mildew

- Spray Dinocap 1ml/lit or Carbendazim 0.5 g/lit.

ii. Downy mildew

- Spray Mancozeb or Chlorothalonil 2 g/lit twice at 10 days interval

iii. Mosaic

- Spray Neem oil 3% plus Teepol 1 ml/lit or Neem Seed Kernel Extract 5 % or Dimethoate 30 % EC @ 1.0 ml/l

RIDGE GOURD

1. Use of high yielding F1 hybrids

- F1 hybrids from certified source

2. Erection of pandhal/ bower system

- Use of steel G.I wires with stone pillars

3. Planting /sowing and population maintenance

- Broad bed system - 1.5 m width and 0.5 m height
- Spacing - 2 .0 x1.5 m
- Population - 3333 plants /ha

4. Use of growth regulators

- Spraying of ethrel @ 100 ppm for 3-4 times from 15 DAS at weekly intervals.

5. Drip fertigation and mulching

- Installation of drip fertigation system
- Fertigation with water soluble fertilizers@ 200:100:100 kg of NPK/ha

Fertigation schedule

Stage	Crop stage	Duration in days	Fertilizer grade	Total fertilizer (kg/ha)	% of requirement		
					N	P	K
1	Crop establishment stage	10	19:19:19 13:0:45 Urea	26.81 11.00 29.03	10	5	10
2	Vegetative stage	30	12:61:0 13:0:45 Urea	12.28 66.00 109.00	30	7.5	30
3	Flower initiation to first picking	30	12:61:0 13:0:45 Urea	12.28 44.00 115.00	30	7.5	20
4	Harvesting stage	45	19:19:19 13:0:45 Urea	26.31 78.00 97.52	30	5	40
		115			100	25	100

Note :75 % of P is applied as basal as super phosphate

- Polythene mulching with - 30 to 50 micron sheets

6. Integrated pest and disease management

1. Pests

Fruit fly

- Collect the affected fruits and destroy. Use of insect traps / fish meal trap with 5 g of wet fish meal and 1 g of dichlorvos in cotton, 50 traps are required per hectare. Neem oil @ 3.0% as foliar spray as need based.

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i. Powdery mildew

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ii. Downy mildew

- Spray Mancozeb or Chlorothalonil 2 g/lit twice at 10 days interval

iii. Mosaic

- Spray Neem oil 3%+Teepol 1 ml/lit or spray Neem Seed Kernel Extract 5 % or Dimethoate 30EC @ 1.0 ml/l

Pandal system cultivation of ridge gourd

FRUIT CROPS

MANGO

Area, production and productivity in Tamil Nadu

Area (000' ha)	Production (000' MT)	Productivity (t/ha)
152.43	714.08	4.7

Technology 1

High density planting using superior grafts of mango varieties (Alphonso, Banganapalli, Imampasand

- 5 x 5 m spacing
- No. of plants – 400 per hectare (as against 156 / hectare at 8 x 8 m)
- Increasing the density →increased productivity and improved land usage→ enhanced income.
- Yield at economic bearing age : 24 t as against 10-16 t /ha
- Cost benefit ratio : 1 : 4.5 (at economic bearing age)
- Break even period on investment : 5-6 years

Technology 2

Converting old and senile orchards to HDP systems.

- Pruning and thinning of existing trees to rejuvenate the vigour
- Interplanting with choice mango grafts under HDP (or) top working with choice varieties wherever feasible
- Use scions of choice varieties like Alphonso and Banganapalli for top working.
- Behead the trees to be top worked portion during July-August leaving the main trunk at a convenient height and allow for new shoots to develop.
- Adopt cleft method of grafting or softwood grafting on the emerging shoots on the main stem from the cut end during September- October.

Rejuvenation of old orchards

Technology 3

Fertigation of mango under irrigated conditions

- Application of 1.0:1.0:1.5 kg of NPK / bearing tree / year under HDP through drip fertigation adopting the following schedule.

Nutrient	Stage of application				
	Immediately after harvest (2 months)	Pre-flowering (2months)	Flowering to fruit set (2months)	Fruit development (4months)	Total
N	25 %	40 %	20 %	15 %	100 %
P	50 %	30 %	20 %	-	100 %
K	25 %	20 %	25 %	30 %	100 %

- Yield increase by 30- 40 %; water saving by at least 30 %
- Increased C:B ratio (1 : 3)

Technology 4

Micronutrient sprays

- Two sprays of Borax 2 kg and zinc sulphate 2 kg once before and once after flowering (or) Use IIHR mango special foliar micronutrient spray (5g / l)
- Spray 2% Sulphate of potash at pea stage and 15 days after to improve yield and quality.
- Improved yield and quality C: B ratio : 1: 3

Technology 5

Canopy management and induction of flowering through judicious use of growth regulators

- Training for form in the early phase & pruning to maintain canopy
- Retain two healthy shoots by trimming away the weak shoots among the crowded terminal shoots during August-September annually.
- Prune back 20 cm of annual growth of the terminals immediately after harvest.
- Use of paclobutrazol to regulate timing of fruit production.
- Soil drenching of 0.75 g a.i. per meter of canopy radius in full bearing tree during first fortnight of September to get maximum number of fruits and yield.
- C: B Ratio : 1 : 4

BANANA

Area, production and productivity in Tamil Nadu

Area (000' ha)	Production (000' MT)	Productivity (t/ha)
111.36	5136.2	46.10

Technology 1

Use of tissue culture planting materials

Advantages

- High yield and productivity
- Uniformity in crop growth, flowering and harvest
- Highly responsive to fertigation
- Free of initial inoculums of viral diseases

Technology 2

Adoption of High density planting in banana:

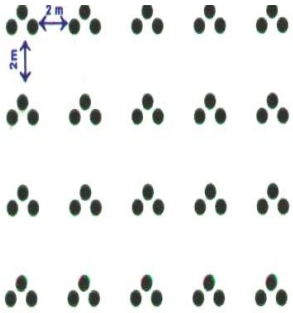
- Cavendish group of bananas
  (Grand Naine) : Planting 3
  suckers / pit at a spacing of 1.8 x 3.6 m
  (4600 plants/ha)

Advantages

- High yield and productivity (>45% increase)

High density planting in Banana

1 sucker/pit
2500 plants/ha



3 suckers/pit
4800 plants /ha

Technology 3

Adoption of drip fertigation system in banana

- Banana responds well for drip fertigation.
- Apply 25 litres of water / day + 200:30:300 g $N:P_2O_5: K_2O$ / plant
- For economizing the cost of fertilizers fertigate using normal fertilizers (Urea and Muriate of potash) with 50% of the recommended dose along with recommended dose of phosphorus as basal at 2nd month after planting.

Fertigation Schedule for banana

Weeks after planting	N (%)	P_2O_5 (%)	K_2O (%)
9 – 18 (10 weeks)	30	100	20
19 – 30 (12 weeks)	50	--	40
31 – 42 (12 weeks)	20	--	32
43 – 45 (3 weeks)	--	--	8
Total	100	100	100

Technology 4

Spraying micronutrients

Spraying micronutrients viz., $ZnSO_4$ (0.5%), $FeSO_4$ (0.2%), $CuSO_4$ (0.2%) and H_3BO_3 (0.1%) at 3^{rd} , 5^{th} and 7^{th} months after planting to increase yield and quality of banana or use NRC Banana Micronutrient mixture or IIHR Banana Special (Rs 100-125/kg).

GRAPES

Area, production and productivity in Tamil Nadu

Area (000' ha)	Production (000' MT)	Productivity (t/ha)
2.68	43.38	16.2

Technology 1

- Extension of area with grapes cv 'Red Globe'

Advantage of Red Globe

- High yield (> 40t / ha/ 2 seasons)
- Attractive Red coloured bold berries
- Premium price in the market
- 4 x 2 m (1250 plants)
- Requires 'Dog Ridge' rootstock

Technology 2

Judicious use of Growth Relators

- GA_3 25 ppm at 10-12 days after fruit set to maintain vigour, yield and quality parameters
- Dipping the fruit clusters in solution containing Brassinosteroid at 0.5 ppm

Technology 3

- Pruning Intensity & thinning
- 50 % canes for production and 50 % vegetative growth
- 4 bud level for Muscat / 5-6 bud level for Red Globe
- Tipping of shoots and tying of clusters. Nipping back the growing shoots of axillary buds and terminal buds at 12 to 15 buds.
- Fruit thinning is done in compact bunches by removing 20 % of the berries at pea stage.

Technology 4

- Fertigation technology
- Adopt recommendation given by NRC grapes
- > 30 % increase yield & > 25-40 % water savings

GUAVA

Technology 1

- High density planting at a spacing of 3 x 2 m.
- Plant population : 1666 per hectare.(> 400 in conventional)
- Increasing the density will increase productivity and improves land usage.

Technology 2

Drip and Fertigation

- Provide 1 Kg each of N, P_2O_5 and K_2O / plant > 30 % yield increase (45-60 t / ha as against 25 t /ha)

Technology 3

Micro nutrients spray

Spraying of a combination spray containing $ZnSO_4$, $MgSO_4$ and $MnSO_4$ @ 0.5% and $CuSO_4$ and $FeSO_4$ @ 0.25% plus Teepol @ 1 ml per 5 litres of solution on various stages.

1. New flush
2. One month after first spray
3. Flowering
4. Fruit Set

Technology 4

- Thinning of shoots for induction of flowering in the current seasons growth.
- Pruning of past season's terminal growth to a length of 10-15 cm is to be done during September-October and February – March to encourage more laterals. The erect growing branches are to be bent by tying on to pegs driven on the ground. Old unproductive but healthy trees can be rejuvenated may be either pollarded or cut back to 75 cm from ground level or dehorned by cutting the secondary branches at a distance of 75 cm from their origin.

PAPAYA

Area, production and productivity in Tamil Nadu

Area (000' ha)	Production (000' MT)	Productivity (t/ha)
0.960	184.24	191

Technology 1

- Adoption of CO-8 Papaya for cultivation.

Advantages

- High yield (220 t /ha)
- Red pulp suitable for table purpose
- Papain can also be extracted

Technology 2

Drip Fertigation

- Application of 10 litres of water per day + 13.5 g urea and 10.5 g muriate of potash / week through drip irrigation and soil application of super phosphate 300 g per plant at bimonthly intervals starting from 3-4 months after planting immediately after thinning of plants.

Technology 3

Foliar spray of Micro nutrients

- Foliar spray of 0.5 % zinc sulphate and 0.1% Boric acid at 4^{th} and 8^{th} MAP to improve growth and yield.

Technology 4

Management of PRSV

- To enable at least one crop (15 Months)
- Raise seedlings under nethouse
- Grow maize as border crop
- Spray insecticides to control the vectors.
- Micronutrient spray at fortnight intervals.

Technology 5

Management of papaya mealy bug

- Release of mealy bug Parasitoid *Acerophagus papayae* 100 nos / block or village can be highly helpful.

FLORICULTURE & LANDSCAPING

List of technologies

- Jasmine precision production technology
- Marigold precision production technology
- Carnation precision production technology
- Improved agrotechniques for cut rose
- Fertigation schedule for lilium
- Jasmine export packaging technology
- Dry flower technology

1. Precision production technology for jasmine

Area under jasmine in Tamil Nadu	:	10839 ha
Production	:	84938 t
Productivity	:	7.84 t/ha
Focus districts	:	Coimbatore, Madurai, Dindigul, Thanjavur, Ramanathapuram, Dharmapuri, Krishnagiri, Trichy, Pudukkottai, Sivagangai and Kanyakumari

Problems / critical issues

- Poor yield during off season (September to February)
- Micronutrient deficiency
- Incidence of bud worm, gall midge and mite reduces the quality and market value of flowers.

Details of Precision production technology for jasmine

Precision production technology was standardized for *Jasminum sambac* (Gundumalli) which involves the following techniques.

- Spacing: 1.2 x 1 m (8,300 plants/ha.)
- Media consortia : FYM 5 kg/pit, neem cake 500 g/pit, vermicompost 100 g/pit + *Azospirillum* and Phosphobacteria each 3kg/ha
- Drip irrigation @ 3 days interval
- Fertigation : 100% RDF at weekly intervals (60:120:120 g NPK/plant/year)
- Biostimulants : Humic acid 0.4%, Panchagavya 3%, monthly spraying
- Micronutrients: Monthly spraying of Fe_2SO_4 0.5% and $ZnSO_4$ 0.5%.
- Integrated pest and disease management

Precision method

Conventional method

2. Precision production technology for marigold

Area, production and productivity

Variety / Hybrid	Area (ha)	Production (t)	Productivity (t/ha)
Variety (Local type & MDU1)	1000	8000	12.00
Hybrid	4000	80000	20.00
Total	**5000**	**88000**	**Avg = 16.00**

Potential flower growing belts in Tamil Nadu

- Conventional growers (for flower) - Dindigul, Madurai,Trichy, Theni
- Contract farming (for xanthophyll) - Sathyamangalam (Erode District), Coimbatore, Madurai and Theni

Problems / critical issues

- Micronutrient deficiencies
- Pests - mealy bug, bud borer, leaf miner, thrips, red spider mite
- Disease - leaf spot

Details of Precision production technology for marigold

Precision production technology was standardized for African marigold (*Tagetes erecta* Linn.) which involves the following techniques.

- Raising seedlings in protrays
- Seedling dip: 0.5% *Pseudomonas fluorescens*
- Field preparation – chisel, disc plough, cultivator and rotovator
- Fertigation - 75% RDF at weekly intervals (90:90::75 kg NPK/ha)
- Micronutrients : 0.5% $FeSO_4$ and $ZnSO_4$ - through foliar application at 30 & 45 days after transplanting
- Biostimulants: 0.2% Humic acid - through foliar application at 30 & 45 days after transplanting
- Integrated pest & disease management

Precision method

Conventional method

Biostimulants application - Xanthophyll enhancement in marigold

Field view

Marigold L3 Hybrid

Treatments

Application of biostimulants at 30 & 45 DAT

[Humic acid (0.2%) + Sea weed extract (0.25%)]

Xanthophyll content - 1.92 g/1000g (Control 1.40g/1000g)

Flour Meal

Pellets

Oleoresin Xanthophyll

3. Precision production technology for carnation

Area under carnation in Tamil Nadu	:	45 ha
Production	:	1800 lakhs stems
Productivity	:	350 stems / m^2
Focus areas	:	Nilgiris, Kodaikanal

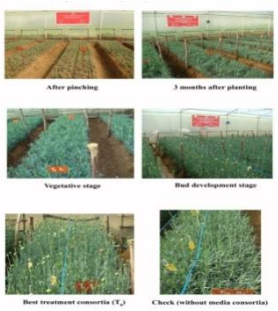
Problems/Issues

- Non availability of quality planting material
- High cost of planting material
- Low soil pH (acidic) in hilly soils (pH 4.0-4.5)
- Nutrient management
- Diseases: Fusarium wilt, leaf spot, leaf rust
- Insects: Red spider mite, Thrips, Bud borer, Rodents

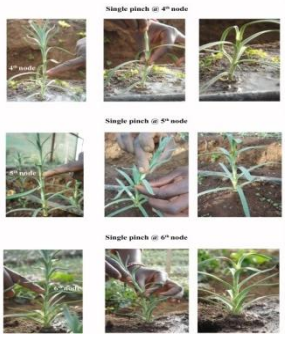
Details of Precision production technology for carnation

Precision production technology for carnation was standardized which involves the following techniques.

- Fumigation - Dazomet @ 30g/m^2
- Growing in media consortia / sq. m : 10:1:1 of farmyard manure @ 25 kg /m^2, vermicompost @ 2.5 kg /m^2, cocopeat @ 2.5 kg /m^2, biofertilizers *viz.*, Azospirillum, phosphobacteria, Vesicular Arbuscular Mycorrhiza and biocontrol agents *viz., Trichoderma viridae, Pseudomonas fluorescens* each @ 20 g/m^2.
- Spacing: 15 x 15 cm (36 plants /m^2)
- Planting stage: 30 day old rooted cuttings
- Pinching: Single pinch at the 5th node
- Calyx splitting: Spray 0.1 % borax
- Integrated pest & disease management



Growing media consortia



Pinching levels in carnation

4. Improved agrotechniques for greenhouse cut rose

Area under cut rose in Tamil Nadu	:	100 ha
Production	:	3500 lakh stems
Productivity	:	300 - 350 stems/m^2
Focus areas	:	Hosur

Problems/Issues

- Non availability of quality planting material
- Improper nutrient management
- Diseases: Black spot, powdery mildew
- Insect: Red spider mite, Thrips

Improved agrotechniques recommended for cut rose

Bending	:	Bending at shoot junction bud + application of 200 ppm BA
Fertigation	:	NPK: 125% of RDF @ 208:104:104 g/m^2 /yr at weekly intervals
Micronutrient s	:	Foliar spray of 0.5 % EDTA micronutrient mixture at 10 days intervals
Powdery mildew management	:	*Bacillus megaterium + B. amyloliquefaciens* each @ 10 ml/m^2 at weekly intervals as soil and foliar application

Benefits of the improved agrotechniques

- Higher number of "A" grade flowers / (218.47/m^2)
- Higher flower yield (324.84 flowers /m^2/year)

Flower bud emergence 35 days after bending

Stem length in bending and control treatments

Post harvest and value addition technologies

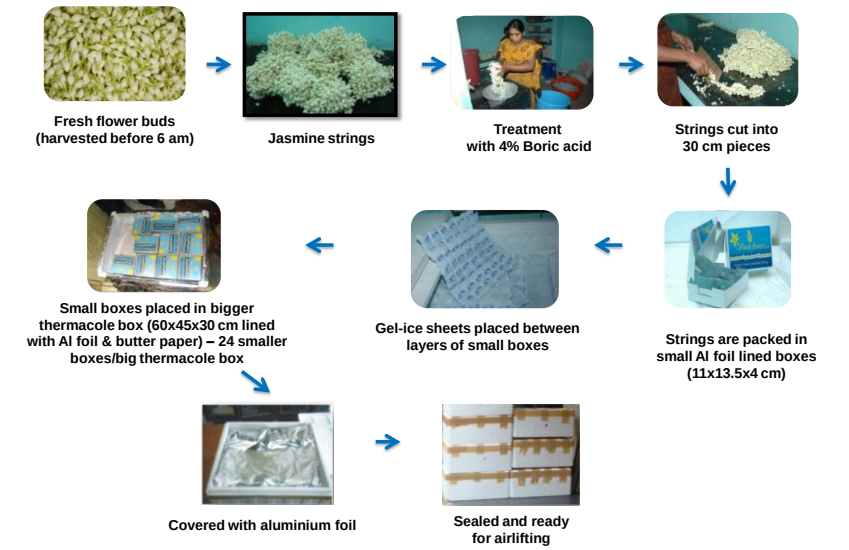
1. Export packaging technology for jasmine

Post harvest loss in jasmine	:	35 to 40 %
Countries to which India exports Jasmine	:	Singapore, Malaysia, Dubai, USA

An export packaging technology was developed with the objective of minimizing the high post harvest losses (40%) encountered in jasmine flowers during transit. Details of the technology are furnished below.

- Jasmine buds are harvested early in the morning before 7.00a m at fully developed tight bud stage.
- The buds are made into strings of 30 cm length
- The strings are dipped in 4% boric acid
- The treated jasmine strings are surface dried and five pieces of strings are packed in a small aluminium lined cardboard box of dimension 11 x 13.5 x 4 cm
- These boxes are then packed in a larger thermocole box of dimension 60 x 45 x 30 cm lined with aluminium foil in three layers comprising of 24 boxes with 8 boxes per layer
- Ice gel sheets are placed in between each layer
- Finally, the top layer is covered with aluminium foil and the boxes are closed and covered with brown sealing tape and are airlifted to the USA market.
- This technology has been filed for patent (Patent No. 1370/CHE/2010 dt. 14.05.2010).

Jasmine export packaging technology for long distance overseas market (USA)



2. Improved dry flower processing technologies

Value of dry flower exports from India	:	Rs.400 crores
Share of Tamil Nadu	:	70% (Rs.250 crores)
Countries to which India exports dry flowers	:	USA, Europe, Australia and Japan
Annual growth rate of Indian dry flower industry	:	8-10%

The following improved processing technologies have been standardized for dry flower making.

For domestic market

Bark arrangement

- **Species used**
  1. *Thuja orientsalis*
  2. *Pteris confusa*
  3. *Pinus spp*
  4. *Grevillea robusta,*
  5. *Castonospermum australe ,*
  6. *Plumeria alba*
  7. *Denrdanthemum graniflorum*

- **Processes** – Glycerinised leaves , silica gel dried flowers , bleached and dyed pods

- **Products developed** – Bark arrangements , gift arragements penstands , key chains , Table and wall decors etc

Gift arrangement

Key Chains

For export market

Wreaths

- **Species used**
  1. *Thuja orientalis,*
  2. *Grevillea robusta,*
  3. *Jacaranda mimosifolia ,*
  4. *Camellia reticulata*
  5. *Castonospermum australe*
  6. *Podocarpus microphyllus*
  7. *Citrus reticulata*

- **Processes** – Glycerinised leaves , air dried slices , bleached and dyed pods

- **Products developed** – Wreath , garland , swag , potpourris , etc.,

Garland

Swag

Potpourris

i. **Delicate flower species suitable for freeze drying:** Carnation and jasmine flowers were found suitable for freeze drying. These flowers recorded optimum percentage of moisture loss and scored better for quality parameters (colour and shape retention).]

ii. **Glycerinisation technique for fragile leaves:** Glycol preservation with 30 % Glycerine followed by 30 % Ethylene glycol was found ideal for glycerinization of foliage of My*rtus* sp., *Thuja orientalis, Eucalyptus glaucescens and Asparagus virgatus.* This treatment resulted in soft foliage with natural appearance and maximum colour and shape retention.

iii. **Bleaching techniques to achieve varying degree of whiteness:** The following bleaching techniques were developed for plant parts of *Acacia auriculiformis, Pongamia glabra, Gossypium hirsutum, Pinus spp. and Sesamum indicum.*

- **For half whiteness:** Single step bleaching with 20% Sodium chlorite + 5 % Hydrochloric acid proved superior with minimum bleaching time of 6 h resulting in the required degree of half whiteness and maximum scores for shape retention with minimum percentage of damage.
- **For super whiteness** Double step bleaching with a first step bleaching with 30% Sodium chlorite + 5% HCl followed by the second step bleaching with 30% of first dip + 40% Hydrogen peroxide proved superior with minimum bleaching time and maximum super whiteness with highest whiteness index and minimum percentage of damage and brittleness.

iv. **Dyeing techniques with mordant to improved fastness property:** Treatments involving 2g dye with 5% Alum mordant for 3 minutes resulted good colour strength with maximum scores for rubbing, washing and light fastness properties**.**

v. **Products developed from processed plant parts:** Using the various processed botanicals obtained from all the above improved processing techniques, 25 different dry flower products suitable for export and domestic markets were developed.

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