CROP PRODUCTION GUIDE

2012

DEPT.OF AGRICULTURE, GOVT.OF TAMIL NADU
Chennai - 5

TAMIL NADU AGRICULTURAL UNIVERSITY
Coimbatore - 3

CROP PRODUCTION GUIDE - 2012

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RICE (*Oryza sativa* L.)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/Season	Month	Varieties
I. Cauvery Delta Zone		
a. Thanjavur/Nagapattinam/Tiruvarur		
Kuruvai	(Jun -Jul)	ADT 36, ADT 37, ASD 16, ASD 18, MDU 5, IR 50, ADT 43, ADT (R) 45, ADT (R) 47, ADT (R) 48, CO 47, CORH 3
Samba	(Aug)	I.White Ponni, CO 43, CR 1009, ADT 38, TRY 1*, TRY 3*, ADT (R) 44, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49,TNAU Rice ADT 50, Swarna sub1
Late Samba / Thaladi	(Sep -Oct)	ADT 38, ADT 39, TRY 1*, TRY 3*, ADT (R) 46, ADT (R) 49, CO (R) 48, CO (R) 49, CO (R) 50
Navarai	(Dec -Jan)	ADT 36, ADT 37, ASD 16, ASD 18, MDU 5, CO 47,CORH 3
4. Tiruchirapalli		
Kuruvai	(Jun -Jul)	ADT 36, ASD 16, ADT 37, ASD 18, MDU 5, ADT 43, CO 47, ADT (R) 45, ADT (R) 47, CORH 3
Samba	(Aug)	I.White Ponni, CO 43, CR 1009, TRY 1*, TRY 3* ASD 19, ADT (R) 44, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49, TNAU Rice ADT 50,CORH 4
Late Samba / Thaladi	(Sep -Oct)	I.White Ponni, ADT 39, TRY 1*, TRY 3*, ADT (R)46, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49
Navarai	(Dec -Jan)	ADT 36, ASD 16, ASD 18, MDU 5, ASD 20, CO 47, CORH 3
II. North Eastern Zone		
a. Kanchipuram/Tiruvallur		
Sornavari	(April -May)	ADT 36, ADT 37, ASD 16, ASD 18, MDU 5, IR 50, ADT 43, CO 47, ADT (R) 45, ADT (R) 47, ADT (R) 48, CORH 3
Samba	(Aug)	I.White Ponni, CO 43, TRY 1*, TRY 3*, ADT(R) 44, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49, TNAU Rice ADT 50
Late Samba	(Sep - Oct)	I.White Ponni, ADT 39, TRY 1*, TRY 3*, ADT (R)46, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49
Navarai	(Dec -Jan)	ADT 36, ASD 16, ASD 18, MDU 5, CO 47,CORH 3
Rainfed direct seeded	(July - Aug)	MDU 5, TKM 11,PMK (R) 3, TKM (R) 12, Anna (R) 4
Semi-dry	(July - Aug)	TKM 10, TKM 11, TKM (R) 12, MDU 5, PMK (R) 3, Anna (R) 4
b. Vellore/Tiruvannamalai		
Sornavari	(April-May)	ADT 36, ADT 37, ASD 16, ASD 18, ADT 43, MDU 5, IR 50, CO47, ADT(R)45, ADT(R)47, ADT(R)48, CORH3
Samba	(Aug)	CR 1009, ADT 44, Bhavani, I.White Ponni, CO 43, Paiyur 1, TRY 1*, TRY 3*, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49, TNAU Rice ADT 50
Navarai	(Dec -Jan)	ADT 36, ADT 39, ASD 16, ASD 18, MDU 5, CO 47, CORH 3, ADT 43, ADT (R) 45

c. Cuddalore/ Villupuram		
Sornavari	(April -May)	ADT 36, ASD 16, ASD 18, ADT 43, ADT (R) 45, ADT (R) 47, MDU 5, IR 50, CO 47, CORH 3
Samba	(Aug)	I.White Ponni, CO 43, CR 1009, ADT 38, TRY 1*, ASD 19, ADT (R) 44, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49, TNAU Rice ADT 50
Navarai	(Dec-Jan)	ADT 36, ADT 39, ASD 16, ASD 18, ADT 43, ADT (R) 45, MDU 5, CO 47,CORH 3, ADT 43, ADT (R) 45
III. Western zone		
a. Coimbatore/Tirupur		
Kar	(May - Jun)	ADT 36, ASD 16, ASD 18, MDU 5, IR 50, ADT 43, CO 47, ADT (R) 45, ADT (R) 47, CORH 3
Samba	(Aug)	CO 43, I.White Ponni, TRY 1*, TRY 3*, Bhavani, ADT(R) 44, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT 38, ADT (R) 49,TNAU Rice ADT 50
Late Samba/Thaladi	(Sep - Oct)	ADT 38, ADT 39, ADT(R) 46, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49
Navarai	(Dec -Jan)	ADT 36, ASD 16, MDU 5, CO 47, ADT (R) 47,CORH 3, ADT 43, ADT 45
b. Erode		
Kar	(May - Jun)	ASD 16, ADT 36, IR 50, MDU 5, ADT 43, CO 47, ADT (R) 45, ADT (R) 47, CORH 3
Samba	(Aug)	Bhavani, CO 43, I.White Ponni, TRY 1*, ADT (R) 44, CO (R) 48, CO (R) 49, CO (R) 50, ADT 38, ADT (R) 49, TNAU Rice ADT 50
Late Samba	(Sep - Oct)	I.White Ponni, ADT 39, TRY 1*, ADT 38, ADT (R) 46, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49
Navarai	(Dec – Jan)	ADT 36, ASD 16, ADT 43, ADT 45, CO 47,MDU 5, CORH 3
c. Karur/Perambalur/Ariyalur		
Kuruvai	(Jun -Jul)	ADT 36, ASD 16, ADT 37, ASD 18, IR 50, MDU 5, ADT 43, CO 47, ADT (R) 45 (except Karur), ADT(R)47, CORH 3
Samba	(Aug)	I.White Ponni, CO 43, ADT 40, CR 1009, TRY 1*, ADT 38, ADT(R) 44, CO(R) 48, CO(R) 49, CO (R) 50, ADT(R)49, TNAU Rice ADT50,Swarna Sub1, ADT(R) 46
Late Samba / Thaladi	(Sep -Oct)	I.White Ponni, ADT 39, CO 43, TRY 1*, ASD 19, ADT 38, ADT (R)46, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49
Navarai	(Dec -Jan)	ADT 36, ASD 16, ASD 18, MDU 5, CO 47, ADT 43, ADT 45, CORH 3
IV. North Western Zone		
a. Salem/Namakkal		
Kar	(May - Jun)	ADT 36, ADT 37, ASD 16, ASD18, MDU 5, ADT 43, CO 47, ADT (R) 45, ADT (R) 47,CORH 3
Samba	(Aug)	I.White Ponni, Bhavani, CO 43, TRY 1*, TRY (R) 3*, ADT (R) 44, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49, TNAU Rice ADT 50
Navarai	(Dec - Jan)	ADT 36, ASD 18, ASD 19, ADT 42, MDU 5, ASD 20, CORH 3, ADT 43, ADT 45
b. Dharmapuri/ Krishnagiri		
Kar	(May -Jun)	ADT 36, ADT 37, ASD 16, ASD18, MDU 5, ADT 43, CO 47, ADT (R) 45, ADT (R) 47,CORH 3

Samba/Late Samba	(Aug - Oct)	TRY 3*, Bhavani, I.White Ponni, CO 43, ADT (R) 44, ADT(R) 46, CO(R) 48, CO(R) 49, CO(R) 50, ADT(R) 49
Navarai	(Dec- Jan)	ADT 37, ASD 16, ADT 36, ASD 18, ADT 42, MDU 5, ASD 20, CORH 3
V. High Altitude zone		
a. The Nilgiris		
Samba	(Jul -Aug)	CO 43, ADT (R) 46, ADT 39, CORH 4
VI. Southern zone		
a. Pudukottai		
Kuruvai	(Jun -Jul)	ADT 36, ASD 16, MDU 5, CO 47, ADT 43, ADT (R) 45, ADT (R) 47, CORH 3
Samba	(Aug)	I.White Ponni, CO 43, Ponmani, TRY 1, ADT (R) 44, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49, TNAU Rice ADT 50
Late Samba/Thaladi	(Sep - Oct)	ADT 38, ADT 39, TRY 1*, ASD 19, CO 43, ADT (R) 46, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49
Rainfed direct seeded	(Jul -Aug)	ADT 36, TKM 10, TKM (R) 12, PMK (R) 3, Anna (R) 4
Semi-dry	(Jul -Aug)	ADT 36, TKM 10, TKM (R) 12, PMK (R) 3, Anna (R) 4
b. Madurai/Dindigul/Theni		
Kar	(May -Jun)	ADT 36, ADT 37, ASD 16, ASD 18, ADT 42, MDU 5, ASD 20, ADT43, CO47, ADT(R)45, ADT(R)47, CORH 3
Samba	(Aug)	I.White Ponni, CO 43, ADT (R) 46,TRY 3*, ADT (R) 44, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49, TNAU Rice ADT 50
Late Samba/Thaladi	(Sep - Oct)	I.White Ponni, ADT 39, ADT 38, ADT (R)46, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49, CORH 4
Navarai	(Dec -Jan)	ADT 36, ADT 37, ASD 16, ASD 18, MDU 5, CORH 3
Semi-dry	(Jul -Aug)	MDU 5, TKM (R) 12, PMK (R) 3, Anna (R) 4
c. Ramanathapuram		
Samba	(Aug)	I.White Ponni, CO 43, TRY 1*, ADT (R) 44, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49, TNAU Rice ADT 50
Rainfed direct seeded & Semidry	(Jul -Aug)	MDU 5, TKM (R) 12, PMK (R) 3, Anna (R) 4, RMD (R) 1
d. Virudhunagar		
Samba	(Sep-Oct)	CO 43, TRY 1, TRY 3*, ADT (R)46, ADT 39, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49
Rainfed direct seeded	(Jul -Aug)	ADT 36, MDU 5, TKM (R) 12, PMK (R) 3, Anna (R) 4
e. Sivaganga		
Semi-dry	(Jul –Aug)	ADT 36, ADT 39, MDU 5, PMK (R) 3, Anna (R) 4
f. Tirunelveli, Thoothukudi		
Early Kar	(Apr - May)	ADT 36, ADT 42, ADT 43, ADT 45, CO 47, ADT (R) 47, IR 50
Kar	(May -Jun)	ASD 16, ASD 18, IR 50, ADT 43, CO 47, ADT (R) 45, TRY (R) 2*, ADT (R) 47, CORH 3
Late Samba/Thaladi	(Sep - Oct)	I.White Ponni, ADT 39, TRY 1*, ADT (R)46, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49
Pishanam/Late Pishanam	(Sep-Oct.)	ASD 18, ASD 16, CO 43, TRY 1*, ADT (R) 46, CORH 4, CO (R) 48, CO (R) 49, CO (R) 50, ADT (R) 49
Semi Dry	(July- Aug)	MDU 5, ADT 36, TKM (R) 12, PMK (R) 3, Anna (R) 4

VII. High Rainfall zone		
a. Kanyakumari		
Kar	(May –Jun)	ADT 36, ASD 16, ASD 17, ASD 18, MDU 5, ADT 43, ADT(R) 45, CO 47, ADT (R) 47, CORH 3
Pishanam / Late Samba / Thaladi	(Sep – Oct)	I.White Ponni, CR 1009, CO 43, TRY 1*, TPS 2, TPS 3, ADT (R) 44, ADT 39, ASD 18, ASD 19, MDU 5, ADT (R) 46, CORH 4, CO (R) 48, CO (R) 49, CO(R) 50, ADT (R) 49
Semi-dry	(Jul – Aug)	ADT 36, ASD 17, TKM (R) 12, PMK (R) 3

* suitable for salt affected soils

Note of Caution of the varieties*: IR 50 and ADT43 are recommended for Kar, Sornavari and Kuruvai seasons and should not be grown during cold weather period. Improved White Ponni is also susceptible to blast and care should be taken on plant protection measures. All samba/late samba season varieties are likely to get infected with false smut and hence prophylactic spraying has to be adopted.*

II. PARTICULARS OF RICE VARIETIES

PARTICULARS	BHAVANI	ADT 36	CO 43
Parentage	Peta x BPI 76	Triveni x IR 20	Dasal x IR 20
Duration (Days)	130 - 135	110	135 - 140
Average Yield (kg/ha)	5000	4000	5200
1000 grain wt (g)	21.5	20.6	20
Grain L/B ratio	4.72	3.1	3.5
Grain type	Long Slender	Medium	Medium slender
Morphological Characters			
Habit	Medium tall	Erect	Erect
Leaf sheath	Green	Green	Green
Septum	Cream	Green	Green
Ligule	Colourless	Colourless	White, longer
Auricle	Colourless	Colourless	Colourless
Panicle	Long compact	Long compact	Long drooping
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Absent	Absent	Absent
Grain size (mm)			
Length	9.6	7.8	8.1
Breadth	2.03	2.5	2.3
Thickness	1.5	2	1.8
Seed source	Seed centre, TNAU, Coimbatore-3	Seed centre, TNAU, Coimbatore-3	Seed centre, TNAU, Coimbatore-3
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

PARTICULARS	IR 50	CR 1009	I.White Ponni
Parentage	IR 2153-14 X IR 28 X IR 36	Pankaj x Jagannath	Taichung 65/2 Mayang Ebos-80
Duration (Days)	105 (Summer) 130 (Winter)	155 - 160	135 - 140
Average Yield (kg/ha)	6000	5300	4500
1000 grain wt (g)	20.35	23.5	16.4
Grain L/B ratio	3.9	2.2	3.22
Grain type	Long Slender	Short bold	Medium slender
Morphological Characters			
Habit	Erect	Erect	Medium tall
Leaf sheath	Green	Green	Green
Septum	Green	Green	Green
Ligule	Colourless	White	White
Auricle	Colourless	Colourless	Colourless
Panicle	Long & drooping	Medium drooping	Long drooping
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Absent	Absent	Absent
Grain size (mm)			
Length	8.9	6.9	8.0
Breadth	2.3	3.1	3.0
Thickness	1.8	2.1	2.0
Seed source	Seed centre, TNAU, Coimbatore-3	Seed centre, TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

PARTICULARS	CO 47	ASD 16	ADT 37
Parentage	IR 50 / CO 43	ADT 31/CO 39	BG 280-1 2/ PTB 33
Duration (Days)	110-115	110 - 115	105
Average Yield (kg/ha)	5832	5600	6200
1000 grain wt (g)	20.6	24.2	23.4
Grain L/B ratio	2.7	2.6	1.79
Grain type	Medium slender	Short Bold	Short bold
Morphological Characters			
Habit	Erect	Semi dwarf	Semi dwarf
Leaf sheath	Green	erect	semi erect
Septum	Yellow	Green	Green
Ligule	Acute to acuminate, white	Cream	White
Auricle	Colourless	White	White
Panicle	Compact	Colourless	White
Husk colour	Straw	Long Compact	Compact
Rice colour	White	Straw	Straw
Abdominal white	Absent	Present	Present
Grain size (mm)			
Length	7.7	7.86	5
Breadth	2.3	3.02	2.8

Thickness	1.7	1.96	1.88
Seed source	Seed centre,TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

PARTICULARS	**ADT 38**	**TPS 2**	**ADT 39**
Parentage	IR 1529-680-3-2/ IR 4432-52-6-4/ IR 7963-30-2	IR 26/CO 40	IR 8/IR 20
Duration (Days)	130 - 135	125 - 130	120 - 125
Average Yield (kg/ha)	6200	4615	5000
1000 grain wt (g)	21	23.5	18
Grain L/B ratio	3.2	2.89	2.9
Grain type	Long Slender	Short Bold	Medium slender
Morphological Characters			
Habit	Semi dwarf, erect	Semi dwarf	Semi dwarf
Leaf sheath	Green	Green	Green
Septum	White	Cream	Light Cream
Ligule	White Non-prominent	White	Papery white
Auricle	White	White	Non-pigmented
Panicle	Long moderately	Medium	Medium, Moderately dense
Husk colour	Straw	White	Straw
Rice colour	White	White	White
Abdominal white	Absent	Present	Absent
Grain size (mm)			
Length	6.9	8.1	7.6
Breadth	2.4	2.8	2.3
Thickness	2.0	2.0	1.9
Seed source	Seed centre,TNAU, Coimbatore-3		
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

PARTICULARS	**ASD 18**	**MDU 4**	**TKM 10**
Parentage	ADT 31/IR 50	AC 2836/Jagannath	CO 31/C22
Duration (Days)	105 - 110	120 - 125	135
Average Yield (kg/ha)	5900	5900	2563
1000 grain wt (g)	21.8	22.9	23.2
Grain L/B ratio	3.2	4	3.6
Grain type	Medium slender	Long slender	Medium slender
Morphological Characters			
Habit	Semi dwarf(90cm)	Erect, tall	Semi tall
Leaf sheath	Pale Green	Green	Green
Septum	Light green	Green	Green
Ligule	White clefted	Colourless	Colourless
Auricle	Pale green	Colourless	Colourless
Panicle	Medium, compact	Compact, Medium	Compact

	exerted		
Husk colour	Straw	Yellow	Light brown
Rice colour	White	White	White
Abdominal white	Slightly present	Absent	Present
Grain size (mm)			
Length	8.64	9.12	9.0
Breadth	2.7	2.26	2.53
Thickness	2.2	—	1.75
Seed source	Seed centre,TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

PARTICULARS	**ASD 19**	**TRY 1**	**TPS 3**
Parentage	Lalnakanda/ IR 30	IR578-172-2-2/ BR-1-2-B-1	RP 31-492/LMN
Duration (Days)	127 (120-132)	135-140	135 -140
Average Yield (kg/ha)	5800	5255	5253
1000 grain wt (g)	18.39	24	23.2
Grain L/B ratio	3.06	2.6	2.06
Grain type	Short, slender	Medium	Short Bold
Morphological Characters			
Habit	Semi-dwarf, erect	Erect	Semi dwarf/erect
Leaf sheath	Light green	Green	Green
Septum	Cream	White	Cream
Ligule	White	White	—
Auricle	Palegreen	White	—
Panicle	Compact, dense drooping & well exerted	Long, moderately compact	Long
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Absent	Absent	Present
Grain size (mm)			
Length	8.28	6.2	7.96
Breadth	2.32	2.4	3
Thickness	1.72	1.8	2
Seed source	Seed centre,TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

PARTICULARS	**ASD 20**	**ADT 43**	**MDU 5**
Parentage	IR 18348/IR25863/ IR 58	IR 50/White Ponni	*O.glaberrima* x Pokkali
Duration(Days)	110	110	95 - 100
Average Yield (kg/ha)	6000	5900	4500

1000 grain wt(g)	22.08	15.5	21.1
Grain/L/B ratio	3.12	2.81	3.12
Grain type	Long Slender	Medium slender	Medium slender
Morphological characters			
Habit	Erect	Semi dwarf	Erect
Leaf sheath	Pale green	Light green	Green
Septum	Cream	Cream	-
Ligule	Pale white	White	Colourless
Auricle	Pale green	-	Colourless
Panicle	Medium compact	Moderately long, Intermediate type, drooping	Intermediate
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Absent	Very occasionally present	-
Grain size(mm)			
Length	9.38	5.46	8.45
Breadth	2.18	1.94	2.7
Thickness	1.46	1.63	-
Seed source	Seed centre,TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

PARTICULARS	**TKM 11**	**ADT (R) 44**	**ADT (R) 45**
Parentage	C22/BJ1	IET 14099-IR56/ OR142-99	IR50 / ADT 37
Duration(Days)	110 - 120	148	110
Average Yield (kg/ha)	3000	6214	5400
1000 grain wt(g)	21.4	23.9	17.5
Grain/L/B ratio	3.2	2.21	2.98
Grain type	Long slender	Short Bold	Medium slender
Morphological characters			
Habit	Erect	Medium Tall	Semi dwarf, erect
Leaf sheath	Green	Light Green	Green
Septum	Cream	Cream	Cream
Ligule	Colourless	White	White
Auricle	Light green	-	-
Panicle	Long, compact, drooping	Long Compact	Compact
Husk colour	White	Straw	Straw
Rice colour	-	White	White
Abdominal white		Present	Absent
Grain size(mm)			
Length	9.3	8.07	8.00
Breadth	2.3	2.95	2.16
Thickness	1.6	2.06	1.97
Seed source	Seed centre,TNAU,	Seed centre,TNAU,	Seed centre, TNAU,

	Coimbatore-3	Coimbatore-3	Coimbatore-3
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

PARTICULARS	**ADT (R) 46**	**TKM (R)12**	**TRY (R)2**
Parentage	ADT38 / CO 45	TKM 9/ TKM 11	IET 6238 / IR 36
Duration(Days)	135	115-120	115-120
Average Yield (Kg / ha)	6656	3043	5362
1000 grain wt(g)	23.8	18.3	22.8
Grain/L/B ratio	3.12	2.42	3.5
Grain type	Long Slender	Medium slender	Long slender
Morphological characters			
Habit	Erect, semi-dwarf	Erect	Semi-dwarf erect
Leaf sheath	Green	Green	Green
Septum	Cream	Cream	Light green
Ligule	Long white	White	distinct
Auricle	Pale green	Dull white	Hairy light brown
Panicle	Intermediate	Medium compact	Compact
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Absent	Present	Absent
Grain size(mm)			
Length	9.58	7.5	9.1
Breadth	2.46	3.1	2.6
Thickness	1.95	2.3	1.7
Seed source	Seed centre, TNAU, Coimbatore-3	Seed centre, TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

PARTICULARS	**PMK (R)3**	**ADT (R) 47**	**ADT (R) 48**
Parentage	UPLRI 7/ CO 43	ADT 43/ Jeeragasamba	IET 11412/ IR 64
Duration(Days)	110-115	118	94-99
Average Yield (Kg/ ha)	3025	6200	4800
1000 grain wt(g)	26.10	13.5	22.0
Grain/L/B ratio	2.84	2.72	3.25
Grain type	Long Bold	Medium slender	Long slender
Morphological characters			
Habit	Erect	Semidwarf erect	Semidwarf erect
Leaf sheath	Green	Green	Green
Septum	-	-	Cream
Ligule	Pale green	-	Acute, prominent
Auricle	-	Light green	-
Panicle	Intermediate	Long and droopy	Intermediate
Husk colour	Golden yellow with brown streaks	straw	straw
Rice colour	White	White	White

Abdominal white	-	Occasionally present	Occassionally present
Grain size(mm)			
Length	6.75	7.20	9.15
Breadth	2.38	2.20	2.54
Thickness	2.08	1.80	1.90
Seed source	Seed centre,TNAU, Coimbatore-3	Seed centre, TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

PARTICULARS	**CO (R) 48**	**CO (R) 49**	**CO (R) 50**
Parentage	CO 43/ASD 19	C 20/RNR 52147	CO 43 / ADT 38
Duration(Days)	130-135	130-135	130-135
Average Yield (Kg/ ha)	6007	6286	6338
1000 grain wt(g)	18.0	15.9	20.5
Grain/L/B ratio	2.79	2.79	2.90
Grain type	Medium slender	Medium slender	Medium slender
Morphological characters			
Habit	Medium tall	Semi dwarf	Medium tall with New plant type
Leaf sheath	Green	Green	Green
Septum	-	-	-
Ligule	-	-	-
Auricle	Pale green	Pale green	Pale green
Panicle	long, compact, droopy	Long, compact, droopy	Long compact droopy
Husk colour		Straw	Straw
Rice colour	Straw	White	White
Abdominal white	White, Occasionally present	Occasionally present	Occassionally present
Grain size(mm)			
Length	5.30	5.60	6.10
Breadth	1.90	2.01	2.10
Thickness	-	-	-
Seed source	Seed centre,TNAU, Coimbatore-3	Seed centre, TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

PARTICULARS	**Anna (R) 4**	**CORH 3**	**CORH 4**
Parentage	Pantdhan 10 x IET 9911	TNAU CMS 2A/CB 87R	TNAU CMS 23 A / CB 174 R
Duration(Days)	105-110	110-115	130 - 135
Average Yield (Kg/ ha)	3700	7500	7348
1000 grain wt(g)	25.7	22.0	20.40
Grain/L/B ratio	3.45	2.95	2.96

Grain type	Long slender	Medium slender	Medium slender
Morphological characters			
Habit	Semidwarf erect	Semi dwarf	Semi dwarf
Leaf sheath	Green	Green	Green
Septum	-	-	-
Ligule	-	-	-
Auricle	Pale green	Pale green	Pale green
Panicle	Intermediate	Long, compact, droopy	Long compact droopy
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Absent	Occasionally present	Occasionally present
Grain size(mm)			
Length	6.90	6.2	5.67
Breadth	2.00	2.1	1.91
Thickness	-	1.2	-
Seed source	Seed centre,TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3	Seed centre,TNAU, Coimbatore-3
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

PARTICULARS	**TNAU Rice ADT 49**	**TNAU Rice ADT 50**
Parentage	CR1009/ Jeeraga Samba	BPT 5204 / CR 1009
Duration(Days)	131	149
Average Yield (Kg/ ha)	6173	5945
1000 grain wt(g)	14.0	15.9
Grain/L/B ratio	2.77	2.56
Grain type	Medium Slender	Medium Slender
Morphological characters		
Habit	Semi dwarf, Erect	Semi dwarf, Erect
Leaf sheath	Green	Green
Septum	Cream	Cream
Ligule	Split , white	Split , white
Auricle	Colourless	Absent
Panicle	Compact	Compact
Husk colour	straw	straw
Rice colour	white	white
Abdominal white	Occasionally present	Occasionally present
Grain size(mm)		
Length	7.36	7.24
Breadth	2.24	3.50
Thickness	1.69	1.65
Seed source	Seed centre, TNAU, Coimbatore	Seed centre, TNAU, Coimbatore
Marketability	Central Warehousing Corporation and Regulated markets	Central Warehousing Corporation and Regulated markets

CROP MANAGEMENT

SYSTEMS OF RICE CULTIVATION IN TAMIL NADU

Rice is cultivated under **puddled** and **un-puddled lowland** situations in Tamil Nadu. ‘Transplanting’ and ‘direct wet seeding’ are the two environments under puddled lowland. Whereas, un-puddled lowland cultivation undergoes different environments like, dry seeding exclusively with rainfall, locally called as ‘rainfed rice’, with supplemental irrigation during peak vegetative and reproductive phases by the rain water collected / harvested in tanks (‘semi-dry rice’) and also assured irrigation from canal after 30-45 days of dry situation (also called semi-dry rice) . They are grouped as follows:

1. **Transplanted puddled lowland rice**
2. **Direct seeded lowland rice**
   a. Wet seeded rice in puddled soil
   b. Dry seeded rice in un-puddled soil
      i) Rainfed
      ii) Semi dry - supplemental irrigation
      iii) Semi dry - canal irrigation* (contingent crop)
3. **Dry seeded upland rice** – This system of rice cultivation is there in areas with high rainfall (like Assam and NE frontiers of India) where the land is slopy and terraced and there is no possibility for bunding to stagnate the water. Grain yield is poor due to loss of nutrients and soil mainly caused by water erosion. Moisture availability is mostly at saturation or at wet range. There is very limited area in Dharmapuri district, Tamil Nadu.
4. **Deep water rice** cultivation exists in certain pockets of Nagapattinam and Tiruvarur districts particularly during NE monsoon with heavy downpour.

1. TRANSPLANTED PUDDLED LOWLAND RICE

TRANSPLANTED RICE
1.1. Nursery management
1.1.1. Wet nursery
Nursery area

Select 20 cents (800 m^2) of land area near to water source for raising seedlings for one hectare.

Seed rate

30 kg for long duration
40 kg for medium duration
60 kg for short duration varieties and
20 kg for hybrids

Seed treatment

a. Treat the seeds in Carbendazim or Pyroquilon or Tricyclozole solution at 2 g/l of water for 1 kg of seeds. Soak the seeds in water for 10 hrs and drain excess water.
b. This wet seed treatment gives protection to the seedlings up to 40 days from seedling disease such as blast and this method is better than dry seed treatment.
c. If the seeds are required for sowing immediately, keep the soaked seed in gunny in dark and cover with extra gunnies and leave for 24hrs for sprouting.
d. **Seed treatment with *Pseudomonas fluorescens***: Treat the seeds with talc based formulation of *Pseudomonas fluorescens* 10g/kg of seed and soak in 1lit of water overnight. Decant the excess water and allow the seeds to sprout for 24hrs and then sow.
e. **Seed treatment with biofertilizers :** Five packets (1kg/ha) each of *Azospirillum* and Phosphobacteria or five packets (1kg/ha) of Azophos bioinoculants are mixed with sufficient

water wherein the seeds are soaked overnight before sowing in the nursery bed (The bacterial suspension after decanting may be poured over the nursery area itself).

- Biocontrol agents are compatible with biofertilizers
- Biofertilizers and biocontrol agents can be mixed together for seed soaking
- Fungicides and biocontrol agents are incompatible

Forming Seedbeds

- Mark plots of 2.5m breadth with channels 30cm wide all around the seedbeds.
- Length of the seed bed may vary from 8 to 10m according to soil and slope of the land.
- Collect the puddled soil from the channel and spread on the seedbeds or drag a heavy stone along the channel to lower it, so that the seed bed is at a higher level.
- Level the surface of the seedbed, so that the water drains into the channel.

Sowing

- Sow the sprouted seeds uniformly on the seedbed having thin film of water in the surface.

Water Management

- Drain the water 18 to 24hrs after sowing
- Care must be taken to avoid stagnation of water in any part of the seedbed.
- Allow enough water to saturate the soil from 3rd to 5th day. From 5th day onwards, increase the water depth to 1.5cm depending on the height of the seedlings.
- Thereafter maintain 2.5cm depth of water.

Weed Management

- Apply any one of the pre-emergence herbicides *viz*., Pretilachlor + safener 0.3kg/ha, on 3rd or 4th day after sowing to control weeds in the lowland nursery. Keep a thin film of water and allow it to disappear. Avoid drainage of water. This will control germinating weeds.
- Butachlor 2.0 l/ha (or) Pendimethalin 2.5 l/ha (or) Anilophos 1.25 l/ha. Herbicides should be applied on 8 DAS with thin layer of water in the field.

Nutrient management

- Apply 1 tonne of fully decomposed FYM or compost to 20 cents nursery and spread the manure uniformly on dry soil.
- Basal application of DAP is recommended when the seedlings are to be pulled out in 20-25 days after sowing in less fertile nursery soils.
- For that situation, before the last puddling, apply 40 kg of DAP and if not readily available, apply straight fertilizers 16 kg of urea and 120 kg of super phosphate.
- If seedlings are to be pulled out after 25 days, application of DAP is to be done 10 days prior to pulling out.
- For clayey soils where root snapping is a problem, 4 kg of gypsum and 1 kg of DAP/cent can be applied at 10 days after sowing.

1.1.2. Dry nursery

- Dry ploughed field with fine tilth is required.
- Nursery area with sand and loamy soil status is more suitable for this type of nursery.
- Area 20 cents.
- Plots of 1 to 1.5 m width of beds and channels may be formed. Length may be according to the slope and soil. Raised beds are more ideal if the soil is clayey in nature.
- Seed rate and seed treatment as that of wet nursery.
- Sowing may be dry seeding. Seeds may be covered with sand and finely powdered well decomposed farm yard manure.
- Irrigation may be done to wet the soil to saturation.
- Optimum age for transplanting – 4th leaf stage
- This type of nursery is handy in times of delayed receipt of canal water.

1.2. Main Field Management

1.2.1. Land preparation

- Plough the land during summer to economize the water requirement for initial preparation of land.
- Flood the field 1 or 2 days before ploughing and allow water to soak in. Keep the surface of the field covered with water.
- Keep water to a depth of 2.5cm at the time of puddling.
- Special technologies for problem soils:
  a) For fluffy paddy soils: compact the soil by passing 400kg stone roller or oil-drum with stones inside, eight times at proper moisture level (moisture level at friable condition of soil which is approximately 13 to18%) once in three years, to prevent the sinking of draught animals and workers during puddling.
  b) For sodic soils with pH values of more than 8.5, plough at optimum moisture regime, apply gypsum at 50% gypsum requirement uniformly, impound water, provide drainage for leaching out soluble salts and apply green leaf manure at 5 t/ha, 10 to 15 days before transplanting. Mix 37.5 kg of zinc sulphate per ha with sand to make a total quantity of 75 kg and spread the mixture uniformly on the leveled field. Do not incorporate the mixture in the soil. Rice under sodic soil responds well to these practices.
  c) For saline soils with EC values of more than 4 dS/m, provide lateral and main drainage channels (60cm deep and 45cm wide), apply green leaf manure at 5 t/ha at 10 to 15 days before transplanting and 25% extra dose of nitrogen in addition to recommended P and K and $ZnSO_4$ at 37.5 kg/ha at planting
  d) For acid soils apply lime based on the soil analysis for obtaining normal rice yields. Lime is applied 2.5 t/ha before last ploughing. Apply lime at this rate to each crop up to the 5th crop.

1.2.2. Stand Establishment

Optimum age of seedlings for quick establishment

- Optimum age of the seedlings is 18-22 days for short, 25-30 days for medium and 35-40 days for long duration varieties.

Pulling out the seedlings

- Pull out the seedlings at the appropriate time (4th leaf stage).
- Pulling at 3rd leaf stage is also possible. These seedlings can produce more tillers, provided enough care taken during the establishment phase (See section 1.8 Integrated Crop Management (ICM) - Rice-SRI) through thin film of water management and perfect leveling of main field.
- Transplanting after 5th and higher order leaf numbers will affect the performance of the crop and grain yield. Then they are called as 'aged seedlings'. Special package is needed to minimize the grain yield loss while planting those aged seedlings.

Root dipping

- Prepare the slurry with 5 packets (1 kg/ha) each of *Azospirillum* and Phosphobacteria or 5 packets of (1 kg/ha) Azophos inoculant in 40 lit. of water and dip the root portion of the seedlings for 15 - 30 minutes in bacterial suspension and transplant.

Planting seedlings in the main field

Soil	Medium and low fertility			High fertility		
Duration	Short	Medium	Long	Short	Medium	Long
Spacing (cm)	15x10	20x10	20x15	20x10	20x15	20x20
Hills / m^2	66	50	33	50	33	25

- Transplant 2-3 seedlings/hill for short duration and 2 seedlings/hill for medium and long duration varieties
- Shallow planting (3 cm) ensures quick establishment and more tillers.
- Deeper planting (> 5cm) leads to delayed establishment and reduced tillers.
- Line planting permits rotary weeding and its associated benefits.
- Allow a minimum row spacing of 20 cm to use rotary weeder.
- Fill up the gaps between 7^{th} and 10^{th} DAT.

Management of Aged seedlings*

*** Which developed tillers / underwent node elongation in the nursery itself and**
*** About half of its leaf producing capacity may be already over.**

- Follow the spacing recommended to medium and low fertility soil
- Plant two to three seedlings per hill
- Avoid cluster planting of aged seedlings, which are hindering the formation of new tillers.
- New tillers alone are capable of producing normal harvestable panicle. Weak panicle may appear in the mother culm within three weeks after transplanting and vanishes well before harvest.
- To encourage the tiller production, enhance the basal N application by 50% from the recommended and thereafter follow the normal schedule recommended for other stages.

Gap filling

- Fill the gaps if any within 7 - 10 days after planting.

1.2.3. Nutrient management

Application of organic manures

- Apply 12.5 t of FYM or compost or green leaf manure @ 6.25 t/ha.
- If green manure is raised @ 50 kg seeds/ha *in situ,* incorporate it to a depth of 15 cm using a green manure trampler or tractor.
- In the place of green manure, press-mud / composted coir-pith can also be used.

Stubble incorporation

- Apply 10 kg N/ha (22 kg urea) at the time of first puddling while incorporating the stubbles of previous crop to compensate immobilization of N by the stubbles.
- This may be done at least 10 days prior to planting of subsequent crop. This recommendation is more suitable for double crop wetlands, wherein, the second crop is transplanted in succession with short turn around period.

Biofertilizer application

- Broadcast 10 kg of soil based powdered BGA flakes at 10 DAT for the dry season crop. Maintain a thin film of water for multiplication.
- Raise Azolla as a dual crop by inoculating 250 kg/ha 3 to 5 DAT and then incorporate during weeding for the wet season crop.
- Mix 10 packets (2 kg/ha) each of *Azospirillum* and Phosphobacteria or 10 packets (2 kg/ha) of Azophos inoculants with 25 kg FYM and 25 kg of soil and broadcast the mixture uniformly in the main field before transplanting and
- *Pseudomonas fluorescens* (Pf 1) at 2.5 kg/ha mixed with 50 kg FYM and 25 kg of soil and broadcast the mixture uniformly before transplanting.

Application of inorganic fertilizers

- Apply fertilizer nutrients as per STCR-IPNS recommendations for desired yield target (Appendix I) (or)
- N dose may be through Leaf Color Chart (**LCC**)*
- P & K may be through Site Specific Nutrition Management by Omission plot technique**
- If the above recommendation are not able to be followed, adopt blanket recommendation as

follows:

Nutrients	N	P_2O_5	K_2O
	(kg/ha)		
Short duration varieties (**dry season**)			
a) Cauvery delta & Coimbatore tract	150	50	50
b) For other tracts	120	40	40
Medium and long duration varieties (**wet season**)	150	50	50
Hybrid rice	175	60	60
Low N responsive cultivars (like Improved White Ponni)	75*	50	50

* For Ponni, N should be applied in three splits at AT, PI and H stages** in addition to GLM or FYM application.

****Phenological stages of rice (days after sowing)**

Stages	Short (105)	Medium (135)	Long (150)
Active Tillering (AT)	35-40	50-55	55-60
Panicle Initiation (PI)	45-50	70-75	85-90
Heading (H)	70-75	100-105	115-120

*** N management through LCC**

- Time of application is decided by LCC score
- Take observations from 14 DAT in transplanted rice or 21 DAS in direct seeded rice.
- Repeat the observations at weekly intervals up to heading
- Observe the leaf colour in the fully opened third leaf from the top as index leaf.
- Match the leaf color with the colours in the chart during morning hours (8-10 am).
- Take observation in 10 places.
- LCC critical value is 3.0 in low N response cultures like White Ponni and 4.0 in other cultivars and hybrids
- When 6/10 observations show less than the critical colour value, N can be applied as per the following recommendation : Application of 25 kg N ha^{-1} (1 bag urea) at 7 DAT followed by N @ 40 kg ha^{-1} each time for kuruvai/ short duration rice / 30 kg ha^{-1} each time for medium & long duration rice as and when the leaf colour value falls below the critical value of 4 for varieties and hybrids and critical value of 3 for white ponni, monitored from 14 DAT.
- For aged seedlings : Basal application of 35 kg N per ha is recommended to avoid yield loss when seedlings aged 35 - 45 days are used for transplanting and the LCC based N management can be followed from 14 DAT.

****Recommendation of P&K fertilizer rates based on SSNM approach for rice growing tracts of Tamil Nadu (other than Cauvery Delta)**

Sl. No.	**Location**	**Calibrated SSNM fertilizer dose (kg/ha)***	
		P_2O_5	**K_2O**
1	Cauvery delta		
	(i) Old delta	**35**	**50**
	(ii) New delta	**35**	**80**
2	Coimbatore District		
	(i) General	30	40
	(ii) Annamalai block	30	80
3	Killikulam	30	50
4	Trichy	35	50
5	Ambasamudram	40	50
6	Bhavanisagar	20	25
7	Paiyur	25	45

8	Yethapur	30	45
9	Aruppukottai	20	30
10	Cuddalore	30	50

** The above SSNM based fertilizer P and K arrived based on yield response are recommended for specific soil series prevailing in different rice growing areas for adoption by farmers

Split application of N and K

- Apply N and K in four equal splits viz., basal, tillering, panicle initiation and heading stages.
- Tillering and Panicle initiation periods are crucial and should not be reduced with the recommended quantity.
- N management through **LCC** may be adopted wherever chart is available

Application of P fertilizer

- P may be applied as basal and incorporated.
- When the green manure is applied, rock phosphate can be used as a cheap source of P fertilizer. If rock phosphate is applied, the succeeding rice crop need not be supplied with P. Application of rock phosphate + single super phosphate or DAP mixed in different proportions (75:25 or 50:50) is equally effective as SSP or DAP alone.

Application of zinc sulphate

- Apply 25 kg of zinc sulphate/ha mixed with 50 kg dry sand or apply 25 kg of TNAU Wetland rice MN mixture/ha enriched in FYM at 1:10 ratio incubated for 30 days at friable moisture, just before transplanting.
- It is enough to apply 12.5 kg zinc sulphate /ha, if green manure (6.25 t/ha) or enriched FYM, is applied.
- If deficiency symptom appears in the standing crop, foliar application of 0.5% zinc sulphate + 1.0% urea can be given at 15 days interval until the Zn deficiency symptoms disappear.

Application of gypsum

- Apply 500 kg of gypsum/ha (as source of Ca and S nutrients) at last ploughing.

Foliar nutrition

- Foliar spray of 1% urea + 2% DAP + 1% KCl at Panicle Initiation (PI) and 10 days later for all varieties.

Nutrient deficiency / toxicity symptoms

- **Nitrogen deficiency**: Plants become stunted and yellow in appearance first on lower leaves. In case of severe deficiency the leaves will turn brown and die. Deficiency symptoms first appear at the leaf-tip and progress along the midrib until the entire leaf is dead.
- **Potassium deficiency**: Bluish green leaves - when young, older leaves irregular. Chlorotic and necrotic areas - grain formation is poor - weakening of the straw which results in lodging.
- **Magnesium deficiency:** Leaves are chlorotic with white tips.
- **Zinc deficiency:** Lower leaves have chlorotic particularly towards the base. Deficient plants give a brown rusty appearance.
- **Copper deficiency:** Leaves develop chlorotic streaks on either side of the midrib and appearance of dark brown necrotic lesions on leaf tips. Unfolding of the new leaves will also be seen.
- **Iron toxicity:** Brown spots on the lower leaves starting from tips and proceeding to the leaf base and turns into green or orange purple leaves and spreading to the next above leaves.

Neem treated urea and coal-tar treated urea

Blend the urea with crushed neem seed or neem cake 20% by weight. Powder neem cake to pass through 2mm sieve before mixing with urea. Keep it overnight before use (or) urea can be mixed with gypsum in 1:3 ratios, or urea can be mixed with gypsum and neem cake at 5:4:1 ratio to increase the nitrogen use efficiency. For treating 100 kg urea, take one kg coal-tar and 1.5 litres of kerosene. Melt coal-tar over a low flame and dissolve it in kerosene. Mix urea with the solution thoroughly in a plastic container, using a stick. Allow it to dry in shade on a polythene sheet. This can be stored for a month and applied basally.

N management through LCC

For sodic soil

In the case of sodic soils, LCC critical value is 4.0 for varieties and 5.0 for the hybrids.

Other special cultural practices (Contingent Plan)

Application of Pink Pigmented Facultative Methylotroph (*Methylobacterium* sp.) as seed treatment (@ 200 g / 10 kg seeds), soil application (@ 2 kg / ha) and foliar spray (@ 500 ml / ha) at panicle initiation and flag leaf stages for alleviation of water stress effects in both SRI and transplanted system of rice cultivation.

1.2.4. Weed management

- Use of rotary weeder from 15 DAT at 10 days interval. It saves labour for weeding, aerates the soil and root zone, prolongs the root activity, and improves the grain filling though efficient translocation and ultimately the grain yield.
- Cultural practices like dual cropping of rice-azolla, and rice-green manure (described in wet seeded rice section 2.5 & 2.6 of this chapter) reduces the weed infestation to a greater extent.
- Summer ploughing and cultivation of irrigated dry crops during post-rainy periods reduces the weed infestation.

Pre-emergence herbicides

- Use Butachlor 1.25kg/ha or Anilophos 0.4kg/ha as pre-emergence application. Alternatively, pre-emergence application of herbicide mixture viz., Butachlor 0.6kg + 2,4 DEE 0.75kg/ha, or Anilophos + 2, 4 DEE 'ready-mix' at 0.4kg/ha followed by one hand weeding on 30 - 35 DAT will have a broad spectrum of weed control.
- Any herbicide has to be mixed with 50kg of dry sand on the day of application (3 - 4 DAT) and applied uniformly to the field with thin film water on the 3rd DAT. Water should not be drained for next 2 days from the field (or) fresh irrigation should not be given.
- Pre-emergence application of pretilachor at 1.0 kg a.i. ha^{-1} on 3 DAT + weeding with Twin row rotary weeder at 40 DAT
- PE Pyrazosulfuron ethyl 10 % WP @ 150 g ha^{-1} on 3 DAT + hand weeding (HW) on 45 DAT.
- PE butachlor 0.75 kg a.i. ha^{-1} + bensulfuron methyl 50 g ha^{-1} on 3 DAT + HW on 45 DAT
- PE Oxadiazon 87.5 g a.i. ha^{-1} followed by Post emergence (POE) 2,4-D 1 kg a.i. ha^{-1} along with hand weeding on 35 DAT.
- PE butachlor 0.75 kg per hectare + bensulfuron methyl 50 g ha^{-1} on 3 DAT followed by mechanical weeding on 45 DAT is effective for broad spectrum weed control.
- Crop growth and yield were enhanced by butachlor 1.2 + 2,4-DEE 1.5 lit ha^{-1} with 100% inorganic nitrogen.
- Conventional tillage of one dry ploughing and two passes of cage wheel puddling combined with pre-emergence application of butachlor at 1.25 kg ha^{-1} under lowland situation.
- Stale bed preparation by pre-puddling minimum tillage with glyphosate combine with post-plant pre emergence butachlor 1.25 kg ha^{-1} resulted in increased rice grain yield, net income and B: C ratio in rice-rice cropping.
- If pre-emergence herbicide application is not done, hand weeding has to be done on 15th DAT.
- 2,4-D sodium salt (Fernoxone 80% WP) 1.25 kg/ha dissolved in 625 litres with a high volume sprayer, three weeks after transplanting or when the weeds are in 3 - 4 leaf stage.
- Early post emergence application of Bispyripac sodium 50 g a.i. ha^{-1} (2-3 leaf stage of weeds) + Hand weeding on 45 DAT

1.2.5. Water management

- Puddling and leveling minimizes the water requirement
- Plough with tractor drawn cage wheel to reduce percolation losses and to save water requirement up to 20%.
- Maintain 2.5cm of water over the puddle and allow the green manure to decompose for a minimum of 7 days in the case of less fibrous plants like sunnhemp and 15 days for more fibrous green manure plants like Kolinchi (*Tephrosia purpurea*).
- At the time of transplanting, a shallow depth of 2cm of water is adequate since high depth of water will lead to deep planting resulting in reduction of tillering.
- Maintain 2 cm of water up to seven days of transplanting.
- After the establishment stage, cyclic submergence of water (as in table) is the best practice for rice crop. This cyclic 5cm submergence has to be continued throughout the crop period.

Days after disappearance of ponded water at which irrigation is to be given		
Soil type	Summer	Winter
Loamy	1 day	3 days
Clay	Just before/immediately after disappearance	1 - 2 days

- Moisture stress due to inadequate water at rooting and tillering stage causes poor root growth leading to reduction in tillering, poor stand and low yield.
- Critical stages of water requirement in rice are a) panicle initiation, b) booting, c) heading and d) flowering. During these stages, the irrigation interval should not exceed the stipulated time so as to cause the depletion of moisture below the saturation level.
- During booting and maturity stages continuous inundation of 5cm and above leads to advancement in root decay and leaf senescence, delay in heading and reduction in the number of filled grains per panicle and poor harvest index.
- Provide adequate drainage facilities to drain excess water or strictly follow irrigation schedule of one day after disappearance of ponded water. Last irrigation may be 15 days ahead of harvest.

Precautions for irrigation

- The field plot can be 25 to 50 cents depending on the source of irrigation.
- Field to field irrigation should be avoided. Field should be irrigated individually from a channel.
- Small bund may be formed parallel to the main bund of the field at a distance of 30 to 45cm within the field to avoid leakages of water through main bund crevices.
- To minimize percolation loss, the depth of stagnated water should be 5cm or less.
- In water logged condition, form open drains, about 60cm in depth and 45cm width across the field.
- Care should be taken not to allow development of cracks.
- In canal command area, conjunctive use of surface and ground water may be resorted to for judicious use of water.
- In double cropped wetland of command area, raise groundnut / pulse in the place of *Kuruvai* rice if water is a constraint or go for rice cultivation as described in *5. Dry Seeded Irrigated Un-Puddled Lowland Rice*.

1.3. Insect management: See Crop Protection Chapter
1.4. Disease management: See Crop Protection Chapter

1.5. Harvesting

- Taking the average duration of the crop as an indication, drain the water from the field 7 to 10 days before the expected harvest date as draining hastens maturity and improves harvesting conditions.

- When 80% of the panicles turn straw colour, the crop is ready for harvest. Even at this stage, the leaves of some of the varieties may remain green.
- Confirm maturity by selecting the most mature tiller and dehusk a few grains. If the rice is clear and firm, it is in hard dough stage.
- When most of the grains at the base of the panicle in the selected tiller are in a hard dough stage, the crop is ready for harvest. At this stage harvest the crop, thresh and winnow the grains.
- Dry the grains to 12% moisture level for storage. Grain yield in rice is estimated only at 14% moisture for any comparison.
- Maturity may be hastened by 3-4 days by spraying 20% NaCl a week before harvest to escape monsoon rains.

1.6. Seedling throwing method of stand establishment

- 20 days old seedlings of short duration rice varieties
- Requirement of seedlings will be approximately 20% more than the line planting or equal to random planting.
- The seedlings are thrown into the puddled leveled field by labour without using force.
- Suitable for all seasons except *Thaladi* or heavy rain season.
- 50% labour shaving as compared to line planting and 35% to random planting.
- Up to 7-10 days of seedling throwing care should be taken to maintain thin film of water (similar to wet seeded rice).
- Other cultural operations are same as in transplanted rice
- Grain yield will be equal to line planted crop and 10-12% higher than random planted crop.

1.7. Transplanted hybrid rice

Seed rate	20 kg per hectare
Nursery	Basal application of DAP at 2 kg/cent of nursery area. Sparse sowing of seeds at one kg/cent of nursery area will give robust seedlings with 1-2 tillers per seedling at the time of planting. If the soil is heavy, apply 4 kg gypsum/cent of nursery area, 10 days before pulling of seedlings.
Age of seedling	20 to 25 days
Spacing (cm)	20 x 10 (50 hills/m^2) or 25 x 10 (40 hills/m^2) according to soil fertility
Seedlings/ hill	One (along with tillers if already produced)
Fertilizer	175:60:60 kg N, P_2O_5 and K_2O/ha

Other package of practices: same as in transplanted rice varieties.

1.8. INTEGRATED CROP MANAGEMENT (ICM) - RICE (SRI)

1.8.1. Season

- Dry season with assured irrigation is more suitable.
- Difficulty in crop establishment may be seen in areas with heavy downpour (NE Monsoon periods of Tamil Nadu)

1.8.2. Varieties

- Hybrids and varieties with heavy tillering feature

1.8.3. Nursery

1.8.3.1. Seed rate

- 5-7 kg/ha for single seedling per hill
- 12 -15 kg/ha for two seedlings per hill wherever difficulty in establishment of rice is seen

1.8.3.2. Mat nursery preparation

- *Preparation of nursery area:* Prepare 100 m^2 nursery to plant 1 ha. Select a level area near the water source. Spread a plastic sheet or used polythene gunny bags on the shallow raised bed to prevent roots growing deep into soil.
- *Preparation of soil mixture:* Four (4) m^3 of soil mix is needed for each 100 m^2 of nursery. Mix 70% soil + 20% well-decomposed pressmud / bio-gas slurry / FYM + 10% rice hull. Incorporate 1.5 kg of powdered DAP or 2 kg 17-17-17 NPK fertilizer in the soil mixture.
- *Filling in soil mixture:* Place a wooden frame of 0.5 m long, 1 m wide and 4 cm deep divided into 4 equal segments on the plastic sheet or banana leaves. Fill the frame almost to the top with the soil mixture.
- *Seed Treatment with biofertilizers :* Five packets (1 kg/ha) of *Azospirillum* and five packets (1 kg/ha) of Phosphobacteria or five packets (1 kg/ha) of Azophos. Biofertilizers are mixed with water used for soaking and kept for 4 hrs. The bacterial suspension after draining may be sprinkled in the nursery before sowing the treated seeds
- *Pre-germinating the seeds 2 days before sowing:* Soak the seeds for 24 hr, drain and incubate the soaked seeds for 24 hr, sow when the seeds sprout and radicle (seed root) grows to 2-3 mm long.
- *Soil application of biofertilizers :* Application of *Azospirillum* @ 2 kg and Arbuscular mycorrhizal fungi @ 5 kg for 100 m^2 nursery area
- *Sowing:* Sow the pre-germinated seeds weighing 90 -100 g / m^{-2} (100g dry seed may weigh 130g after sprouting) uniformly and cover them with dry soil to a thickness of 5mm. Sprinkle water immediately using rose can to soak the bed and remove the wooden frame and continue the process until the required area is completed.
- *Watering:* Water the nursery with rose can as and when needed (twice or thrice a day) to keep the soil moist. Protect the nursery from heavy rains for the first 5 DAS. At 6 DAS, maintain thin film of water all around the seedling mats. Drain the water 2 days before removing the seedling mats for transplanting.
- *Spraying fertilizer solution* (optional): If seedling growth is slow, sprinkle 0.5% urea + 0.5% zinc sulphate solution at 8-10 DAS.
- *Lifting seedling mats:* Seedlings reach sufficient height for planting at 15 days. Lift the seedling mats and transport them to main field.
- For elite seedling production under modified mat nursery : seed fortification with 1.0% KCl mixed with native soil and powdered DAP @ 2.0 kg per cent along with *Pseudomonas* 240 g/ cent followed by drenching with 0.5 % urea solution on 9 DAS

1.8.4. Main field preparation
- Puddled lowland prepared as described in transplanted section
- Perfect leveling is a pre-requisite for the water management proposed hereunder

1.8.5. Transplanting
- 1-2 seedlings of 14-15 days old
- Square planting of 25 x 25 cm (10 x 10 inch)
- Fill up the gaps between 7^{th} and 10^{th} DAT.
- Transplant within 30 minutes of pulling out of seedlings.
- There may be difficulty in crop establishment in areas with heavy downpour (North East Monsoon periods of Tamil Nadu)

1.8.6. Irrigation management
- Irrigation only to moist the soil in the early period of 10 days
- Restoring irrigation to a maximum depth of 2.5 cm after development of hairline cracks in the soil until panicle initiation (PI)
- Increasing irrigation depth to 5.0 cm after PI one day after disappearance of ponded water

1.8.7. Weed management
- Using rotary weeder / Cono weeder / power operated two row weeder
- Moving the weeder with forward and backward motion to burry the weeds and as well as to

aerate the soil at 7-10 days interval from 10-15 days after planting on either direction of the row and column.

- Manual weeding is also essential to remove the weeds closer to rice root zone.

1.8.8. Nutrient management

- As per transplanted rice.
- Use of LCC has more advantage in N management.
- Green manure and farm yard manure application will enhance the growth and yield of rice in this system approach.
- Under sodic soils, during rotary weeding, apply Azophosmet @ 2.2 kg/ha and PPFM as foliar spray @ 500 ml/ha

1.8.9. Other package of practices as recommended to transplanted rice

- STCR based fertilizer recommendation for transplanted rice (for some selected districts) is given in the **Appendix I.**

2. WET SEEDED PUDDLED LOWLAND RICE

WET SEEDED RICE

2.1. Area

- Direct wet seeding can be followed in all the areas wherein transplanting is in vogue.

2.2. Season

- As that of translated rice

2.3. Field preparation

- On receipt of showers during the months of May - July repeated ploughing should be carried out so as to conserve the moisture, destroy the weeds and break the clods.
- After inundation puddling is to be done as per transplanting. More care should be taken to level the field to zero level.
- Stagnation of water in patches during germination and early establishment of the crop leads to uneven crop stand.
- Land leveling has say over efficient weed and water management practices.
- Provision of shallow trenches (15 cm width) at an interval of 3m all along the field will facilitate the draining of excess water at the early growth stage.

2.4. Varieties

All the varieties recommended for transplanting can do well under direct wet seeded conditions also. However, the following varieties are more suited.

Varieties	Duration (days)	Time of sowing
Ponmani	160 to 165	1st to 30th August for *Samba*
CO 43, IR20, ADT 38 ADT 39, Ponni, Improved White Ponni	125 to135	1st to 30th September for *Thaladi*
ADT 36, ADT 37	105 to 110	1st to 10th June for *Kuruvai* 1st to 10th October for late *Thaladi*

2.5. Sowing

- Follow a seed rate of 60 kg / ha
- Pre-germinate the seeds as for wet nursery
- Seed treatments as adopted for transplanted rice
- Sow the seeds by **drum seeder** or broadcast uniformly with thin film of water.
- Dual cropping of rice-green manure is economic for nutrient budget and efficient for grain

production. For this method use 'TNAU Rice-Green manure seeder'.

2.6. After cultivation

- Thinning and gap filling should be done 14 - 21 days after sowing, taking advantage of the immediate rain.
- If dual cropped with green manure, incorporate the green manure when grown to 40 cm height or at 30 days after sowing, whichever is earlier, using Cono-weeder.
- Green manure incorporated fields may be operated again with rotary weeder a week later in order to aerate the soil and to exploit organic acids formed if any.

2.7. Manures and fertilizer application

- For direct wet seeded lowland rice, the recommendation is same at that of transplanted rice.
- Apply N and K as 25% each at 21 DAS, at active tillering, PI and heading stages.
- If N applied through LCC, use the critical value 4 for line sown drill seeded rice.
- Entire P as basal applied in the last plough or at the time of incorporation of green manure/ compost.
- Biofertilizers as recommended to transplanted rice may be followed wherever feasible and moisture available.
- Micro nutrient, foliar application and biofertlizers as recommended to transplanted rice.

2.8. Weed management

- In wet seeded rice, pre-emergence application of pretilachlor 0.75 kg/ha on 8 DAS or pretilachlor + safener (Sofit) at 0.45kg/ha on 3-4 DAS followed by one hand weeding on 40 DAS in direct drum seeded rice
- In wet seeded rice, sowing with drum seeder and cono weeding (manual / power weeder) is done at 10, 20 and 30 DAS
- In transplanted rice, hand weeding twice on 15 - 20 DAT and 45 DAT will control the weeds effectively (or) Pendimethalin 3.0 lit/ha at 8 DAT with optimum moisture condition and one hand weeding on 45 DAT.
- Productivity and economic returns of wet seeded rice with dual cropping of danicha could be maximized by the pre-emergence application of pretilachlor + safner at 0.45 kg ha^{-1} followed by one cono weeder in between rows and manual weeding with the rice rows on 35 DAS in lowland conditions.
- PE pretilachlor + safner 0.45 kg/ha^{-1} on 3 DAS + roto cylindrical weeder weeding on 45 DAS in wet seeded rice resulted in excellent control of weeds like *Echinochloa crusgalli, Panicum repens, Eclipta alba* and *Monochoria* vaginalis and higher grain yield, net monetary return and B:C ratio.
- PE pretilachlor (S) 0.45 kg ha^{-1} on 3 DAS fb azimsulfuron 50 DF 35 g ha^{-1} on 20 DAS + hand weeding on 45 DAS for broad spectrum weed control and higher grain yield and economic returns in both irrigated and rainfed direct seeded rice.
- Higher productivity of wet direct seeded (drum seeded) rice could be achieved by integrating intercropping of daincha and pre-emergence application of pretilachlor + safner at 0.45 kg ha^{-1} on 4 DAS followed by one hand weeding on 35 DAS.
- In rice -rice -fallow system intercropping of *Sesbania rostrata* control the weeds of rice field along with incorporation of *Sesbania rostrata* in to the field and one hand weeding on 35 DAT.
- Apply PE pretilachlor 0.45 kg ha^{-1} on 3 DAS + Roto cylindrical weeds + weeding on 45 DAS in wet seeded rice have good control of weeds like *Echinochloa crusgalli, Panicum repens, Eclipta alba* and *Monochoria vaginalis.*

2.9. Water management

- During first one week just wet the soil by thin film of water.

- Depth of irrigation may be increased to 2.5cm progressively along the crop age.
- Afterwards follow the schedule as given to transplanted rice.

2.10. Insect management: See Crop Protection Chapter
2.11. Disease management: See Crop Protection Chapter

Other package of practices

- As recommended in transplanted rice

3. DRY SEEDED RAINFED UN-PUDDLED LOWLAND RICE

RAINFED RICE

The crop establishment, growth and maturity depend up on the rainfall received. There will be standing water after crop establishment for a minimum period of few days to a maximum up to grain filling, depending up on the rainfall. This type of cultivation in Tamil Nadu is called as **'rainfed rice'**, with the assumption that the soil moisture will be under unsaturated (dry) condition during establishment or entire growth period, with reference to tropical climate.

3.1. Area

- Coastal districts of Tamil Nadu like Kanchipuram, Tiruvallur, Pudukottai, Ramanathapuram, Virudhunagar, Sivagangai and Kanyakumari.

3.2. Season

- June – July – (Coastal northern districts)
- September – October (Coastal southern districts)

3.3. Field preparation

- Dry plough to get fine tilth taking advantage of rains and soil moisture availability.
- Apply gypsum at 1 t/ha basally wherever soil crusting and soil hardening problem exist.
- Perfect land leveling for efficient weed and water management.
- Provide shallow trenches (15 cm width) at an interval of 3m all along the field to facilitate draining excess water at the early growth stage.

3.4. Varieties

- Short duration varieties as mentioned in season and varieties including local land races suitable for those tracts.

3.5. Sowing

- Seed rate: 75kg/ha dry seed for any recommended variety.
- Seed hardening with 1% KCl for 16 hours (seed and KCl solution 1:1) and shade dried to bring to storable moisture. This will enable the crop to withstand early moisture stress.
- On the day of sowing, treat the hardened seeds first with *Pseudomonas fluorescens* 10g/kg of seed and then with *Azophos* 1 kg or *Azospirillum and Phosphobacteria* @ 1 kg each per ha seed, whichever is available.
- Drill sow with 20 cm inter row spacing using seed drill.
- The seeds can also be sown behind the country plough
- Depth of sowing should be 3 - 5 cm and the top soil can be made compact with leveling board.
- Pre-monsoon sowing is advocated for uniform germination.

3.6. After cultivation

- 10 packets (2 kg/ha) each of *Azospirillum* inoculant and Phosphobacteria or 10 packets

(2 kg/ha) of Azophos mixed with 25 kg of FYM may be broadcasted uniformly over the field just after the receipt soaking rain / moisture.

- Thinning and gap filling should be done 14 - 21days after sowing, taking advantage of the immediate rain
- Spray Cycocel 1000 ppm (1 ml of commercial product in one lit. of water) under water deficit situations to mitigate ill-effects.
- Foliar spray of Kaolin 3% or KCl 1% to overcome moisture stress at different physiological stages of rice.

3.7. Manures and fertilizer application

- Blanket recommendation : 50:25:25 kg N:P_2O_5:K_2O /ha
- Apply a basal dose of 750 kg of FYM enriched with fertilizer phosphorus (P at 25 kg/ha)
- Apply N and K in two equal splits at 20 - 25 and 40 - 45 days after germination.
- If the moisture availability from the tillering phase is substantial, three splits (25 kg N and 12.5 kg K at 20-25, 40-45 and 60-65 DAG) can be adopted.
- N at PI may be enhanced to 40 kg, if the tiller production is high (may be when the estimated LAI is greater than 5.0) and moisture availability ensured by standing water for 10 days.
- Basal application of $FeSO_4$ at 50 kg/ha is desirable for iron deficient soil (or) apply TNAU Rainfed rice MN mixture @12.5 kg/ha as EFYM at 1:10 ratio incubated for 30 days at friable moisture.
- Need based foliar application of 0.5% $ZnSO_4$ and 1% $FeSO_4$ may be taken up at tillering and PI stages.
- Foliar spray of 1% urea + 2% DAP + 1% KCl at PI and 10 days later may be taken up for enhancing the rice yield if sufficient soil moisture is ensured

3.8. Weed management

- First weeding can be done between 15 and 21 days after germination.
- Second weeding may be done 30 - 45 days after first weeding.
- Apply pendimethalin 1.0 kg/ha on 5 days after sowing or Pretilachlor + safener (Sofit) 0.45 kg/ha on the day of receipt of soaking rain followed by one hand weeding on 30 to 35 days after sowing.
- Seed drill sowing with pre-emergence application of pretilachlor + safener @ 0.3 kg/ha followed by two weedings with star / rotary weeder is recommended.

3.9. Insect management: See Crop Protection Chapter
3.10. Disease management: See Crop Protection Chapter

3.11. Harvesting

- Same as that for wet rice cultivation

4. DRY SEEDED RAINFED UN-PUDDLED LOWLAND RICE WITH SUPPLEMENTAL IRRIGATION

Semi dry rice

It is called as **semi-dry rice**. Crop establishment is as that of rainfed rice but the rain water collected in village tank (Kanmai) is supplemented to protect the crop during peak vegetative and reproductive phases. Interaction between applied nutrients and crop is positive here due to better moisture availability than rainfed rice and hence varieties may be improved ones and nutrient levels may be higher than the previous system.

4.1. Area

- Kanchipuram, Tiruvallur, Ramanathapuram, Sivaganga, Kanyakumari, Nagapattinam, Tiruvarur and Pudukottai.

4.2. Seasons

- July to August - Kanchipuram/Tiruvallur, Kanyakumari
- August - Nagapattinam/Tiruvarur, Pudukottai
- September to October - Ramanathapuram, Sivaganga

4.3. Field preparation

- Dry plough to get fine tilth taking advantage of rains and soil moisture availability.
- Apply gypsum at 1 t/ha basally wherever soil crusting and soil hardening problem exist.
- Perfect land leveling for efficient weed and water management.
- Provide shallow trenches (15 cm width) at an interval of 3m all along the field to facilitate draining excess water at the early growth stage.

4.4. Varieties

- Short duration varieties as mentioned in season and vanities including local land races suitable for those tracts.
- Since there is supplemental irrigation high yielding improved short duration varieties can yield more yield than the land races.

4.5. Sowing

- Seed rate: 75 kg/ha dry seed for any recommended variety.
- Seed hardening with 1% KCl for 16 hours (seed and KCl solution 1:1) and shade dried to bring to storable moisture. This will enable the crop to withstand early moisture stress.
- On the day of sowing, treat the hardened seeds first with *Pseudomonas fluorescens* 10g/kg of seed and then with *Azophos* 1 kg/ha or *Azospirillum and Phosphobacteria @ 1 kg/ha* each per ha seed, whichever is available.
- Drill sow with 20 cm inter row spacing using seed drill.
- The seeds can also be sown behind the country plough
- Depth of sowing should be 3 - 5 cm and the top soil can be made compact with leveling board.
- Pre-monsoon sowing is advocated for uniform germination.

4.6. After cultivation

- 10 packets (2kg/ha) each of *Azospirillum* inoculants and Phosphobacteria or 10 packets (2 kg/ha) of Azophos mixed with 25 kg of FYM may be broadcasted uniformly over the field just after the receipt soaking rain / moisture.
- Thinning and gap filling should be done 14-21days after sowing, taking advantage of the immediate rain
- Spray Cycocel 1000 ppm (1 ml of commercial product in one lit. of water) under water deficit situations to mitigate ill-effects.
- Foliar spray of Kaolin 3% or KCl 1% to overcome moisture stress at different physiological stages of rice. .

4.7. Manures and fertilizer application

- Blanket recommendation : 75:25:37.5 kg N:P_2O_5:K_2O /ha
- Apply a basal dose of 750 kg of FYM enriched with fertilizer phosphorus (P at 25 kg/ha)
- Apply N & K in three splits at 20-25, 40-45 and 60-65 days after germination.
- Each split may follow 25kg N and 12.5 kg K_2O.
- If the moisture availability is substantial, split application at panicle initiation may be done with 40 kg N and 12.5 kg K_2O.
- If the moisture availability is substantial, the split at 40-45 DAS (panicle initiation) may be applied up to 40kg N and 12.5kg K_2O to enhance the growth and the grain yield.
- Basal application of $ZnSO_4$ at 25kg/ha and $FeSO_4$ at 50/ha is desirable wherever zinc and iron deficiency were noted (or) apply TNAU Rainfed rice MN mixture @12.5 kg/ha as EFYM at 1:10 ratio incubated for 30 days at friable moisture.
- Need based foliar application of 0.5% $ZnSO_4$ and 1% $FeSO_4$ may be taken up at tillering and

PI stages.

- Foliar spray of 1% urea + 2% DAP + 1% KCl at PI and 10 days later may be taken up for enhancing the rice yield if sufficient soil moisture is ensured

4.8. Weed management

- First weeding should be done between 15 and 21 days after germination.
- Second weeding may be done 30 - 45 days after first weeding.
- Apply pendimethalin 1.0 kg/ha on 5 days after sowing or Pretilachlor + safener (Sofit) 0.45 kg/ha on the day of receipt of soaking rain followed by one hand weeding on 30 to 35 days after sowing.
- PE butachlor 1.0 kg ha^{-1} followed by weeding using finger type single row and double row rotary weeders resulted in higher grain yield and net profit.

4.9. Water management

- The crop is irrigated from 30-35 days onwards, utilizing water impounded in the tanks.
- Irrigation may be to a depth of 2.5 -5.0 cm only. Follow the schedule of one day after disappearance of ponded water in order to save water and to bring additional area under this type of rice cultivation.

4.10. Insect management: See Crop Protection Chapter
4.11. Disease management: See Crop Protection Chapter

4.12. Harvest

- It is same as that of transplanted rice.
- These areas are more suitable for combine-harvester

5. DRY SEEDED IRRIGATED UN-PUDDLED LOWLAND RICE

Also be called 'semi-dry rice'

It is a contingent plan to command areas, anticipating the release of water; rice crop can be established under rainfed condition up to a maximum of 45 days as that of previous two situations. Filed is converted to wet condition on receipt of canal water. Conversion depends up on receipt of canal water and nutrient management is decided according to the period of irrigation.

5.1. Area

- Tiruvarur and Nagapattinam districts

5.2. Season

- Samba / Thaladi seasons command areas.

5.3. Field preparation

- Dry plough to get fine tilth taking advantage of rains and soil moisture availability.
- Apply gypsum at 1 t/ha basally wherever soil crusting and soil hardening problem exist.
- Perfect land leveling for efficient weed and water management.
- Provide shallow trenches (15 cm width) at an interval of 3m all along the field to facilitate draining excess water at the early growth stage.

5.4. Varieties

- Medium duration varieties, if sown in August and short duration varieties beyond September, as mentioned in season and vanities.
- Since there is assured irrigation from canal, high yielding improved short or medium duration varieties can be cultivated depending up on the situation (month of sowing, nearness to canal, depth of standing water during NEM etc).

5.5. Sowing

- Seed rate: 75kg/ha dry seed for any recommended variety.
- Seed hardening with 1% KCl for 16 hours (seed and KCl solution 1:1) and shade dried to bring to storable moisture. This will enable the crop to withstand early moisture stress.
- On the day of sowing, treat the hardened seeds first with *Pseudomonas fluorescens* 10g/kg of seed and then with *Azophos* 1 kg/ha or *Azospirillum and Phosphobacteria* @ 1 kg/ha each per ha seed, whichever is available.
- Drill sow with 20 cm inter row spacing using seed drill.
- The seeds can also be sown behind the country plough
- Depth of sowing should be 3 - 5 cm and the top soil can be made compact with leveling board.
- Pre-monsoon sowing is advocated for uniform germination.
- Pre-monsoon sowing with medium duration variety is an advantage for higher grain yield and as well to manage the heavy rainy season.

5.6. After cultivation

- 10 packets (2 kg/ha) each of *Azospirillum* inoculant and Phosphobacteria or 10 packets (2 kg/ha) of Azophos mixed with 25 kg of FYM may be broadcasted uniformly over the field just after the receipt soaking rain / moisture.
- Thinning and gap filling should be done 14 - 21 days after sowing, taking advantage of the immediate rain.

5.7. Manures and fertilizer application

- Apply FYM/compost at 12.5 t/ha or 750 kg of FYM enriched with 50 kg P_2O_5 as basal dose in clay soils of Nagapattinam / Tiruvarur district.
- Blanket recommendation : 75:50:37.5 kg N:P_2O_5:K_2O /ha
- N and K in three splits at around 20-25, 40-45 and 60-65 days for short duration varieties or four splits for medium duration varieties at around 20-25, 40-45, 60-65 and 80-85 days after germination is suitable.
- Each split may follow 25kg N and 12.5 kg K_2O.
- If the moisture availability is substantial and canal water received from tillering phases itself, the split at panicle initiation (40-45 DAS in short duration and 60-65 DAS in medium duration) may be applied up to 40kg N and 12.5kg K_2O to enhance the growth and the grain yield.
- To induce tolerance under short and prolonged drought situation in Kuruvai season, apart from seed treatment, foliar spray with 1% KCl + CCC at 500ppm during vegetative stage is effective in mitigating the drought and in increasing the yield.
- Basal application of $ZnSO_4$ at 25 kg/ha and $FeSO_4$ at 50 kg/ha is desirable wherever zinc and iron deficiency were noted (or) apply TNAU Rainfed rice MN mixture @12.5 kg/ha as EFYM at 1:10 ratio incubated for 30 days at friable moisture.
- Need based foliar application of 0.5% $ZnSO_4$ and 1% $FeSO_4$ may be taken up at tillering and PI stages
- Foliar spray of 1% urea + 2% DAP + 1% KCl at PI and 10 days later may be taken up for enhancing the rice yield if sufficient soil moisture is ensured

5.8. Weed management

- First weeding should be done between 15 and 21 days after germination.
- Second weeding may be done 30 - 45 days after first weeding.
- Apply pendimethalin 1.0 kg/ha on 5 days after sowing or Pretilachlor + safener (Sofit) 0.45 kg/ha on the day of receipt of soaking rain followed by one hand weeding on 30 to 35 days after sowing.

5.9. Other special cultural practices

- Spray Cycocel 1000 ppm (1 ml of commercial product in one lit. of water) under water deficit situations to mitigate ill-effects.
- Foliar spray of Kaolin 3% or KCl 1% to overcome moisture stress at different physiological

stages of rice.

- For delayed water release in LBP area, irrigating rice to 5cm depth three days after disappearance of pounded water and growing ADT 38 rice can be resorted to if the release of water is delayed up to September.
- First top dressing should be applied immediately after the receipt of sufficient rain or canal water.
- Hand weeding, thinning and gap filling should be done before N-fertilizer application.
- Subsequent top dressings in two or three splits should be done before heading.

5.10. Water management

- As that of irrigated rice when canal water is used for irrigation
- Possibility of subsequent conversion towards deep water situation is seen in this tract, then variety should be specific for those areas.

5.11. Insect management: See Crop Protection Chapter
5.12. Disease management: See Crop Protection Chapter

5.13. Harvest

- As that of transplanted rice. This area is more suitable to combine harvester.

5.14. DEEP WATER RICE

- Cultivation is like the methods described in this section except the harvest. Harvest may some times restricted only to panicle because of the standing water even after maturity.

DRY SEEDED UPLAND RICE

Establishment

- As that of section 3 to 5.

Area

- There are small batches in and around Dharmapuri district. Rainfall availability in these tract is better than the rainfed rice cultivated in other parts of Tamil Nadu. There is no bund to stagnate the water. Moisture availability is there but crop growth depends on the nutrient status.

Other Cultural practices

- As recommended to semi-dry rice (sec. 4)
- Nutrient may be split applied depending upon the growth.
- LCC based N application is more suitable for this tract.
- Use of PPFM-Pink Pigmented Facultative Microbes (seed treatment @ 0.2 kg / 5 kg seeds, soil application basal @ 2.0 kg/ha and foliar spray@ 500 ml/ha at PI & flag leaf stages)for mitigation of terminal drought is recommended.

Intercropping

- Blackgram for every four rows of rice.

Grain Yield

- Grain yield depends up on the moisture availability and nutrient status.

AEROBIC RICE

- Suitable variety PMK (R) 3
- Optimum plant population : 50 hills per m^2 (20 x 10 cm)
- Green manure intercrop in aerobic rice : Daincha intercropping and incorporation at 25 DAS
- Ridges and furrows
- Weed management : Pre emergence application of pendimethalin at 0.75 kg/ha followed by two hand weeding or mechanical weeding on 25 and 45 DAS
- PE pendimethalin 1.0 kg ha^{-1} along with single tyne sweep weeding on 45 DAS which was comparable with PE along with hand weeding.
- Fertilizer dose : 150 : 50 : 50 kg NPK/ha.
- N in four splits : 20 % at 15 DAS, 30 % at tillering and PI and 20% at flowering or Nitrogen management at LCC value of 4
- Basal application of $ZnSO_4$ at 25 kg/ha and $FeSO_4$ at 50 kg/ha is desirable wherever zinc and iron deficiency were noted (or) apply TNAU Rainfed rice MN mixture @12.5 kg/ha as EFYM at 1:10 ratio incubated for 30 days at friable moisture.
- Need based foliar application of 0.5% $ZnSO_4$ and 1% $FeSO_4$ may be taken up at tillering and PI stages
- Irrigation : IW/CPE ratio of 1.0 with 3 cm depth of water – total water requirement of 650 mm.
- **Surface drip fertigation:** Under aerobic rice conditions, schedule surface drip irrigation (with the lateral distance of 80 cm) at 125 % Open Pan Evaporation (PE) for clay soil / 150 % PE for sandy soil along with fertigation of 500 ml / ha of *Azophosmet* (composite biofertilizer) as seed treatment (@ 200 g / 10 kg seeds) and fertigation through drip system @ 500 ml / ha to be given during panicle initiation and flag leaf stages
- **Sub-surface drip biogation:** Under aerobic rice conditions, schedule sub-surface drip fertigation (laterals concealed at 10 cm soil depth at a distance of 80 cm) scheduled at 125 % Open Pan Evaporation (PE) for clay soil / 150 % PE for sandy soil along with fertigation of *Azophosmet* as seed treatment @ 200 g 10 kg / seeds and fertigation @ 500 ml / ha and along with biogation of seaweed extract @ 500 ml / ha to be given during panicle initiation and flag leaf stages

POST HARVEST TECHNOLOGY OF RICE PROCESSING OF RICE

Parboiling

- Parboiling is a hydrothermal treatment followed by drying before milling for the production of milled parboiled grain. Parboiling of paddy has been known in the orient for centuries. Nearly 50 per cent of the paddy produced in India at present is parboiled.
- In general, the three major steps in parboiling, i.e. soaking, steaming and drying and have a great influence on the final characteristics and quality of parboiled rice.
- Parboiling is the latest premilling treatment which improves the quality of rice. The traditional parboiling process in India is carried out in different ways.

Paddy
↓
Cleaning
↓
Soaking in water (8 h)
↓
Draining
↓
Steaming (20 minutes)
↓
Aerating (3h) and heaping (3h)
↓
Tempering (1h)
↓

Sun drying (2-4 h)
↓
Dried paddy (14% moisture)

Improved parboiling method of CFTRI, Mysore, India (Batch)

Paddy
↓
Cleaning
↓
Soaking in hot water for 3 h (70 ^{0} C)
↓
Draining the water
↓
Steaming
↓
Shade drying (2-4 h)
↓
Dried paddy (15 % moisture)

MILLING OF PADDY

Milling of dried paddy (raw and parboiled)
↓
Destoner (remove dust, dirt, chaff and stones)
↓
Sheller
↓

Husk (aspirated through fan box)	Brown rice and unshelled paddy

Brown rice and unshelled paddy
↓
Huller (primary polishing)
↓

Bran	Polished rice

Polished rice
↓
Cone polishing
↓

Bran	Head rice

Head rice
↓
Packaging

PROCESSED PRODUCTS

Parched rice *

It is prepared by throwing rice in sand heated to a high temperature in an iron or mud pan. On stirring, rice begins to crackle and swell. Then the content of the pan are removed and sieved to separate the parched rice from sand. Parboiled rice is used for making grayish to brilliant white colour parched rice and sold either salted or unsalted. It is eaten as such or mixed with butter milk or milk.

Expanded cereals
Expanded rice (Pori) *

- Expanded rice (murmura, pori, muri) is a traditional convenience food widely consumed in India either as such or with Jaggery, roasted Bengal gram and shredded vegetables and spices. The product is mostly produced in home or cottage sector by skilled artisans.
- In the traditional process, the paddy is soaked in water preferably over night until saturation, drained and then either steamed or dry roasted in sand for parboiling. The parboiled paddy is milled, salted and again roasted in sand for expansion.

Flow chart

Paddy
↓
Soaking in water (30% m.c)
↓
Parboiled rice (14% m.c)
↓
Milling (15% m.c)
↓
Dry heat parboiled rice in pans (110°C)
↓
Salting (Sodium chloride 10g/100ml water per kg of rice)
↓
Roasting in hot sand (250°C)
↓
Expanded rice (0.5% m.c)

Puffing / Popping *

Puffed rice : (using rice)

This popular ready-to-eat snack product is obtained by puffing milled parboiled rice. In the traditional process rice is gently heated on the furnace without sand to reduce the moisture content slightly. It is then mixed with salt solution and again roasted on furnace in small batches with sand on a strong fire for a few seconds to produce the expanded rice. Rice expands about 8 times retaining the grain shape and is highly porous and crisp.

Parched paddy or puffed rice: (using paddy)

Sun dried paddy is filled in mud jars and is moistened with hot water. After 2-3 min. the water is decanted and the jars are kept in an inverted position for 8-10 hours. Next the paddy is exposed to the sun for a short time and then parched in hot sand as in the preparation of parched rice. Puffed rice is prepared by throwing pretreated paddy into sand heated to a high temperature in an iron pan. During parching the grain swell and burst into a soft white product. The parched grains are sieved to remove sand and winnowed to separate the husk.

Puffed rice from parboiled rice

The rice is soaked in salt water to increase the moisture to about 20%. The moist rice is introduced into a hot vessel at about 250-275°C for 30-40 seconds. The rice puffs suddenly.

Popped rice

This is yet another traditional value added product prepared from raw paddy. The paddy at a moisture content of 12-14% is directly roasted in iron pans using sand as a medium at a temperature of 150-200°C. The production of popped rice is comparatively less and the product is mainly used in religious functions and ceremonies.

Flaking *

Flaked rice is another important value added product prepared from paddy. Traditionally, it is prepared from soaked paddy, after heat treatment and immediate flattening using a flaking machine (an edge runner)

Paddy
↓
Soaking (12-18 hours)
↓
Roasting (200 – 250^{0}C for 20-30 sec)
↓
Tempering (5 min)
↓
Flaking (using an edge runner)
Flaking machine
↓
Flaked rice

Flaked rice is made from parboiled rice. Paddy is soaked in water for 2 -3 days to soften the kernel followed by boiling water for a few minutes and the water is drained off. The paddy is heated in a shallow earthen vessel or sand in iron pan till the husks break open. It is pounded by a wooden pestle which flattens the kernel and removes the husk. The husk is separated by winnowing. Flaked rice is thin and papery and of white colour.

Quick cooking rice is made by steeping polished rice in water to a moisture content of 35 per cent, cooking under pressure and drying. Alternatively the rice may be subjected to freezing, thawing and dehydration.

Derived products

Polished rice may be precooked and canned as rice pudding and also used to make dry breakfast cereals.

RICE AND RICE PRODUCTS

Modernization of rice milling Industry also results in production of quality by-products viz., broken rice, husk and rice bran. Technology is now available for the production of value- added products from these by-products.

Byproducts of Rice

Broken rice

The broken rice is widely used in the food preparations and in the industries for making flour and in the manufacture of baby foods. The starch extracted from broken rice finds wider application in the pharmaceutical, textile and other industries.

Rice husk

Rice husk that contains about 38% cellulose and 32% lignin and is one of the most abundant renewable agriculture based fuel materials. The production of rice husk is about 80 million tonnes per year, equivalent in energy to about 170 million barrels of oil. Paddy husk contains about 22 per cent ash of which 95 per cent is silica. Because of its high silica content, it is used as an abrasive. Large quantities of husk are used in India as fuel for boilers, kilns and household purposes.
‘

Rice bran

Commercially rice bran is the most valuable by-product, which is characterized by its high fat (15 to 20%) and protein content. It also contains vitamins, minerals and many other useful chemicals. It is a potential source of edible oil. Because of its nutritional value, it is being used as feed for poultry and livestock. More stable defatted bran containing higher percentage of protein, vitamins and minerals is an excellent ingredient for both food and feed. The bran is the most nutritious byproduct of rice milling and is used almost exclusively as a feedstuff. It is generally contaminated with husk, which lowers its nutritive value. Rice bran contains about 12 per cent protein and 15 per cent fat.

Rice bran oil

Bran oil is obtained by the extraction of rice bran with solvents. Bran oil is also obtained in the solvent extraction milling of rice. The oil contains a high percentage of unsaturated fatty acids, yet it is quite stable because of the presence of natural antioxidants. When refined, bleached and deodorized, it is used for salad dressing and as cooking oil. Bran after solvent extraction has a higher percentage of protein that the original material. With its low fat content it keeps well.

Importance

Rice bran oil is the oil extracted from the germ and inner husk of rice. Rice bran oil is rich in vitamin E, γ-oryzanol (an antioxidant that may help prevent heart attacks) and phytosterols (compounds believed to help lower cholesterol absorption) which may provide associated health benefits. It has a mild taste and is popular in Asian cuisine because of its suitability for high-temperature cooking methods such as deep-frying and stir-frying. Rice bran oil is mostly monounsaturated - a tablespoon contains 7 grams of monounsaturated fat, three of saturated fat and five of polyunsaturated fat.

Rice bran oil also contains components of vitamin E that may benefit health. The unique components, such as oryzanol or tocotrienol, have been drawing people's attention. Numerous studies show rice bran oil reduces the harmful cholesterol (LDL) without reducing good cholesterol (HDL). In those studies, Oryzanol is reported as the key element responsible for that function. Tocotrienol, on the other hand, is highlighted as the most precious and powerful vitamin E existing in nature and is said to have an anti-cancer effect, too. As a Vitamin-E source, rice bran oil is rich not only in alpha Tocopherol but also has the highest amount of Tocotrienol in liquid form vegetable oils.

Uses

Rice bran oil is ideal oil for margarine and shortening. The flavor gives the good palatability and the desired prime form crystal provides smooth plasticity and spreading qualities. When processed to retain high levels of tocols, rice bran oil may be used as a natural antioxidant source for topically coating a wide range of products such as crackers, nuts, and similar snacks to extend shelf life.

Rice polishing

Rice polishing is also rich in nutrients. They are not recovered in sizeable quantity in India. They are mostly used as animal feed.

Uses of defatted bran and bran

Defatted bran can be successfully used as an ingredient in the bakery products such as bread, cake, biscuits etc. After finer grinding, it can be incorporated into maida flour up to 20 per cent for the preparation of bakery products.

Appendix – I

I.Cereals

Rice (1)

Soil : River alluvium (Noyyal series)
Season : Kharif
Target : 70 q ha^{-1}

$FN = 4.39\ T - 0.52\ SN - 0.80\ ON$
$FP_2O_5 = 2.22\ T - 3.63\ SP - 0.98\ OP$
$FK_2O = 2.44\ T - 0.39\ SK - 0.72\ OK$

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + GM @ 6.25 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1}+ PSB @ 2 kg ha^{-1}			NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + Azospirillum @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	SP	SK	N	P_2O_5	K_2O	FN	FP_2O_5	FK_2O
180	12	240	160	89	44	159	90	55
200	14	260	150	82	36	148	83	47
220	16	280	140	74	29	138	75	40
240	18	300	130	68	21	128	69	32
260	20	320	120	60	13	117	61	24

Rice (2)

Soil : River alluvium (Noyyal series)
Season : Rabi
Target : 70 q ha^{-1}

$FN = 4.63\ T - 0.56\ SN - 0.90\ ON$
$FP_2O_5 = 1.98\ T - 3.18\ SP - 0.99\ OP$
$FK_2O = 2.57\ T - 0.42\ SK - 0.67\ OK$

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + GM @ 6.25 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}			NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + Azospirillum @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	SP	SK	N	P_2O_5	K_2O	FN	FP_2O_5	FK_2O
180	12	240	170	77	46	168	78	57
200	14	260	159	71	38	157	72	49
220	16	280	148	65	29	146	66	40
240	18	300	137	58	21	135	59	32
260	20	320	126	52	13	124	53	24

Rice (3)

Soil : Red -Sandy loam (Irugur series)
Season : Kharif
Target : 70 q ha^{-1}

$FN = 5.19\ T - 0.89\ SN - 0.98\ ON$
$FP_2O_5 = 2.27\ T - 4.50\ SP - 1.09\ OP$
$FK_2O = 3.11\ T - 0.59\ SK - 1.02\ OK$

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + GM @ 6.25 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1}+ PSB @ 2 kg ha^{-1}			NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + Azospirillum @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	SP	SK	N	P_2O_5	K_2O	FN	FP_2O_5	FK_2O
160	8	160	168	80*	80*	166	80*	80*
180	10	180	150	80*	80*	148	80*	80*
200	12	200	132	80*	67	130	80*	78
220	14	220	115	73	55	113	74	66
240	16	240	97	64	43	95	65	54

*maximum dose

Rice (4)

Soil : Red- Sandy loam (Irugur series)
Season : Rabi
Target : 70 q ha^{-1}

$FN = 4.88\ T - 0.68\ SN - 0.72\ ON$
$FP_2O_5 = 2.06\ T - 2.91\ SP - 2.27\ OP$
$FK_2O = 2.89\ T - 0.47\ SK - 0.59\ OK$

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + GM @ 6.25 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}			NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + Azospirillum @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**N**	**P_2O_5**	**K_2O**	**FN**	**FP_2O_5**	**FK_2O**
160	8	160	180	98	94	178	99	100*
180	10	180	167	92	85	165	93	96
200	12	200	153	86	75	151	87	86
220	14	220	139	81	66	137	82	77
240	16	240	126	75	57	124	76	68

*maximum dose

Rice (5)

Soil : Black alluvium (Adanur series)
Season : Rabi (Thaladi)
Target : 80 q ha^{-1}

FN = 2.80 T - 0.29 SN - 0.89 ON
FP_2O_5 = 1.35 T - 1.28 SP - 1.78 OP
FK_2O = 2.50 T - 0.42 SK - 1.14 OK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + GM @ 6.25 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}			NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + Azospirillum @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**N**	**P_2O_5**	**K_2O**	**FN**	**FP_2O_5**	**FK_2O**
180	16	240	119	65	66	117	66	77
200	18	260	113	62	58	111	63	69
220	20	280	107	59	49	105	60	60
240	22	300	101	57	41	99	58	52
260	24	320	96	54	33	94	55	44

Rice (6)

Soil : Black alluvium (Kalathur series)
Season : Kharif (kuruvai)
Target : 80 q ha^{-1}

FN = 5.29 T - 0.75 SN - 0.89 ON
FP_2O_5 = 1.65 T - 1.76 SP - 0.78 OP
FK_2O = 2.73 T - 0.37 SK - 0.82 OK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + GM @ 6.25 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}			NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + Azospirillum @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**N**	**P_2O_5**	**K_2O**	**FN**	**FP_2O_5**	**FK_2O**
180	16	240	235	81	96	233	82	100*
200	18	260	220	77	89	218	78	100
220	20	280	205	74	81	203	75	92
240	22	300	190	70	74	188	71	85
260	24	320	175	67	67	173	68	78

*maximum dose

Rice (7)

Soil : Black alluvium (Kalathur series)
Season : Rabi (Thaladi)
Target : 80 q ha^{-1}

FN = 5.34 T - 0.67 SN - 0.73 ON
FP_2O_5 = 1.90 T – 1.86 SP - 0.70 OP
FK_2O = 2.81 T - 0.33 SK - 0.80 OK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + GM @ 6.25 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}			NPK (kg ha^{-1}) +FYM @ 12.5 t ha^{-1} + Azospirillum @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**N**	**P_2O_5**	**K_2O**	**FN**	**FP_2O_5**	**FK_2O**
180	16	240	253	99	100*	251	100	100*
200	18	260	240	95	100*	238	96	100*

220	20	280	227	92	100*	225	93	100*
240	22	300	213	88	93	211	89	100*
260	24	320	200	84	86	198	85	97

*maximum dose

Rice (8)

Soil : River alluvium (Manakkarai series)
Season : Kharif (Kar)
Target : 70 q ha^{-1}

FN = 4.25 T - 0.60 SN - 0.79 ON
FP_2O_5 = 2.71 T – 4.39 SP - 0.89 OP
FK_2O = 3.83 T - 0.60 SK - 0.82 OK

Initial soil tests (kg ha^{-1})			**NPK (kg ha^{-1}) + GM @ 6.25 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}**			**NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + Azospirillum @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}**		
SN	**SP**	**SK**	**N**	**P_2O_5**	**K_2O**	**FN**	**FP_2O_5**	**FK_2O**
180	12	220	137	80*	80*	135	80*	80*
200	14	240	125	80*	80*	123	80*	80*
220	16	260	113	80*	80*	111	80*	80*
240	18	280	101	80*	67	99	80*	78
260	20	300	89	80*	55	87	80*	66

*maximum dose

Rice (9)

Soil : River alluvium (Manakkarai series)
Season : Rabi (Pishanam)
Target : 70 q ha^{-1}

FN = 4.47 T - 0.58 SN - 0.79 ON
FP_2O_5 = 2.66 T - 3.68 SP - 0.89 OP
FK_2O = 4.08 T - 0.65 SK - 0.82 OK

Initial soil tests (kg ha^{-1})			**NPK (kg ha^{-1}) + GM @ 6.25 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}**			**NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + Azospirillum @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}**		
SN	**SP**	**SK**	**N**	**P_2O_5**	**K_2O**	**FN**	**FP_2O_5**	**FK_2O**
180	12	220	156	100*	100*	154	100*	100*
200	14	240	144	100*	97	142	100*	100*
220	16	260	132	100*	84	130	100*	95
240	18	280	121	97	71	119	98	82
260	20	300	109	90	58	107	91	69

*maximum dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

12 Points for SRI

Use of quality certified / hybrid seed
Seed rate 2 kg per acre
40 m^2 nursery for one acre
Raised bed nursery / Tray nursery
14 days old seedling (3-4 leaf stage)
Levelling with lazer leveller
Marker for square planting
Square planting with 25 cm x 25 cm
Single seedling per hill
Alternate wetting and drying method of irrigation
Cono weeding four times from 10 DAT at an interval of 10-15 days
Use of leaf colour chart (LCC) for N management

CROP PROTECTION

A) Pest management

i) Nursery

An area of 800 sq.m. (20 cents) nursery is required for planting one ha of main field. Forty litres of spray fluid is necessary for spraying the nursery area.

Pests	Management strategies
Army worm *Spodoptera mauritia*	• Drain water from the nursery • **Spray any one of the following insecticides:** Chlorpyriphos 20 EC 80 ml
Thrips *Stenchaetothrips biformis*	• Sampling: Wet your palm with water and pass over the foliage in 12 places in the nursery. If thrips population exceeds 60 numbers in 12 passes or if rolling of 1/2 area of first and 2nd leaves in 10% of seedlings is noticed, • **Spray any one of the following insecticides:** Phosphamidon 40 SL 50 ml Monocrotophos 36 SL 40 ml
Green leafhopper *Nephotettix nigropictus* *N. cincticeps* *N. virescens*	• Sampling: Take 25 net sweepings in the nursery area. If the population exceeds 60 for 25 sweepings or 20/m^2 by actual counting, • **Spray any one of the following insecticides:** Phosphamidon 40 SL 50 ml Phosalone 35 EC 120 ml • **Maintain 2.5 cm of water in the nursery and broadcast anyone of the following in 20 cents** Carbofuran 3 G 3.5 kg Phorate 10 G 1.0 kg
Caseworm *Parapoynx stagnalis*	• Mix 250 ml of kerosene to the standing water • Dislodge the cases by passing a rope and drain water • Collect the cases and destroy • **Spray any one of the following insecticides:** Monocrotophos 36 SL 40 ml Quinalphos 25 EC 80 ml.

ii) Main field

- Remove/destroy stubbles after harvest
- Keep the fields free from weeds
- Trim field bunds
- Provide effective drainage, if required
- Avoid use of excessive 'N' fertilizers.
- Avoid close planting, especially in BPH and leaffolder prone areas and seasons.
- Leave 30 cm space at every 2.5 M
- Use irrigation water judiciously
- Use light traps to monitor pest incidence
- Remove egg masses of stem borer
- In BPH prone areas/seasons, avoid use of synthetic pyrethroids, methyl parathion and quinalphos and use recommended chemical at recommended doses.
- Use insecticides based on ETLs.

Economic threshold level for important pests

Pests	ETL
Stem borer	2 egg masses/m2 or 10% dead hearts
Leaffolder	10% leaf damage at vegetative phase and 5% of flag leaf damage at flowering
Gall midge	10% silver shoots
Whorl maggot	25% damaged leaves
Thrips	60 numbers in 12 passes or rolling of the first and second leaves in 10% of seedlings.
Brown planthopper	1 hopper/ tiller in the absence of predatory spider and 2 hoppers /tiller when spider is present at 1/hill.
Green leafhopper	60/25 net sweeps or 5/hill at vegetative stage or 10/hill at flowering or 2/hill in tungro endemic area
Earhead bug	5 bugs/100 earheads at flowering and 16 bugs/100 earheads from milky stage to grain maturity

Pests	Management strategies
Stem borer *Scirpophaga incertulas*	• 25% of existing ETL for insecticides (2 egg masses/m^2) is the action threshold level (ATL) for release of the egg parasitoid, *Trichogramma japonicum* for the management of the rice yellow stem borer. 25% of ETL adopted for application of insecticide is the ATL for spraying Neem seed kernel extract to control stem borer. • **Spray any one of the following insecticides :** Phosalone 35 EC 1500 ml/ha Acephate 75 % SP 666-1000 g/ha Azadirachtin 0.03% 1000 ml/ha Carbofuran 3% CG 25 kg/ha Carbosulfan 6% G 16.7 kg/ha Carbosulfan 25% EC 800-1000 ml/ha CartapHydrochloride 50 % SP 1 kg/ha Chlorantraniliprole 18.5% SC 150 ml/ha Chlorantraniliprole 0.4% G 10 kg/ha Chlorpyriphos 20% EC 1.25 l/ha Fipronil 5% SC 1000-1500 g/ha Fipronil 80%WG 50- 62.5 kg/ha Flubendiamide 20% WG 125 g/ha Flubendiamide 39.35% M/M SC 50 g/ha Phosphamidon 40% SL 1250 ml/ha Thiacloprid 21.7% SC 500 g/ha Thiamethoxam 25% WG 100 g/ha Triazophos 40% EC 625-1250 ml/ha

Leaffolder *Cnaphalocrocis medinalis*	• Release both *Trichogramma chilonis* (for leaffolder) and *T.japonicum* (for stem borer) thrice @ 1,00,000/ha each (if moth activity is noticed) and spray *Bacillus thuringiensis* @ 1.0 kg/ha when the stem borer / leaffolder crosses ETL. • Seed treatment @ 5g/Kg of seed followed by foliar application @ 5g/l of *Beauveria bassiana* twice at 15 days interval • **Spray any one of the following insectcides:** Phosalone 35 EC 1500 ml/ha Chlorpyriphos 20 EC 1250 ml/ha Carbaryl 50 WP 1.0 kg/ha Acephate 75 % SP 666-1000 ml/ha Azadirachtin 0.03% 1000 ml/ha Carbosulfan 6% G 16.7 kg/ha CartapHydrochloride 50 % SP 1000 g/ha Chlorantraniliprole 18.5% SC 150 g/ha Chlorantraniliprole 0.4% G 10 kg/ha Dichlorvos 76%SC 627 ml/ha Fipronil 80%WG 50-62.5 g/ha Flubendiamide 20% WG 125-250 g/ha Flubendiamide 39.35% M/M SC 50 g/ha Phosphamidon 40% SL 1250 ml/ha Thiamethoxam 25% WG 100 kg/ha Triazophos 40% EC 625-1250 ml/ha
Gall midge *Orseolia oryzae*	• Release *Platygaster oryzae* parasitised galls at 1 per 10 m2 on 10 days after transplanting (DAT) • **Spray any one of the following insectcides:** Phosalone 35 EC 1500 ml/ha Carbosulfan 25% EC 800-1000 ml/ha Chlorpyriphos 20% EC 1250 ml/ha Fipronil 5% SC 1000-1500 g/ha Fipronil 0.3% GR 16670-25000 g/ha Thiamethoxam 25% WG 100 g/ha
Whorl maggot ***Hydrellia sasakii***	• **Spray any one of the following :** Cartap Hydrochloride 4% G 18750-25000 g/ha Chlorpyriphos 20% EC 1250 ml/ha Fipronil 5% SC 1000-1500 g/ha Fipronil 0.3% GR 16670-25000 g/ha Phosalone 35% EC 1428 ml/ha
Case worm ***Nymphula depunctalis***	• **Spray any one of the following insectcides:** Carbaryl 10% DP 25 kg/ha Phenthoate 50% EC 1000 ml/ha
Hispa/ spiny beetle ***Dicladispa armigera***	• **Spray any one of the following insectcides:** Carbofuran 3% CG 50 kg/ha Chlorpyriphos 20% EC 1250ml/ha Malathion 50%EC 1150 ml/ha Triazophos 40% EC 625-1250 ml/ha
Grasshopper	Chlorpyriphos 1.5% DP 25 kg/ha
Cutworm	Dichlorvos 76 % SC 470 g/ha
Thrips *Stenchaetothrips biformis*	• **Spray any one of the following insectcides:** Phosphamidon 40 SL 600 ml /ha Azadirachtin 0.15% W/W 1500-2500 g/ha Thiamethoxam 25% WG 100 g/ha
Brown planthopper *Nilaparvata lugens*	• Avoid excessive use of nitrogen • Control irrigation by intermittent draining • Set up light traps during night or yellow pan traps during day time

	• Drain the water before use of insecticides and direct the spray towards the base of the plants. • **Apply any one of the following insectcides:** Phosalone 35 EC 1500 ml/ha Carbaryl 10 D 25 kg/ha Methyl demeton 25 EC 1000 ml/ha Chlorpyriphos 20 EC 1250 ml/ha Acephate 75 % SP 666-1000 g/ha Azadirachtin 0.03% 1000 ml/ha Neem oil 3% 15 lit/ha Buprofezin 25% SC 800 ml/ha Carbosulfan 25 EC 800-1000 ml/ha Chlorantraniliprole 18.5% SC 150 g/ha Chlorantraniliprole 0.4% G 10 kg/ha Chlorpyrifos 1.5% DP 25 kg/ha Dichlorvos 76%SC 470 ml/ha Fenoucarb (BPMC) 50% EC 500-1500 ml/ha Fipronil 5% SC 1000-1500 ml/ha Fipronil 0.3% GR 16670-25000 g/ha Imidacloprid 70% WG 30-35 kg/ha Imidacloprid 17.8 SL 100-125 ml/ha Phosalone 1428 ml/ha Phosphamidon 875 ml/ha Triazophos 40% EC 625-1250 ml/ha • Seed treatment @ 5g/Kg of seed followed by foliar application @ 5g/l of *Beauveria bassiana* twice at 15 days interval
White backed planthopper *Sogatella furcifera*	• **Apply any one of the following insectcides** Phosphamidon 40 SL 1000 ml/ha. Azadirachtin 0.03% 1000 ml/ha Buprofezin 25% SC 800 ml/ha Carbosulfan 25 EC 800-1000 ml/ha Chlorantraniliprole 18.5% SC 150 g/ha Chlorantraniliprole 0.4% G 10 kg/ha Dichlorvos 76%SC 470 ml/ha Fipronil 5% SC 1000-1500 ml/ha Fipronil 0.3% GR 16670-25000 g/ha Imidacloprid 70% WG 30-35 kg/ha Imidacloprid 17.8 SL 100-125 ml/ha Phosalone 1428 ml/ha Phosphomidon 875 ml/ha Quinalphos 25 EC 1500 ml/ha Triazophos 40% EC 625-1250 ml/ha • Seed treatment @ 5g/Kg of seed followed by foliar application @ 5g/l of *Beauveria bassiana* twice at 15 days interval
Green leafhopper *Nephotettix nigropictus* *N. cincticeps* *N. virescens*	• **Apply any insecticides twice, 15 and 30 days after transplanting** Phosphamidon 40 SL 1000 ml /ha Profenophos 50 EC 1000 ml/ha Carbofuran 3 G 17.5 kg/ha Buprofezin 25% SC 800 g/ha Carbosulfan 25% EC 800-1000 ml/ha Fipronil 5% SC 1000-1500 g/ha Imidacloprid 17.8% SL 100 -125 ml/ha Phosphamidon 40% SL 875 ml/ha Thiamethoxam 25% WG 100 g/ha Triazophos 40% EC 625-1250 ml/ha

	• The vegetation on the bunds should also be sprayed with the insecticides • Set up light traps to attract and control the leafhopper vectors as well as to monitor the population. • Kill the leafhoppers attracted to light trap by spraying any one of the insecticides every morning.
Mealy bug *Brevennia rehi*	• **Spray any one of the following insectcides:** Methyl demeton 25 EC 1000 ml/ha Phosalone 35 EC 1500 ml/ha
Blue jassid	• **Spray any one of the following insectcides:** Carbaryl 10% DP 25 kg/ha Methyl demeton 25 EC 1000 ml/ha
White jassid	• **Spray any one of the following insectcides:** Methyl demeton 25 EC 1000 ml/ha
Black bug *Scotinophora lurida*	• **Spray any one of the following insectcides:** Neem seed kernel extract 5% 25 kg/ha
Earhead bug *Leptocorisa acuta*	• **Dust any one of the following at 25 kg/ha twice, the first during flowering and second a week later:** Quinalphos 1.5 D Methyl parathion 2% DP 25 kg/ha KKM 10 D The new KKM dust formulation consists of 10% of *Acorus calamus* rhizome powder and 90% of flyash which is a waste product from Thermal Power Station. This dust formulation repels the rice earhead bug. • **Spray any one of the following twice as above** Malathion 50 EC 500 ml/ha Neem seed kernel extract 5% 25 kg/ha Notchi or *Ipomoea* or *Prosopis* leaf extract 10%
Termite *Anacanthotermus viarum*	• Apply chopped paddy straw treated with quinalphos 1.5 D 50 kg/ha
Mite *Oligonychus oryzae*	• Apply dicofol 18.5 EC 1250 ml/ha.
Rat *Rattus rattus rufuscens, Rattus meltada*	• Poison bait at 1 part zinc phosphide with 49 parts popped corn/rice/dry fish or warfarin 0.5% 1 part with 19 parts of popped corn/rice/dry fish or bromodialone 0.25 w/w (1:49) at 0.005%. Mix one part of bromodialone + 49 parts of bait and keep inside the field. • Setting up of owl perches

IPM module

- *Pseudomonas fluorescens* – Seed treatment (10 g/kg), seedling dip (2.5 kg/ha), main field application (2.5 kg/ha)
- Pest and disease management in nursery (preferably neem seed kernel extract 5% or Neem oil 2%)
- Integrated Nutrient Management
- Use of neem cake coated urea (5 : 1)
- Inclusion of green manures / biofertilizers
- ‘N’ management by Leaf Colour Chart (LCC)
- ‘K’ application – basal (50%) + one top dressing (50%)
- Adoption of cultural practices
- Variety selection
- Spacing based on season, variety and location (endemic / hot spot)
- Rogueing space (1’ for every 8’)

- Water management – alternate wetting and drying and submergence of recommended level during critical periods only
- Release of biocontrol agents, when the moth activity is noticed
- *Trichogramma japonicum* for stem borer @ 1,00,000 (5 cc) / ha at weekly interval for 3 times
- *Trichogramma chilonis* for leaffolder @ 1,00,000 (5 cc) /ha at weekly interval for 3 times Set up bird (owl) perches at 40 to 50 /ha
- Application of botanicals especially Neem seed kernel extract 5% against leaffolder
- ETL based insecticide / fungicide application (No synthetic pyrethroids)
- Integrated rodent management
  Narrow bund maintenance (45 x 30 cms)
  Zinc phosphide baiting (49: 1)
  Trapping with Thanjavur bow trap (100 nos./ha)
  Baiting with bromodialone

Insecticide Resistance

In case of control failures monitor the insecticide resistance with the following discriminating dose screen.

Rice leaffolder- *Cnaphalocrocis medinalis* Guenee

(IV instar larvae of 20-30 mg weight and 15-18 mm)
1. Monocrotophos topical 0.3375 μg
2. Quinalphos topical 0.5112 μg
3. Chlorpyriphos topical 1.1405 μg 37
4. Phosphamidon topical 5.3979 μg

Resurgence

Repeated application of the following insecticides can cause resurgence of insect pests

- ***Nilaparvata lugens :*** acephate, azinphosmethyl, BPMC, carbofuran, chlorpyriphos,
- cypermethrin, deltamethrin, diazinon, ethopenprox, fenitrothion, fenthion, fenvalerate, methomyl, methylparathion, monocrotophos, permethrin, perthane, phorate, phosalone, phosphamidon, quinalphos, thiometon, triazophos, vamidothion
- ***Nephotettix virescens*** *:* deltamethrin, phorate
- ***Sogatella furcifera*** *:* cypermethrin, deltamethrin, fenvalerate
- ***Cnaphalocrocis medinalis*** *:* carbofuran, phorate

B. Plant Pathology

RTD Management

- To control the vector, green leafhopper in the main field, spray two rounds of any one of the insecticides viz., monocrotophos 36 SL (1000 ml/ha), phosphamidon 40 SL (1000 ml/ha) on 15 and 30 days after transplanting. The vegetation on the bunds should also be sprayed with the insecticides.
- Set up light traps to attract and control the leafhopper vectors as well as to monitor the population. In the early morning, the population of leafhopper alighting near the light trap should be killed by spraying/dusting the insecticides. This should be practiced every day.

Disease management

Disease management in nursery	
Dry seed treatment	• Thiram or captan or carboxin or carbendazim at 2 g/kg of seeds. • Treat the seeds at least 24 hours prior to soaking for sprouting. • The treated seeds can be stored for 30 days without any loss in viability.

Wet seed treatment	• Carbendazim or Tricyclozole at 2 g/lit of water for 1 kg of seed. • Soak the seeds in the solution for 2 h • Drain the solution, sprout the seeds and sow in the nursery bed. • This wet seed treatment gives protection to the seedlings up to 40 days from seedling disease such as blast and this method is better than dry seed treatment **or** • Treat the seeds with talc based formulation of *P. fluorescens* (Pf1) @ 10g/kg of seed and soak in 1lit of water overnight. • Decant the excess water and allow to sprout the seeds for 24 h and then sow.
Seedling dip with *Pseudomonas fluorescens*	• Stagnate water to a depth of 2.5cm over an area of 25m^2 in the main field. • Sprinkle 2.5 kg of the talc based formulation of *Pseudomonas fluorescens* (Pf1) and mix with stagnated water. The seedlings pulled out from the nursery are to be soaked for 30 min. in the stagnated water and then transplanted.

- Biocontrol agents are compatible with biofertilizers
- Biofertilizers and biocontrol agents can be mixed together for seed soaking
- Fungicides and biocontrol agents are incompatible

i.)NURSERY DISEASES	
Name of the Disease	**Management strategies**
Blast *Pyricularia grisea* (*Magnaporthe grisea***)**	**Spray any one of the following: (for 20 cents)** Carbendazim 50WP @ 1g/l Tricyclozole 75 WP @ 1g/l Metominostrobin 20 SC @ 1ml/l Azoxystrobin 25 SC @ 1 ml/l
Brown spot *Drechslera oryzae* (*Cochliobolus miyabeanus*)	**Spray any one of the following: (for 20 cents)** • Metominostrobin @ 1ml /lit of water
Rice Tungro Disease (RTD) *(Rice Tungro Bacilliform virus Rice Tungro Spherical virus)* **Vector** *Nephotettix virescens* *N. nigropictus, N. parvus* *N. malayanus,Recilia dorsalis*	Apply Carbofuran 3G @ 3.5kg at 10 DAS or Spray 2 rounds (10 and 20 DAS) with any one of the following insecticides to control the vector (*Nephotettix virescens*) in 20 cents area • Thiamethoxam 25 WDG 8g • Imidacloprid 17.8 SL 8ml
ii.) Main Field	
Name of the Disease	**Management**
Blast *Pyricularia grisea* *(Magnaporthe grisea)*	**Cultural method** • Remove collateral weed hosts from bunds and channels • Use only disease free seedlings • Avoid excess nitrogen • Apply N in three split doses (50% basal, 25% in tillering phase and 25% N in panicle initiation stage) • Use resistant variety CO 47. **Chemical** • Spray after observing initial infection of the disease, Carbendazim 50WP @ 500g/ha (or) Tricyclozole 75 WP @ 500g/ha (or) Metominostrobin 20 SC @ 500ml/ha (or)

	Azoxystrobin 25 SC @ 500 ml/ha **Biological control** • Seed Treatment with TNAU Pf 1liquid formulation @ 10 ml/kg of seeds • Seedling root dipping with TNAU Pf 1liquid formulation (500 ml for one hectare seedlings) • Soil application with TNAU Pf 1liquid formulation (500ml/ha) • Foliar spray with TNAU Pf 1liquid formulation @ 5ml/lit
Brown spot *Drechslera oryzae* (*Cochliobolus miyabeanus*)	**Spray any one of the following:** Metominostrobin @ 500ml/ha
Sheath rot *Sarocladium oryzae*	**Cultural** • Apply Gypsum @ 500 kg/ha at two equal splits once basally and another at active tillering stage. **Botanicals** • Neem oil 3% • Ipomoea leaf powder extract (25 kg/ha) • Prosopis leaf powder extract (25 kg/ha). First spray at boot leaf stage and second 15 days later **Chemical** • **Spray any one of the following:** • Carbendazim @ 500g/ha • Metominostrobin @ 500 ml/ha • Hexaconazole 75% WG @ 100 mg/ lit 1st spray at the time of disease appearance and 2nd spray 15 days later **Biological control** • Seed Treatment with TNAU Pf 1liquid formulation @ 10 ml/kg of seeds • Seedling root dipping with TNAU Pf 1liquid formulation (500 ml for one hectare seedlings) • Soil application with TNAU Pf 1liquid formulation (500ml/ha) • Foliar spray with TNAU Pf 1liquid formulation @ 5ml/lit
Sheath blight *Rhizoctonia solani* (*Thanatephorus cucumeris*)	**Cultural** • Apply Neem cake at 150 kg/ha **Botanical** • Foliar spray with Neem oil at 3% (15 lit /ha) starting from disease appearance **Chemicial** • Carbendazim 50 WP @ 500g/ha • Azoxystrobin @ 500ml/ha • Hexaconazole 75% WG @ 100mg/ lit 1st spray at the time of disease appearance and 2nd spray 15 days later **Biological control** • Seed Treatment with TNAU Pf 1liquid formulation @ 10 ml/kg of seeds • Seedling root dipping with TNAU Pf 1liquid formulation (500 ml for one hectare seedlings) • Soil application with TNAU Pf 1liquid formulation (500ml/ha) • Foliar spray with TNAU Pf 1liquid formulation @ 5ml/lit

Rice grain discoloration 1. *Helminthosporium oryzae* 2. *Alternaria tenuis* 3. *Fusarium moniliforme* 4. *Sarocladium oryzae*	**Chemical** **Spray** • Carbendazim + Thiram + Mancozeb (1:1:1) 0.2% at 50% flowering stage.
Bacterial blight (*Xanthomonas oryzae pv oryzae*) **Bacterial streak (*Xanthomonas oryzae pv oryzicola*)**	Two sprays of Copper hydroxide 77 WP@1.25 kg/ha 30 DAP & 45 DAP
False smut	Two sprayings of Propiconazole 25 EC @ 500ml/ha **(or)** Copper hydroxide 77 WP @ 1.25 kg/ha at boot leaf and 50% flowering stages

** In addition to the above the following are also found to be associated with the grain discoloration viz., Cladosporium herbarum, Curvularia lunata, Cephalosporium oryzae, Fusarium semitectum, F.solani, Gailarchia oryzae, H.rostratum, H.tetramera, Nigrospora oryzae, Periconia* sp., *Pryenochaeta* sp.,*Rhizoctonia solani,Trichoconis padwickii*

Bacterial leaf blight *Xanthomonas oryzae* pv. *oryzae*	**Botanical / others** • Spray fresh cowdung extract 20% twice (starting from initial appearance of the disease and another at fortnightly interval) • Neem oil 60 EC 3% (or) NSKE 5% is recommended for the control of sheath rot, sheath blight, grain discolouration and bacterial blight
Bacterial leaf streak ***Xanthomonas oryzae* pv. *oryzicola***	**Botanical / others** • Spray fresh cowdung water extract 20% • Copper hydroxide 77 WP@1.25 kg/ha is also recommended
Rice tungro disease **Vector** *Nephotettix virescens* *N. nigropictus* *N. parvus* *N. malayanus* *Recilia dorsalis*	**Physical methods** • Light traps are to be set up to attract and control the leaf hopper vectors as well as to monitor the population. • In the early morning, the population of leafhopper alighting near the light trap should be killed by spraying/dusting the insecticides. This should be practiced every day. • **Spray Two rounds of any one of the following insecticides** • Thiamethoxam 25 WDG 100g/ha • Imidacloprid 17.8 SL 100ml/ha at 15 and 30 days after transplanting. The vegetation on the bunds should also be sprayed with the insecticides. • **<u>Special detection technique</u>** PCR detection facilities available at the Department of Plant Pathology, TNAU, Coimbatore-3 can be used
Phytoplasma (Rice Orange leaf Phytoplasma) Vector: Green Leaf Hopper *Nephotettix virescens* *N. nigropictus*	**Cultural method** • Plough the stubbles as soon as the crop is harvested to prevent the survival of yellow dwarf pathogen during off-season. • Vector control with any one of the following insecticides • Thiamethoxam 25 WDG 100g/ha (or) • Imidacloprid 17.8 SL 100ml/ha spray at15 and 30 days after transplanting. The

	vegetation on the bunds should also be sprayed with the insecticides. • **<u>Special detection technique</u>** • PCR detection facilities available at the Department of Plant Pathology, TNAU, Coimbatore-3 can be used

C) Nematode management

S .No	Nematode pest	Control measures
1	**Rice root nematode,** (*Hirschmanniella oryzae*)	Seed treatment with *Pseudomonas fluorescens* (10 g/kg seed) followed by seedling root dip @1.5 kg/Ha and main field application of *P.flourescens* @ 2.5 Kg/ha and followed by foliar application thrice at 10 days interval after boot leaf stage or Apply Carbofuran 3G 33 kg/ha in 2 cm standing water or Carbofuran 3G @ 3.5 kg/20 cent nursery required for 1 ha.
2	**White tip nematode,** (*Aphelenchoides besseyi*)	Spray Chlorpyriphos 20 EC 1250 ml immediately after the emergence of boot leaf
3	**Rice root and White tip nematodes**	Seed treatment with *Pseudomonas fluorescens* (10 g/kg seed) followed by foliar spraying of the same @ 1 kg/ha thrice at 45, 55 and 65 DAT.

RICE SEED PRODUCTION

Land requirement

- Previous crop should not be the different variety of paddy. It was if same variety, it should have passed production of certified procedure.

Isolation

- Adopt 3m all around the field

Pre-sowing seed management

- In dormant cultivars, break the dormancy by soaking the seeds in equal volume 0.1 N conc.HNO_3 or in 0.5% KNO_3 for a duration of 12-16 h. The seeds are to be dried to original moisture content. (or)
- Upgrade the seeds using specific gravity grading adopting salt water (egg flotation dissolve 1.5 kg of common salt in 1 lit of water grading) to remove ill filled and immatured seed.
- For rainfed rice or direct sowing, harden the seeds by soaking the seeds in equal volume of 1% KCl solution for 16 h and dry back the seeds to original moisture content. (or)
- Harden the seeds with 1% KCl for 16 h and dry back to original moisture content and coating with polymer @ 3 ml/kg + imidachloprid@ 2ml / kg + carbendazim @ 2 g / kg + *Pseudomonas fluorescens* @ 10 g/kg + Azophos @ 120g/kg. (or)
- Soak the seeds in 3 % cowpea sprout extract for 16 h in the seed to solution ratio of 1:1 and dry back to original moisture content. (or)
- Soak the seeds in 80% *Pseudomonas fluorescens* (80 g of powder form mixed in 100 ml of water).

Method of planting

- SRI method can be adopted.

For saline soil

- Incorporation of green manure like daincha
- Designer seed as detailed above.
- Shallow planting @ 3-4 seedlings / hill.

- Planting of seedlings with 5 days more aged seedlings than normal planting.
- Basal application of gypsum @ 500 kg/ha.
- Foliar spray with 0.5% $FeSO_4$ and $ZnSO_4$ at tillering stage.

Fertilizer recommendation

- Short duration : NPK @ 120:40:40 kg ha^{-1}
- Medium duration : NPK @ 150:50:60 kg ha^{-1}
- Long duration : NPK @ 150:50:80 kg ha^{-1}

Zinc deficient soils

- Apply $ZnSO_4$ @ 25 kg ha^{-1}

Roguing space

- Leave a roguing space of 30 cm between the beds size of 150 cm

Foliar application

- DAP 2% or 0.5% NutriGold (organic growth promotor) at boot leaf stage and at 5-10% flowering.
- Spray with 3% cowpea sprout extract at vegetative and flowering stage.

Preparation of pulse sprout extract

- Cowpea seeds were soaked overnight and incubated in a wet cloth for 12 h to enable sprouting. Later, 100 g of sprouts were ground in a mixer grinder by using ice cubes of 100 ml of water to prepare extracts of 100 per cent concentration. The ground material was squeezed through cloth bag to extract the sprout extract

Harvesting

- When 90% of the panicle are in straw colour with the moisture content of 20% for short and medium duration varieties and 17% moisture for long duration varieties.

Threshing

- Threshing at 16-17% moisture content either manually or using mechanical threshers for seed separation.

Drying

- Dry the seeds to 12-13% moisture content for short term storage and 8-9% moisture for long term storage.

Seed Treatment

- Treat the seeds with carbendazim @ 2g kg^{-1} of seed using 5 ml of water kg^{-1} of seed or dry dress with halogen mixture ($CaOCl_2$ + $CaCO_3$ mixture at 1:1 ratio) of seed.
- Coat the seed with polymer (3 ml kg^{-1} in 5 ml of water) + Royal flow 40 sc @ 2.4 ml kg^{-1} of seeds + imidachloprid @ 6 ml kg^{-1} of seed.
- Expose the seeds thrice with 50 % CO_2 (4 days for 50 kg container) at 12 % moisture content at 15 days interval.

Storage

- For short term storage (9-12 months), store the seeds with 12-13% moisture content in gunny bag / cloth bag.
- For medium term storage (12-36 months), store the seed in HDPE bag or polylined gunny bag with 10-12% seed moisture.

Hybrid seed production Techniques (ADTRH 1 and CORH 2)

Land Requirement

- Select fertile land with good drainage and irrigation.
- Previous crop should not be the different varieties / hybrids of paddy

Isolation

- Space isolation : 100 m
- Time isolation : 25 days (later)
- Barrier isolation : Either a distance of 30 m with vegetative barrier or plastic sheet with 2m height

Staggered sowing
Sowing time (Western zone)
Dec – Jan
CORH 3

- Restorer (R) line, the male parent should be sown 6 days (R1), 3 days (R2), earlier than A line sowing and same day (R3) on the sowing of male sterile (A) line, the female parent.

May - June
CORH 3

- Restorer (R) line, the male parent should be sown 3 days (R1) days earlier, same day (R2) on the sowing of male sterile (A) line, the female parent and 3 days later (R3) the sowing of male sterile (A) line, the female parent.

Nov- Dec
CORH 4

- Restorer (R) line, the male parent should be sown 5 days (R1), earlier than, A line sowing and same day (R2) on the sowing of male sterile (A) line, the female parent.
  Planting ratio : 8:2 to 10:2 (Female : Male)
  Border rows : 4 rows all around the field

Main field management
Spacing

- Between 'A' lines 10 cm; between 'R' lines 30 cm; between A and 'R' line 20 cm : within rows 15 cm.

Planting design

- Two paired row @ 2-3 seedlings / hill.

Fertilizer application

- 150 : 60 : 60 kg NPK / ha. N and K applied in 3 split doses *viz.,* basal, active tillering and panicle initiation.

Foliar spray

- Spray DAP 2% at boot leaf stage and at 5-10% flowering (or)
- Spray 0.5% NutriGold (organic growth promoter) at boot leaf stage and at 5-10% flowering (or)
- Spray 3 % cowpea sprout extract at boot leaf stage and at 5-10% flowering.

Panicle exertion

- Spray GA_3 @ 75 g/ha.
- Spray 40 g of GA_3 at 5-10% panicle emergence stage.
- Spray 35 g of GA_3 at 24 h after first spray.
  Note: GA_3 should be dissolved in 70% Ethyl alcohol.

Supplementary pollination

- Rope pulling or shaking the pollen parent with the help of two bamboo sticks at 30-40% of spikelets opening stage. This process is repeated for 3 – 4 times during the day time (10 am to 1 pm) at an interval of 30 min. This has to be repeated for 7 – 10 days during flowering period.

Harvesting

- 'R' line should be harvested first and ensure complete removal from the field followed by harvesting of seed parent.

Grading

- For getting better seed quality, the seeds should be size graded using 1.3 mm x 19 mm oblong sieve.
- The size graded seeds may be upgraded by density grading using gravity separator. Heavy and medium fractions with (90 – 92% recovery) could be selected for seed purpose.
- Hand cleaning of parental line seeds.

Drying

- Moisture content should be reduced to 12 – 13%

Seed treatment

- Treat with carbendazim @ 2g/kg or halogen mixture ($CaOCl_2$ + $CaCO_3$ mixture at 1:1 ratio) @ 3g /kg of seed.
- Sundry the seeds to reduce the moisture content to 12-13% with adequate stirring.

Storage

- As that of varieties.

District wise availability of paddy breeder seeds of different varieties

District	Variety	Place of Availability
Thanjavur, Theni	ADT 36	ARS, Pattukottai ARS, Vaigaidam
Madurai, Coimbatore, Theni	ADT 37	AC&RI, Madurai Dept. of Rice ARS, Vaigaidam
Thanjavur	ADT 38	ARS, Pattukottai SWMRI, Thanjavur
Trichy, Erode	ADT 39	SRS, Sirugamani ARS, Bhavanisagar
Thanjavur	ADT 42	SWMRI, Thanjavur
Thanjavur, Erode, Trichy	ADT 43	SWMRI, Thanjavur ARS, Bhavanisagar SRS, Sirugamani TRRI, Aduthurai
Trichy	ADT 44	TRRI, Aduthurai
Trichy, Thiruvallur, Virudhunagar	ADT 45	SRS, Sirugamani RRS, Tirur CRS, Srivilliputhur
Trichy, Theni	ADT 46	TRRI, Aduthurai ARS, Vaigaidam
Erode	ADT 47	ARS, Bhavanisagar
Thanjavur	ADT 48	TRRI, Aduthurai
Thanjavur	ADT 49	TRRI, Aduthurai

Erode	CO 43	ARS, Bhavanisagar
Coimbatore	CO 48	Dept. of Rice, TNAU, Coimbatore
Coimbatore	CO (R) 49	Dept. of Rice, TNAU, Coimbatore
Coimbatore	CO (R) 50	Dept. of Rice, TNAU, Coimbatore
Theni	IR 36	ARS, Vaigaidam
Erode	IR 50	ARS, Bhavanisagar
Tirunelveli	ASD 16	RRS, Ambasamudram ARS, Thirupathisaram AC&RI, Killikulam
Tirunelveli	ASD 18	RRS, Ambasamudram
Tirunelveli	ASD 19	RRS, Ambasamudram
Erode	Bhavani	ARS, Bhavanisagar
Trichy	CR 1009	AEC&RI, Kumulur
Coimbatore, Trichy, Erode	I.W.Ponni	CRS, Aliyarnagar ADAC&RI, Trichy ARS, Bhavanisagar
Ramanathapuram	Anna (R)4	ARS, Paramakudi
Ramanathapuram	PMK (R) 3	ARS, Paramakudi
Tirunelveli	TPS 3	ARS, Thirupathisaram
Trichy	TRY 1	ADAC&RI, Trichy
Thiruvallur	TKM 9	RRS, Tirur
Dharmapuri	PY 1	RRS, Paiyur
Madurai	MDU 5	AC&RI, Madurai
	CORH 3 Parents	
Coimbatore	A line	Dept.of Rice, TNAU, Coimbatore
Coimbatore	B line	Dept.of Rice, TNAU, Coimbatore
Erode	R line	ARS, Bhavanisagar

STANDARDIZED MARKERS (SSR) FOR VARIETAL PURITY TESTING OF RICE VARIETIES HYBRIDS

S.No.	Markers	Hybrid / Variety
		VARIETY
1.	RM 570	ADT 45 (245 bp)
2.	RM 570	CO 48 (302 bp)
3.	RM 515	I.W.Ponni(231 bp)
		HYBRID
4.	RM 276	CORH3 and its parental lines TNAU CMS 2A and CB 87R.
5.	RM 234	KRH2 and its parental lines IR 58025A and KMR 3R.
6.	RM 258	PRH 10 and its parental lines PUSA 6A and PRR 78.
7.	RM 202	AJAY and its parental lines CRMS 31A and IR-42266-29-3R.
8.	RM 204	RAJALAXMI and its parental lines CRMS 32A and IR_42266-29-3R.

Alternate Varieties for Replacement

S.No.	Existing variety	Alternate variety
1.	BPT 5204	ADT 49, CO 49
2.	CR 1009	ADT 50
3.	ADT 38, IR 20 and CO 43	CO 50

MARKET INFORMATION

Procurement	In Delta Zone (Tanjore, Nagapattinam, Thiruvarur, Trichy (Part), Cuddalore (Part)) Paddy procurement is done through Tamil Nadu Civil Supplies Corporation(TNCSC) and Central Warehousing Corporation (CWC) Non Deltaic Zone Procurement is done through Regulated Market Committees (RMC)
Grades of Indian Rice	Common variety : Short bold & long bold rice Fine Variety : Medium slender rice Super variety : Long slender & Short slender rice
Major Markets in Tamil Nadu	Thanjavar, Thiruvannamabai, Villupurm, Nagpattinum, Coimbatore, Erode, Trichitapallai, Pudukottai, Madurai, Dindigal, Attur, Gingee, Tindivanam
Export Destination	Non Basmati Rice : Malaysia, Singapore, Canada, USA, UK (wherever Indian ethic population is seen at large)

MILLETS

SORGHUM (*Sorghum bicolor*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/Season	Month	Varieties/Hybrids
I. Cauvery Delta Zone		
1. Tiruchirapalli		
Thaipattam	Jan. – Feb.	TNAU SORGHUM HYBRID CO 5, BSR 1
Chithiraipattam	April - May	BSR 1, TNAU SORGHUM HYBRID CO 5
Adipattam	June - July	K Tall, CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1
Puratasipattam	Sept. – Oct.	K Tall, CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1
II. North Eastern Zone		
a. Kanchipuram/Tiruvallur		
Thaipattam	January - February	CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1, TNAU SORGHUM HYBRID CO 5
Chithiraipattam	April - May	CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1, TNAU SORGHUM HYBRID CO 5
Adipattam	June - July	K Tall, CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1, TNAU SORGHUM HYBRID CO 5,
Puratasipattam	Sept.- Oct.	K Tall, CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1
b. Vellore/Tiruvannamalai		
Thaipattam	January - February	CO (S) 28, TNAU SORGHUM variety CO 30, TNAU SORGHUM HYBRID CO 5, BSR 1
Chithiraipattam	April - May	CO (S) 28, TNAU SORGHUM variety CO 30, TNAU SORGHUM HYBRID CO 5, BSR 1
Adipattam	June - July	K Tall, CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1, TNAU SORGHUM HYBRID CO 5, Paiyur 1
Puratasipattam	September - October	K Tall, CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1, Paiyur 2
c. Cuddalore/ Villupuram		
Thaipattam	January - February	CO (S) 28, TNAU SORGHUM variety CO 30, TNAU SORGHUM HYBRID CO 5, BSR 1
Chithiraipattam	April - May	CO (S) 28, TNAU SORGHUM variety CO 30, TNAU SORGHUM HYBRID CO 5, BSR 1
Adipattam	June - July	K Tall, CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1, TNAU SORGHUM HYBRID CO 5
Puratasipattam	September - October	K Tall, CO(S) 28, TNAU SORGHUM variety CO 30, BSR 1
III. Western zone		
a. Coimbatore/Tirupur		
Thaipattam	January - February	CO (S) 28, TNAU SORGHUM variety CO 30, TNAU SORGHUM HYBRID CO 5, BSR 1
Chithiraipattam	April - May	CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1, TNAU SORGHUM HYBID CO 5

Adipattam	June - July	CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1
Puratasipattam	Sept. – Oct.	CO (S) 28, TNAU SORGHUM variety CO 30
b. Erode		
Thaipattam	January - February	CO (S) 28, TNAU SORGHUM variety CO 30, TNAU SORGHUM HYBRID CO 5, BSR 1
Chithiraipattam	April - May	CO (S) 28,TNAU SORGHUM variety CO 30, BSR 1, TNAU SORGHUM HYBRID CO 5
Adipattam	June - July	CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1, Paiyur 2
Puratasipattam	Sept.- Oct.	CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1, Paiyur 2
c. Karur/Perambalur/Ariyalur		
Thaipattam	Jan. – Feb.	TNAU SORGHUM HYBRID CO 5, BSR 1
Chithiraipattam	April - May	BSR 1, TNAU SORGHUM HYBRID CO 5
Adipattam	June - July	K Tall, CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1
Puratasipattam	Sept. – Oct.	K Tall, CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1
IV. North Western Zone		
a. Salem/Namakkal		
Thaipattam	Jan.- Feb.	CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1
Chithiraipattam	April - May	CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1
Adipattam	June - July	CO (S) 28, Paiyur 1, Paiyur 2, BSR 1
Puratasipattam	Sept. – Oct.	CO (S) 28, TNAU SORGHUM variety CO 30, Paiyur 2, BSR 1
b. Dharmapuri/Krishnagiri		
Thaipattam	Jan. – Feb.	CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1
Chithiraipattam	April - May	CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1
Adipattam	June - July	CO (S) 28, TNAU SORGHUM variety CO 30, Paiyur 1, Paiyur 2
Puratasipattam	Sept. – Oct.	CO (S) 28, TNAU SORGHUM variety CO 30, Paiyur 2
V. Southern zone		
a. Pudukottai		
Thaipattam	Jan. – Feb.	BSR 1, TNAU SORGHUM HYBRID CO 5
Chithiraipattam	April - May	BSR 1, TNAU SORGHUM HYBRID CO 5
Adipattam	June - July	CO (S) 28, TNAU SORGHUM variety CO 30, K Tall, BSR 1, TNAU SORGHUM HYBRID CO 5
Puratasipattam	Sept. – Oct.	CO (S) 28, TNAU SORGHUM variety CO 30, K Tall, BSR 1
b. Madurai/Dindigul/Theni		
Thaipattam	Jan. – Feb.	CO (S) 28, TNAU SORGHUM variety CO 30, TNAU SORGHUM HYBRID CO 5, BSR 1
Chithiraipattam	April - May	CO (S) 28, TNAU SORGHUM variety CO 30, BSR 1, TNAU SORGHUM HYBRID CO 5
Adipattam	June - July	CO(S) 28, TNAU SORGHUM variety CO 30, K 11, BSR 1, TNAU SORGHUM HYBRID CO 5, APK 1
Puratasipattam	Sept. – Oct.	CO(S) 28, TNAU SORGHUM variety CO 30, K Tall, K 11, BSR 1, APK 1
c. Ramanathapuram/ Virudhunagar/ Sivaganga		
Thaipattam	January - February	CO (S) 28, TNAU SORGHUM variety CO 30, TNAU SORGHUM HYBRID CO 5

Chithiraipattam	April - May	CO (S) 28,TNAU SORGHUM variety CO 30, BSR 1, TNAU SORGHUM HYBRID CO 5
Adipattam	June - July	BSR 1, TNAU SORGHUM HYBRID CO 5, APK 1
Puratasipattam	Sept. – Oct.	TNAU SORGHUM variety CO 30, K 11, K Tall, BSR 1, APK 1
d. Tirunelveli/ Thoothukudi		
Thaipattam	January - February	CO (S) 28, TNAU SORGHUM variety CO 30, TNAU SORGHUM HYBRID CO 5, BSR 1
Chithiraipattam	April - May	CO (S) 28, TNAU SORGHUM variety CO 30, TNAU SORGHUM HYBRID CO 5, BSR 1
Adipattam	June - July	K Tall, K 11, CO(S) 28, TNAU SORGHUM variety CO 30, BSR 1, APK 1
Puratasipattam	September - October	K Tall, CO (S) 28, TNAU SORGHUM variety CO 30, K 11, BSR 1, APK 1
VI. High Rainfall zone		
a. Kanyakumari		
Thaipattam	Jan. – Feb.	CO (S) 28, TNAU SORGHUM variety CO 30, TNAU SORGHUM HYBRID CO 5
Chithiraipattam	April - May	CO (S) 28, TNAU SORGHUM variety CO 30, TNAU SORGHUM HYBRID CO 5

II. PARTICULARS OF SORGHUM VARIETIES

PARTICULARS	CO (S) 28	TNAU SORGHUM variety CO 30	TNAU SORGHUM HYBRID CO 5
Parentage	Derivative of CO 25 x SPV 942	Derivative of APK 1 x TNS 291	Derivative of ICS 51A x TNS 30
Duration (days)	100-105	95-105	95-105
Area (Districts)	All districts	All districts	All districts
Season (Pattam)			
Rainfed	Adi, Puratasi	Adi, Puratasi	Adi, Puratasi
Irrigated	Thai, Chithirai	Thai, Chithirai	Thai, Chithirai
Grain yield kg/ha			
Rainfed	2493	2400	2770
Irrigated	4568	3360	4340
Fodder yield kg/ha			
Rainfed	12600	7000	7560
Irrigated	17700	9200	10550
Stalk	Juicy	Juicy	Juicy
Height (cm)	220-240	220-240	210-230
Sheath colour	Tan Green	Tan Green	Tan Node Green
Midrib	Dull white	Dull white	Dull white
Earhead shape	Cylindrical	Cylindrical	Cylindrical
Compactness	Semi compact	Semi compact	Semi Loose Elliptical
Grain colour	White	White	Pearly white
Special features	Moderately resistant to shootfly, ear head bugs and grain mould	Moderatly high dry Matter digestibility tolerance to shootfly, grainmould and downy mildew	Moderatly high dry Matter digestibility tolerance to shootfly, grainmould

II. PARTICULARS OF SORGHUM VARIETIES (CONTD...)

PARTICULARS	PAIYUR 1	K Tall	K 11
Parentage	CO 19 x CO 24	2219A x IS3541	K 7 x A 6552
Duration (days)	145 - 150	90	110-115
Area (Districts)	North east and north western districts	Southern districts and other districts	Southern districts
Season (Pattam)			
Rainfed	Adi, Puratasi	Adi, Puratasi	Puratasi
Irrigated	...	Thai, Chithirai	…
Grain yield kg/ha			
Rainfed	1000	3750	1560
Irrigated	...	4250	--
Stalk yield kg/ha			
Rainfed	9000	11250	10360
Irrigated	...	13250	--
Stalk	Juicy	Juicy	Thin, Juicy and Sweet
Height (cm)	300	254	220-260
Sheath colour	Green	Brown	Reddish purple at maturity
Node	Green	Green	Green, glabrous
Midrib	White	Dull white	Dull white
Earhead shape	Lax panicle	…	Erect, loose panicle,
Compactness	Open	Lanceolate Semi open	Semiopen
Grain colour	Pearly white	Cream pearly	Red colour, partially covering the grain
Special features	Tolerant to drought, non lodging, photosensitive	--	Tolerant to drought Resistant to lodging, non shattering

II. PARTICULARS OF SORGHUM VARIETIES (CONTD...)

Particulars	BSR 1	Paiyur 2	APK 1
Parentage	(Multiple cross derivative (SC 108 - 3 x ICSV 4) 16-3-1 x (MR-801 x R 2751) 4-1-1	Pureline selection from IS 15845	Hybrid derivative of TNS 30 x CO 26
Duration (days)	105-110	90-95	105-110
Area (Districts)	Western Zone (Coimbatore, Erode, parts of Salem, Trichirappalli Perambalur, Karur and Dindigul)	Salem, Namakkal	Southern districts of Tamil Nadu
Season (Pattam)			
Rainfed	Adi-puratasi	Puratasi	Adi, Puratasi
Irrigated	Thai-Chitirai		
Grain yield (Kg/ha)			
Rainfed	2500 - 3500	2113	2619
Irrigated	6000 – 6500	…	…
Fodder Yield(kg/ha)			
Rainfed	8600	8789	8090
Irrigated	9600	…	…

Stalk	Juicy, sweet	Juicy, sweet	Pithy
Height (cm)	150 – 180	200-215	175
Sheath colour	Reddish purple	Green	Tan
Node	Green	Green	Green
Mid rib	Dull white	White	Dull white
Earhead shape	Long, cylindrical	Elliptic	Medium cylindrical
Compactness	Semi-compact	Semi-compact	Semi-compact
Grain colour	Pearly white	Red	White
Special features	Fertilizer responsive, moderately resistance to earhead bug, shoot fly and stem borer.	Dual purpose red grain sorghum. Tolerant to downy mildew and charcoal rot diseases.	Non-lodging

CROP MANAGEMENT

I. SELECTION OF SEEDS

Good quality seeds are to be collected from disease and pest-free fields.

Quantity of seed required

Irrigated Transplanted - 7.5 kg/ha; Direct sown - 10 kg/ha
Rainfed Direct sown - 15 kg/ha

Sorghum under irrigated condition is raised both as a direct sown and transplanted crop. Transplanted crop has the following advantages:

a. Main field duration is reduced by 10 days.
b. Shoot fly, which attacks direct sown crops during the first 3 weeks and which is difficult to control, can be effectively and economically controlled in the nursery itself.
c. Seedlings which show chlorotic and downy mildew symptoms can be eliminated, thereby incidence of downy mildew in the main field can be minimised.
d. Optimum population can be maintained as only healthy seedlings are used for transplanting.
e. Seed rate can also be reduced by 2.5 kg/ha.

Population

150 plants for 10 m^2, leaving only one healthy plant per hill.

II. NURSERY PRACTICES

1. NURSERY PREPARATION

For raising seedlings to plant one hectare, select 7.5 cents (300 m^2) near a water source where water will not stagnate.

2. APPLICATION OF FYM TO THE NURSERY

i. Apply 750 kg of FYM or compost for 7.5 cents nursery and apply another 500 kg of compost or FYM for covering the seeds after sowing.
ii. Spread the manure evenly on the unploughed soil and incorporate by ploughing or apply just before last ploughing.

3. LAYING THE NURSERY

i. Provide three separate units of size 2 m x 1.5 m with 30 cm space in between the plots and all around the unit for irrigation.
ii. Excavate the soil from the inter-space and all around to a depth of 15 cm to form channels and spread the soil removed on the bed and level.

4. PRE-TREATMENT OF SEEDS

i. Treat the seeds 24 hours prior to sowing with Carbendazim or Captan or Thiram at 2g/kg of seed.

ii. Treat the seeds with three packets (600 g) / ha of Azospirillum and 3 packets (600g) of phosphobacteria or 6 packets of Azophos (1200g) using rice gruel (Kanji) as binder.

5. SOWING AND COVERING THE SEEDS

1. Make shallow rills, not deeper than 1 cm on the bed by passing the fingers vertically over it.
2. Broadcast 7.5 kg of treated seeds evenly on the beds.
3. Cover by leveling the rills by passing the hand lightly over the soil.

6. WATER MANAGEMENT

i. Provide one inlet to each nursery unit.
ii. Allow water to enter through the inlet and cover all the channels till the raised beds are wet and then cut off water and
iii. Adjust the frequency of irrigation according to the soil types as follows:

Number of irrigations	Red soils	Heavy soils
First irrigation	Immediately after sowing	Immediately after sowing
Second irrigation	3rd day after sowing	4th day after sowing
Third irrigation	7th day after sowing	9th day after sowing
Fourth irrigation	12th day after sowing	16th day after sowing

NOTE: Do not keep the seedlings in the nursery for more than 18 days. If older seedlings are used, establishment and yield are adversely affected. Do not allow cracks to develop in the nursery by properly adjusting the quantity of irrigation water.

III. MAIN FIELD PREPARATION FOR IRRIGATED CROP

1. PLOUGHING

Plough the field with an iron plough once (or) twice. Sorghum does not require fine tilth since it adversely affects germination and yield in the case of direct sown crop.

To overcome the subsoil hard pan in Alfisols (deep red soils) chiselling the field at 0.5 m intervals to a depth of 40 cm on both the directions of the field followed by disc ploughing once and cultivator ploughing twice help to increase the yield of sorghum and the succeeding crops.

Application of FYM and 100% of recommended N can also be followed. In soils with sub-soil hard pan, chiselling should be done every year at the start of the cropping sequence to create a favourable physical environment.

2. APPLICATION OF FYM

Spread 12.5 t/ha FYM or composted coir pith along with 10 packets of Azospirillum (2000 g/ha) and 10 packets (2000 g/ha) of phosphobacteria or 20 packets of Azophos (4000 g/ha) on the unploughed field and incorporate the manure in the soil. Apply well decomposed poultry manure @ 5 t/ha to improve the grain yield as well as physical properties of soils.

3. FORMATION OF RIDGES AND FURROWS

i. Form ridges and furrows of 6 m length and 45 cm apart
ii. Form irrigation channels across the furrows
iii. Alternatively, form beds of size 10 m^2 and 20 m^2 depending on the availability of water.

4. APPLICATION OF FERTILIZERS
Transplanted crop

If soil test recommendations are not available, adopt a blanket recommendation of 90 N, 45 P_2O_5, 45 K_2O kg/ha.

i. Apply N @ 50:25:25 % at 0, 15 and 30 DAS and full dose of P_2O_5 and K_2O basally before planting

Soil test crop response based integrated plant nutrition system (STCR- IPNS) recommendation may be adopted for prescribing fertilizer doses for specified yield targets. (ready reckoners are furnished).

Sorghum (1)

Soil :Red – Sandy loam (Irugur series) FN = 4.86 T - 0.53 SN - 0.98 ON
Season:Kharif FP_2O_5 = 1.63 T - 0.87 SP - 0.90 OP
Target:50 q ha^{-1} FK_2O = 4.56 T - 0.59 SK - 0.76 OK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
160	10	160	106	41	90*
180	12	180	96	39	82
200	14	200	85	37	70
220	16	220	74	36	58
240	18	240	64	34	46

*maximum dose

Sorghum (2)

Soil : Mixed black calcareous (Perianaickenpalayam series) FN = 6.06 T - 0.81 SN - 0.53 ON
FP_2O_5 = 2.06 T – 3.14 SP - 0.72 OP
Season : Kharif K_2O = 5.03 T - 0.47 SK - 0.66 OK
Target : 50 q ha^{-1}

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + *Azospirillum* @2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
180	10	300	105	40	71
200	12	340	89	33	52
220	14	380	73	27	33
240	16	420	57	23*	23*
260	18	460	40	23*	23*

*maintenance dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

ii. In the case of ridge planted crop, open a furrow 5 cm deep on the side of the ridge at two thirds the distance from the top of the ridge and place the fertilizer mixture along the furrow and cover with soil upto 2 cm.

iii. Soil application of Azospirillum at 10 packets (2 kg/ha) and 10 packets (2000g/ha) of phosphobacteria or 20 packets of Azophos (4000g/ha) after mixing with 25 kg of FYM + 25 kg of soil may be carried out before sowing/planting.

Direct sown crop

i. Apply NPK fertilizers as per soil test recommendations as far as possible. If soil test recommendations are not available, adopt a blanket recommendation of 90 N, 45 P_2O_5, 45 K_2O kg/ha.

ii. Apply N @ 50:25:25 % at 0, 15 and 30 DAS and full dose of P_2O_5 and K_2O_5 basally before sowing and if basal application is not possible the same could be top dressed within 24 hours.

iii. In the case of bed planted crop, mark lines to a depth of 5 cm and 45 cm apart. Place the fertilizer mixture at the depth of 5 cm along the lines. Cover the lines upto 2 cm from the top before sowing.
iv. In the case of sorghum raised as a mixed crop with a pulse crop (Blackgram, Greengram or Cowpea) open furrows 30 cm apart to a depth of 5 cm.
v. Apply fertilizer mixture in two lines in which sorghum is to be raised and cover upto 2 cm.
vi. Skip the third row in which the pulse crop is to be raised and place fertilizer mixture in the next two rows and cover upto 2 cm with soil.
vii. Application of bio-fertilizers: When Azospirillum is used apply only 75% of recommended N for irrigated sorghum.

5. APPLICATION OF MICRONUTRIENT MIXTURE

Transplanted Crop

i. Mix 12.5 kg/ha of micronutrient mixture formulated by the Department of Agriculture, Tamil Nadu with enough sand to make a total quantity of 50 kg and apply the mixture over the furrows and on top one third of the ridges.
ii. If micronutrient mixture is not available, mix 25 kg of zinc sulphate with sand to make a total quantity of 50 kg and apply on the furrows and on the top one third of the ridges.

Direct Sown Crop

i. Mix 12.5 kg of micronutrient mixture formulated by the Department of Agriculture, Tamil Nadu with enough sand to make a total quantity of 50 kg.
ii. Spread the mixture evenly on the beds.
iii. Basal application of 25 kg $ZnSO_4/ha^{-1}$ for the deficient soils or 12.5 kg Zn SO_4 ha^{-1} + FYM for the Zn deficient soils
iv. Basal application of $FeSO_4$, 50 kg/ha along with 12.5 t/ha FYM for iron deficient soils.

IV. MANAGEMENT OF MAIN FIELD

Spacing: 45 x 15 cm
Population: $15/m^2$

1. TRANSPLANTED CROP

i. Pull out the seedlings when they are 15 to 18 days old.
ii. Prepare slurry with 5 packets of Azospirillum (1000g/ha) and 5 packets (1000g/ha) of Phosphobacteria or 10 packets of Azophos (2000 g/ha) in 40 lit. of water and dip the root portion of the seedlings in the solution for 15-30 minutes and transplant.
iii. Let in water through the furrows
iv. Plant one seedling per hill
v. Plant the seedlings at a depth of 3 to 5 cm.
vi. Plant the seedlings on the side of the ridge, half the distance from the top of the ridge and the bottom.

2. DIRECT SOWN CROP

i. In the case of pure crop of sorghum, maintain the seed rate at 10kg/ha.
ii. In the case of inter crop of sorghum with pulse crop, maintain the seed rate of sorghum at 10 kg/ha and pulse crop at 10 kg/ha.
iii. In the case of pure crop of sorghum, sow the seeds with a spacing of 15 cm between seeds in the rows which are 45 cm apart.
iv. Maintain one plant per hill.
v. If shootfly attack is there, remove the side shots and retain one healthy shoot.
vi. Sow the seeds over the lines where fertilizers are placed.
vii. Sow the seeds at a depth of 2 cm and cover with soil.
viii. In the case of sorghum intercropped with pulses sow one paired row of sorghum alternated with a single row of pulses. The spacing between the row of sorghum and pulse crop

is 30 cm.

Forage cowpea CO 1 can be intercropped in sorghum at two rows of fodder cowpea in between paired rows of sorghum.

3. WEED MANAGEMENT

i. Apply PE Atrazine @ 0.25 kg/ha on 3-5 DAS followed by 2,4-D @ 1 kg/ha on 20-25 DAS on the soil surface, using Backpack/Knapsack/Rocker sprayer fitted with a flat fan nozzle using 500 litres of water/ha (or) if herbicides are not used, hand weeding twice on 10-15 DAS and 30-35 DAS.
ii. Apply PE Atrazine@0.25 kg/ha on 3-5 DAS followed by one hand weeding on 30-35 DAS.
iii. In line sown crop, apply PE Atrazine @ 0.25 kg/ha on 3-5 DAS followed by Twin Wheel hoe weeder weeding on 30-35 DAS.
iv. In transplanted crop, apply PE Atrazine @ 0.25 kg/ha on 3-5 DAT followed by 2,4-D @ 1 kg/ha on 20-25 DAT.
v. If pulse crop is to be raised as an intercrop in sorghum do not use Atrazine, spray PE Pendimethalin @ 0.75 kg/ha on 3-5 DAS

4. THINNING OF THE SEEDLINGS AND GAP FILLING

Direct sown crop

Thin the seedlings and gap fill with the seedlings thinned out. Maintain a spacing of 15 cm between plants after the first hand weeding. Thin the pulse crop to a spacing of 10 cm between plants for all pulse crop except cowpea, for which spacing is maintained at 20 cm between plants.

5. DEFICIENCY SYMPTOMS

Zinc: Deficiency symptoms first appear in the newly formed leaves at 20 to 30 days age. Older leaves have yellow streaks or chlorotic striping between veins.

Iron:Interveinal chlorosis will be observed. If the deficiency continues the entire leaf including the veins may exhibit chlorotic symptoms. Newly formed leaves exhibit chlorotic symptoms. The entire crop may exhibit bleached appearance, dry and may die.

Direct sown crop

i. Spray only if micronutrient mixture is not applied.
ii. Apply in case of iron deficiency.
iii. If soil is calcareous

V. WATER MANAGEMENT

Regulate irrigation according to the following growth phase of the crop.

	Transplanted crop	Direct sown crop
Growth phase	1 to 40 days	1 to 33 days
Flowering phase	41 to 70 days	34 to 65 days
Maturity phase	71 to 95 days	66 to 95 days

STAGES	No. of Irrigation	Days of Transplanting/Sowing of Crop	
		Transplanted	**Direct sown**
Light soils			
i. Irrigate for germination	1	1st day	1st day
or establishment	2	4th day	4th day

ii. Regulate irrigation	1	15th day	15th day
during vegetative phase	2	28th day	28th day
iii. Flowering phase (copious irrigation)	1	40th day	40th day
	2	52nd day	52nd day
	3	..	64th day
iv. Maturity phase (Control irrigation)	1	65th day	76th day
	2	..	88th day
v. Stop irrigation thereafter	..	..	
Heavy soils			
i. Irrigate for germination	1	1st day	1st day
or establishment	2	4th day	4th day
ii. Regulate irrigation	1	17th day	17th day
during vegetative phase	2	30th day	30th day
iii. Flowering phase (give	1	40th day	45th day
copious irrigation)	2	52nd day	60th day
	3	..	75th day
iv. Maturity phase (Control irrigation)	1	72nd day	90th day
v. Stop irrigation thereafter			

NOTE : Adjust irrigation schedule according to the weather conditions and depending upon the receipt of rains. Contingent Plan: This should be done before 75% of soil moisture is lost from available water. Spraying 3% Kaolin (30 g in one litre of water) during periods of stress will mitigate the ill effects.

V. HARVESTING AND PROCESSING

i. Consider the average duration of the crop and observe the crop. When the crop matures the leaves turn yellow and present a dried up appearance.
ii. The grains are hard and firm.
iii. At this stage, harvest the crop by cutting the earheads separately.
iv. Cut the stalk after a week, allow it to dry and then stack.
v. In the case of tall varieties, cut the stem at 10 to 15 cm above ground level and afterwards separate the earheads and stack the stalk.
vi. Dry the earheads.
vii. Thresh using a mechanical thresher or by drawing a stone roller over the earheads or by using cattle and dry the produce and store.

RATOON SORGHUM CROP

1. RATOONING TECHNIQUE

i. Harvest the main crop leaving 15 cm stubbles.
ii. Remove the first formed two sprouts from the main crop and allow only the later formed two sprouts to grow. Allow two tillers per hill.

2. HOEING AND WEEDING

i. Remove the weeds immediately after harvest of the main crop.
ii Hoe and weed twice on 15th and 30th day after cutting.

3. APPLICATION OF FERTILIZERS

i. Apply 100 kg N/ha in two split doses.
ii. Apply the first dose on 15th day after cutting and the second on 45th day after cutting.
iii. Apply 50 kg P_2O_5/ha along with the application of N on 45th day.

4. WATER MANAGEMENT

i. Irrigate immediately after cutting the main crop.
ii. Irrigation should not be delayed for more than 24 hours after cutting.
iii. Irrigate on 3rd or 4th day after cutting.
iv. Subsequently irrigate once in 7 - 10 days.
v. Stop irrigation on 70 - 80 days after ratooning.

5. HARVEST

Harvest the crop when the grains turn yellow.

NOTE: The duration of the ratoon crop is about 15 days less than the main crop.

RAINFED SORGHUM

1. RAINFALL

Average and well distributed rainfall of 250-300 mm is optimum for rainfed sorghum.

2. DISTRIBUTION

Madurai, Dindigul, Theni, Ramanathapuram, Tirunelveli, Thoothukudi, Virudhunagar, Sivagangai, Tiruchirapalli, Erode, Salem, Namakkal, Coimbatore and Dharmapuri Districts.

3. SEASON

The crop can be grown in South West and North East monsoon seasons provided the rainfall is evenly distributed.

4. FIELD PREPARATION

i Field has to be prepared well in advance taking advantage of early showers. FYM application should be done @ 12.5 t / ha and well incorporated at the time of ploughing.

ii. Chiseling for soils with hard pan

Chisel the soils having hard pan formation at shallow depths with chisel plough at 0.5 m interval, first in one direction and then in the direction perpendicular to the previous one once in three years. Apply 12.5 t FYM or composted Coir pith/ha besides chiseling to get an additional yield of about 30% over control.

iii. To conserve the soil moisture sow the seeds in flat beds and form furrows between crop rows during inter cultivation or during third week after sowing.

5. SEED RATE

15 kg/ha

6. SEED TREATMENT

Direct sown crop

Seed hardening ensures high germination. The seeds are pre-soaked in 2% potassium dihydrogen phosphate solution for 6 hours in equal volume and then dried back to its original moisture content in shade and are used for sowing. (or)

i) Harden the seeds with 1% aquous fresh leaf extract of *Prosopis juliflora* and pungam, (*Pongamia pinnata*) mixed in 1:1 for 16 hrs at 1:0.6 ratio (Seed and solution) followed by drying and subsequently pelleting the seeds with Pungam leaf powder @300 g/kg with gruel.

ii) Halogenise the seeds containing CaOCl, $CaCO_3$ and arappu leaf powder @ 5:4:1 ratio or iodine based (containing 2 mg of Iodine in 3 g of $CaCO_3$) formulation @ 3g/kg packed in polylined cloth bag to maintain seed viability for more than 10 month.

iii) Treat the seeds with three packets of azospirillum (600 g) and 3 packets of phosphobacteria or 6 packets of Azophos (1200 g/ha). In the main field, apply 10 packets of azospirillum 2000 g/ha and 10 packets (2000g/ha) of phosphobacteria or 20 packets of Azophos (4000 g/ha) with phosphobacteria 2 kg with 25 kg FYM + 25 kg soil.

iv) The seed is pelletised with 15 g of Chloropyriphos in 150 ml of gum and shade dried.

7. SOWING

Sow the seeds well before the onset of monsoon at 5 cm depth (by seed drill or by country plough).

Pre-monsoon sowing

Sow the hardened seeds at 5 cm depth with seed cum fertilizer drill to ensure uniform depth of sowing and fertilizer application before the onset of monsoon as detailed below:

District	Optimum period
1. Coimbatore	37-38th week (II to III week of September)
2. Erode	38th week (III week of September)
3. Sivaganga	40th week (I week of October)
4. Ramanathapuram	40th week (I week of October)
5. Thoothukudi	39-40th week (Last week of September to I week of October)
6.Vellore, Tiruvannamalai	37th-38th week (September II week to September III week)

i. Sow the sorghum seeds over the line where the fertilizers are placed.
ii. Sow the seeds at a depth of 5 cm and cover with the soil.
iii. Sow the seeds with the spacings of 15 cm in the paired rows spaced 60 cm apart.
iv. Sow the pulse seeds to fall 10 cm apart in the furrows between the paired rows of sorghum.

8. SPACING

45 x 15 cm or 45 x 10 cm.

9. FERTILIZER

Apply 12.5 t/ha of Composted Coir pith + NPK at 40:20:0; Apply enriched FYM 750 kg/ha. The recommended dose of 40 kg N and 20 kg P_2O_5/ha for rainfed sorghum can be halved if FYM @ 5 t/ ha is applied.

10. WEED MANAGEMENT

Keep sorghum field free of weeds from second week after germination till 5th week. If sufficient moisture is available spray Atrazine 0.25 kg/ha as pre-emergence application within 3 days after the receipt of the soaking rainfall for sole sorghum and for sorghum based intercropping system with pulses, use Pendimethalin at 0.75 kg/ha.

Under rainfed sorghum intercropped with cowpea as a pre-plant incorporation of isoproturba @ 0.5 kg ha^{-1} gave good control of weed with applied after 1st and 2nd spell of rainfall pendimethalin 1.0 kg ha^{-1} will be safer for both the crops.

11. CROPPING SYSTEM

- The most profitable and remunerative sorghum based cropping system adopted is sorghum with cowpea, redgram, lab-lab, blackgram.
- In rainfed Vertisol, adopt paired row planting in sorghum and sow one row of blackgram/ cowpea in between paired rows of sorghum to have 100% population of sorghum plus 33% population of blackgram/cowpea.
- Intercropping of sunflower CO 1, with the main crop of sorghum CO 26 in 4:2 ratio is recommended under rainfed conditions during North-East monsoon for black soils of CBE.
- Intercropping of soybean with sorghum in the ratio 4:2 is recommended for kharif seasons.
- For sorghum - blackgram intercropping system as well as sole cropping, application of 20 kg N and 20 kg P_2O_5/ha through enriched FYM and treating the seeds with Azospirillum is recommended for Aruppukottai region.

- For sorghum (CO 25) + Fodder cowpea (CO 1) intercropping system, application of 20 kg N and 20 kg P_2O_5/ha with enriched FYM is recommended for Coimbatore region.
- The intercropping system, fodder sorghum (K 7) + Fodder cowpea (CO 5) at 3:2 ratio is found profitable for rainfed Vertisols of Aruppukottai.
- Tamarind and Neem trees upto 3-4 years from date of planting form an ideal tree component for agroforestry in black cotton soils of Kovilpatti. Sorghum and blackgram gave higher yield even at 50 per cent of the recommended level of fertilizer application.

CROP PROTECTION

A. Pest management

Pre-treatment of seeds

- Dissolve 0.5 g of gum in 20 ml of water. Add 4 ml of chlorpyriphos 20 EC or phosalone 35 EC. To this add one kg of seed, pellet and shade dry.

Economic threshold level for important pests

Pests	ETL
Shoot fly	1 egg/plant in 10% of plants in the first two weeks of sowing or 10 % dead hearts
Mite	5 mites/cm^2 of leaf area
Stemborer	10% damage
Grain midge	5 / earhead
Earhead bug	10 / earhead
Earhead caterpillar	2 / earhead

Pest management strategies

Pests	Management strategies
Shoot fly *Atherigona soccata*	▪ Take up early sowing of sorghum immediately after the receipt of South West or North East monsoon to minimise the shoot fly incidence. ▪ Use seeds pelleted with insecticides ▪ Seed treatment with imidacloprid 70 WS @ 10 g/kg of seeds ▪ In case of direct seeding, use increased seed rate upto 12.5 kg/per hectare and remove the shoot fly damaged seedlings at the time of thinning or raise nursery and transplant only healthy seedlings. ▪ Plough soon after harvest, remove and destroy the stubbles. ▪ Set up the TNAU low cost fish meal trap @ 12/ha till the crop is 30 days old. **Spray one of the following for an area of 120 m^2 nursery :** Methyl demeton 25 EC 12 ml/ha Dimethoate 30 EC 12 ml/ha **In main field for direct sown crop spray any one of the following** Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha Neem Seed Kernel extract 5% ▪ Soil application of phorate 10 G 18 kg/ha or carbofuran @ 33.3 kg /ha at the time of sowing
Mite *Oligonychus indicus*	▪ **Spray any one of the following :** Wettable sulphur 3.75 kg/ha Dicofol 18.5 EC 1500 ml/ha. Direct the spray fluid towards the under surface of the leaves

Aphids *Rhopalosiphum maidis* *Melanaphis sacchari*	▪ **Spray any one of the following :** Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha ▪ Dust carbaryl 10 D @ 25kg /ha
Stemborer *Chilo partellus sesamia inferens*	▪ Sowing the lab lab / cowpea as an intercrop to minimise stemborer damage (Sorghum: Lab lab /cowpea 4:1). ▪ Set up of light traps till mid night to monitor, attract and kill adults of stem borer, grain midge and earhead caterpillars ▪ **Mix any one of the following insecticides with sand to make up a total quantity of 50 kg/ha and apply in the leaf whorls :** Phorate 10 G 8 kg/ha Carbofuran 3 G 17 kg/ha ▪ **Spray any one of the following insecticides :** Carbaryl 50 WP 1.00 kg/ha (500 l spray fluid/ ha).
Grain midge *Contarinia sorgicola*	▪ Sett up of light traps till mid night to monitor, attract and kill adults of stem borer, grain midge and earhead caterpillars. ▪ **Apply any one of the following on 3rd and 18th day after panicle emergence :** Carbaryl 10 D 25 kg/ha Malathion 5 D 25 kg/ha Phosalone 4 D 25 kg/ha Neem seed kernel extract 5% (or) Spray malathion 50 EC @ 1600 ml/ha or phosalone 1150 ml/ha ▪ The sowing of sorghum should be completed in as short a time as possible to avoid continuous flowering which favours grain midge and earhead bug multiplication in an area.
Earhead bug *Calocoris angustatus*	▪ **Apply any one of the following on 3rd and 18th day after panicle emergence :** Carbaryl 10 D 25 kg/ha Malathion 5 D 25 kg/ha Neem seed kernel extract 5% ▪ Spray twice with Malathion 50 EC 500 ml/ha. in 500 lit of water at 10% heading and 9days after.
Earhead caterpillar *Helicoverpa armigera*	▪ Set up of light traps till mid night to monitor, attract and kill adults of stem borer, grain midge and earhead caterpillars. ▪ Set up sex pheromone traps at 12/ha to attract male moths of *Helicoverpa armigera* from flowering to grain hardening. Two applications of NPV at 10 days interval at 1.5 X10^{12} POB along with crude sugar 2.5 kg + cotton seed kernel powder 250 g on the earheads is effective in reducing the larval population of *Helicoverpa*. ▪ **Apply any one of the following on 3rd and 18th day after panicle emergence :** Carbaryl 10 D 25 kg/ha Malathion 5 D 25 kg/ha Phosalone 4 D 25 kg/ha
Storage Rice weevil *Sitophilus oryzae*	▪ Treat the seeds with chlorpyriphos 20 EC 4 ml/kg of seed.

Resurgence

Repeated application of the insecticide fenvalerate can cause resurgence of the aphid, *Rhopalosiphum maidis.*

RATOON SORGHUM CROP

CROP PROTECTION

A. Pest management

Nursery practices
Seed treatment: Treat the seeds 24h prior to sowing with Carbendazim or Captan or Thiram 2g/kg of seed or Metalaxyl 6g/ kg of seed.

Rust: *Puccinia purpurea*	• Spray Mancozeb at 1kg/ha. Repeat fungicidal application after 10 days
Ergot or Sugary disease: *Sphacelia sorghi* and *Claviceps purpurea*	• Sowing period to be adjusted so as to prevent heading during rainy season and severe winter. • Spray any one of the following fungicides at emergence of earhead (5 - 10% flowering stage) followed by a spray at 50% flowering and repeat the spray after a week if necessary • Mancozeb – 1000g/ha • Propiconazole 500ml/ha
Head Mould: Fungal complex *Fusarium, Curvularia, Alternaria, Aspergillus* and *Phoma* sp.	• Spray any one of the fungicides like Mancozeb or Captan @ 1000g+ Aureofungin sol. 100 g/ha in case of intermittent rainfall during earhead emergence and repeat if necessary a week later.
Downy Mildew: *Peronosclerospora sorghi*	• Rogue infected plants up to 45 days of sowing • Spray any one of the fungicides like Metalaxyl + Mancozeb 500 g or Mancozeb 1000g/ha after noticing the symptoms of foliar diseases, for both transplanted and direct sown crops.
Charcoal Rot: *Macrophomina phaseolina*	• Treat the seeds with *Pseudomonas fluorescens* @10g/kg or *Trichoderma viride* @ 4g/kg of seed.

SEED PRODUCTION

Varietal Seed Production

Land requirement
- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation
- For certified / quality seed production leave a distance of 100 m all around the field from the same and other varieties of the crop.
- The distance may be extended to 400 m for the presence of Johnson grass.

Season
- June - July and October - November

Pre-sowing seed treatment
- Soak the seeds in 2% KH_2PO_4 for 16h in a seed to solution ratio of 1:0.6 and dry back the seeds to original seed moisture content (8 – 9%) under shade. This can be adopted both for the garden and dry land ecosystem.

- For better establishment in mine spoils harden the seed with 2 % KH_2PO_4 for 6 h and coat the seed with pink polymer @ 3 g/kg of seed + carbendazim @ 2 g/kg + imidachloprid @ 1 ml / kg + DAP @ 30 g/kg + micro nutrient mixture @ 20 g/kg + Azospirillum @ 40 g/kg of seed

Fertilizer requirement
- As basal application, apply NPK @ 100 : 50 : 50 kg ha^{-1}

Spacing
- 45 x 10 cm

Pre-harvest sanitation spray
- Ten days before harvest, spray 2% carbendazim against black mould.

Harvesting
- Seeds attain maturity 40 – 45 days after 50% flowering with 25-28% seed moisture content.
- Harvest the earheads when the seed attain the characteristic yellow colour, as once over harvest.

Threshing
- Thresh the earheads either manually or mechanically at a moisture content of 15 – 18 %.

Seed grading
- Size grade the seeds either with 9/64" (3.6 mm) or 10/64" (4.0 mm) round perforated metal sieve depending upon the size distribution in a variety.

Seed treatment
- Slurry treat the seeds with carbendazim @ 2g/kg^{-1} of seed along with carbaryl @ 200 mg kg^{-1} of seed (or)
- Slurry treat the seeds with halogen mixture @ 3 g/kg^{-1} ($CaOCl_2$ + $CaCO_{3n}$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) as eco – friendly treatment.

Storage
- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with the seed moisture content of 10 - 12%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with the seed moisture content of 8 – 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with the seed moisture content of less than 8%.

Hybrid seed production

Land Requirement
- Fertile land with good drainage and irrigation is selected for seed production.
- Field should not have volunteer plants. Hence, the previous crop should not be the same or different variety / hybrid of sorghum.

Isolation
- For certified / quality seed production leave a distance of 200 m all around the field from the same and other varieties of the sorghum.

Season
- For increased seed set and effective synchronization, sow the crop during October – November.

Planting ratio

- Sow the female and male seeds in the ratio of 4:2 for foundation seed production and in the ratio of 5:2 for certified seed production.

Border rows

- Sow the male parent in four rows around the field for the availability of adequate pollen.

Fertilizer requirement

- Apply NPK @100: 50: 50 kg ha^{-1}. Apply NPK @ 50:50:50 kg ha^{-1} as basal 25 kg of nitrogen after first weeding and another 25 kg of nitrogen during boot leaf stage as top dressing.

Foliar spray

- At primordial initiation stage, spray 0.5%, $FeSO_4$ and thereafter two sprays at ten days interval to enhance pollen viability and enhanced seed set.

Synchronization techniques (Adopt any one of the following)

- Spray growth retardant, MH@ 500 ppm at 45 DAS to advancing parent.
- Apply 1% urea at initiation of flowering to the lagging parent.
- Withhold one irrigation for advancing parent.
- Stagger the sowing of male and female parents depending upon the hybrid and location.
- Spray CCC @ 300 ppm for delaying the flowering.

Harvesting

- Harvest the crop when seeds of 90 % of the earhead have attained the characteristic yellow colour, as once over harvest, but 'R' lines should be harvested first and remove from the field before harvesting the (hybrid) female plants.

Other management practices

- The techniques recommended for varieties can be adopted.

CUMBU (*Pennisetum glaucum* (L) R. Br.)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/Season	Month	Varieties/Hybrids
I. Cauvery Delta Zone		
1. Tiruchirapalli		
Chithiraipattam	Mar.- April	CO 7, CO (Cu) 9, X 7, ICMV 221, TNAU cumbu hybrid Co 9
Masipattam	Jan. – Feb.	CO 7, CO (Cu) 9, X 7, ICMV 221, TNAU cumbu hybrid Co 9
Adipattam	June - July	CO 7, CO (Cu) 9, X 7, ICMV 221, TNAU cumbu hybrid Co 9
Puratasipattam	Sept. –Oct.	CO 7, CO (Cu) 9, X 7, ICMV 221, TNAU cumbu hybrid Co 9
II. North Eastern Zone		
a. Vellore/Tiruvannamalai / Cuddalore/ Villupuram / Tiruvallur		
Chithiraipattam	Mar.- April	CO 7, CO (Cu) 9, X 7, ICMV 221,TNAU cumbu hybrid Co9
Masipattam	Jan. – Feb.	CO 7, CO (Cu) 9, X 7, ICMV 221, TNAU cumbu hybrid Co 9
Adipattam	June - July	CO 7, CO (Cu) 9, X 7, ICMV 221,TNAU cumbu hybrid Co 9
Puratasipattam	Sept. –Oct.	CO 7, CO (Cu) 9, X 7, ICMV 221,TNAU cumbu hybrid Co 9
III. Western zone		
a. Coimbatore / Erode / Karur/Perambalur /Tirpur / Ariyalur		
Chithiraipattam	Mar.- April	CO 7, CO (Cu) 9, X 7, ICMV 221, TNAU cumbu hybrid Co9
Masipattam	Jan. – Feb.	CO 7, CO (Cu) 9, X 7, ICMV 221, TNAU cumbu hybrid Co 9
Adipattam	June - July	CO 7, CO (Cu) 9, X 7, ICMV 221, TNAU cumbu hybrid Co9
Puratasipattam	Sept. –Oct.	CO 7, CO (Cu) 9, X 7, ICMV 221,TNAU cumbu hybrid Co9
IV. North Western Zone		
a. Salem/Namakkal / Dharmapuri / Krishnagiri		
Chithiraipattam	Mar.- April	CO 7, CO (Cu) 9, X 7, ICMV 221,TNAU cumbu hybrid Co 9
Masipattam	Jan. – Feb.	CO 7, CO (Cu) 9, X 7, ICMV 221, TNAU cumbu hybrid Co 9
Adipattam	June - July	CO 7, CO (Cu) 9, X 7, ICMV 221,TNAU cumbu hybrid Co 9
Puratasipattam	Sept. –Oct.	CO 7, CO (Cu) 9, X 7, ICMV 221,TNAU cumbu hybrid Co 9
V. Southern zone		
a. Madurai/Dindigul/Theni/ Ramanathapuram/ Virudhunagar/ Sivaganga / Tirunelveli/ Thoothukudi		
Chithiraipattam	Mar.- April	CO 7, CO (Cu) 9, X 7, ICMV 221,TNAU cumbu hybrid Co 9
Masipattam	Jan. – Feb.	CO 7, CO (Cu) 9, X 7, ICMV 221, TNAU cumbu hybrid Co 9
Adipattam	June - July	CO 7, CO (Cu) 9, X 7, ICMV 221,TNAU cumbu hybrid Co 9
Puratasipattam	Sept. –Oct.	CO 7, CO (Cu) 9, X 7, ICMV 221,TNAU cumbu hybrid Co 9

II. PARTICULARS OF CUMBU HYBRIDS AND VARIETIES

PARTICULARS	CO 7	X 7	CO (Cu) 9	ICMV 221	TNAU cumbu hybrid CO 9
Parentage	(CO 6 x PK 560) PT 1921	L111 A x PT 1890	Selection from ICMV 93752	ICRISAT Composite	ICMA 93111A x PT 6029-30
Season-irrigated/ rainfed	Both	Both	Both	Both	Both
Duration (Days)	90 - 100	90	80-85	75-80	75-80
Grain yield (kg/ha)					

Rainfed	2500 - 2800	2513	2354	13% > ICTP 8203	2707
Irrigated	3000 - 3500	3295	2865	-	3728
Plant height (cm)	130 - 145	155 - 180	186-222	140-200	160-180
Tillers (No.)	6 - 10	4 - 7	3-6	3-5	4-6
Pigmentation	Green	Non-pigmented	--	-	-
Hairiness	Glabrous	Glabrous	Glabrous	Absent	Glabrous
Days to 50% bloom	65 - 70	50 - 55	50-55	50-55	45-50
Shape of earhead	Conical/ Cylindrical/ Spindle	Candle	Candle to Cylindrical	Semicompact to compact lanceloate to oblanceolate	Candle to Cylindrical
Bristles	Nil	—	Absent	Usually non bristled	Absent
Length of earhead (cm)	22 - 26	25 - 35	33-39	-	25-35
Earhead girth diameter(cm)	3 - 4	—	3.1-3.7	Wide in girth	3.1-3.6
Grain colour	Slate colour	Slate	Grey seed with yellow base	Dark grey	Greyish yellow
1000 grains weight (gm)	6.8 - 7.2	8.0 - 9.0	9-11	10-15	13-14
Special features	Resistant to downy mildew	Resistant to downy mildew	Resistant to downy mildew	Resistant to downy mildew	Short duration Resistant to downy mildew

CROP MANAGEMENT

II. NURSERY

1. PREPARATION OF LAND

i. For raising seedlings to plant one ha select 7.5 cents near a water source. Water should not stagnate.
ii. Plough the land and bring it to the fine tilth.

2. APPLICATION OF FYM

Apply 750 kg of FYM or compost and incorporate by ploughing. Cover the seeds with 500 kg of FYM.

3. FORMING RAISED BED

i. In each cent mark 6 plots of the size 3 m x 1.5 m with 30 cm channel in between the plots and all around.
ii. Form the channel to a depth of 15 cm.
iii. Spread the earth excavated from the channel on the beds and level.

NOTE: The Unit of 6 plots in one cent will form one unit for irrigation.

4. REMOVAL OF ERGOT AFFECTED SEEDS AND SCLEROTIA TO PREVENT PRIMARY INFECTION

i. Dissolve one kg of common salt in 10 litres of water.
ii. Drop the seeds into the salt solution

iii. Remove the ergot and sclerotia affected seeds which will float.
iv. Wash seeds in fresh water 2 or 3 times to remove the salt on the seeds.
v. Dry the seeds in shade.
vi. Treat the seeds with three packets (600g) of the Azospirillum inoculant and 3 packets (600g) of phosphobacteria or 6 packets (1200g) of azophos.

5. TREATMENT OF THE NURSERY BED WITH INSECTICIDES

Apply phorate 10 G 180 g or Carbofuran 3 G 600 g mixed with 2 kg of moist sand, spread on the beds and work into the top 2 cm of soil to protect the seedlings from shootfly infestation.

6. SOWING AND COVERING THE SEEDS

i. Open small rills not deeper than 1 cm on the bed by passing the fingers over it.
ii. Sow 3.75 kg of seeds in 7.5 cents (0.5 kg / cent) and use increased seed rate upto 12.5 kg per ha in shootfly endemic area and transplant only healthy seedlings.
iii. Cover the seeds by smoothening out the rills with hand. Sprinkle 500 kg of FYM or compost evenly and cover the seeds completely with hands.

NOTE: Do not sow the seeds deep as germination will be affected.

7. IRRIGATION TO THE SEED BED

i. Provide one inlet to each unit of 6 plots to allow water in the channels.
ii. Allow water to enter the channel and rise up in it. Turn off the water when the raised bed is wet.
iii. Irrigate as per the following schedule.

Light Soil		Heavy Soil
1st	immediately after sowing	Immediately after sowing
2nd	on 3rd day after sowing	On 3rd day after sowing
3rd	on 7th day after sowing	On 9th day after sowing
4th	on 12th day after sowing	On 16th day after sowing
5th	on 17th day after sowing	

8. PROTECTION OF SEEDLINGS IN THE NURSERY FROM PEST ATTACK

If seed bed is not treated before sowing, protect the nursery by applying any one of the insecticides given below on the 7th and 14th day of sowing by mixing in 6 litres of water. Endosulfan 35 EC 12ml ; Methyl demeton 25 EC 12 ml, Dimethoat 30 EC 12 ml.

Note: 1. The seedlings should not be kept in nursery for more than 18 days. Otherwise the establishment and yield will be affected adversely.
2. Ensure that cracks should not develop in the nursery. This can be avoided by properly adjusting the quantity of irrigation water.

III. PREPARATION OF MAIN FIELD

1. FIELD PREPARATION

i. Plough with an iron plough twice and with country plough twice. Bring the soil into fine tilth.
ii. CHISELING FOR SOILS WITH HARD PAN: Chisel the soils having hard pan formation at shallow depths with chisel plough at 0.5m interval, first in one direction then in the direction perpendicular to the previous one, once in three years.

2. APPLICATION OF FYM OR COMPOST

Spread 12.5 t/ha of FYM or compost or composted coir pith uniformly on unploughed soil. Incorporate the manure by working the country plough and apply Azospirillum to the soil @ 10 packets per ha (2000 g) and 10 packets (2000g) of phosphobacteria (or) 20 packets (4000g) of azophos with 25kg of soil and 25 kg of FYM.

3. FORMING RIDGES AND FURROWS/BEDS

i. Form ridges and furrows (using 3 ridges) 6 m long and 45 cm apart. If pulses is intercropped, form ridges and furrows 6 m long and 30 cm apart.

ii. If ridge planting is not followed, form beds of the size 10 m^2 or 30 m^2 depending upon water availability.

iii. Form irrigation channels.

iv. To conserve soil moisture under rainfed condition, sow the seeds in flat and form furrows between crop rows during intercultivation on third week after sowing.

4. APPLICATION OF FERTILIZERS

Apply NPK fertilizers as per soil test recommendations as far as possible. If soil test recommendation is not available follow the blanket recommendation of 70:35:35 kg N, P_2O_5, K_2O/ ha for all varieties. For hybrids, apply 80 kg N, 40 kg P_2O_5 and 40 kg K_2O per ha. Apply the recommended N in three splits as 25:50:25 per cent at 0,15 and 30 DAS and full dose of phosphorus and potassium basally. Combined application of azospirillum and phosphobacteria or azophos along with 75 per cent of the recommended level of N and P is recommended for rainfed conditions.

Method of application: For transplanted crop, open a furrow more than 5 cm deep on the side of the ridge (1/3 distance from the bottom), place the fertilizer and cover. For the direct sown crop, mark the lines more than 5 cm deep 45 cm apart in the beds. Place the fertilizer below 5 cm depth and cover upto 2 cm from the top before sowing. In the case of intercropping with pulses, mark lines more than 5 cm deep 30 cm apart in the beds. Apply fertilizer only in the rows in which cumbu is to be sown and cover upto 2 cm. When azospirillum inoculant is used for seeds, seedlings use only 50 kg N/ha for variety, 60 kg N/ha for hybrid, as soil application in other words, reduce 25% N of soil test recommendations.

5. APPLICATION OF MICRONUTRIENT MIXTURE

Apply 12.5 kg/ha of micronutrient mixture formulated by the Department of Agriculture. Mix the mixture with enough sand to make 50 kg and apply on the surface just before planting/after sowing and cover the seeds. Broadcast the mixture on the surface to seed line. If micronutrient mixture is not available apply 25 kg of zinc sulphate per ha. Mix the chemical with enough sand to make 50 kg and apply as above.

IV. MANAGEMENT OF MAIN FIELD

1. TRANSPLANTING SEEDLINGS OR SOWING PRE-TREATED SEEDS Transplanted Crop

i. Pull out the seedlings when they are 15 to 18 days old.

ii. Adopt the spacing 45 x 15 cm for all the varieties / hybrids.

iii. Plant seedlings on the side of ridge, half way from the bottom. Depth of planting should be 3 to 5 cm.

iv. Root dipping with bio-fertilizers: Prepare the slurry with 5 packets (1000 g)/ha of Azospirillum inoculant and 5 packets (1000g/ha) of phosphobacteria or 10 packets of azophos (2000g/ha) in 40 lit. of water and dip the roots of the seedlings 15 - 30 minutes before planting.

Direct sown crop

Soaking of cumbu seeds either in 2% Potassium chloride (KCl) or 3% Sodium Chloride (NaCl) for 16 hours followed by 5 hours shade drying improves germination and stand.

i. Adopt the spacing of 45 x 15 cm for all varieties / hybrids. If pulse is intercropped, adopt a spacing of 30 x 15 cm for cumbu and 30 x 10 cm for pulses. One pair row of cumbu is alternated with a single row of pulse crop.

ii. In the furrows in which fertilizers have been applied, place 5 kg of seed, allowing them to fall 4 - 5 cm apart (Use higher seed rate of 5 kg to offset mortality). The optimum population should be 1,45,000 per ha. Use increased seed rate upto 12.5 kg per hectare in shoot fly endemic area and remove the shootfly damaged seedlings at the time of thinning.

iii. Where pulse seeds are to be sown, drop pulse seeds to fall 5 cm apart and cover.

2. WEED MANAGEMENT

Transplanted crop

Spray PE Atrazine 0.25 kg/ha on 3 DAT followed by one hand weeding on 30 - 35 DAT. If herbicide is not used hand weeding twice on 15 DAT and 30 - 35 DAT.

Direct Sown crop

i. Apply the PE Atrazine 0.25 kg/ha on 3 DAS as spray on the soil surface using Back-pack/Knapsack/Rocker sprayer fitted with flat type nozzle using 500 litres of water/ha.
ii. Apply herbicide when there is sufficient moisture in the soil.
iii. Hand weeding 30 - 35 DAT if pre-emergence herbicide is applied.
iv. If pre-emergence herbicide is not applied hand weeding twice on 15 and 30 DAT.

3. THINNING AND GAP FILLING

In direct sown crop after 1st weeding at the time of irrigation, gap fill and thin the crop to a spacing of 15 cm between plants; cowpea crop to 20 cm between plants and other pulses crops to 10 cm between plants.

4. TOP DRESSING OF FERTILIZERS

i. Top dress the nitrogen at 15 and 30 days after transplanting or direct sowing.
ii. In transplanted crop, open a furrow 5 cm deep with a stick or hoe at the bottom of the furrow, place the fertilizer and cover.
iii. In the case of direct sown crop apply the fertilizer in band. If intercropped with pulses apply the fertilizer to cumbu crop only.
iv. After the application of fertilizer, irrigate the crop.

V. WATER MANAGEMENT

	Days after transplantation/sowing	
STAGES	**Transplanted Crop**	**Direct Sown Crop**
Light Soils		
i. Germination	1st day after transplanting	1st day after sowing
	4th day	4th day
ii. Vegetative phase	15th Day	17th day
	28th day	30th day
iii. Flowering phase	40th day	42nd day
	52nd day	55th day
	65th day	68th day
iv. Maturity phase	77th day	79th day
Total	8 irrigations	8 irrigations
Heavy Soils		
i. Germination	1st day after planting	1st day after sowing
	4th day	5th day
ii. Vegetative phase	15th day	15th day
	28th day	30th day
iii. Flowering phase	42nd day	45th day
	54th day	57th day
iv. Maturity Phase	66th day	70th day
Total	7 irrigations	7 irrigations

NOTE: This is only a guideline and the irrigation schedule is to be adjusted depending upon the prevailing weather conditions.

VI. HARVESTING THE CROP

1. SYMPTOMS OF MATURITY

i. Leaves will turn yellow and present a dried apprearance.
ii. Grains will be hardened.

2. HARVESTING

i. Cut the earheads separately.
ii. Cut the straw after a week, allowing it to dry and stack it in the field till it can be transported.

3. THRESHING, CLEANING, DRYING AND STORING

i. Dry the earheads
ii. Thresh in a mechanical thresher or
iii. Spread it and drag a stone roller over it or
iv. Cattle thresh.
v. Dry the seeds below 10 per cent and mix 100 kg of grains with 1kg of activated kaolin to reduce the rice weevil and rice moth incidence.
vi. Spray Malathion 50EC 10 ml/ lit @ 3 lit of spray fluid/100 m^2 over the bags during storage godowns,
vii. For grain purpose the grain should be dried well below 10% moisture and stored in gunny bags.

CROP PROTECTION

Protection of seedlings in the nursery from pest attack

If seed bed is not treated before sowing, protect the nursery by applying any one of the insecticides given below on the 7^{th} and 14^{th} day of sowing by mixing in 6 litres of water; Methyl demeton 25 EC 12 ml, Dimethoate 30 EC 12 ml.

Note: 1. The seedlings should not be kept in nursery for more than 18 days. Otherwise the establishment and yield will be affected adversely.
2. Ensure that cracks should not develop in the nursery. This can be avoided by properly adjusting the quantity of irrigation water.

A. PEST MANAGEMENT

Pest management strategies

Pest	Management strategies
Shoot fly *Atherigona approximata*	▪ Use seeds pelleted with insecticides (see sorghum) ▪ Seed treatment with imidacloprid 70 WS 10 g/kg of seeds ▪ Plough soon after harvest, remove and destroy the stubbles. ▪ Set up the TNAU low cost fish meal trap 12/ha till the crop is 30 days old. ▪ **Spray any one of the following :** Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha Neem seed kernel extract 5%
Ear midge *Geromyia pennisetti*	▪ **Apply any one of the following at 50 % flowering :** Carbaryl 10 D 25 kg/ha Malathion 5 D 25 kg/ha Carbaryl 50 WP 750 g/ha or dimethoate 30 EC 600 ml/ha (500 l of spray fluid/ ha).

Seed treatment

- **Removal of ergot / sclerotia to prevent primary infection**
  Dissolve 1 kg of common salt in 10 litres of water. Drop the seeds into the salt solution. Remove the ergot and sclerotia affected seeds which will float. Wash seeds in fresh water 2 or 3 times to remove the salt on the seeds. Dry the seeds in shade. Treat the seeds with Thiram @ 2g /kg of seed.
- Treat the seeds with Metalaxyl 6g/kg for the control of downy mildew in endemic areas

Sugary or Ergot disease: *Claviceps fusiformis*	• Spray any one of the fungicides like Carbendazim 500g or Mancozeb 1000g /ha when 5 - 10% flowers have opened and again at 50% flowering stage.
Rust: *Puccinia penniseti*	• Sowing during December - May result in less incidence. • Adopt control measures when there is rust incidence in the early stages as spread of infection to top leaves results in poor grain filling. • Spray any one of the following fungicides when the initial symptoms of the diseases are noticed. Wettable sulphur 2500g / ha Mancozeb 1000g/ha • Repeat application 10 days after if necessary.
Downy Mildew: *Sclerospora graminicola*	• Grow downy mildew resistant varieties CO7, WCC 75, CO(Cu)9, TNAU-Cumbu Hybrid-CO9 • Transplanting reduces disease incidence. At the time of planting infected seedlings should be removed. • In the direct sown crop, infested plants should be removed up to 45 days of sowing as and when the symptoms are noticed. • Spray any one of the fungicides Metalaxyl + Mancozeb @500 g or Mancozeb 1000g/ha

Integrated management strategies for major pest and diseases of pearl millet

- Seed treatment with Metalaxyl @ 6g/kg of seeds + Seed treatment with Imidacloprid @ 5g/kg of seeds + Removal of downy mildew infected plants up to 45 days of sowing + Spraying of Mancozeb @ 1000g/ha + Spraying of NSKE 5% @ 50% flowering against downy mildew, rust and shoot fly.

Varietal Seed Production

Land requirement

➢ Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

➢ For certified/ quality seed production leave a distance of 200 m all around the field from the same and other varieties of cumbu.

Season

➢ October – December and June-September.

Pre-sowing seed treatment

- Soak the seeds in 2% KCl for 16h in a seed to solution ratio of 1:1 and dry back the seeds to original seed moisture content (8 – 9%) under shade. This can be adopted both for the garden and dry land ecosystem.

Fertilizer requirement

- The crop requires NPK @100 : 50 : 50 kg ha^{-1}. Apply NPK @ 50 :50:50 kg ha^{-1} as basal and 50 kg N on 30 days after sowing as top dressing.

Spacing

- 45 x 20 cm

Foliar spray

- At peak tillering stage, spray DAP @ 1 % to enhance pollen viability and enhanced seed set.

Harvesting

- Seeds attain physiological maturity 27-30 days after 50% flowering.
- Harvest the earheads when the seed attained the characteristic pale green colour, as once over harvest at 20-25 % moisture content.
- Harvest the crop as two pickings when the tiller number is more.
- Earheads from late-formed tillers (after 7 earheads from first formed tillers) should not be selected for seed purpose.

Threshing

- Thresh the earheads either manually or mechanically at moisture content of 15 - 20 %. Drying
- Dry the seed either under sun or using mechanical hot air driers to reduce the moisture content to 10%.

Seed grading

- Grade the seeds with 4/64" (1.6mm) round perforated metal sieve for varieties and 5/64" (2.0mm) round perforated metal sieve for WCC 75 / bold varieties.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} of seed. (or)
- Slurry treat the seeds with halogen mixture @ 3g kg^{-1} ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) as eco – friendly treatment.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with the seed moisture content of 10-12 %.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with the seed moisture content of 8 – 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with the seed moisture content of less than 8%.

Hybrid seed production

Land requirement

- Select fertile land with good drainage and irrigation.
- Field should not have volunteer plants. Hence, the previous crop should not be the same or different variety / hybrid of cumbu.

Isolation

- All around the field leave 200 m distance from same and other varieties/ hybrids of cumbu.

Season

- October – November and June –July.

Spacing

- 45 x 20 cm.

Planting ratio

- Sow the female and male lines in the ratio of 8: 2 to 12: 2 depending upon the hybrids.

Fertilizer requirement

- Apply NPK @120:60:60 kg ha^{-1} as basal application.

Foliar spray

- At peak tillering stage, spray 2 % DAP for enhanced seed set.

Synchronization techniques

- Stagger the sowing of male and female parents depending upon the hybrid and location.

Harvesting

- Harvest the crop when seeds of 90 % of the ear head have attained the characteristics pale green colour, as once over harvest, but 'R' lines should be harvested first and remove from the field before harvesting the (hybrid) female plants.

Other management practices

- The techniques recommended for varieties can be adopted.

RAGI (*Eleusine coracana*)
IRRIGATED

CROP IMPROVEMENT

1. SEASONS AND VARIETIES

Zone District/Season	Month	Varieties/Hybrids
I Cauvery Delta Zone		
1. Tiruchirapalli		
Marghazipattam	Dec - Jan	CO 9, CO 13, CO (Ra) 14 , TRY 1
Chithiraipattam	April - May	CO 9, CO 13, CO (Ra) 14
Adipattam	June - July	Paiyur 1, CO 13, CO (Ra) 14, Paiyur 2
Puratasipattam	Sept. – Oct.	Paiyur 1, CO 13, CO (Ra) 14
II. North Eastern Zone		
a. Kanchipuram/Tiruvallur / Vellore/Tiruvannamalai / Cuddalore/ Villupuram		
Marghazipattam	Dec - Jan	CO 9, CO 13, CO (Ra) 14 , TRY 1
Chithiraipattam	April - May	CO 9, CO 13, CO (Ra) 14
Adipattam	June - July	Paiyur 1, CO 13, CO (Ra) 14, Paiyur 2
Puratasipattam	Sept. – Oct.	Paiyur 1, CO 13, CO (Ra) 14
III. Western zone		
a. Coimbatore/ Tirupur / Erode / Karur/Perambalur / Trichy		
Marghazipattam	Dec - Jan	CO 9, CO 13, CO (Ra) 14 , TRY 1
Chithiraipattam	April - May	CO 9, CO 13, CO (Ra) 14
Adipattam	June - July	Paiyur 1, CO 13, CO (Ra) 14, Paiyur 2
Puratasipattam	Sept. – Oct.	Paiyur 1, CO 13, CO (Ra) 14
IV. North Western Zone		
a. Salem/Namakkal / Dharmapuri / Krishnagiri		
Marghazipattam	Dec - Jan	CO 9, CO 13, CO (Ra) 14 , TRY 1
Chithiraipattam	April - May	CO 9, CO 13, CO (Ra) 14
Adipattam	June - July	Paiyur 1, CO 13, CO (Ra) 14, Paiyur 2
Puratasipattam	Sept. – Oct.	Paiyur 1, CO 13, CO (Ra) 14
V. Southern zone		
a. Madurai / Dindigul / Theni /Pudukottai / Ramanathapuram/ Virudhunagar/ Sivaganga / Tirunelveli / Thoothukudi		
Marghazipattam	Dec - Jan	CO 9, CO 13, CO (Ra) 14 , TRY 1
Chithiraipattam	April - May	CO 9, CO 13, CO (Ra) 14
Adipattam	June - July	Paiyur 1, CO 13, CO (Ra) 14, Paiyur 2
Puratasipattam	Sept. – Oct.	Paiyur 1, CO 13, CO (Ra) 14

II. PARTICULARS OF RAGI STRAINS

PARTICULARS	CO 9	CO 13	CO (Ra) 14
Parentage	EX 4336 x PLR 1	CO 7 X TAH 107	Malawi 1305 x CO 13
Duration (days)	100-105	95 - 100	105-110
Season			
Rainfed/ Irrigated	Both	Both	Both
Grain yield kg/ha Irrigated	4500	3600	2892
Rainfed	3100	2300	2794

Straw yield kg/ha Irrigated	8000	10000	8113
Rainfed	6500	7500	8503
Stem	Erect	Erect	Erect
Height (cm)	75-80	85 - 90	115-120
Tillers	5-8	3 - 5	8-9
Days to 50% flowering	65-70	55 - 60	72
Ear size and shape	incurved fingers	Open	top curved
Fingers	8-9	10 –17	9-12
Ear length (cm)	8	8-10	10-12
Grain colour	White	Light Brown	Brown
1000 grain wt (g)	2.7	1.7	3.1

PARTICULARS	Paiyur 1	TRY 1	Paiyur 2
Parentage	Pureline selection from PR 722	Selection from HR 374	VL 145 x Selection 10
Duration (days)	115-120	102	115
Season			
Rainfed / Irrigated	Rainfed	Kharif irrigated Sodic/ saline soils	Rainfed
Grain yield kg/ha Irrigated	..	4011	--
Rainfed	3125	..	2527
Straw yield kg/ha Irrigated	..	6800	--
Rainfed	5750	..	4200
Stem	Erect	Erect	Errect
Height (cm)	110	100	90
Tillers	1 - 3	5 - 7	3-4
Days to 50% flowering	80	78	81
Ear size and shape	Open	Incurved	Incurved
Fingers	6 - 8	5-8	7-8
Ear length (cm)	8	7.6	7.0
Grain colour	Brown	Brown	Brown
1000 grain wt (g)	2.7	2.74	2.9

CROP MANAGEMENT

I. PREPARATION OF NURSERY (IRRIGATED TRANSPLANTED CROP)

1. PREPARATION OF LAND

i. For raising seedlings to plant one ha of main field, select 12.5 cents (500 m^2) of nursery area near a water source, where water does not stagnate.

ii. Mix 37.5 kg of super phosphate with 500 kg of FYM or compost and spread the mixture evenly on the nursery area.

iii. Plough two or three times with a mould board plough or five times with a country plough.

2. FORMING RAISED BED

i. Mark units of 6 plots each of size 3 m x 1.5 m. Provide 30 cm space between plots for irrigation.

ii. Excavate the soil from the interspace and all around to a depth of 15 cm to form channels and spread the soil removed from the channels on the bed and level.

3. PRE-TREATMENT OF THE SEEDS WITH FUNGICIDES

i. Seed treatment with Azospirillum may be done @ 3 packets/ha (600 g/ha) and 3 packets (600 g/ha) of Phosphobacteria or 6 packets of Azophos (1200 g/ha).

ii. Mix the seeds in a polythene bag to ensure a uniform coating of seeds with Thiram 4 g/ kg or Captan 4 g/kg or Carbendazim 2 g/kg of seeds.

4. SOWING AND COVERING THE SEEDS

i. Make shallow rills not deeper than one cm on the beds by passing the fingers vertically over them.

ii. Broadcast 5 kg of treated hand seeds evenly on the beds.

iii. Cover the seeds by the hand lightly over the soil.

iv. Sprinkle 500 kg of powdered FYM over the beds evenly to cover the seeds which are exposed and compact the surface lightly.

NOTE: Do not sow the seeds deep as germination will be adversely affected.

5. WATER MANAGEMENT

i. Provide one inlet to each nursery unit.

ii. Allow water to enter through the inlet and cover all the channels around the beds. Allow the water in the channels to raise till the raised beds are wet and then cut off water.

iii. Adjust the frequency of irrigation according to the soil type.

No. of irrigations	RED SOILS	HEAVY SOILS
1st	Immediately after sowing	Immediately after sowing
2nd	3rd day after sowing	4th day after sowing
3rd	7th day after sowing	9th day after sowing
4th	12th day after sowing	16th day after sowing
5th	17th day after sowing	..

NOTE: 1. One irrigation is given on the 3rd day in the case of red soil to soften the hard crust formed on the soil surface and also to facilitate seedlings to emerge out.

2. Do not allow cracks to develop in the nursery bed by properly adjusting the quantity of irrigation water.

6. PULLING OUT THE SEEDLINGS FOR PLANTING

Pull out seedlings on the 17th to 20th day of sowing for planting.

II. PREPARATION OF MAIN FIELD

1. PLOUGHING THE FIELD

Plough twice with mould board plough or thrice with wooden plough till a good tilth is obtained.

2. APPLICATION OF FYM OR COMPOST

Spread 12.5 t/ha of FYM or compost or composted coir pith evenly on the unploughed field and then plough and incorporate in the soil. NOTE: Do not spread and leave the manure uncovered in the field as nutrients will be lost.

3. APPLICATION OF FERTILIZERS

In soils having high intensive cropping system viz., Ragi-Maize-Cowpea, having high soil available K (310 kg/ha) potassium need not be applied.

I If soil test recommendation is not available, adopt a blanket recommendation of 60 kg N, 30 kg PO_5 and 30 kg K_2O_5 per ha.

ii. Apply half the dose of N and full dose of N and full dose of P_2O_5 basally before planting.

Iii Broadcast the fertilizer mixture over the field before the last ploughing and incorporate into the soil by working a country plough.

Soil test crop response based integrated plant nutrition system (STCR- IPNS) recommendation may be adopted for prescribing fertilizer doses for specified yield targets. (ready reckoners are furnished)

Ragi (1)

Soil : Mixed black calcareous (Perianaickenpalayam series)

Season : Kharif

Target : 40 q ha^{-1}

FN = 4.35 T - 0.37 SN - 0.98 ON

FP_2O_5 = 1.18 T - 1.03 SP - 0.80 OP

K_2O = 2.68 T - 0.14 SK - 0.40 OK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + *Azospirillum* @2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
180	10	300	55	15*	25
200	12	340	48	15*	20
220	14	380	41	15*	15*
240	16	420	33	15*	15*
260	18	460	30*	15*	15*

*maintenance dose

Ragi (2)

Soil : Red sandy loam (Somayanur series)

Season : Kharif

Target : 40 q ha^{-1}

FN = 4.94 T - 0.55 SN

FP_2O_5 = 1.36 T - 0.96 SP

FK_2O = 4.20 T - 0.46 SK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + *Azospirillum* @2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
160	10	160	58	15*	54
180	12	180	47	15*	45
200	14	200	36	15*	36
220	16	220	30*	15*	27
240	18	240	30*	15*	18

*maintenance dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

iv. Apply 10 packets/ha (2000 g) of Azospirillum and 10 packets (2000 g/ha) of Phosphorous solubilizing bacteria or 20 packets of Azophos (4000 g/ha) after mixing with 25 kg of soil and 25 kg FYM before transplanting.

4. FORMING BEDS AND CHANNELS

i. Form beds of size 10 m^2 to 20 m^2 according to topography of the field.
ii. Provide suitable irrigation channels.

5. APPLICATION OF MICRONUTRIENT MIXTURE

i. Mix 12.5 kg of micronutrient mixture formulated by the Department of Agriculture, Tamil Nadu with enough sand to make a total quantity of 50 kg/ha.
ii. Apply the mixture evenly on the beds.
iii. Do not incorporate the mixture in the soil.

III. MANAGEMENT OF MAIN FIELD

1. TRANSPLANTING THE SEEDLINGS

i. Let water into the bed, level the bed, if it is not levelled.
ii. Plant 2 seedlings per hill.
iii. Plant the seedlings at a depth of 3 cm.
iv. Plant 18 to 20 days old seedlings.
v. Adopt a spacing of 30x10 cm for planting.
vi. Adopt 22.5 x 10 cm spacing for direct sowing.
vii. Root dipping with Azospirillum: Prepare slurry with 5 packets (1000 g/ha) of Azospirillum and 5 packets (1000g/ha) of Phosphobacteria or 10 packets of Azophos (2000 g/ha) in 40 litres of water and dip the root portion of the seedlings in the solution for 15-30 minutes and transplant.

2. WEED MANAGEMENT

i. Apply PE Oxyfluorfen @ 0.05 kg a.i/ha on 3 DAS using Backpack Knapsack/Rocker sprayer fitted with flat fan type of nozzle with 500 litre of water/ha followed by one hand weeding on 20 DAS.
ii. Apply the herbicides when there is sufficient moisture in the soil or irrigate immediately after application of herbicide.
iii. If pre-emergence herbicide is not applied, hand weed twice on 10th and 20th DAT.
iv. For rainfed direct seeded crop, apply post emergence herbicide; 2,4-DEE or 2,4-D Na salt at 0.5 kg/ha on 10 DAS depending on the moisture availability.

3. HOEING AND HAND WEEDING

i. Hoe and hand weed on the 15th day of planting in light soils and 17th day of planting in heavy soils and subsequently on 30th and 32nd days, respectively.
ii. Allow the weeds to dry for 2 or 3 days after hand weeding before giving irrigation.

NOTE: Do not adopt hoeing and hand weeding if herbicide is applied.

IV. WATER MANAGEMENT

Regulate irrigation according to the following growth phases of the crop

Stages	No. of irrigations	Crop duration		
		80 days	100 days	120 days
Vegetative phase(Nursery)		1 to 16	1 to 18	1 to 20
Vegetative phase (in main field)		1 to18	1 to 20	1 to 22
Flowering phase		19 to 40	21 to 55	23 to 69
Maturity phase		Beyond 40 days	Beyond 55 days	Beyond 69 days

Heavy soils

Establishment	1	1st day	1st day	1st day
(1-7 days)	2	5th day	5th day	5th day
Vegetative phase	1	18th day	20th day	20th day
(8-20 days)	2	31st day	33rd day	30th day
Flowering phase	1	41st day	42nd day	37thd ay
(21-55 days)	2	51st day	52nd day	44th day
	3	--	--	63rd day
Maturity phase	1	61st day	62nd day	78th day
(56-120 days)	2	--	--	93rd day
Stop irrigation thereafter				
Light soils				
Establishment	1	1st day	1st day	1st day
(1 – 7 days)	2	5th day	5th day	5th day
Vegetative phase	1	15th day	16th day	16th day
(8 - 20 days)	2	26th day	28th day	28th day
Flowering phase	1	36th day	36th day	36th day
(21 - 55 days)	2	45th day	45th day	45th day
	3	..	54th day	54th day
Maturity phase	1	58th day	69th day	78th day
(56 - 120 days)	2	70th day	85th day	93rd day
Stop irrigation thereafter				

NOTE: The irrigation schedule is given only as a general guideline. Regulate irrigation depending upon the prevailing weather conditions and receipt of rain.

V. HARVESTING

1. DECIDE WHEN TO HARVEST

i. Ragi crop does not mature uniformly and hence the harvest is to be taken up in two stages.
ii. When the earhead on the main shoot and 50% of the earheads on the crop turn brown, the crop is ready for the first harvest.

2. HARVEST OF THE CROP
First harvest

i. Cut all earheads which have turned brown.
ii. Dry, thresh and clean the grains by winnowing.

Second Harvest

i. Seven days after the first harvest, cut all the earheads including the green ones.
ii. Cure the grains to obtain maturity by heaping the harvested earheads in shade for one day without drying, so that the humidity and temperature increase and the grains get cured.
iii. Dry, thresh and clean the grains by winnowing and store the grains in gunnies.

i. Threshing

Green earheads if harvested will contaminate the seeds with immature seeds and interfere cleaning, drying and grading. Dry earheads until seed moisture content reaches 15% and separate manually by threshing with bamboo stick or machine thresher.

ii. Precleaning and drying

Threshed seeds should be precleaned before sundrying, seeds must be dried to 12% moisture content before grading.

Protection from storage pests

1. Grain purpose: Dry the seeds adequately to reduce the moisture level to 10%.

2. Seed purpose: Admix one kg of Activated kaolin or Malathion 5% D for every 100 kg of seed. Pack in gunny or polythene lined gunny bags for storage.

Special problems

i. Root Aphids: Mix Dimethoate 3 ml in one litre of water and drench the rhizosphere of the infested and surrounding plants with the insecticidal solution.

ii. Rainfed ragi: Azospirillum mixed with FYM and applied to field saves the cost of nitrogen by 50% with a comparable yield obtained with 40 kg N/ha.

iii. Management of aged seedlings of ragi under rainfed conditions: When planting **ragi** seedlings beyond 21 days, increase the number of seedlings to 3/hill and increase N level by 25% to minimise yield loss.

iv. Apply VAM culture (*Glomus fasciculatum*) at 100 g/m^2 in the nursery and also treat with Azospirillum and Phosphobacterium as seed treatment, seedling dip and field application to reduce the reniform nematode population in ragi.

RAGI : RAINFED

Rainfall

Average and well distributed rainfall of 450-500 mm is optimum for rainfed ragi

Season

Finger millet is grown in different seasons in different parts of the country. As a rainfed crop, it is normally sown in June- July in Tamil Nadu. It also grown in winter season (rabi) by planting in September – October in Tamil Nadu and as a summer irrigated crop by planting January – February.

Tillage

Fall ploughing is advantageous for moisture conservation. In the month of April or May, one deep ploughing with mould board plough followed by ploughing with wooden plough twice is necessary. Before sowing secondary tillage with cultivator and multiple tooth hoe to prepare smooth seed bed is necessary.

Seed rate and planting

A plant population of 4 – 5 lakhs per ha is optimum for getting higher yields and higher or lower population than the optimum will reduce the yield. Line sowing is ideal and seed drills giving spacing of 22.5 – 30 cm between rows should be used. Finger millet seeds are very small (400 seeds/g) and the recommended seed rate is 10 kg/ha. Therefore, even when seed drill is used thinning within the row leaving a spacing of 7.5 – 10 cm between plants, must be followed.

Sowing by seed-cum-fertilizer drill is advantageous for line sowing besides efficient utilization of applied nutrients.

Maintenance of optimum plant population is an important prerequisite for getting higher yield under rainfed conditions. Poor germination, often, is the result of inadequate moisture after sowing in low rainfall areas. Under these conditions, the adoption of a simple technique like seed hardening will not only improve germination and subsequent plant stand but also impart early seedling vigour and tolerance to drought.

The procedure of seed hardening technique is as follows.

1. Sole seeds in water for 6 hours. Use one litre water for every kg seed for soaking.
2. Drain the water and keep the seeds in wet cloth bag tightly tied for two days.
3. At this stage, the seeds will show initial signs of germination.
4. Remove seeds from the wet cloth bag and dry them in shade on a dry cloth for 2 days.
5. Use the above hardened seeds for sowing.

Manuring and fertilization

Finger millet responds well to fertilizer application especially to N and P. The recommended doses of fertilizers vary from state to state for rainfed crop. Recommended dose of 40:20:20 kg/ha N:P:K was applied. With judicious application of farmyard manure inorganic fertilizer efficiency is enhanced. Entire P_2O_5 and K_2O are to be applied at sowing, whereas nitrogen is to be applied in two or three split doses depending upon moisture availability. In areas of good rainfall and moisture availability, 50% of recommended nitrogen is to be applied at sowing and the remaining 50% in two equal splits at 25-30 and 40-45 days after sowing. In areas of uncertain rainfall, 50% at sowing and the remaining 50% around 35 days after sowing is recommended.

Bio-fertilizers

Treating seeds with *Azospirillum brasilense* (N fixing bacterium) and *Aspergillus awamori* (P solubilizing fungs) @ 25 g/kg seed is beneficial. In case seeds are to be treated with seed dressing chemicals, treat the seeds first with seed dressing chemicals and then with bio-fertilizers at the time of sowing.

Procedures for inoculating seeds with biofertilizers

1. Bio-fertilizer culture specific to the crop is to be used @ 25 g per kg of seed.
2. Sticker solution is necessary for effective seed inoculation. This can be prepared by dissolving 25 g jaggery or sugar in 250 ml water and boiling for 5 minutes. The solution thus prepared is cooled.
3. Smear the seeds well using the required quantity of sticker solution. Then add culture to the seeds and mix thoroughly so as to get a fine coating of culture on the seed.
4. The culture-coated seeds is to be dried well in shade to avoid clumping of seeds.
5. Use the inoculated seeds for sowing.

Weed control

i. In line sown crop 2-3 inter-cultivations are necessary. In assured rainfall and irrigated areas spraying 2,4-D sodium salt @ 0.75 kg.a.i./ha as post-emergent spray on 20-25 days after sowing effectively controls weeds.

ii. Apply, Isoproturon @ 0.5 a.i/ha as pre-emergence on 3 DAS is also effective in control of weeds. In broadcast crop two effective hand weedings will minimize weeds as inter cultivations is not possible.

iii. For direct sown rainfed ragi post-emergence application of 2, 4 DNA salt (or) EE formulation at 0.5 kg ha^{-1} applied on 10 days after sowing and at 0.75 kg ha^{-1} applied on 15 days after sowing will give effective weed control as well as higher grain yield.

Cropping systems

Crop rotation

Rotation with legumes like greengram / blackgram / field bean / soybean / horse gram or ground nut in southern state will minimize inorganic fertilizer application and also sustain higher yields.

Intercropping

Finger millet based inter cropping system with pigeon pea at 4:1 ratio is recommended for rainfed situation to obtain high grain yield

CROP PROTECTION

A. Pest Management

Pests	Management strategies
Aphids *Schizaphis graminum* *Rhopalosiphum maidis*	▪ Spray any one of the following insecticides mixed in 10 litres of water using a high volume sprayer if dusting is not done : Methyl demeton 25 EC 20 ml/ha Dimethoate 30 EC 20 ml/ha
Stem borer *Sesamia inferens*	▪ Spray any one of the following : Carbaryl 50 WP 1 kg/ha (500 l spray fluid/ha).
Root aphid *Tetraneura nigriabdominalis*	▪ Spray any one of the following : Carbaryl 50 WP 1 kg/ha (500 l spray fluid/ha).
Ear head bug	▪ Spray carbaryl 50 WP 1.0 kg/ha at milky stage
Earhead caterpillar	▪ Spray carbaryl 50 WP 1.0 kg/ha at milky stage

Nursery

- **Seed treatment:** Thiram 4 g or Captan 4 g or Carbendazim 2 g/kg or *Pseudomonas fluorescens* @10g/kg of seed.

Main field

Blast: *Pyricularia grisea*	• Spray any one of the fungicides Edifenphos 500 ml or Carbendazim 500 g or Iprobenphos(IBP) @ 500 ml/ha. First spray immediately after noticing the symptoms. Second and third sprays at flowering stage at 15 days interval to control neck and finger infection. • Foliar spray with Aureofungin sol 100 ppm at 50% earhead emergence followed by a second spray with Mancozeb 1000g/ha or *Pseudomonas fluorescens* @ 0.2% 10 days later
Virus diseases **Mosaic and Mottle streak**	• Rogue out the affected plants. • Spray any one of the insecticides like Monocrotophos 36 WSC 700 ml/ha or Methyl dematon 25EC 500 ml/ha on noticing symptoms and repeat twice if necessary at 20 days intervals for control of insect vectors

Varietal Seed Production

Land Requirement

➢ Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

➢ For certified/ quality seed production leave a distance of 3 m all around the field from the same and other varieties of the ragi.

Pre-sowing seed treatment

➢ Soak the seeds in 0.5% $CaCl_2$ for 6h in a seed to solution ratio of 1:1 and dry back the seeds to original seed moisture content (8 – 9%) under shade. This can be adopted both for the garden and dry land ecosystem.

➢ Slurry treat the graded seed with carbendazim @ 2 g kg^{-1} of seed.

➢ For better establishment of mine spoils, soak the seeds in 0.1 ppm brassinoloid for 6 h and coat with pink polymer @ 3g / kg + carbendazim 2 g / kg + imidachloprid 1 ml / kg + DAP 30 g / kg + micronutrient mixture 20 g / kg + Azospirillum 60 g / kg of seed.

Nursery sowing

- In raised bed, sow the seeds not deeper than 1 cm and sprinkle with 200 kg of powdered FYM. Lightly level and compact the surface of nursery.

Harvesting

- Harvest the crop in 2 harvests.
- First, harvest the earheads when the seeds of 50 % of the earheads have attained the characteristic brown colour.
- A week to ten days later, when all the remaining earhead turn brown (spikelets are non-shattering) take up the second harvest.

Threshing

- Do not harvest the green earheads as it will contaminate the seeds with immature seeds and interfere with cleaning, drying and grading.
- Dry the earheads until the seed moisture content is 15% and seeds are separated manually by threshing with pliable bamboo stick or machine thresher.
- Threshed seeds are pre-cleaned before sun drying.
- Dry the seeds to 12% moisture content before grading.

Seed grading

- Grade the seeds either with BSS 10 x 10 or BSS 12 x 12 (aperture width 2.0 mm) depending upon the variety.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} of seed.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 10-12 %.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content less than 8%.

MAIZE (*Zea mays* L.)

I. SEASON AND VARIETIES

SEASON	STRAIN
1. Adipattam (July - August)	TNAU maize hybrid Co 6, Baby corn Co(Bc) 1
2. Purattasipattam (September - October)	TNAU maize hybrid Co 6, Baby corn Co(Bc) 1
3. Thaipattam (January - February)	TNAU maize hybrid Co 6, Baby corn Co(Bc) 1

MAIZE - MORPHOLOGICAL DESCRIPTION

PARTICULARS	TNAU maize hybrid Co 6	Baby corn Co(Bc) 1
Parentage	(UMI 1200 x UMI 1230)	Composite involving UMI 836 and UMI 836-1-2
Duration (days)	110 days	55 – 65 (fresh cobs harvest)
Area of Adoption	All maize growing areas	All maize growing areas
Rainfed/Irrigated	Both	Both
Grain yield (kg/ha) Irrigated	7400	6.7 tonnes of tender cobs & 32.3 tonnes of green fodder / ha
Rainfed	5000	3 tonnes of tender cobs per ha.
Special features	High starch (76.30 %), high protein (11.25%) and high beta- carotein (0.48 mg/100g) with moderate level of fat (4.65 %) and crude fibre (1.25%). High shelling (81%) with high test weight (400 g /1000 seeds). Multiple disease resistance to Sorghum downy mildew, *Maydis* leaf blight, *Turcicum* leaf blight, Post flowering stock rot and Banded leaf and sheath blight. Moderately resistant to stem borer. Hybrid seed production is much easier since male and female parents can be sown simultaneously for flowering synchronization.	2 to 3 cobs / plant, possessing delightful sweet taste and flavour Suitable for inland and export market Green fodder has good forage value.
Stem colour	Green	Greenish pink
Leaf: Anthocyanin colouration of sheath	Present	Nil
Ear: Anthocyanin colouration of silk	Present	Present
Cob size	Big	Small
Ear: Husk coverage	Full	Full
Colour of top of Grains	Orange Yellow	Yellow
Type of kernels	Semi dent	Dent

CROP MANAGEMENT

I. IRRIGATED MAIZE

1. APPLICATION OF FYM OR COMPOST

Spread 12.5 t/ha of FYM or compost or composted coir pith evenly on the unploughed field along with 10 packets of Azospirillum (2000 g/ha) and incorporate in the soil.

2. FIELD PREPARATION

Plough the field with disc plough once followed by cultivator ploughing twice, after spreading FYM or compost till a fine tilth is obtained.

3. FORMING RIDGES AND FURROWS OR BEDS

i. Form ridges and furrows providing sufficient irrigation channels. The ridges should be 6 m long and 60 cm apart.

ii. If ridges and furrows are not made, form beds of size 10 m^2 or 20 m^2 depending on the availability of water.

iii. Use a bund former or ridge plough to economise cost of production.

4. APPLICATION OF FERTILIZERS

i. Soil test crop response based integrated plant nutrition system (STCR- IPNS) I If soil test recommendation is not available adopt a blanket recommendation of 135:62.5:50 NPK kg/ha ha for varieties and 250:75:75 kg/ha for hybrid maize.

ii. Apply quarter of the dose of N; full dose of P_2O and K_2O basally before sowing.

iii. In the case of ridge planted crop, open a furrow 6 cm deep on the side of the ridge, at two thirds the distance from the top of the ridge.

iv. Apply the fertilizer mixture along the furrows evenly and cover to a depth of 4 cm with soil.

v. If bed system of planting is followed, open furrows 6 cm deep at a distance of 60 cm apart.

vi. Place the fertilizer mixture along the furrows evenly and cover to a depth of 4 cm with soil.

Soil test crop response based integrated plant nutrition system (STCR- IPNS) recommendation may be adopted for prescribing fertilizer doses for specified yield targets. (ready reckoners are furnished)

Maize (1)

Soil : Mixed black calcareous (Perianaickenpalayam series)
Season : Kharif
Target : 50 q ha^{-1}

FN = 4.60 T - 0.55 SN
FP_2O_5 = 2.25 T – 1.80 SP
FK_2O = 5.16 T - 0.49 SK

Initial soil tests (kg ha^{-1})			**NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + *Azospirillum* @2 kg ha^{-1} + PSB @ 2 kg ha^{-1}**		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
180	10	300	79	63	71
200	12	340	68*	59	51
220	14	380	68*	56	32
240	16	420	68*	52	25*
260	18	460	68*	49	25*

*maintenance dose

Maize (2)

Soil : Mixed black calcareous (Perianaickenpalayam series)
Season : Rabi
Target : 50 q ha^{-1}

$FN = 5.29\ T - 0.38\ SN – 0.78\ ON$
$FP_2O_5 = 2.08\ T – 1.29\ SP – 0.89\ OP$
$FK_2O = 5.20\ T – 0.45\ SK – 0.78\ OK$

Initial soil tests (kg ha^{-1})			**NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + *Azospirillum* @2 kg ha^{-1} + PSB @ 2 kg ha^{-1}**		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
180	10	300	144	59	85
200	12	340	137	57	67
220	14	380	129	54	49
240	16	420	121	51	31
260	18	460	114	49	25*

*maintenance dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

vii. When Azospirillum is used as seed and soil application, apply 100 kg of N/ha (25% reduction on the total N recommended by soil test).

Defieciency symptoms

Nitrogen deficiency	:	Leaves become yellow, older leaves show drying at the tips which progress along mid veins, stalks become slender.
Phosphorus deficiency	:	Leaves are purplish green during early growth. Growth spindly, slow maturity, irregular ear formation.
Potassium deficiency	:	Leaves show yellow or yellowish green streaks, become corrugated. Tips and marginal scorch. Tips end in ears are poorly filled. Stalks have short internode. Plants become weak and may fall down.
Magnesium deficiency	:	Older leaves are the first to become chlorotic at margins and between veins. Streaked appearance of leaves. Necrotic or chlorotic spots seen in leaves.
Zinc deficiency	:	Older leaves have yellow streaks or chlorotic striping between veins. In several cases, unfolding of young leaves, which may be white or yellow.
Iron deficiency	:	Interveinal chlorosis. The entire crop may exhibit bleached appearance.

5. APPLICATION OF MICRONUTRIENT

i. 12.5 kg of micronutrient mixture formulated by the Department of Agriculture, Tamil Nadu, mixed with sand to make a total quantity of 50 kg/ha is to be applied.

Ii Apply TNAU MN mixture @ 30 kg /ha as Enriched FYM (Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade).

or) 5 kg Zn + 40 kg S + 1.5 kg B in deficient soils
zinc sulphate @ 37.5 kg/ha is recommended for hybrid maize in Zn deficient soils

iii. Apply the mixture over the furrows and two thirds in the top of ridges, if ridge planting is followed.

iv. If bed system of sowing is followed, apply the micronutrient mixture over the furrows.

v. Do not incorporate the micronutrient mixture in the soil.

6. SEED RATE

Select good quality seeds and adopt the seed rate of 20 kg/ha for CO 1 and TNAU Maize Hybrid CO 6 and 25 kg /ha for COBC 1.

7. SPACING

Adopt a spacing of 25 cm between plants in the rows which are 60 cm apart.

Population : For varieties and hybrids 6 – 7 plants / sq. m. and
For baby corn, 8 – 9 plants / sq. m.

8. SEED TREATMENT

Step 1: Use pelleted seeds with insecticides (treat one kg of seeds with Chlorpyriphos 20EC or Monocrotophos 36 WSC or Phosalone 35 EC @ 4 ml + 0.5 gram gum in 20 ml of water) for the control of stem borer or seed treatment with imidacloprid 70 WS 10 g/kg of seeds.

Step 2: Seed treatment with Metalaxyl or Thiram @ 2 g/kg of seed for the control of downy mildew and crazy top

Step 3: Seeds treated with fungicides may be treated with three packets (600 g/ha) of Azospirillum before sowing.

9. SOWING

i. Dibble the seeds at a depth of 4 cm along the furrow in which fertilizers are placed and cover with soil.
ii. Put one seed per hole if the germination is assured otherwise put two seeds per hole

10. WEED MANAGEMENT

i. Apply Atrazine @ 0.25 kg/ha as pre-emergence on 3-5 DAS using Backpack/ Knapsack/ Rocker sprayer fitted with a flat fan nozzle using 500 litres of water/ha followed by one hand weeding on 30-35 DAS. (or)
ii. Apply Atrazine @ 0.25 kg/ha as pre-emergence on 3-5 DAS followed by 2,4-D @ 1 kg/ha on 20-25 DAS, using Backpack/Knapsack/Rocker sprayer fitted with a flat fan nozzle using 500 litres of water/ha.
iii. In line sown crop, apply PE Atrazine @ 0.25 kg/ha on 3-5 DAS followed by Twin Wheel hoe weeder weeding on 30-35 DAS.
iv. Apply herbicide when there is sufficient moisture in the soil.
v. Do not disturb the soil after herbicide application.
vi. If pulse crop is to be raised as intercrop, do not use Atrazine. Spray Pendimethalin @0.75 kg/ha as pre emergence on 3-5 DAS.

11. THINNING AND GAP FILLING

i. If two seeds were sown, leave only one healthy and vigorous seedling per hole and remove the other on the 12-15 days after sowing.
ii. Where seedlings have not germinated, dibble presoaked seeds at the rate of 2 seeds per hole and immediately irrigate.

12. HOEING, HAND-WEEDING AND EARTHING UP

i. Hoe and hand-weed on the 30th day of sowing.
ii. Earth up and form new ridges so that the plants come directly on the top of the ridges. This will provide additional anchorage to the plants.

13. TOP DRESSING WITH N

i. Place half of the dose of N on the 25th day of sowing along the furrows evenly and cover it with soil.
ii. Place the remaining quarter of N on the 45th day of sowing

14. WATER MANAGEMENT

Maize crop is sensitive to both moisture stress and excessive moisture, hence regulate irrigation according to the requirement. Ensure optimum moisture availability during the most critical phase (45 to 65 days after sowing); otherwise yield will be reduced by a considerable extent.

Regulate irrigation according to the following growth phase of the crop.

Germination & establishment phase	1 to 14 days
Vegetative phase	15 to 39 days
Flowering phase	40 to 65 days
Maturity phase	66 to 95 days

Heavy soils		
Stage	**No. of irrigation**	**Days after sowing**
Germination & establishment	3	After sowing, Life irrigation -4^{th},12^{th} day
Vegetative	2	25^{th}, 36^{th} day
Flowering(Irrigate copiously)	2	48^{th}, 60^{th} day
Maturity phase (Control irrigation)	2	72^{nd}, 85^{th} day
Light soils		
Germination & establishment	3	After sowing, Life irrigation -4^{th} ,12^{th}day
Vegetative Phase	3	22^{nd} ,32^{nd} & 40^{th} day
Flowering phase (Irrigate copiously)	3	50^{th} ,60^{th} & 72^{nd} day
Maturity phase (Controlled irrigation)	2	85^{th} , 95^{th} day

DRIP IRRIGATION TO MAIZE

Irrigation once in 2 days
Irrigation based on climatological approach
Irrigation volume:
= Pe x Kp x Kc x A x Wp – Re

Pe – Pan evaporation rate (mm/day)
Kp – Pan co-efficient (0.75 to 0.80)
Kc – Crop co-efficient (0.4 – Vegetative stage; 0.75 – Flowering stage; 1.05 – Grain formation stage)
A – Area (75 x 30 cm)
Wp – Wetted percentage (80% for maize)
Re – Effective rainfall (mm)

Irrigation duration
= Water requirement per plant once in 2 days

No. of dripper / plant x Discharge rate (lph)

DRIP FERTIGATION TECHNOLOGY

- Method of planting : paired row planting
  (60/90 × 30 cm)
- Fertilizer dose = 150:75:75 kg NPK per ha
- Drip fertigation with Water soluble fertilizer (WSF)
  - N Polyfeed 19-19-19
  - P MAP 12-61-00
  - K KNO_3 13-00-45

Fertigation Device : Ventury assembly (3/4”) with injector pump (0.5 HP)

Fertigation schedule for Hybrid maize with Water Soluble Fertilizers at (75 % RDF)

Stage (days)	Duration (days)	Fertilizer form	Fertilizer grade			Dose/ ha/ day	Total Qty (Kg/ha)	Nutrients kg/ha		
			N	P	K			N	P	K
6 to 25	20	MAP	12	61	0	2.813	56.25	6.75	34.31	0.00
	20	Urea	46	0	0	0.938	18.75	8.63	0.00	0.00
26-60	35	PolyFeed	19	19	19	2.143	75.00	14.25	14.25	14.25
	35	Multi-K	13	0	45	1.500	52.50	6.83	0.00	23.63
	35	Urea	46	0	0	2.143	75.00	34.50	0.00	0.00
61-75	15	PolyFeed	19	19	19	2.750	41.25	7.84	7.84	7.84
	15	Multi-K	13	0	45	1.600	24.00	3.12	0.00	10.80
	15	Urea	46	0	0	4.500	67.50	31.05	0.00	0.00
								112.96	56.40	56.51

Fertigation schedule for Hybrid maize with Normal Fertilizers (100% RDF)

Stage (days)	Duration (days)	Fertilizer form	Fertilizer grade			Dose/ ha/ day	Total Qty (Kg/ha)	Nutrients kg/ha		
			N	P	K			N	P	K
6 to 25	20	DAP	18	46	0	5.00	100	18.0	46.0	0.0
	20	Urea	46	0	0	2.50	50	23.0	0.0	0.0
26-60	35	DAP	18	46	0	1.86	65	11.7	29.9	0.0
	35	Urea	46	0	0	4.29	150	69.0	0.0	0.0
	35	MOP	0	0	60	2.14	75	0.0	0.0	45.0
61-75	15	Urea	46	0	0	4.13	62	28.5	0.0	0.0
	15	MOP	0	0	60	3.33	50	0.0	0.0	30.0
								150.2	75.9	75.0

15. HARVESTING

STAGE OF HARVEST

Observe the following symptoms, taking into consideration the average duration of the crop.

i. The sheath covering the cob will turn yellow and dry at maturity.
ii. The seeds become fairly hard and dry. At this stage the crop is ready for harvest.

HARVESTING THE CROP

i. Tear off the cob sheath by using the gunny needle and remove the cobs from the plant.
ii. Carry out harvest operations at a single stage for easy transportation.

THRESHING THE COBS

i. Dry the cobs under the sun till the grains are dry.
ii. Use mechanical threshers or by running the tractor over dried cobs to separate the grains from the shank.
iii. Clean the seeds by winnowing
iv. Collect and store the dry grains in gunnies.

STACKING THE STRAW FOR FEEDING CATTLE

i. Maize straw can also be used as a good cattle feed when it is green.
ii. Harvest the crop and cut the green straw into bits with a chaff cutter or chopping knife and feed the cattle.

II. RAINFED MAIZE

1. FIELD PREPARATION

Chisel the soil having hard pan formation at shallow depths with chisel plough at 0.5 m interval first in one direction and then in the direction perpendicular to the previous one once in three years. Apply 12.5 t/ha of FYM or compost or composted coir pith besides chiselling, to get an additional yield of about 30% over control.

2. APPLICATION OF FYM OR COMPOST

Spread 12.5 t/ha of FYM or compost or composted coir pith evenly on the unploughed field along with 10 packets of Azospirillum (2000 g/ha) and incorporate in the soil.

3. APPLICATION OF FERTILIZER

i. Apply NPK as per soil test recommendation as far as possible. If soil test recommendation is not available, adopt a blanket recommendation of 60 : 30 : 30 NPK kg/ha for Alfisols and 40 : 20 : 0 NPK kg/ha for Vertisols.
ii. Apply half of N and full dose of P_2O and K_2O with enriched FYM as basal along with Azospirillum (10 packets/ha).
iii. Top dress remaining half of N at tasseling.
iv. Apply TNAU MN mixture @ 7.5 kg /ha as Enriched FYM (Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade).

4. SEED RATE

Select good quality seeds. Adopt the seed rate @ 20 kg/ha for hybrids and 25 kg/ha for varieties

5. SPACING

Adopt a spacing of 45 cm between rows and 20 cm between plants in the row.
Population : 10 - 11plants/m^2

6. PRE-TREATMENT OF SEEDS WITH BIOFERTILIZER

Seeds treated with fungicides may be treated with three packets (600 g/ha) of Azospirillum

7. SOWING

Dibble or drill the seeds at a depth of 4 cm.

8. CROPPING SYSTEMS

i. Intercropping system of maize + cowpea or maize + blackgram is recommended for higher net returns in the red lateritic soils of Southern districts.
ii. For Vertisols of Southern district, maize + redgram intercropping systems is ideal.

CROP PHYSIOLOGY

Foliar spray of TNAU Maize Maxim @ 3 kg/acre in 200 litres of water at tassel initiation and at grain filling stages improves grain filling, grain yield and drought tolerance.

CROP PROTECTION

A. PEST MANAGEMENT

<table>
<tr><th>Pests</th><th>Management strategies</th></tr>
<tr><td>Shoot fly
Atherigona orientalis</td><td>• Use seeds pelleted with insecticides (see sorghum)
• Seed treatment with imidacloprid 70 WS 10 g/kg of seeds
• Plough soon after harvest, remove and destroy the stubbles.
• Set up the TNAU low cost fish meal trap 12/ha till the crop is 30 days old.
• Soil application of phorate 10%CG 10 kg/ha at the time of sowing
Apply any one of the following insecticides:
Methyl demeton 25 EC 500 ml/ha
Carbofuran 3%CG 33.3 kg/ha
Dimethoate 30%EC 1155 ml/ha
Methyl demeton 25% EC 1000 ml/ha
Phorate 10%CG 10 kg/ha</td></tr>
<tr><td>Stem borer
Chilo partellus</td><td rowspan="3">• Mix any of the following granular insecticides with sand to make up a total quantity of 50 kg and apply in the leaf whorls on the 20th day of sowing
• Phorate 10% CG10 kg/ha
• Carbaryl 4% G 20 kg/ha.
• For stem borer, release egg p[arasitoid Trichogramma chilonis @ 2,50,000 /ha coinciding egg laying period. Three releases at weekly interval are desirable. Third release is to be accompanied with larval parasitoid Cotesia flavipes @ 5000/ha
• If granular insecticides are not used, spray any one of the following :
• Carbaryl 50 WP 1 kg/ha on the 20th day of sowing (500 l of spray fluid/ha).
• Dimethoate 30% EC 660 ml/ha</td></tr>
<tr><td>Ash weevil
Myllocerus spp</td></tr>
<tr><td>Aphids
Rhopalosiphum maidis</td></tr>
<tr><td>Cob borer
Helicoverpa armigera</td><td>• Apply any one of the following insecticides at silk drying stage :
• Carbaryl 50 WP 1.0 kg/ha.
• Repeat the insecticidal application 15 days later (500 l spray fluid/ha).</td></tr>
<tr><td>Thrips</td><td>Apply any one of the following insecticides:
Carbofuran 3% CG 33.3 kg/ha</td></tr>
</table>

B. Disease Management

Seed treatment: Carbendazim @ 2 g/kg or Thiram @ 4g/kg or Metalaxyl @ 3g/kg of seed

Downy mildew or Crazy top: *Peronosclerospora sorghi*	• Use resistant TNAU maize hybrid CO-6 • Rogue out affected plants. • Spray Metalaxyl+ Mancozeb @ 1000g, Mancozeb 1000g/ha at 20 days after sowing
Turcicum leaf blight – *Exserohilum turcicum*	• Spray Mancozeb or Zineb @2-4 g/litre at 10 days interval after first appearance of the disease
Post Flowering Stalk rot - *Macrophomina phaseolina*	• Follow crop rotation • Avoid water stress at flowering time reduced disease incidence • Avoid nutrient stress. Apply potash @ 80 kg/ha in endemic areas • Soil application of *P. fluorescens* (or) *T. viride* @ 2.5 kg / ha + 50 kg of well decomposed FYM or sand at 30 days after sowing

Varietal Seed Production

Land requirement

- Land should be free from volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified quality seed production leave a distance of 200 m all around the field from the same and other varieties of maize.

Season

- November – February and June – September.

Pre-sowing seed treatment

- Soak the seeds in 2 % KH_2PO_4 in the seed to solution ratio of 1:1 for 8 h (or)
- Biopriming with *Pseudomonas fluorescens* at 80 % concentration for 12 h. (80 g of *Pseudomonas fluorescens* in powder form mixed in 100 ml of water).
- For mine spoils, soak the seeds in 2 % KH_2PO_4 for 8 h and coat with pink polymer @ 3g/kg + carbendazim @ 2 g/ kg + imidachloprid @ 1 ml / kg + DAP 30 g / kg + micro nutrient mixture @ 20 g / kg + Azospirilum @ 60 g / kg.

Spacing

- 45 x 10 cm

Fertilizer requirement

- The crop requires NPK @ 150:75:75 kg ha^{-1}. Apply NPK @ 40:75:40 kg ha^{-1} as basal, 50 kg at 20 days after sowing and 60:0:35 kg NPK at 40 days after sowing.

Foliar spray

- 0.5 % Nutrigold spray at silking and maturity stage (or)
- 2-3 % cowpea sprout extract at silking and maturity stage. (Preparation as in rice)

Preparation of pulse sprout extract

- Cowpea seeds were soaked overnight and incubated in a wet cloth for 12 h to enable sprouting. Later, 100 g of sprouts were ground in a mixer grinder by using ice cubes of 100 ml of water to prepare extracts of 100 per cent concentration. The ground material was squeezed through cloth bag to extract the sprout extract

Harvest

- Harvest the cobs as once over harvest.
- Verify true to type cobs based on kernel and shank color (cob sorting) variation.
- Remove the diseased cobs and do not select for seed purpose.

Shelling

- Shell the cobs either by beating with pliable bamboo stick or using maize sheller with required rpm at a seed moisture content of 15 – 18%.
- Improper shelling leads to pericarp injury up to 48% and will promote saprophytic fungal growth.
- Estimate mechanical / pericarp injury through 20% $FeCl_3$ test or using 0.25% Tetrazolium solution.

Size grading

- Grade the seeds using 18/64” round perforated metal sieve.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2 g kg^{-1} of seed using 5ml of water kg^{-1} of seed.

- Dry dress the seeds with halogen mixture @ 3g kg^{-1} of seed ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) for grain cum seed storage.

Storage
- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 10-12 %.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 - 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 8%.

Hybrid seed production

Land requirement
- Select fertile land with good drainage and irrigation.
- Field should not have volunteer plants. Hence, the previous crop should not be the same or different variety /hybrid of maize.

Isolation
- All around the field leave 200 m distance from same and other varieties/ hybrids of maize.

Pre-sowing seed treatment
- Coat the seed with polymer @ 6 g / kg + carbendazim @ 2g / kg + imidachloprid@ 1 ml / kg + micronutrient mixture (Agromin) @ 3 ml / kg of seed.

Spacing
- Adopt 60 x 25 cm.

Planting ratio
- Sow the female and male parent in the ratio of 6:2.

Border rows
- Sow the male parent all around the field in 4 rows for effective pollination.

Fertilizer requirement
- Apply NPK @ 150: 75: 75 kg ha^{-1} in 3 split applications of N @ 25 kg / ha an vegetative 5 % flowering and 10 days after second application + 2 split application of K @ 18.75 kg / ha at 5 % flowering and maturity stage.

Foliar spray
- At 50% flowering stage, spray 0.5% $ZnSO_4$ + 0.2% boric acid to enhance the seed setting (or)
- Spray with 0.15 % Agromin at silking and maturity stage.

Other management practices
- The techniques recommended for varieties can be adopted.
- Coat with polymer @ 3 ml / kg of seed using 5 ml of water and add Royal flow 40 sc @ 2.4 ml / kg + imidachloprid@ 6 ml / kg.

SWEET CORN

Season
- October – November

Planting method
- Ridges and furrows.

Spacing

- 60 x 20 cm.

Fertilizer

- Basal application NPK @ 120:60:45 kg/ha

Pre-storage seed treatment

- Treat the seed (dry) with fenugreek seed powder @ 2 g/ kg of seed.

SMALL MILLETS

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Crop	Districts grown
Tenai	Dharmapuri, Krishnagiri, Vellore, Tiruvannamalai, Cuddalore, Villupuram, Salem, Namakkal, Erode, Coimbatore, Tiruchirapalli, Perambalur, Karur, Madurai, Theni, Tirunelveli and Thoothukudi.
Samai	Dharmapuri, Vellore, Tiruvannamalai, Erode, Salem, Namakkal, Coimbatore, Madurai, Dindigul, Theni, Tirunelveli and Thoothukudi.
Varagu	Vellore, Thiruvannamalai, Kanchipuram, Tiruvallur, Dharmapuri, Krishnagiri, Salem, Namakkal, Cuddalore, Villupuram, Tiruchirapalli, Perambalur, Karur, Thanjavur, Tiruvarur, Nagapattinam, Madurai, Dindigul, Theni and Ramanathapuram
Panivaragu	Vellore, Tiruvannamalai, Salem, Namakkal, Dharmapuri, Krishnagiri, Madurai, Dindigul, Theni, Tirunelveli and Thoothukudi
Kudiraivali	Salem, Namakkal, Dharmapuri, Krishnagiri, Coimbatore, Tiruchirapalli, Perambalur,Karur, Pudukottai, Madurai, Dindigul, Theni, Ramanathanpuram, Tirunelveli and Thoothukudi.

Season	Variety
1. TENAI	
Rainfed	
a) June-July	CO 6, CO (Te) 7
b) September-October	CO 6, CO (Te) 7
Irrigated	
a) February-March	
b) September-October	CO 6, CO (Te) 7
2. SAMAI	
a) June-July	CO 3, CO (Samai) 4
b) July-August	Paiyur 1, Paiyur 2, CO 3, CO (Samai) 4
c) September-October	CO 3, CO (Samai) 4
3. VARAGU	
Rainfed	
a) June-July	CO 3
b) July-August	
4.PANIVARAGU	
Rainfed	
a) September-October (Madurai, Dindigul, Theni, Tirunelveli & Thoothukudi)	CO 4, K 2, CO(PV)5
Irrigated	
a) February-March	K 2 , CO 4, CO(PV) 5
5. KUDIRAIVALI	
Rainfed	
a) September-October	CO 1, CO(KV)2
Irrigated	
a) February-March	CO 1, CO(KV)2

SMALL MILLETS - MORPHOLOGICAL DESCRIPTION

TENAI

PARTICULARS	CO 6	CO (Te) 7
Parentage	Hybrid derivative of CO 5 x ISE 301	CO 5 x ISE 248
Duration (days)	85-90	80-85
Pigmentation	green	Greenish purple
Tillering ability	High	high
Panicles	Long and drooping	Long, compact
Grain Character	Bold & Yellow	yellow
Grain Yield (kg/ha) Straw	1565 3.7 t/ha	1855 5.1 t/ha
Special features	Suitable for irrigated & rainfed conditions, good grain quality, rich in protein, fat and minerals than CO 5	Non lodging High yielding

SAMAI

PARTICULARS	Paiyur 1	Paiyur 2	CO 3	CO(Samai) 4
Parentage	Pureline selection from Santhur local	Pure line selection from PM 295	Selection from germplasm bank	CO 2 x MS 1684
Duration (days)	105 -110	85	80 - 85	75-80
Pigmentation	Dark green	Green	Green	Green
Tillering ability	Moderate	Moderate	High	High
Panicles	Semi compact long	long, loose panicle	long, loose panicle	Open and Loose
Grain Character	Brown	Brown	Brown	Grayish yellow
Grain Yield (kg/ha) Rainfed	870	850	1066	1567
Special features	Long duration	Short duration, suitable for little millet – Horse gram cropping sequence	Bold grain, Non-lodging suits for early & late sowing	Short duration, suitable for the existing double cropped rainfed situation of North, North Western and Western zones of Tamil Nadu

VARAGU

PARTICULARS	CO 3
Parentage	Selection from Georgia variety
Duration (days)	120
Pigmentation	Purple stem
Tillering ability	High
Panicles	Well exposed clusters and spikelets
Grain Character	Brown & Bold with hard seed coat
Grain Yield (kg/ha) Rainfed	1500 - 1800
Special features	Tolerant to smut, short duration

PANIVARAGU

PARTICULARS	K 2	CO 4	CO(PV) 5
Parentage	Selection from PV1685	Pureline selection from Sengathur local	PV 1403 x GPUP 21
Duration (days)	75	75	70
Pigmentation	Green	Green	Green
Tillering ability	High	High	High
Panicles	Loose	Loose, densely pubescent	Compact, dense with bold grains
Grain character	Grey	Golden yellow	Golden yellow
Grain yield (kg/ha) Rainfed	3184	1500	2400
Special features	Non-lodging drought tolerant Non-shattering and responsive to fertilizers	High tillering, wider adaptability	High tillering, short duration ,fits well in the double cropped rainfed situation

KUDIRAIVALI

PARTICULARS	CO 1	CO(KV) 2
Parentage	Pure line selection from Coimbatore local	Pure line selection from EF 79
Duration (days)	75	95
Pigmentation	Green	Green
Tillering ability	High	High
Panicles	Loose	Compact, Pyrimidal
Grain Character	Yellow	Brownish grey
Grain Yield (kg/ha) Rainfed	1750	2650
Special features	No major diseases noted	Good grain quality

CROP MANAGEMENT

Package of practices for Tenai
Seeds and sowing

For line planting : 10kg/ha

For sowing : 12.5 kg/ha for use of Gorru or seed drill is recommended.

Seed treatment : Treat 1 kg of seeds with 2 g Thiram or Carbendazim.

Field preparation : Plough the field thoroughly using a small iron plough or country plough to fine tilth.

Fertilizer application : Apply basally
FYM/Compost 12.5 t/ha
Nitrogen 44 kg/ha
Phosphorus 22 kg/ha

Spacing : For line planting 22.5 cm x 10 cm (10 cm in between plants)

Weeding : First weeding on 15th DAS and the second on 40th DAS

Thinning : Before 20 DAS

Plant protection : Generally no major problem of pests and diseases

Package of practices for Samai

Seeds and sowing	:	For line planting 10 kg/ha For broad casting 12.5 kg/ha use of Gorru or seed drill is recommended.
Seed treatment	:	Treat 1 kg of seeds with 2 g Thiram or Carbendazim.
Field preparation	:	Plough the field thoroughly 2 or 3 times using a small iron plough or country plough to fine tilth.
Fertilizer application	:	Apply basally FYM/COMPOST : 12.5 t/ha Nitrogen : 44 kg/ha Phosphorus : 22 kg/ha
Spacing	:	For line planting 25 x 10 cm (10 cm in between plants)
Weeding	:	First weeding is done on the 15th DAS and the second weeding on 40th DAS
Thinning	:	Thinning is done soon after weeding or before 20 DAS
Plant Protection	:	Usually no major problem of pests and diseases

Package of practices for Varagu

Seeds and sowing	:	For line planting 10 kg/ha; For sowing 12.5 kg/ha Use of Gorru or seed drill is recommended.
Seed treatment	:	Treat 1 kg of seeds with 2 g Thiram or Carbendazim.
Field preparation	:	Plough the field thoroughly using a small iron plough or country plough to fine tilth.
Fertilizer application	:	Apply basally FYM/Compost 12.5 t/ha; Nitrogen 44 kg/ha Phosphorus 22 kg/ha
Spacing	:	For line planting 45 x 10 cm (10 cm in between plants)
Weeding	:	First weeding is done on the 15th DAS and the second weeding on 40th DAS
Thinning	:	Thinning is done soon after weeding or before 20 DAS
Plant protection	:	Generally no major problem of pests and diseases

WHEAT (*Triticum aestivum.*)

CROP IMPROVEMENT

I. SEASON AND VARIETY

Suitable districts

Plains & adjoining areas near to hills and hills in Theni, Dindigul, Karur, Coimbatore, Erode, Salem, Dharmapuri, Vellore, Thiruvannamalai and Kancheepuram Districts

Season

Ideal sowing time is 15th October to 1st week of November. Sowing must be completed within the first fortnight of November.

Variety : COW(W)1, TNAU Samba Wheat COW 2

2. Morphological Description of COW(W) 1

Particulars	COW (W) 1	COW (W) 2
Parentage	HD2646/HW2002A/CPAN3057	Mutant of NP 200
Duration (days)	85-90	110
Grain yield (Kg /ha)	2364	4040
Stem	Erect	Erect to semi erect
Height (cm)	73 – 78	75-80 cm
Tillers	5-6	10-12
Days to 50% flowering	50 days	73 days
Ear size and shape	Fusiform ears	Long & slightly tappering
Grain colour	Amber	Raddish
1000 grains weight (g)	37	41
Special features	Non lodging, non shattering; tolerance to stem and leaf rust ; suitable for chappathi and bread making.	Resistant to rust, heat tolerant

3. SEED RATE: 100 kg/ha

CROP MANAGEMENT

1. FIELD PREPARATION

Plough twice with an iron plough and two to three times with cultivator and prepare the land to a fine tilth.

2. APPLICATION OF FYM OR COMPOST

Spread 12.5 t/ha of FYM or compost on the unploughed field and incorporate in the soil.

3. SEED TREATMENT WITH FUNGICIDES

Treat the seeds with Carbendazim or Thiram at 2 g/kg of seeds 24 hours before sowing.

4. FORMING BEDS AND CHANNEL

Form beds size on 10 m^2 or 20 m^2. The irrigation channels are to be provided sufficiently.

5. APPLICATION OF FERTILIZERS

l If soil test recommendation is not available, adopt a blanket recommendation of 80:40:40 NPK kg/ha.

ii. Apply half of N and full dose of P_2O_5 and K_2O_5 basally before sowing and incorporate in the sowing line.

Soil test crop response based integrated plant nutrition system (STCR- IPNS) recommendation may be adopted for prescribing fertilizer doses for specified yield targets. (ready reckoners are furnished)

Hill Wheat

Soil : Laterite (Ooty series)
Season : Rabi
Target : 40 q ha^{-1}

FN = 7.60 T – 0.55 SN - 0.92 ON
FP_2O_5 = 3.59 T – 0.26 SP - 0.54 OP
FK_2O = 3.88 T - 0.45 SK - 0.51 OK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1}		
SN	SP(Bray)	SK	FN	FP_2O_5	FK_2O
200	100	160	139	98	53
220	150	175	128	85	46
240	200	190	117	72	39
260	250	205	106	59	32
280	300	220	95	46	26

Wheat (Plains)

Soil : Mixed black calcareous (Perianaickenpalayam series)
Season : Rabi
Target : 40 q ha^{-1}

FN = 8.83 T – 0.71 SN - 0.88 ON
FP_2O_5 = 4.52 T – 1.75 SP - 0.95 OP
FK_2O = 6.05 T - 0.20 SK - 0.83 OK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1}		
SN	SP	SK	FN	FP_2O_5	FK_2O
200	10	300	156	120*	80*
220	12	350	142	120*	80*
240	14	400	128	120*	80*
260	16	450	114	120*	80*
280	18	500	99	120*	80*

*maximum dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

6. SOWING

Draw the lines 20 cm apart and sow the seeds continuously after application of fertilizers to a depth of 5 cm. Avoid deep sowing.

7. WEED MANAGEMENT

i. Spray Isoproturon 800 g/ha as pre-emergence spray on 3 DAS followed by one hand weeding on 35th DAS.
ii. If herbicide is not applied, give two hand weedings on 20th and 35th DAS.

8. WATER MANAGEMENT

The crop requires 4 - 6 irrigations depending on the soil type and rainfall. Wheat crop requires minimum of 5 irrigations at the following critical stages.

I – Immediately after sowing
II – Crown root intiation : 15-20 DAS
III- Active tillering stage : 35-40 DAS

IV- Flowering stage : 50-55 DAS

V- Grain filling stage : 70-75 DAS

Crown root initiation and flowering are the most critical stages. Water stagnation should be avoided at the time of germination.

9. TOP DRESSING

Apply remaining half of N at crown root initiation stage (15-20 DAS).

10. HARVESTING

Harvest the crop when the grains become hard and straw becomes dry and brittle. Thresh and winnow the grains. Use mechanical threshers to reduce the cost of threshing and winnowing.

CROP PROTECTION

Seed treatment: Treat the seed with any one of the following fungicides Carbendazim @ 2 g/kg of seed, Thiram @ 2 g/kg of seed or Carboxin @ 2 g/kg of seed.

PULSES

REDGRAM (*Cajanus cajan (L.) Millsp.*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

District/season	Varieties
Vaigasi Pattam (May-June)	
Krishnagiri, Dharmapuri, Salem, Erode, Coimbatore Dindigul, Theni and Madurai	Co (Rg) 7
Adi/Avanipattam (June - August)	
Vellore, Thiruvannamalai, Salem, Namakal, Perumbalur, Ariyalur, Madurai, Dindigul, Theni, Pudukkottai and Sivagangai	Co 6
June 15th to July 15th sowing	LRG 41
July 15th to August 15th sowing	Vamban 2
Purattasipattam (September – October)	
Vellore, Tiruvannamalai, Dharmapuri, Salem, Namakkal, Erode,	Co (Rg) 7, APK 1
Coimbatore, Madurai, Dindigul, Theni Pudukkottai, Sivagangai, Perumbalur, Ariyalur,	Co (Rg) 7
Markazhipattam (Winter Irrigated)	
All districts except The Nilgiris and Kanyakumari	Co (Rg) 7, VBN(Rg) 3, APK 1
Chithiraipattam (Summer Irrigated)	
All districts except The Nilgiris and Kanyakumari	VBN (Rg) 3, APK 1 CO (Rg) 7
Wetland bunds	BSR 1 , Vamban 2, LRG 41

II DESCRIPTION OF REDGRAM VARIETIES

PARTICULARS	BSR 1	Co 6
Parentage	Pureline selection from Mayiladumparai	Mutant of SA 1 (25 Kr gamma rays)
Year of release	1986	1991
50% flowering (days)	100-110	120 - 130
Duration days)	Perennial	170 - 180
Grain Yield (kg/ha)		
Rainfed	0.75 - 1.0 kg of green pods/plant	893
Irrigated	..	..
Height (cm)	150 - 200	166
Branches	7-10	8-12
Plant spread	Semi spreading	Semi spreading
Colour of standard petal	Red at dorsal side	Yellow with light purple streaks at the base
Colour of pod	Red with diagnal constriction	Green with purple streaks
Colour of grain	Reddish brown	Reddish brown
100 seed weight (g)	12 .0	8.8
Pattern of growth	NDT	NDT

NDT: Non-Determinate **DT : Determinate**

- Since the duration of Co(Rg) 7 is 120-130 days and varieties like VBN(Rg) 3 and APK 1 are 95-105 days, they are to be sown in such a way that flowering / harvest does not coincide with heavy rains.

PARTICULARS	APK 1	VBN 2
Parentage	Pure line selection from ICPL 87101	ICPL 341 x Bhavanisagar local
Year of release	1999	1999
50% flowering (days)	70	70
Duration days)	95 – 105	172 – 180
Grain Yield (kg/ha)		
Rainfed	900	1050
Irrigated	1250	-
Height (cm)	91 – 128.2	200 - 250
Branches	4 – 5	8-12
Plant spread	Erect	Semi spreading
Colour of standard petal	Deep red in back of standard petal	Yellow with faint Red veins at the base
Colour of pod	Green with purple streaks	Green with purple streaks
Colour of grain	Reddish brown	Reddish brown
100 seed weight (g)	10.9 – 11.0	7.5 - 8-0
Pattern of growth	DT	NDT

PARTICULARS	Co (Rg) 7	VBN (Rg) 3
Parentage	Selection from PB 9825	Vamban 1 x Gulbarga
Year of release	2004	2005
50% flowering (days)	70 – 90	65 – 70
Duration days)	120 – 130	100 – 105
Season	May, 1st fortnight of September	December – January; May
Grain Yield (kg/ha)		
Rainfed	950	880
Irrigated	1168	-
Height (cm)	120 – 130	100 - 120
Branches	7 – 9	3 - 10
Plant spread	Semi spreading	Erect, Semi - determinate and open type
Colour of standard petal	Yellow with light red vein at the base	Yellow
Colour of pod	Green with purple streaks	Green with purple streaks
Colour of grain	Reddish brown	Reddish brown
100 seed weight (g)	8.5– 11.0	7.5 – 8.0
Pattern of growth	NDT	SDT

NDT: Non-Determinate **DT : Determinate** **SDT: Semi- determinate**

CROP MANAGEMENT

III. SEED RATE

Quantity of seed required kg/ha

Varieties	Co 6	Vamban 2	LRG 41	Co(Rg) 7	VBN (Rg) 3	APK 1
Sole Crop	8	8	**8**	**15**	15	**15**
Mixed Crop	3	3	**3**	**5**	5	5

[BSR 1 (Bund planting) 50 g/100 metre]

Select good seeds from pest and disease free plants.

IV. MANAGEMENT OF FIELD OPERATION

1. PREPARATION OF THE LAND

Prepare the land to fine tilth and apply 12.5 t FYM/ha or composted coir pith at the time of last ploughing and form ridges and furrows

2. SEED TREATMENT

Treat the seeds with Carbendazim or Thiram @ 2 g/kg of seed 24 hours before sowing (or) with talc formulation of *Trichoderma viride* @ 4g/kg of seed (or) *Pseudomonas fluorescens* @ 10 g/kg seed. Bio control agents are compatible with biofertilizers. First treat the seeds with biocontrol agents and then with rhizobium. Fungicides and biocontrol agents are incompatible.

3. TREATMENT OF THE SEEDS WITH BIOFERTILIZER

a) Fungicide (or) bio control agents treated seeds should be again treated with bacterial culture after 24 hours. Treat the seeds required for sowing 1 ha with Rhizobial culture CRR 6 / CPR 9, phosphobacteria (*Bacillus megaterium*) and PGPR (*Pseudomonas* sp.) developed at TNAU, with one packet each (200g). For red lateritic soil, Rhizobial culture VPR 1 is effective.

b) Using rice kanji as binder, Rhizobium should be given as seed treatment only. For PSB and PGPR, if the seed treatment is not carried out, apply 10 packets (2 kg) of Phosphobacteria (*Bacillusm megaterium*) and 10 packets (2 kg) of PGPR (*Pseudomonas sp.)* with 25 kg of FYM and 25 kg of soil before sowing.

4. APPLICATION OF FERTILIZERS

If soil test is not done, apply fertilizers basally before sowing

a) Apply fertilizers basally before sowing.
Rainfed : 12.5 kg N + 25 kg P_2O_5 + 12.5 kg K_2O +10 kg S*/ha
Irrigated : 25 kg N + 50 kg P_2O_5 + 25 kg K_2O + 20 kg S*/ha
*Note : Applied in the form of gypsum if Single Super Phospate is not applied as a source of phosphorus

Soil test crop response based integrated plant nutrition system (STCR- IPNS) recommendation may be adopted for prescribing fertilizer doses for specified yield targets. (ready reckoners are furnished)

Soil : Mixed black calcareous (Perianaickenpalayam series)
Season : Kharif
Target : 9 q ha^{-1}

FN = 10.84 T - 0.39 SN
FP_2O_5 = 7.23 T -1.00 SP
FK_2O = 5.20 T - 0.04 SK

Initial soil tests (kg ha^{-1})			**NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + PSB @ 2 kg ha^{-1}**		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**

160	10	160	13*	23	13*
180	12	180	13*	21	13*
200	14	200	13*	19	13*
220	16	220	13*	17	13*
240	18	240	13*	15	13*

*maintenance dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

b) Soil application of 25 kg $ZnSo_4$/ha under irrigated condition

c) Soil application of TNAU micronutrient mixture @ 5 kg/ha as Enriched FYM (Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade).

d) Foliar spray of 1% urea for yield improvement in black gram

For yield improvement through increasing the physiological, biochemical attributes, foliar spray of urea 1% on 30 and 45 days after sowing is recommended. For rice fallow pulses in Delta area, the present recommendation of foliar spray of 2% DAP may be continued.

e) Foliar spraying to mitigate moisture stress

Foliar spraying of 2%KCl + 100 ppm Boron during dry spell as mid season management practice in black gram during *Rabi* season is recommended to increase the yield over KCl spray alone .

Economizing the use of micronutrients through seed treatment for blackgram

Seed coating with biofertilizers and micronutrients viz., Zn, Mo & Co @ 4, 1, 0.5 g/kg of seed is recommended.

Nitrogen substitution by organic sources for pulses

50 per cent nitrogen can be substituted through organic source (850 kg of vermicompost per hectare).

Lime application is recommended for pulses with soil pH less than 6.0.

5. SOWING THE SEEDS

Dibble the seeds adopting the following spacing.

Variety	Pure crop		Mixed crop
	Low fertility	High fertility	
Co(Rg) 7	45 cm x 30 cm	60 cm x 30 cm	120 cm x 30 cm
Vamban (Rg) 3, APK 1	45 cm x 20 cm	60 cm x 20 cm	120 cm x 30 cm
Co 6, Vamban 2, LRG 41	90 cm x 30 cm	120 - 150 x 30 cm	240 cm x 30 cm
Bund Crop	60 cm for BSR 1 and 30 cm for others.		

6. Season

- Long duration varieties (Co 6, VBN 2, LRG 41) : Second fortnight of July and August months.
- Short duration varieties : January - May and September first fort night.
- Note: Sowing season should be planned in such a way that flowering and pod maturity stage does not coincide with rain.

7. WEED MANAGEMENT

i) Pre emergence application of Pendimethalin 0.75 kg/ha (2.5 litres/ha) on 3 DAS mixed with 500 litres of water using Backpack/Knapsack/Rocker sprayer using flat fan deflector type of nozzle. Then irrigate the field. Following this, one hand weeding may be given on 30-35 DAS

ii) If herbicide is not given, give two hand weedings on 20 and 35 DAS.

iii) In case of labour problem, apply Pendimethalin 0.75 kg (2.5 lit/ha) on 3 DAS followed by early post emergence application of Imazethapyr @ 60 g ai/ha on 15 DAE of weeds (2 - 3 leaves stage of weeds) and quizalofop ethyl @ 50 g ai/ha on 20 DAE of weeds (2 - 3 leaves of weeds) are recommended for controlling broad leaved and grassy weeds, respectively. If both the weeds are present, tank mix application of Imazethapyr @ 60 g ai/ha and quizalofop ethyl @ 50 g ai/ha at 15 - 20 days after emergence of weeds (2 - 3 leaves stage of weeds) is recommended.

iv) Apply PE metalachlor 1.0 kg ha^{-1} on 3 DAS followed by one hand weeding on 40 DAS.

Note: At the time of herbicide application, there should be sufficient soil moisture

8. WATER MANAGEMENT

Irrigate immediately after sowing, 3rd day after sowing, bud initiation, 50 % flowering and pod development stages. Water stagnation should be avoided.

9. SPRAYING OF DIAMMONIUM PHOSPHATE OR UREA, NAA AND SALICYLIC ACID

a) Foliar spray of NAA 40 mg/l once at pre-flowering and another at 15 days thereafter

b) Foliar spray of DAP 20 g/l or urea 20 g/l once at flowering and another at 15 days there after

c) Foliar spray of salicylic and 100 mg/litre once at preflowering and another at 15 days there after

10. HARVESTING THE CROP

1) Harvest the whole plants when 80% of the pods mature.
2) Heap for 2 – 3 days
3) Dry and process.

11. INTER-CROPPING

a) Raise one row of long duration redgram varieties as inter crop for every six rows of groundnut (6:1) under rainfed situation.

b) Raise one row of short or medium duration redgram as inter crop for every four rows of groundnut (4:1) under rainfed as well as irrigated condition.

c) **Multistoreyed cropping**: For rainfed Vertisols of Virudhunagar, Tirunelveli, Thoothukudi districts recording more than 300 mm of rainfall during the crop growth period, multistoreyed cropping system Agathi + Redgram (Co 5) + Cotton (MCU 10) + Blackgram (Co 5) is highly profitable. (Agathi in I tier with 1 x 1 m spacing - Redgram in II tier with a spacing of 45 x 20 cm - Cotton in the III tier with a spacing of 45 x 15 cm - Blackgram in the IV tier with the spacing of 30 x 10 cm).

For rainfed Vertisols receiving less than 300 mm of rainfall, Agathi + Sorghum (CO 26) + Cotton (MCU 10) + Blackgram (Co 5) system is ideal. (Agathi in I tier with a spacing of 1 x 1 m - sorghum in II tier with a spacing of 45 x 15 cm - cotton in III tier with the spacing of 45 x 15 cm and Blackgram in IV tier with 30 x 10 cm). For both systems, apply 40 kg N and 20 kg P_2O_5/ha.

12. REDGRAM TRANSPLANTING

- Select only long duration redgram varieties
- Transplant within the month of August either under rainfed condition or under irrigated condition
- Select poly bag with a size of 6x4 inches and 200 micron thickness

- Fill the poly bag with native soil: Sand: FYM @1:1:1 and put 3-4 holes in the bottom to avoid water stagnation
- Soak the seeds in 0.2% Calcium chloride for one hour and dry it under shade for 7 hours to harden the seeds
- Treat the hardened seeds with *T. viride* @ 4g/kg and 100 g Rhizobium and 100 g phosphobacterium. Sow the seeds @2/poly bag at 1 cm depth
- Sow the seeds in polybags 30-45 days prior to transplanting
- Plough the field deeply to get fine tilth followed by 2-3 harrowings at 3 weeks prior to transplanting
- In medium to deep soils for raising long duration varieties, dig 15 sqcm pits at 5' X 3' for pure crops and 6' x 3' for intercropping under irrigated condition. In rainfed condition dig the pits at a spacing of 5'x3'. For short duration varieties dig 15 sq cm pits at 3' x 2' spacing.
- Under water logging condition, form furrows before digging pits
- Apply inorganic fertilizers @ 25:50:25 kg NPK /ha at 20-30 days after planting as urea, DAP and potash around the seedlings
- Apply $ZnSO_4$ @ 25 kg/ ha as basal along with FYM or sand
- Nip (removal of top 5 cm) the plants at 20 – 30 days after planting to arrest the terminal growth
- Spray planofix @ 0.5 ml/litre to control flower dropping

13. NUTRITIONAL DISORDERS

Redgram / Greengram/Blackgram/Cowpea

Zinc: Symptom appears within a month of sowing. The plants are stripped with yellow or pale green foliage. Veins and mid ribs of the leaves are green although tissue around them becomes yellow and bronzed.

Iron: Reduced concentration of Chlorophyll in leaves - pale leaf colour may be indistinguishable from deficiency of nitrogen or other elements.

CROP PHYSIOLOGY

Foliar spray of TNAU Pulse Wonder @ 2 kg/acre in 200 litres of water at flower initiation stage decreases flower shedding, increases yield and offers moisture stress tolerance

CROP PROTECTION

A. Pest management

Pests	ETL
Aphids	20/2.5 cm shoot length
Pod borers	10% of affected pods
Plume moth	5/plant
Spotted pod borer	3/plant

Pests	Management strategies
Aphids *Aphis craccivora*	▪ **Spray any one of the following :** Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha

Pod borers Blister beetle *Mylabris* spp. Spotted pod borer *Maruca vitrata*	• For pod borers, raise one row of sunflower as intercrop for every 9 rows of pigeon pea and plant maize as border crop. • Pheromone traps for *Helicoverpa armigera* 12/ha
Plume moth	

Exelastis atomosa **Grampod borer** *Helicoverpa armigera* **Pod fly** *Melanagromyza obtusa* **Pod bug** *Clavigralla gibbosa*	• Bird perches 50/ha • Mechanical collection of grown up larva and blister beetle • Ha NPV 3 x10^{12} POB/ha in 0.1% teepol • **Apply any one of the following insectcides:** Azadirachtin 0.03 % WSP 2500-5000 g/ha *Bacillus thuringiensis* serovar kurstaki (3a,3b,3c) 5%WP 1000-1250 g/ha Dimethoate 30% EC 1237 ml/ha Emamectin benzoate 5% SG 220 g/ha Indoxacarb 15.8% SC 333 ml/ha Chlorantraniliprole 18.5 SC 150ml/ha Spinosad 45%SC 125-162 ml/ha NSKE 5% twice followed by triazophos 0.05% Neem oil 2% Phosalone 0.07% (Spray fluid 625 ml/ha) (Note : Insecticide / Ha NPV spray should be made when the larvae are upto third instar)

C. Disease management

Seed treatment — Talc formulation of *Trichoderma viride* @ 4g or *P. fluorescens* @ 10 g/kg seed (or) Carbendazim 2 g/kg or Thiram @ 4 g/kg

Disease	Management methods
Wilt *Fusarium udum*	*P. fluorescens* (or) *T. viride* – 2.5 kg / ha + 50 kg of well decomposed FYM or sand at 30 days after sowing
Root rot *Rhizoctonia bataticola* *(Macrophomina phaseolina)*	Spot drenching with Carbendazim @ 1 gm/ lit
Sterility Mosaic *Pigeonpea sterility mosaic virus* *Vector : Aceria cajani*	Rogue out the infected plants in the early stages of growth. Spray Fenazaquin @ 1 ml/lit on 45 and 60 DAS as prophylactic spray

C. Nematode management

Nematode pest	Control measures
Cyst nematode- *Heterodera cajani*	Seed treatment with *Pseudomonas fluorescens* and *Trichoderma viride* (5g + 5g) and Soil application of *Pseudomonas fluorescens* or *Trichoderma viride* @ 2.5 kg/ha at the time of sowing.

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified seed production leave a distance of 100 m all around the field from the same and other varieties of redgram.

Pre-sowing seed treatment

- Soak the seeds for 3 h in 100 ppm $ZnSO_4$, (10g/100 lit of water) at 1/3 volume before sowing and quickly air dry in shade to their original moisture content.
- Slurry treat the seeds with carbendazim 75% WP @ 2 g dissolved in 5 ml of water per kg of seeds and air-dried
- Pellet the seeds with *Rhizobium* culture (50 g kg^{-1} of seed) before sowing.

Foliar application

- At the time of first appearance of flowering, spray 2% DAP and a second spray is given at 15 days after the first spray.
- At first flowering, spray NAA 40 ppm and after a fortnight the second spray is given.
- NAA can be mixed with fungicide and insecticide.

Pre-harvest sanitation spray

- Spray endosulfan 35 EC @ 0.07% or malathion 50 EC @ 0.05% before harvesting (3 - 5 days before) to minimize the carry over of bruchid infestation from field to storage.

Harvest

- The pods attained physiological maturation at 40 days after 50% flowering.
- Harvest the pods as one or two pickings for harvesting the quality seeds.

Drying

- Dry the pods immediately to about 12 to 13 per cent moisture content.
- Dry the seeds to 10 % moisture content.

Seed grading

- Size grade the seeds using wire mesh sieve BSS 5 x 5 (width of square aperture 3.35 mm) for large seeded varieties and BSS 6 x 6 (2.8 mm) for small seeded varieties.
- Do not select the discoloured and broken seeds for seed purpose.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g using 5 ml of water kg^{-1} of seed (or)
- Dress the seeds are dry with halogen mixture (Pure $CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder at (5:4:1) ratio) @ 3g/kg of seed (or)
- Treat the seeds with neem oil/ groundnut oil or leaf powder of tobacco/ notchi/ neem/ *Albizzia amara* (arappu) or fruit rind powder of *Sapindus laurifolius* (Poochi kottai) or *Acacia concinna* (Soapnut powder) @ 1:100 ratio.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8-9 %.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 8%.

Other management techniques

- As in crop management technique.

Hybrid seed production

Land requirement

- Select fertile land with good drainage and irrigation.
- Field should not have volunteer plants. Hence, the previous crop should not be the same or different variety /hybrid of redgram.

Isolation

- For foundation seed production (parental lines seed production) leave a distance of 200 m all around the field from the same and other varieties / hybrids of redgram.
- A distance of 100 m has to be left around the field for hybrid seed production from the same and other varieties / hybrids of redgram.

Planting ratio

- Sow the female and male line in the ratio of 4:2.

Border rows

- Sow the male parent all around the field in 2 rows for effective pollination.

Spacing

- 45 x 15 cm.

Fertilizer

- Apply NPK @ 25:50:25 kg ha^{-1}as basal application.

Roguing

- Pull out all fertile plants in female rows for effective hybrid seed set.

Seed Treatment

- Slurry treat the seeds with carbendazim @ 2g using 5 ml of water kg^{-1} of seed.
- Dry dress the seeds with halogen mixture (Pure $CaOCl_2$ + $CaCO_3$ + arappu (*Albizia amara*) leaf powder at mixed in 5:4:1 ratio) @ 3g/kg of seed.
- Treat the seeds with turmeric rhizome powder (or) neem leaf powder @ 1:50 powder to seed ratio against bruchid infestation as eco-friendly seed treatment.

Other management practices

- The techniques recommended for varieties can be adopted.

PERENNIAL REDGRAM

Variety	: BSR 1
Economic uses	: Tender beans are pinkish green in colour and can be cooked as curry or added to Kurma or Sabji. When the beans mature they can be used as Dhal. Recommended for growing in kitchen gardens, backyards, farm road sides, as border crop in sugarcane, banana and betelvine and as a shade crop in turmeric and as a bund crop in paddy double cropped wetlands.
Season	: June – July
Height of the plant	: 150 - 200 cm
Number of branches	: 7 - 10
Flowering	: Five months from date of sowing
Pit Size	: Small pits are dug 90 cm apart and the pits are filled with a mixture of well decomposed manure or compost and soil.
Fertilizer application	: Urea 15 g and superphosphate 30 g / pit.
Planting methods	: Two to three seeds are dibbled per pit and watered. When they grow six inches height one plant may be retained in each pit.
Irrigation	: Need based
Harvesting	: If harvested when the pods are tender the beans will be fit for making curry. Each plant will yield two to three kg of green pods at an average seed yield of 750 g to one kg per plant. After the first harvest the branches are pruned and allowed to grow further. In another 45 - 60 days the plants produce the second flush. For pure crop, about 3 kg of seeds may be required.

BLACKGRAM (*Vigna mungo L.*)

CROP IMROVEMENT

1. SEASON AND VARIETIES

District/Season	Varieties
Adipattam (June-August)	
All districts except Kanyakumari and Nilgiris	VBN (Bg) 4, VBN(Bg) 5, TNAU (Black gram) VBN 7
Puratasipattam (September-November)	
Vellore, Tiruvannamalai Dharmapuri, Salem, Namakkal, Perambalur, Erode, Coimbatore, Madurai, Dindigul, Theni, Pudukottai,, Sivagangai, Ramanathapuram, Virudhunagar, Thoothukudi and Tirunelveli.	VBN 3 (To avoid Yellow Mosaic Virus treat the seeds with Imidachlorphid @ 1 ml / kg seed) VBN(Bg) 4, VBN (Bg) 5, TNAU (Blackgram) VBN 6, TNAU (Blackgram) Co 6, APK 1
Markazhi – Thaipattam(Winter Irrigated)	
All districts except Kanyakumari and Nilgiris	VBN 3, VBN (Bg) 4, VBN (Bg) 5, TNAU (Blackgram) VBN 6, TNAU (Blackgram) Co 6, TMV 1
Rice fallows (January) Thanjavur,Tiruvarur, Nagapattinam, Cuddalore, Villupuram and Kanchipuram	ADT 3
Chithiraipattam (Summer Irrigated)	
Thanjavur, Tiruvarur, Nagapattinam, Cuddalore, Villupuram, Tiruchirappalli, Perambalur, Thiruvallur, Kancheepuram,	ADT 5

II. DESCRIPTION OF BLACKGRAM VARIETIES

Particulars	VBN 3	VBN(Bg) 4	VBN(Bg) 5	TNAU (Blackgram) VBN 6	TNAU (Blackgram) VBN 7
Parentage	LBG 402 x LBG 17	CO 4 x PTU 102	Vamban 1 x UK 17	Vamban 1 x *Vigna mungo silvestris*	Vamban 3 x *Vigno mungo silvestris*
Year of release	2000	2003	2007	2011	2012
Maturity duration (days)	65-70	75-80	65-70	65-70	65-70
Grain yield (kg/ha) Rainfed	775	780	836	850	882
Irrigated	900	900	820	890	981
Height (cm)	25-35	40-45	34	18.6	20
Hairiness of pods	Hairy	Non hairy	Hairy	Hairy	Hairy
100 grain wt (g)	4.5	4.8	4.0	3.8-4.0	3.8 – 4.0
Special features	Best suited for Puratasi and Markazhipattam in other seasons Yellow Mosaic incidence will be high	Resistant to Yellow Mosaic. Need based fertilization and irrigation has to practiced, excess fertilization and irrigation leads to leafiness	Moderately resistant to Yellow Mosaic	Resistant to Yellow Mosaic, synchronized pod maturity	Resistant to Yellow Mosaic, synchronized pod maturity

Particulars	TNAU (Blackgram) Co 6	ADT 3	ADT 5	APK 1	TMV 1
Parentage	DU 2 X VB 20	Pure line selection from Thirunelveli local	Pure line selection from Kanpur	ADT 2 x RU 1	Midiuzhundu x KM 1
Year of release	2010	1981	1988	1993	1979
Maturity duration (days)	60 - 65	70-75	65-70	65-70	60-70
Grain yield (kg/ha) Rainfed	877	720 (Rice fallow)	-	-	-
Irrigated			1323	800	1320
Height (cm)	30 -35	50	20-25	-	-
Hairiness of pods	Non Hairy	Hairy	Hairy	Hairy	Hairy
100 grain wt (g)	5.0 to 6.2	3.6	3.6	-	-
Special features	Moderately resistant to YMV disease. Field tolerance to aphids, pod borer and Synchronized maturity.	Yellow mosaic incidence will be less during Markazhi and Thai pattam	After 65 days second sett of flowering starts	Drought tolerant, suitable for inter cropping in cotton	Resistant to yellow mosaic and root rot diseases

III. SEED RATE

STRAIN	Quantity of seed required kg/ha Pure crop	Mixed crop
T 9, CO 5, TMV 1, VBN 1, VBN 2, VBN 3, VBN (Bg) 4 ADT 5, TMV 1	20	10
ADT 3 (Rice fallows)	25	..
Optimum plant population 3,25,000/ha		

CROP MANAGEMENT

IV. MANAGEMENT OF FIELD OPERATIONS

1. FIELD PREPARATION

i. Prepare the land to fine tilth and form beds and channels.

ii. Amendments for soil surface crusting: To tide over the soil surface crusting apply lime at the rate of 2t /ha along with FYM at 12.5 t/ha or composted coirpith at 12.5 t/ha to get an additional yield of about 15 - 20%.

2. SEED TREATMENT

Treat the seeds with Carbendazim or Thiram @ 2 g/kg of seed 24 hours before sowing (or) with talc formulation of *Trichoderma viride* @ 4g/kg of seed (or) *Pseudomonas fluorescens* @ 10 g/kg seed. Bio control agents are compatible with biofertilizers. First treat the seeds with Biocontrol agents and then with Rhizobium. Fungicides and biocontrol agents are incompatible.

Note: Seed treatment will protect the seedlings from seed borne pathogens, root-rot and seedlings diseases.

3. SEED TREATMENT WITH BIOFERTILIZER

Treat the seeds with one packet (200 g/ha) of Rhizobial culture BMBS 47 + one packet (200 g/ha) of PGPR and one packet (200 g/ha) of Phosphobacteria developed at TNAU using rice kanji as binder. If the seed treatment is not carried out apply 10 packets of PGPR (2 kg/ha) and 10 packets (2kg) of Phosphobacteria mixed with 25 kg of FYM and 25 kg of soil before sowing.

4. FERTILIZER APPLICATION

If soil test is not done, apply fertilizers basally before sowing

a) Apply fertilizers basally before sowing.
Rainfed : 12.5 kg N + 25 kg P_2O_5 + 12.5 kg K_2O +10 kg S*/ha
Irrigated : 25 kg N + 50 kg P_2O_5 + 25 kg K_2O + 20 kg S*/ha
*Note : Applied in the form of gypsum if Single Super Phospate is not applied as a source of phosphorus

Soil test crop response based integrated plant nutrition system (STCR- IPNS) recommendation may be adopted for prescribing fertilizer doses for specified yield targets. (ready reckoners are furnished)

Soil : Mixed black calcareous (Perianaickenpalayam series)
Season : Kharif
Target : 9 q ha^{-1}

FN = 10.84 T - 0.39 SN
FP_2O_5 = 7.23 T -1.00 SP
FK_2O = 5.20 T - 0.04 SK

Initial soil tests (kg ha^{-1})			**NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + PSB @ 2 kg ha^{-1}**		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
160	10	160	13*	23	13*
180	12	180	13*	21	13*
200	14	200	13*	19	13*
220	16	220	13*	17	13*
240	18	240	13*	15	13*

*maintenance dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

b) Soil application of 25 kg $ZnSo_4$/ha under irrigated condition

c) Soil application of TNAU micronutrient mixture @ 5 kg/ha as Enriched FYM (Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade).

d) Foliar spray of 1% urea for yield improvement in black gram

For yield improvement through increasing the physiological, biochemical attributes, foliar spray of urea 1% on 30 and 45 days after sowing is recommended. For rice fallow pulses in Delta area, the present recommendation of foliar spray of 2% DAP may be continued.

e) Foliar spraying to mitigate moisture stress

Foliar spraying of 2% KCl + 100 ppm Boron during dry spell as mid season management practice in black gram during *Rabi* season is recommended to increase the yield over KCl spray alone .

Economizing the use of micronutrients through seed treatment for blackgram

Seed coating with biofertilizers and micronutrients viz., Zn, Mo & Co @ 4, 1, 0.5 g/kg of seed is recommended.

Nitrogen substitution by organic sources for pulses

50 per cent nitrogen can be substituted through organic source (850 kg of vermicompost per hectare).

Lime application is recommended for pulses with soil pH less than 6.0.

5. SOWING OF SEEDS

a) For irrigated crop dibble the seeds adopting 30 x 10 cm cm spacing
b) For rainfed crop dibble the seeds adopting 25 cm x 10 cm spacing

6. WATER MANAGEMENT

Irrigate immediately after sowing, followed by life irrigation on the third day. Irrigate at intervals of 7to 10 days depending upon soil and climatic conditions. Flowering and pod formation stages are critical periods when irrigation is a must. Avoid water stagnation at all stages. Apply KCl at 0.5 per cent as foliar spray during vegetative stage if there is moisture stress.

7. SPRAYING OF DIAMMONIUM PHOSPHATE OR UREA, NAA AND SALICYLIC ACID

a. Foliar spray of Spray of NAA 40 mg/lt once at pre-flowering and another at 15 days thereafter
b. i) For rice fallow crops foliar spray of Pulse wonder @ 5 kg/ha once at flowering or DAP 20 g/litre once at flowering and another at 15 days thereafter
   ii) For irrigated and rainfed crops, foliar spray of Pulse wonder @ 5 kg/ha once at flowering or DAP 20 g/litre or Urea 20 g/litre once at flowering and another at 15 days thereafter.
c. Foliar spray of salicylic acid 100 mg/litre once at preflowering and another at 15 days there after.

8. WEED MANAGEMENT

i) Pre emergence application of Pendimethalin 3.3 litres/ha under irrigated condition 2.5 litres/ha under rainfed condition on 3 days after sowing using Backpack/ Knapsack/Rocker sprayer fitted with flat fan nozzle using 500 litres of water for spraying one ha followed by one hand weeding at 20 DAS (or) EPOE application of quizalofop ethyl @ 50 g ai/ha^{-1} and imazethapyr @ 50 g ai ha^{-1} on 15 – 20 DAS. If herbicides are not applied give two hand weedings on 15 and 30 days after sowing.
ii) For the irrigated blackgram PE isoprotwron @ 0.5 kg ha^{-1} followed by one hand weeding on 30 DAS.

9. Multi bloom technology

A special technology being practiced in Pattukottai block of Tanjore district for blackgram and greengram. The soil is alluvial and rich in organic matter and nutrients. The crop is sown during early summer (Jan.-Feb.) as normal crop and fertilizer is applied as per the recommendation for irrigated crop. In addition to that, top dressing of Nitrogen is done with an extra dose of 25 to 30 kg through urea. Since pulses are indeterminate growth habit and continue to produce new flashes, the top dressing will be done on 40-45 days after sowing. The crops complete its first flesh of matured pods during 60-65th day, further their second new flesh within 20-25 days. Therefore two fleshes of pods can be harvested at a time within the duration of 100 days.

CROP PROTECTION

A. Pest management

Economic threshold level for important pests

Pests	ETL
Aphids	20/2.5 cm shoot length
Pod borers	10% of affected pods
Spotted pod borer	3/plant
Stem fly	10% of affected plants
Tobacco cut worm	8 egg masses/100 m

Pest management strategies

Pests	Management strategies
Stem fly *Ophiomyia phaseoli*	Seed treatment with dimethoate 30 EC 5 ml/kg of seed Phorate 10% G 10 kg/ha
Aphids *Aphis craccivora*	**Spray any one of the following** (Spray fluid 250 l /ha) Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha
Whitefly *Bemisia tabaci*	**Spray any one of the following** (Spray fluid 250 l /ha) Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha
Mite *Tetranychus urticae*	Wettable sulphur 1.5 kg/ha
Tobacco cut worm *Spodoptera litura*	• Set up the sex pheromone traps at 12/ha to monitor the activity of the pest and to synchronise the pesticide application, if need be, at the maximum activity stage. • Growing castor along borders. • Removal and destruction of egg masses in castor and cotton crops. • Removal and destruction of early stage larvae found in clusters which can be located easily even from a distance. • Hand picking and destruction of grown up caterpillars. • **Spray any one of the following insecticides using, a high volume sprayer covering the foliage and soil surface :** Dichlorvos 76 WSC 1.0 l/ha Fenitrothion 50 EC 625 ml/ha. * Spraying NPV at 1.5 x 10^{12} POB/ha with teepol (1ml/ lit.) * Spraying of insecticide should be done either in the early morning or in the evening and virus in the evening. * Use of poison bait pellets prepared with rice bran 12.5 kg, jaggery 1.25 kg, carbaryl 50 WP 1.25 kg and water 7.5 litres. This bait can be spread in the fields in the evening hours so that the caterpillars coming out of the soil, feed and get killed.
Blue butterflies *Lampides boeticus* *Euchrysops cnejus*	**Spray any one of the following insectcides** (Spray fluid 500 l/ha) Emamectin benzoate 5%SG 220 g/ha Indoxacarb 15.8%SC 333 ml/ha
Apids *Aphis craccivora*	NSKE 5% twice followed by triazophos 0.05% Neem oil 2%

Spotted pod borer *Maruca vitrata*	Phosalone 0.07% (Spray fluid 625 ml/ha) Note : When the activity of coccinellid predator (both grubs and adults) is seen, insecticide application should be avoided.
Pod bugs	Dimethoate 30% EC 500ml/ha Methyl demeton 25%EC 500ml/ha Imidacloprid 17.8 SL 100-125 ml/ha Thiamethoxam 25% WG 100 g/ha
Storage pests Bruchid- *Callosobruchus chinensis* *C. maculatus*	• Dry the seeds adequately to reduce moisture level to 10 %. • Use pitfall traps or two in one model trap to assess the time of emergence of field carried over pulse beetle in storage and accordingly sun-dry the produce. • **Seed:** Mix any one of the following for every 100 kg : • Malathion 5 D 1 kg Pungam oil 1 lit. Pack in polythene lined gunny bags for storage

B. Disease management

Seed treatment	Talc formulation of *T. viride* @ 4g or *P. fluorescens* @ 10 g/kg seed (or) Carbendazim 2 g/kg or Thiram @ 4 g/kg

Disease	Management methods
Powdery Mildew *Erysiphe polygoni*	▪ Spray NSKE 5% or Neem oil 3% twice at 10 days interval from initial disease appearance. ▪ Spray Eucalyptus leaf extract 10% at initiation of the disease and 10 days later. ▪ Spray Carbendazim 500 g or wettable sulphur 1500g/ha or Propiconazole 500 ml/ha at initiation of the disease and 10 days later
Rust *Uromyces appendiculatus*	▪ Spray Mancozeb 1000g or wettable sulphur 1500g /ha at initiation of the disease and 10 days later.
Leaf spot *Cercospora canescens*	▪ Spray Carbendazim 500 g/ha or Mancozeb 1000g /ha at initiation of the disease and 10 days later.
Yellow mosaic (*Geminivirus*) **and** **Leaf Crinkle** Vector: *Bemisia tabaci* **Leaf Curl** (*Tospovirus*) Vector: *Frankliniella schultzii* *Thrips tabaci* *Scirtothrips dorsalis*	**Integrated Disease Management** ▪ Growing resistant varieties such as VBN 4, VBN 6 and VBN 7 ▪ Seed treatment with Dimethoate (or) Imidacloprid @ 5 ml /kg ▪ Installation of yellow sticky traps 12 nos/ha ▪ Rogue out the infected plants up to 45 days ▪ Foliar spray of notchi leaf extract 10% at 30 DAS or neem formulation 3 ml/lit ▪ Spray methyl demeton 25 EC 500 ml/ha or dimethoate 30 EC 500 ml/ha or thiamethoxam 75 WS 1g /3 lit and repeat after 15 days, if necessary.
Root rot *Rhizoctonia bataticola* *(Macrophomina phaseolina)*	▪ Seed treatment with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* 10 g/kg ▪ Basal application of zinc sulphate 25 kg/ha ▪ Basal application of neem cake @ 150 kg/ha ▪ Soil application *P. fluorescens* or *T. viride* – 2.5 kg / ha + 50 kg of well decomposed FYM or sand at 30 days after sowing. ▪ Spot drenching of Carbendazim @ 1 gm/ lit
Root rot-stem fly complex	▪ Seed treatment with *Beauveria bassiana* + *Pseudomonas fluorescens* @ 5 g each/kg of seed

C. NEMATODE MANAGEMENT

Nematode pest	Control measures
Cyst nematode, *Heterodera cajani*	Soil application of *Pseudomonas fluorescens* or *Trichoderma viride* @ 2.5 kg/ha at the time of sowing.

RICE-FALLOWS

VARIETIES AND SEED RATE

VARIETIES	Quantity of seed required kg/ha Sole crop	Mixed crop
Co 4, ADT 2, ADT 3, ADT 4, ADT 5, TMV 1 (Rice fallows)	30	..

1. TIME OF SOWING

Third week of January –Second week of February

2. SOWING OF SEEDS

a) For relay cropping broadcast the seeds in the standing crop 5 to 10 days before the harvest of the paddy crop uniformly under optimum soil moisture conditions so that the seeds should get embedded in the waxy mire.

b) For combined harvesting areas, broadcast the seeds before harvesting the paddy crop with machinerie

3. SPRAYING OF DIAMMONIUM PHOSPHATE, NAA AND SALICYLIC ACID

a. Foliar Spray of NAA 40 mg/lt once at pre-flowering and another at 15 days thereafter

b. Foliar spray of pulse wonder @ 5 kg/ha once at flowering or DAP 20 g/lt once at flowering and another at 15 days thereafter

c. Foliar spary of salicylic acid 100 mg/litre once at prefloweing in another and 15 days there after.

4. HARVESTING

i) Picking the matured pods, drying and processing

ii) Uprooting or cutting the whole plants, heaping, drying and processing

SEED PRODUCTION

Varietal Seed Production

Land Requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 5 m all around the field from the same and other varieties of the crop.

Pre-sowing seed treatment

- Remove all discoloured seeds and use only normal coloured seeds (black coloured in blackgram and olive green in greengram) for seed purpose.
- Do not select bruchid infested seeds for sowing.
- If the presence of hard seed percentage exceeds more than 10 %, scarify the seeds with commercial H_2SO_4 for 2 min.

- Both for the garden and dry land ecosystem, harden the greengram seeds in 100 ppm $MnSO_4$ for 3h in a seed to solution ratio of 1:0.3 and for blackgram seeds in 100 ppm $ZnSO_4$ for 3 h in a seed to solution ratio of 1:0.3 and dry back the seeds to original seed moisture content (8 - 9%) under shade (or)
- In blackgram, fortify the seeds with $ZnSO_4$ 0.2%, $MnSO_4$ 0.2% and Na_2MO_4 0.1% in 1/3 volume to enhance the field establishment under irrigated conditions (or)
- In both the crops as organic treatment, soak the seeds in 3 % cowpea sprout extract for 3 h in seed to solution ratio of 3:1 ratio.
- In mine spoils, soak seeds with 100 ppm $ZnSO_4$ for 3 h in seed solution ratio of 1:1 and coat with black polykote @ 3 g/ kg + carbendazim @ 2g / kg + dimethoate @ 5 ml / kg+ DAP @ 30 g kg^{-1} + micro nutrient mixture @ 20 g / kg + *Rhizobium* @ 30 g / kg suitable for mine soils.

Preparation of pulse sprout extract

- Cowpea seeds were soaked overnight and incubated in a wet cloth for 12 h to enable sprouting. Later, 100 g of sprouts were ground in a mixer grinder by using ice cubes of 100 ml of water to prepare extracts of 100 per cent concentration. The ground material was squeezed through cloth bag to extract the sprout extract

Fertilizer

- NPK @ 25 : 50 : 25 kg / ha + 5 kg / ha of TN micro nutrient mixture.

Foliar application

- Spray 2% DAP at the time of first appearance of flowers and a second spray at 15 days after first spray for enhanced seed set.
- Spray NAA 40 ppm at first flowering and a second spray after a fortnight to reduce the flower drop.NAA can be mixed with insecticides and fungicides.
- Spray 0.1 % brassinoloid on 35^{th} and 45^{th} day after sowing (or) spray with 3 % cowpea extract at 30 days after sowing (or) spray with 0.5 % Nutrigold at 30 / 40 days after sowing.

Pre-harvest sanitation spray

- Spray endosulphan 35 EC @ 0.07% or malathion 50 EC @ 0.05% three to 5 days before harvesting of seed crop minimize the bruchid infestation in storage.

Harvest

- Harvest the pods 30 days after the 50 per cent flowering for blackgram and greengram. At this stage the colour of majority of the pods (80%) will be black in blackgram and brown in greengram. The pod moisture content will be about 17 – 18%.
- Harvest the pods as pickings if the flowering period is longer.
- Dry the pods to 13 to 15 per cent moisture content.

Threshing

- Thresh the pods either with pliable bamboo stick or pulse thresher.

Drying

- Dry the seeds to 8 - 9 per cent moisture content.

Seed grading

- Grade the seeds using BSS 7 x 7 wire mesh sieve for large seeded varieties.
- Do not select the discoloured and broken seeds for seed.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} of seed along with carbaryl @ 200 mg kg^{-1} of seed (or)
- Slurry treat the seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) @ 3g kg^{-1} of seed as eco – friendly treatment. (or)
- Treat the seed with neem oil/ groundnut oil or leaf powder of tobacco/ notchi/ neem/ *Albizzia amara* (arappu) or fruit rind powder of *Sapindus laurifolius* (Poochi kottai) or *Acacia concinna* (Soapnut powder) in the ratio of 1:100. (or)

- Expose the seeds thrice with 50 % CO_2 (4 days for 50 kg container) at 8 % moisture content at 15 days interval.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 – 9%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 8%.

GREENGRAM (*Vigna radiata* L.)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

District/Season	Varieties
Adipattam (June - July)	
All districts except Kanyakumari and Nilgiris	Co 6, Co(Gg) 7, VBN 2, VBN(Gg) 3
Vellore and Thiruvannamalai	VRM(Gg) 1,
Puratasipattam (September - October)	
Kanchipuram, Tiruvallur, Dharmapuri, Vellore, Tiruvannamalai, Salem, Namakkal, Cuddalore, Villupuram, Thiruchirapalli, Perumbalur, Erode, Coimbatore, Madurai, Dindigul, Theni, Pudukottai, Pudukkottai, Sivagangi, Ramanthapuram, Virudhunagar, Thothukudi and Thirunelveli	Co 6, VBN(Gg) 2, VBN(Gg) 3
Vellore and Tiruvannamalai,	VRM(Gg) 1
Margazhi-Thai Pattam (December – January)	
All districts except Kanyakumari and Nilgiris	VBN(Gg) 2, VBN(Gg)3
Rice fallows (January - February)	
Thanjavur, Tiruvarur, Nagapattinam, Cuddalore,	ADT 3
Summer (February - March)	
Thanjavur, Tiruvarur, Nagapattinam, Cuddalore, Villupuram, Tiruchirapalli, Perambalur, Thiruvallur, Kanchipuram	Co 6, VBN(Gg) 3

II. DESCRIPTION OF GREENGRAM VARIETIES

Particulars	Co 6	Vamban (Gg) 2	VBN (Gg) 3	VRM (Gg) 2	Co (Gg) 7	ADT 3
Parentage	WGG 37 x Co 5	VGG 4 x MH 309	CO 1 x Vellore local	Pure selection from KM851	MGG336 x CoGG 902	H7016 x Rajendran G65
Year of release	2000	2001	2009	2001	2006	1988
Duration (days)	65 – 70	65-70	65-75	60-70	60 - 65	66
Plant height(cm)	35 – 55	50-60	35-55	-	30 - 45	35-45
100 grain wt (g)	3.0 – 3.5	3.6-3.9	2.8-3.5	-	3.5 – 4.0	2.3
Grain yield (kg/ha)						
Rainfed	900	750	775	1100	978	500 kg/ha (Rice fallow)
Irrigated	1050	978	878		-	-
Pod Colour at maturity	Black	Black	Brown	Black	Brown	
Special features	Suitable For all seasons	Moderately resistant to Yellow Mosaic, Synchronize pod maturity	Moderately resistant to powdery mildew and Yellow mosaic Indeterminate flowering	Moderatly resistant to yellow mosaic virus	High protein content (25.2%), High seed weight and synchronized maturity	Suitable only for Rice fallow and Margazhi pattam

CROP MANAGEMENT

III. SEED RATE

Particulars	Quantity of seed required kg/ha	
	Pure crop	Mixed crop
All varieties	20	10
Rice fallows - ADT 3	30	--

IV. MANAGEMENT OF FIELD OPERATIONS

1. FIELD PREPARATION

i. Prepare the land to get fine tilth and form beds and channels.

Ii Amendments for soil surface crusting: To tide over the soil surface crusting apply lime at the rate of 2 t/ha along with FYM at 12.5 t/ha or composted coir pith at 12.5 t/ha to get an additional yield of about 15 - 20%.

2. SEED TREATMENT

Treat the seeds with Carbendazim or Thiram @ 2 g/kg of seed 24 hours before sowing (or) with talc formulation of *Trichoderma viride* @ 4g/kg of seed (or) *Pseudomonas fluorescens* @ 10 g/kg seed. Bio control agents are compatible with biofertilizers. First treat the seeds with Biocontrol agents and then with Rhizobium. Fungicides and biocontrol agents are incompatible.

***3.* SEED TREATMENT WITH BIOFERTILIZER**

Treat the seeds with one packet (200 g/ha) of Rhizobial culture CRM 6 and one packet (200 g/ha) of Phosphobacteria one packet (200 g/ha) of PGPR developed at TNAU using rice kanji as binder. If the seed treatment is not carried out apply 10 packets (2 kg) of Phosphobacteria and 10 packets (2 kg) of PGPR with 25 kg of FYM and 25 kg of soil before sowing.

4. FERTILIZER APPLICATION

a) If soil test is not done ,

Apply fertilizers basally before sowing.

Rainfed : 12.5 kg N + 25 kg P_2O_5 + 12.5 kg K_2O +10 kg S*/ha

Irrigated : 25 kg N + 50 kg P_2O_5 + 25 kg K_2O + 20 kg S*/ha

*Note : Applied in the form of gypsum if Single Super Phospate is not applied as a source of phosphorus

Soil test crop response based integrated plant nutrition system (STCR- IPNS) recommendation may be adopted for prescribing fertilizer doses for specified yield targets. (ready reckoners are furnished)

Soil : Red Sandy loam (Irugur series) FN = 25.07 T - 0.71 SN

Season : Kharif FP_2O_5 = 15.44 T - 5.48 SP

Target : 8 q ha^{-1} FK_2O = 11.00 T - 0.19 SK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
200	10	160	47	37	18
220	12	180	33	26	14
240	14	200	19	25*	13*
260	16	220	13*	25*	13*
280	18	240	13*	25*	13*

*maintenance dose **maximum dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

c) Soil application of 25 kg $ZnSo_4$/ha under irrigated condition

d) Soil application of TNAU micronutrient mixture @ 5 kg/ha as Enriched FYM (Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade).

Multi-blooming technology for irrigated green gram in new delta region of Thanjavur

For higher yield and income, apply 25:50:25:20 kg NPKS/ha.+25 kg N/ha. in 3 equal splits on 30, 45 and 60 days after sowing + 2% DAP spray on 45 and 60 days after sowing.

e) **Foliar spray of 1% urea for yield improvement in green gram**

For yield improvement through increasing the physiological, biochemical attributes, foliar spray of urea 1% on 30 and 45 days after sowing is recommended. For rice fallow pulses in Delta area, the present recommendation of foliar spray of 2% DAP may be continued.

Economizing the use of micronutrients through seed treatment for greengram

Seed coating with biofertilizers and micronutrients viz., Zn, Mo & Co @ 4,1,0.5 g/kg of seed is recommended.

5. SOWING

Dibble the seeds adopting a spacing of 30 x 10 cm. For bund crop dibble the seeds at 30 cm spacing.

6. WATER MANAGEMENT

Irrigate immediately after sowing, followed by life irrigation on the third day. Irrigate at intervals of 7 to 10 days depending upon soil and climatic conditions. Flowering and pod formation stages are critical periods when irrigation is a must. Avoid water stagnation at all stages. Apply KCl at 2.0 per cent as foliar spray during vegetative stage if there is moisture stress.

7. SPRAYING OF DIAMMONIUM PHOSPHATE OR UREA, NAA AND SALICYLIC ACID

a. Foliar spray of NAA 40 mg/litre and Salicylic acid 100 mg/litre once at pre-flowering and another at 15 days thereafter

b. i) For rice fallow crops, foliar spray of Pulse wonder @ 5 kg/ha once at flowering or DAP 20 g/litre once at flowering and another at 15 days thereafter

ii) For irrigated and rainfed crops foliar spray of Pulse wonder @ 5 kg/ha once at flowering or DAP 20 g/litre or urea 20 g/litre once at flowering and another at 15 days thereafter.

8. WEED MANAGEMENT

i) Pre emergence application of Pendimethalin @ 3.3 litres per hectare under irrigated condition or 2.5 litres per hectare under rainfed condition on 3 days after sowing using Backpack/ Knapsack/Rocker sprayer fitted with flat fan nozzle using 500 litres of water for spraying one ha. After this, one hand weeding on 30^{th} days after sowing gives weed free environment throughout the crop period (or) EPOE application of quizalofop ethyl @ 50 g ai/ha^{-1} and imazethapyr @ 50 g ai ha^{-1} on 15 – 20 DAS.

ii) If herbicide is not applied give two hand weedings on 15 and 30 days after sowing.

9. MULTI BLOOM TECHNOLOGY

A special technology being practiced in Pattukottai block of Tanjore district for blackgram and greengram. The soil is alluvial and rich in organic matter and nutrients. The crop is sown during early summer (Jan.-Feb.) as normal crop and fertilizer is applied as per the recommendation for irrigated crop. In addition to that, top dressing of Nitrogen is done with an extra dose of 25 to 30 kg through urea. Since pulses are indeterminate in growth habit and continue to produced new flushes, the top dressing will be done on 40-45 days after sowing. The crop complete its first flushes of matured pods during 60-65th day and put further second new flush within 20-25 days. Therefore two flushes of pods can be harvested at a time within the duration of 100 days.

CROP PROTECTION

A. Pest management

Economic threshold level for important pests

Pests	ETL
Aphids	20/2.5 cm shoot length
Pod borers	10% of affected pods
Spotted pod borer	3/plant
Stem fly	10% of affected plants
Tobacco cut worm	8 egg masses/100 m

Pest management strategies

Pests	Management strategies
Stem fly *Ophiomyia phaseoli*	Seed treatment with dimethoate 30 EC 5 ml/kg of seed Phorate 10% G 10 kg/ha
Aphids *Aphis craccivora*	**Spray any one of the following** (Spray fluid 250 l /ha) Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha
Whitefly *Bemisia tabaci*	**Spray any one of the following** (Spray fluid 250 l /ha) Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha
Mite *Tetranychus urticae*	Wettable sulphur 1.5 kg/ha
Tobacco cut worm *Spodoptera litura*	• Set up the sex pheromone traps at 12/ha to monitor the activity of the pest and to synchronise the pesticide application, if need be, at the maximum activity stage. • Growing castor along borders. • Removal and destruction of egg masses in castor and cotton crops. • Removal and destruction of early stage larvae found in clusters which can be located easily even from a distance. • Hand picking and destruction of grown up caterpillars. • **Spray any one of the following insecticides using, a high volume sprayer covering the foliage and soil surface :** Dichlorvos 76 WSC 1.0 l/ha * Spraying NPV at 1.5 x 10^{12} POB/ha with teepol (1ml/ lit.) * Spraying of insecticide should be done either in the early morning or in the evening and virus in the evening. * Use of poison bait pellets prepared with rice bran 12.5 kg, jaggery 1.25 kg, carbaryl 50 WP 1.25 kg and water 7.5 litres. This bait can be spread in the fields in the evening hours so that the caterpillars coming out of the soil, feed and get killed.

Blue butterflies *Lampides boeticus* *Euchrysops cnejus*	**Spray any one of the following insectcides** (Spray fluid 500 l/ha) Emamectin benzoate 5%SG 220 g/ha Indoxacarb 15.8%SC 333 ml/ha NSKE 5% twice followed by triazophos 0.05% Neem oil 2% Phosalone 0.07% (Spray fluid 625 ml/ha) Note : When the activity of coccinellid predator (both grubs and adults) is seen, insecticide application should be avoided.
Apids *Aphis craccivora*	
Spotted pod borer *Maruca vitrata*	
Pod bugs	Dimethoate 30% EC 500 ml/ha Methyl demeton 25%EC 500 ml/ha Imidacloprid 17.8 SL 100-125 ml/ha Thiamethoxam 25% WG 100 g/ha
Storage pests Bruchid- *Callosobruchus chinensis* *C. maculatus*	• Dry the seeds adequately to reduce moisture level to 10 %. • Use pitfall traps or two in one model trap to assess the time of emergence of field carried over pulse beetle in storage and accordingly sun-dry the produce. • **Seed:** Mix any one of the following for every 100 kg : Malathion 5 D 1 kg Pungam oil 1 lit. Pack in polythene lined gunny bags for storage

B. Disease Management

Seed treatment	Talc formulation of *T. viride* @ 4g or *P. fluorescens* @ 10 g/kg (or) carbendazim 2 g/kg or Thiram @ 4 g/kg
Disease	**Management methods**
Powdery Mildew *Erysiphe polygoni*	▪ Spray NSKE 5% or Neem oil 3% twice at 10 days interval from initial disease appearance. ▪ Spray Eucalyptus leaf extract 10% at initiation of the disease and 10 days later. ▪ Spray Carbendazim 500 g or wettable sulphur 1500 g/ha
Rust *Uromyces appendiculatus*	▪ Spray Mancozeb 1000g or wettable sulphur 1500 g/ha.
Leaf spot *Cercospora canescens*	▪ Spray Carbendazim 500 g/ha or Mancozeb 1000 g/ha
Yellow mosaic (*Geminivirus*) **and** **Leaf Crinkle** Vector: *Bemisia tabaci* **Leaf Curl** (*Tospovirus*) Vector: *Frankliniella schultzii* *Thrips tabaci* *Scirtothrips dorsalis*	**Integrated Disease Management** ▪ Seed treatment with Dimethoate (or) Imidacloprid @ 5 ml /kg ▪ Growing sorghum as border crop ▪ Installation of yellow sticky traps 12 nos/ha ▪ Rogue out the infected plants up to 45 days ▪ Foliar spray of notchi leaf extract 10% at 30 DAS or neem formulation 3 ml/lit. ▪ Spray methyl demeton 25 EC 500 ml/ha or Dimethoate 30 EC 500 ml/ha or Thiamethoxam 75 WS 1g/3 lit and repeat after 15 days, if necessary.

Root rot *Rhizoctonia bataticola (Macrophomina phaseolina)*	▪ Seed treatment with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* 10 g/kg ▪ Basal application of zinc sulphate 25 kg/ha ▪ Basal application of neem cake @ 150 kg/ha ▪ Soil application *P. fluorescens* or *T. viride* – 2.5 kg / ha + 50 kg of well decomposed FYM or sand ▪ Spot drenching of Carbendazim @ 1 gm/ lit.
Root rot-stem fly complex	▪ Seed treatment with *Beauveria bassiana* + *Pseudomonas fluorescens* @ 5 g each/kg of seed

Integrated management of viral diseases of blackgram and greengram

1. Grow resistant variety like Vamban 4 black gram
2. Grow seven rows of sorghum as border crops
3. Treat the seeds with Imidacloprid 70WS@ 5ml/kg
4. Give one foliar spray of insecticide (Dimethoate @750ml/ha) on 30 days after sowing .

RICE-FALLOWS

VARIETIES AND SEED RATE

Varieties	Quantity of seed required kg/ha Sole crop	Mixed crop
ADT 3	30	-

1.TIME OF SOWING

Third week of January –Second week of February

2.SOWING OF SEEDS

a) For relay cropping broadcast the seeds in the standing crop 5 to 10 days before the harvest of the paddy crop uniformly under optimum soil moisture conditions so that the seeds should get embedded in the waxy mire.

b) For combined harvesting areas, broadcast the seeds before harvesting the paddy crop with machineries

3. SPRAYING OF DIAMMONIUM PHOSPHATE, NAA AND SALICYLIC ACID

a. Foliar spray of NAA 40 mg/litre once at pre-flowering and another at 15 days thereafter

b. Foliar spray of pulse wonder @ 5 kg/ha once at flowering or DAP 20 g/lt once at flowering and another at 15 days thereafter

c. Foliar spray of 100 mg/litre once at preflowering and anothere at 15 days there after.

4. HARVESTING

i) Picking the matured pods, drying and processing

ii) Uprooting or cutting the whole plants, heaping ,drying and processing

SEED PRODUCTION

Varietal Seed Production

Land Requirement

➢ Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

➢ For certified / quality seed production leave a distance of 5 m all around the field from the same and other varieties of the crop.

Pre-sowing seed treatment

- Remove all discoloured seeds and use only normal coloured seeds (black coloured in blackgram and olive green in greengram) for seed purpose.
- Do not select bruchid infested seeds for sowing.
- If the presence of hard seed percentage exceeds more than 10 %, scarify the seeds with commercial H_2SO_4 for 2 min.
- Both for the garden and dry land ecosystem, harden the greengram seeds in 100 ppm $MnSO_4$ for 3h in a seed to solution ratio of 1:0.3 and for blackgram seeds in 100 ppm $ZnSO_4$ for 3 h in a seed to solution ratio of 1:0.3 and dry back the seeds to original seed moisture content (8 - 9%) under shade (or)
- In blackgram, fortify the seeds with $ZnSO_4$ 0.2%, $MnSO_4$ 0.2% and Na_2MO_4 0.1% in 1/3 volume to enhance the field establishment under irrigated conditions (or)
- In both the crops as organic treatment, soak the seeds in 3 % cowpea sprout extract for 3 h in seed to solution ratio of 3:1 ratio.
- In mine spoils, soak seeds with 100 ppm $ZnSO_4$ for 3 h in seed solution ratio of 1:1 and coat with black polykote @ 3 g/ kg + carbendazim @ 2g / kg + dimethoate @ 5 ml / kg+ DAP @ 30 g kg^{-1} + micro nutrient mixture @ 20 g / kg + *Rhizobium* @ 30 g / kg suitable for mine soils.

Preparation of pulse sprout extract

- Cowpea seeds were soaked overnight and incubated in a wet cloth for 12 h to enable sprouting. Later, 100 g of sprouts were ground in a mixer grinder by using ice cubes of 100 ml of water to prepare extracts of 100 per cent concentration. The ground material was squeezed through cloth bag to extract the sprout extract

Fertilizer

- NPK @ 25 : 50 : 25 kg / ha + 5 kg / ha of TN micro nutrient mixture.

Foliar application

- Spray 2% DAP at the time of first appearance of flowers and a second spray at 15 days after first spray for enhanced seed set.
- Spray NAA 40 ppm at first flowering and a second spray after a fortnight to reduce the flower drop.NAA can be mixed with insecticides and fungicides.
- Spray 0.1 % brassinoloid on 35^{th} and 45^{th} day after sowing (or) spray with 3 % cowpea extract at 30 days after sowing (or) spray with 0.5 % Nutrigold at 30 / 40 days after sowing.

Pre-harvest sanitation spray

- Spray endosulphan 35 EC @ 0.07% or malathion 50 EC @ 0.05% three to 5 days before harvesting of seed crop minimize the bruchid infestation in storage.

Harvest

- Harvest the pods 30 days after the 50 per cent flowering for blackgram and greengram. At this stage the colour of majority of the pods (80%) will be black in blackgram and brown in greengram. The pod moisture content will be about 17 – 18%.
- Harvest the pods as pickings if the flowering period is longer.
- Dry the pods to 13 to 15 per cent moisture content.

Threshing

- Thresh the pods either with pliable bamboo stick or pulse thresher.

Drying

- Dry the seeds to 8 - 9 per cent moisture content.

Seed grading

- Grade the seeds using BSS 7 x 7 wire mesh sieve for large seeded varieties.
- Do not select the discoloured and broken seeds for seed.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} of seed along with carbaryl @ 200 mg kg^{-1} of seed (or)
- Slurry treat the seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) @ 3g kg^{-1} of seed as eco – friendly treatment. (or)
- Treat the seed with neem oil/ groundnut oil or leaf powder of tobacco/ notchi/ neem/ *Albizzia amara* (arappu) or fruit rind powder of *Sapindus laurifolius* (Poochi kottai) or *Acacia concinna* (Soapnut powder) in the ratio of 1:100. (or)
- Expose the seeds thrice with 50 % CO_2 (4 days for 50 kg container) at 8 % moisture content at 15 days interval.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 – 9%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 8%.

COWPEA (*Vigna unguiculata* (L.) Walp.aggreg.)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

DISTRICT/SEASON	VARIETIES
Adipattam (June-August)	
For all districts except Kanyakumari and Nilgiris	Co 6, Co(CP) 7, Paiyur 1, VBN 1
Purattasipattam (September - November)	
Vellore, Thiruvannamalai, Dharmapuri, Salem, Namakkal, Perembalur, Erode, Coimbatore, Madurai, Dindigul, Theni and Virudhunagar	Co 6, Co(CP) 7, Paiyur 1
Margazhi - Thaipattam (December – February)	
Kanchipuram, Thiruvallur, Vellore, Thiruvannamalai, Dharmapuri, Salem, Namakkal, Coimbatore, Erode, Madurai, Dindigul, Theni, Tiruchirappalli, Perambalur, Ariyalur, Karur, Pudukkottai, Tirunelveli and Thoothukudi	Co 2, Co 6, Co(CP) 7, VBN 2

II. PARTICULARS OF VARIETIES

Particulars	Co 2	Paiyur 1	Co 6	VBN 1	VBN 2	Co(CP) 7
Parentage	Hybrid derivative (C521 x C49)	Selection from VM 16	MS 9804 x C 152	Selection from T 85F 2020	Selection from IT 81-D-1228-10	Gamma mutant of Co 4 (20 Kr)
Year of release	1972	1985	1993	1997	1998	2002
50% flowering(days)	45	45-50	35	35 – 40	40-45	40 – 45
Duration (days)	90	90	65 – 70	55 – 65	75 - 80	70 – 75
Grain yield(kg/ha) Rainfed		900	700	950	-	1000
Irrigated	1375	-	-	-	-	1600
Vegetable (Kg/ha)	9400	-	-	-	10580	-
Plant height (cm)	30 - 40	60 - 70	34.5	25 - 30	45 - 60	40 – 55
Stem, branches	Green stem, purple wash at nodes, 3-4 branches	Erect	Green stem, purple wash at nodes, 3-4 branches	Erect green, 2 – 4 branches	Green erect, 2 – 3 branches	Green with purple ring at fruiting nodes, 5 – 8 branches

Leaves	Trifoliate, broad and long petioles	Dark green leaflets possessing triangular white spots	Trifoliate entire, green, purple spot at the abse of leaflet	Light green	Dark green trifoliate	Ovate, trifoliate, entire, green and glabrous
Colour of pods	Tender greenish white	Green	Dark green pigmented tip	Greenish white	Light green	Green
Dry	Greyish white	Brown	Brown at maturity	Cream	Cream	Light brown
Colour of grain	Reddish brown with irregular patches	Brick red	Light cream	White	Ivory white, hilum with tan ring surrounded by brown band	Brownish white and square shape
100 grain wt (g)	12.5	9.9	9.9	12 - 15	13 - 15	12 - 14

All the varieties of cowpea are suitable for intercropping with maize, redgram etc.

III. SEED RATE

Seed rate (pure crop) : 25 kg/ha

CROP MANAGEMENT

IV. MANAGEMENT OF FIELD OPERATIONS

1. FIELD PREPARATION

Prepare the land to fine tilth and form beds and channels.

2. SEED TREATMENT

Treat the seeds with Carbendazim or Thiram 2 g/kg of seed 24 hours before sowing (or) with talc formulation of *Trichoderma viride* @ 4g/kg of seed (or) *Pseudomonas fluorescens* @ 10 g/kg seed.

- Biocontrol agents are compatible with biofertilizers.
- First treat the seeds with biocontrol agents and then with Rhizobium.
- Fungicides and biocontrol agents are incompatible.

3. SEED TREATMENT WITH BIOFERTILIZER

a) Fungicide-treated seeds, should be again treated with a bacterial culture. There should be an interval of atleast 24 hours between fungicidal and biofertilizer treatments.

b) The improved rhizobial strain COC 10 is more effective in increasing the yield. Treat the seeds with one packet (200 g/ha) of Rhizobial culture (COC 10) and one packet (200 g/ha) of Phosphobacteria developed at TNAU using rice kanji as binder. If the seed treatment is not carried out apply 10 packets (2 kg/ha) of Phosphobacteria with 25 kg of FYM and 25 kg of soil before sowing. Dry the biofertilizer treated seeds in shade for 15 minutes before sowing.

4. FERTILIZER APPLICATION

a) Apply fertilizers basally before sowing.
Rainfed : 12.5 kg N + 25 kg P_2O_5 + 12.5 kg K_2O +10 kg S*/ha
Irrigated : 25 kg N + 50 kg P_2O_5 + 25 kg K_2O + 20 kg S*/ha
*Note : Applied in the form of gypsum if Single Super Phosphate is not applied as a source of phosphorus

b) Soil application of 25 kg $ZnSo_4$/ha along with 50 kg FYM or sand under irrigated condition

5. SOWING

Dibble the seeds adopting the following spacing.

Varieties	Spacing
VBN 1, Paiyur 1	30 cm X 15 cm
Co 6, Co(CP) 7, VBN 2, Co 2	45 cm x 15 cm

6. WATER MANAGEMENT

Irrigate immediately after sowing followed by life irrigation on the third day. Irrigate at intervals of 7 to 10 days depending upon soil and climatic conditions. Flowering and pod formation stages are critical periods when irrigation is a must. Avoid water stagnation at all stages. Apply KCl at 2.0 per cent as foliar spray during vegetative stage if there is moisture stress.

7. SPRAYING OF DIAMMONIUM PHOSPHATE OR UREA, NAA AND SALICYLIC ACID

a. Foliar spray of DAP 20 g/litre or urea 20 g/litre once at flowering and another at 15 days thereafter
b. Foliar spray of NAA 40 mg/litre once at flowering and another at 15 days thereafter
c. Foliar spray of salicylic acid 100 mg/litre once at flowering and another at 15 days ther after.

8. WEED MANAGEMENT

i) Pre emergence application of Pendimethalin @ 2.5 litre on 3 days after sowing using Backpack/ Knapsack/Rocker sprayer fitted with flat fan nozzle using 500 lit of water for spraying one hectare followed by one hand weeding on 30 days after sowing gives weed free environment throughout the crop period.
ii) If herbicide is not applied, give two hand weeding on 15 and 30 days after sowing.

CROP PROTECTION

A. Pest management

Economic threshold level for important pests

Pests	**ETL**
Aphids	20/2.5 cm shoot length
Spotted pod borer	3/plant
Stem fly	10% of affected plants

Pest management strategies

Pests	**Management strategies**
Stem fly *Ophiomyia phaseoli*	Seed treatment with dimethoate 30 EC 5 ml/kg of seed Phorate 10%CG 10 kg/ha
Aphids *Aphis craccivora*	**Spray any one of the following** (Spray fluid 250 l /ha) Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha
Apids *Aphis craccivora*	**Spray any one of the following insectcides** (Spray fluid 500 l/ha) Emamectin benzoate 5%SG 220 g/ha Indoxacarb 15.8%SC 333 ml/ha NSKE 5% twice followed by triazophos 0.05% Neem oil 2% Phosalone 0.07%
Spotted pod borer *Maruca vitrata*	(Spray fluid 625 ml/ha) Note : When the activity of coccinellid predator (both grubs and adults) is seen, insecticide application should be avoided.

Pod bugs	**Spray any one of the following insectcides** (Spray fluid 500 l/ha) Dimethoate 30% EC 500ml/ha Methyl demeton 25%EC 500ml/ha Imidacloprid 17.8 SL 100-125 ml/ha Thiamethoxam 25% WG 100 g/ha
Storage pests Bruchid- *Callosobruchus chinensis* *C. maculatus*	• Dry the seeds adequately to reduce moisture level to 10 %. • Use pitfall traps or two in one model trap to assess the time of emergence of field carried over pulse beetle in storage and accordingly sun-dry the produce. • **Seed:** Mix any one of the following for every 100 kg : Malathion 5 D 1 kg Pungam oil 1 lit. Pack in polythene lined gunny bags for storage

Seed treatment: Talc formulation of *T. viride* @ 4g or *P. fluorescens* @ 10 g/kg seed (or) Carbendazim @ 2 g/kg or Thiram @ 4 g/kg

Rust: *Uromyces appendiculatus*	• Two sprays of chlorothalonil 0.1% or one spray with 0.1% chlorothalonil followed by 3% Neem oil after the appearance of disease
Root rot: *Macrophomina phaseolina (Rhizoctonia bataticola)*	• Soil application *P. fluorescens* or *T. viride*– 2.5 kg / ha + 50 kg of well decomposed FYM or sand • Spot drenching with Carbendazim @ 1 gm/ litre
Aphid borne Mosaic Virus: (*Potyvirus*) Vector: *Aphis craccivora, A. fabae, A. gossypii* and *Myzus persicae*	• Roguing out of cowpea mosaic virus diseased plants in the early stage of growth up to 30 days and spraying twice at fortnightly intervals with Monocrotophos 500 ml/ ha (or) Methyldemeton 25 EC 500 ml/ha.

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 5 m all around the field from the same and other varieties of cowpea.

Season

- September - October and June - July.

Pre-sowing seed treatment

- Remove the discoloured seeds and use only the highly germinable (>75%) seeds for sowing.

Intercultural operation

- Pinch the tendrils off for promotion of flower production.
- Spray NAA 40 ppm (40 mg in 1 litre) to reduce the flower drop.
- Spray DAP 2% at flower initiation and at peak flowering stage to promote pod setting.
- Pull out and destroy the plants exhibiting severe symptoms of mosaic in the early stages of growth.

Harvesting

- Seeds attain physiological maturity 27-30 days after anthesis. At this stage the moisture content of seeds will be about 18 per cent.
- Harvest the pods as they turn light straw in colour and the seeds turn brown or mottled in colour.
- Harvest the pods as picking (4 –5 no) at 10 days interval.
- Air dry the pods for 1-2 days and then sundry until they become brittle.

Seed extraction

- Beat the pods with pliable bamboo stick or pulse thresher by adjusting the cylinder speed to avoid splitting and cracking of seeds.

Seed grading

- At 10% moisture content, grade the seeds using 12/64" (4.8 mm) round perforated sieve for cv. CO2 and with 10/64" (4.0 mm) round perforated sieve for small seeded varieties.

Drying

- The broken and immature seeds should not be selected for seed purpose.
- Dry the seeds to 8-10% moisture content.

Seed treatment

- Slurry treat with carbendazim @ 2g kg^{-1} of seed along with carbaryl @ 200 mg kg^{-1} of seed (or)
- Slurry treat seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) @ 3g kg^{-1} as eco – friendly treatment .

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 - 9%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 8%.

Other management practices

- As in crop management technique.

HORSEGRAM (*Macrotyloma uniflorum*)

I. SEASON AND VARIETIES

DISTRICT/SEASON	VARIETIES
November (Winter season) (Rainfed)	
All districts except The Nilgiris and Kanyakumari	Paiyur 1, Paiyur 2

II. DESCRIPTION OF VARIETIES

Variety	Paiyur 1	Paiyur 2
Parentage	PurelineSelection from Mettur local	Gamma irradiation of Co 1
Year of release	1988	1998
50% flowering (days)	45 - 50	45 - 50
Maturity duration(days)	110	100 - 105
Grain yield (Kg/ha)		
Rainfed	650	870
Height (cm)	35 - 40	40 - 45
Branches	2-3	4 - 5
Colour of grain	Light brown	Pale brown
100 grain weight (g)	3.4	3.5

III. SEED RATE

For a pure crop 20 kg/ha is needed.

CROP MANAGEMENT

IV. MANAGEMENT OF FIELD OPERATIONS

1. FIELD PREPARATION

Prepare the land to fine tilth.

2. SEED TREATMENT WITH FUNGICIDES

Treat the seeds with any one of the following fungicides. Carbendazim or Thiram at 2 g/kg seed.

3. FERTILIZER RECOMMENDATION

Apply basally 12.5 t/ha FYM/Compost, 12.5 kg/ha nitrogen, 25 kg/ha phosphorus , 12.5 kg/ha potassium if soil is deficient in NPK status.

4. SEED TREATMENT WITH BIOFERTILIZER

Treat the seeds with one packet (200 g/ha) of Rhizobial culture and one packet (200 g/ha) of Phosphobacteria developed at TNAU using rice kanji as binder. If the seed treatment is not carried out apply 10 packets of Phosphobacteria with 25 kg of FYM and 25 kg of soil before sowing. Dry the biofertilizer treated seeds in shade for 15 minutes before sowing.

5. SOWING

Dibble the seeds with a spacing of 30 x 10 cm.

6. WEED MANAGEMENT

Give one weeding and hoeing on 25-30 days after sowing

7. HARVESTING

Harvest the matured whole plant, thresh and extract seeds

CROP PROTECTION

Seed treatment: Treat the seeds with Carbendazim@ 2 g/kg or Thiram at 4 g/kg seed.

SEED PRODUCTION

Varietal Seed Production

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 10 m all around the field from the same and other varieties of horsegram.

Season

- October - November

Pre sowing seed treatment

- Slurry treat the seeds with carbendazim @ 2 g kg^{-1} of seed.

Crop management

- Spray magnesium chloride against any chlorotic symptom @ 6 g $litre^{-1}$ with a power sprayer for 2 - 3 times at 5 days interval.

Harvesting

- Seeds attain physiological maturity when the pods turn yellowish brown in colour.
- Harvest the pods as once over harvest when 75 - 80% of the pods have matured.
- Timely harvest is essential, taking care not to expose the pods to rain or very moist weather which may change the seed coat colour from light brown to dark brown or light black.

Seed grading

- Grade the seeds with round perforated metal sieves having 8/64" diameter (3.2 mm).
- Remove the discoloured seeds from the lot as they will loose viability much faster than the normal seeds in storage.

Storage

- The hard seededness upto 50 - 55% noticed (Immediately after harvest) and it will declined to 4 to 6% over a period of 2 months.
- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8- 9.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 7– 8%.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 7%.

Other management practices

- As in crop management technique.

BENGALGRAM (*Cicer arietinum L.*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

DISTRICT/SEASON	VARIETIES
November (Winter season) Rainfed Vellore, Tiruvannamalai, Salem, Namakkal, Tiruchirapalli, Perambalur, Karur, Dharmapuri, Pudukottai, Erode, Coimbatore, Madurai, Dindigul, Theni, Virudhunagar, Ramanathapuram, Sivagangai, Tirunelveli, Thoothukudi.	Co 3, Co 4

II. DESCRIPTION OF VARIETIES

Variety	Co 3	Co 4
Parentage	Pureline selection from Maharashtra collection	Cross derivative of ICC 42 x ICC 12237
Year of release	1986	1998
50% flowering (days)	35 – 40	40
Duration (days)	85	85
Grain yield (Kg/ha)		
Rainfed	1000	1150
Height (cm)	25 - 30	35 - 40
Branches	3 - 5	3 - 5
Flower colour	Light pink & veined	Light pink & veined
Colour of grain	Light brown	Brown
100 seed weight (g)	30-32	30 - 32

III. SEED RATE

- CO 3 - 90 kg/ha.
- CO 4 - 75 kg/ha.

CROP MANAGEMENT

IV. MANAGEMENT OF FIELD OPERATIONS

1. FIELD PREPARATION

Prepare the land to fine tilth and apply 12.5 t FYM/ha

2. SEED TREATMENT

Treat the seeds with Carbendezim (or) Thiram @ 2g/kg of seed 24hrs before sowing (or) with talc formulation of *Trichoderma viride* @ 4 g/kg seed (or) *Pseudomonas fluorescens* @ 10 g/kg seed. Biocontrol agents are compatible with biofertilizers. First treat the seeds with biocontrol agents and then with Rhizobium. Fungicides and biocontrol agents are incompatible. The above seed treatment will protect the seedlings from seed borne pathogens in the early stages.

3. SEED TREATMENT WITH BIOFERTILIZER

Treat the seeds with one packet (200 g/ha) of Rhizobial culture and one packet (200 g/ha) of Phosphobacteria developed at TNAU using rice kanji as binder. If the seed treatment is not carried out apply 10packets of Rhizobium (2 kg/ha) and 10 packets(2 kg) of Phosphobacteria with 25 kg of FYM and 25 kg of soil before sowing. Dry the biofertilizer treated seeds in shade for 15 minutes before sowing.

4. FERTILIZER APPLICATION

a) Apply fertilizers basally before sowing.

Rainfed : 12.5 kg N + 25 kg P_2O_5 + 12.5 kg K_2O +10 kg S*/ha

Irrigated : 25 kg N + 50 kg P_2O_5 + 25 kg K_2O + 20 kg S*/ha

*Note : Applied in the form of gypsum, if Single Super Phospate is not applied as a source of phosphorus

5. SOWING

Dibble the seeds by adopting a spacing of 30 cm x 10 cm.

6. WEED MANAGEMENT

i) Pre emergence application of Pendimethalin @ 2.5 litres on 3rd day after sowing using Backpack/ Knapsack/Rocker sprayer fitted with flat fan nozzle using 500 litres of water for spraying one ha followed by one hand weeding on 25 - 30 days after sowing.

ii) If herbicide is not applied give two hand weedings on 15th and 30th day after sowing.

7. INTERCROPPING IN BENGALGRAM

Bengalgram in paired row planting with one or two rows of Coriander as intercrop would give the highest return. Wheat can also be intercropped in deep black cotton soil in Coimbatore, Erode, Salem, Namakkal and Dharmapuri districts.

CROP PROTECTION

A. Pest management

Economic threshold level for important pests

Pests	ETL
Gram caterpillar	2 early instar larvae/plant 5-8 eggs/plant
Aphids	20/2.5 cm shoot length

Pest management strategies

Pests	Management strategies
Aphid *Aphis craccivora*	**Spray any one of the following :** Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha
Gram caterpillar *Helicoverpa armigera*	• Pheromone traps for *Helicoverpa armigera* 12/ha • Bird perches 50/ha • Hand picking of grown up larvae and blister beetles • Ha NPV 1.5 x10^{12} POB/ha with teepol (1 ml/lit.) **Apply any one of the following** (Spray fluid 625 ml/ha) Dichlorvos 76 WSC 625 ml/ha Neem seed kernel extract 5% (31.0 kg/ha) twice followed by Triazophos 40 EC 780 ml/ha Neem oil 12.5 lit./ha Phosalone 35 EC 1.25 lit./ha (Note : Insecticide / Ha NPV spray should be made when the larvae were upto third instar)
Storage pests	• Dry the seeds adequately to reduce moisture level to 10 %. • Use pitfall traps or two in one model trap to assess the time of emergence of field carried over pulse beetle in storage and accordingly

	sun-dry the produce. • Seed: **Mix any one of the following for every 100 kg** : • Malathion 5 D 1 kg • Pungam oil 1 lit. • Pack in polythene lined gunny bags for storage

B.Disease Management

Seed treatment: Talc formulation of *T. viride* @ 4g or *P. fluorescens* @ 10 g/kg seed (or) Carbendazim @ 2 g/kg or Thiram @ 4 g/kg of seed

Wilt: *Fusarium oxysporum* f.sp. *ciceri*	• Soil application with P. *fluorescens* @ 2.5 kg/ha + 50 kg of well decomposed FYM or sand.
Root rot: *Macrophomina phaseolina (Rhizoctonia bataticola)*	• Soil application *P. fluorescens* or *T. viride*– 2.5 kg / ha + 50 kg of well decomposed FYM or sand. • Spot drenching with Carbendazim @ 1 gm/ litre

SEED PRODUCTION

Varietal Seed Production

Land requirements

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 5 m all around the field from the same and other varieties of bengalgram.

Pre-sowing treatment

- Soak the seeds in 1% aqueous solution of KH_2PO_4 for 3-4 h at 1/3rd volume of seeds and are dried in shade.
- Avoid bruchid infected seed for seed purpose.

Harvesting

- Seeds attain physiological maturity 35 – 40 days after anthesis.
- Harvest the crop as once over harvest when 70 – 80% of pods are creamy in colour.

Seed grading

- Grade the seeds using 13/64” (5.2 mm) or 18/64" (7.2 mm) round perforated metal sieve depending on the variety.
- Dry the seeds to 8-10% moisture content.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2 g kg^{-1} of seed (or).
- Slurry treat seeds also with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) @ 3g kg^{-1} of seed as eco – friendly treatment.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 - 9%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than 15 months) with seed moisture content of less than 8%.

Other management practices

- As in crop management technique

GARDEN LAB LAB (AVARAI)
(*Lab lab purpureus* (L.) var. *typicus*.)

CROP IMPROVEMENT

I.SEASON AND VARIETIES

DISTRICT/SEASON	VARIETIES
Adipattam (Jul - Aug)	
Kanchipuram, Tiruvallur, Dharmapuri, Coimbatore, Madurai, Dindigul, Theni, Vellore, Tiruvannamalai, Ramanathapuram, Virudhunagar, Sivagangai, Tirunelveli, Thoothukudi , Salem, Namakkal,	CO 13, CO (Gb) 14
Thanjavur, Tiruvarur, Nagapattinam, Tiruchirapalli, Perambalur, Karur, Pudukottai, Kanyakumari, Erode	CO 12, CO 13, CO (Gb) 14
Purattasipattam (Sept - Nov)	
Kanchipuram, Tiruvallur, Tiruchirapalli, Perambalur, Karur, Vellore, Tiruvannamalai, Cuddalore, Villupuram.	CO 13, CO (Gb) 14
Dharmapuri, Salem, Namakkal	CO 13, CO (Gb) 14
Pudukottai, Erode, Coimbatore, Madurai, Dindigul, Theni, Ramanathapuram, Sivagangai, Virudhunagar, Tirunelveli, Thoothukudi , Thanjavur, Tiruvarur, Nagapattinam.	CO 12, CO 13, CO (Gb) 14
Summer (April)	
Kanchipuram, Tiruvallur, Vellore, Tiruvannamalai, Cuddalore, Villupuram.	CO 12, CO 13, CO (Gb) 14
Dharmapuri, Salem, Namakkal, Thanjavur, Tiruvarur, Nagapattinam.	CO 12, CO 13, CO (Gb) 14
Kanyakumari, Pudukottai, Erode, Coimbatore, Madurai, Dindigul, Theni, Ramanathapuram, Virudhunagar, Tirunelveli, Thoothukudi, Sivagangai	CO 12, CO 13, CO (Gb) 14

II.DESCRIPTION OF AVARAI VARIETIES

Particulars	CO 12	CO 13	CO (Gb) 14
Parentage	Pedigree selection from CO 9 x CO 4	Derivative of CO 9 x Florikifield	Cross derivative of CO 9 x CO 4
Year of release	1991	1997	2007
1st flowering (days)	40	40	35-40
Duration	100 - 110 days	110 - 120 days	80-85 days (seed to seed) 70-75 days (vegetable type)
Grain yield (kg/ha)			
Irrigated	9700	10000	7584 Green pod
Habit	Erect, bushy	and tendency to form tendrils	Dwarf, bushy without tendrils
Height (cm)	60 - 70	50 - 75	56-62
Colour of flowers	Purple	White	White
Colour of pod	Deep purple	Whitish green	

Shape of pod	Broad, flat	Flat and long	
Colour of grain	Black	Brown	Raddish brown
100 seed wt (g)	38.4	35.2	34-36

III. SEED RATE

Particulars	Quantity of seed required kg/ha Sole crop	Mixed crop
CO 12	20	10.0
CO 13, CO (Gb) 14	25	-

CROP MANAGEMENT

IV. MANAGEMENT OF FIELD OPERATIONS

1. FIELD PREPARATION

Prepare the land to fine tilth. Form beds and channels for bushy types.

2. SEED TREATMENT WITH FUNGICIDES

Treat the seeds with Carbendezim (or) Thiram @ 2g/kg of seed 24hrs before sowing (or) with talc formulation of *Trichoderma viride* @ 4 g/kg seed (or) *Pseudomonas fluorescens*@ 10 g/kg seed. Biocontrol agents are compatible with biofertilizers. First treat the seeds with biocontrol agents and then with Rhizobium. Fungicides and biocontrol agents are incompatible.

3. SEED TREATMENT WITH BACTERIAL CULTURE

Fungicide treated seeds should be again treated with bacterial culture. There should be an interval of atleast 24 hours between fungicidal and bacterial culture treatments. Three packets of bacterial culture are sufficient for treating seeds required for one ha. The bacterial culture slurry may be prepared with rice kanji. Dry the inoculated seeds in shade for 15 minutes before sowing.

4. FERTILIZER APPLICATION

a) Apply fertilizers basally before sowing.
Rainfed : 12.5 kg N + 25 kg P_2O_5 + 12.5 kg K_2O +10 kg S*/ha
Irrigated : 25 kg N + 50 kg P_2O_5 + 25 kg K_2O + 20 kg S*/ha
*Note : Applied in the form of gypsum if Single Super Phospate is not applied as a source of phosphorus

b) Soil application of 25 kg $ZnSo_4$/ha under irrigated condition

5. SOWING

Dibble the seeds adopting the following spacing.

Varieties		
CO 12	:	45 cm X 15 cm
CO 13, CO (Gb) 14	:	45 cm X 30 cm

6. WEED MANAGEMENT

i) Pre emergence application of Pendimethalin @ 2.5 litres/ha on 3 days after sowing using Backpack/ Knapsack/Rocker sprayer fitted with flat fan nozzle using 500 litres of water for spraying one ha. After this, one hand weeding on 40-45 days after sowing gives weed free environment throughout the crop period.

ii) If herbicide is applied give two hand weedings on 25 and 45days after sowing.

7. WATER MANAGEMENT

Irrigate immediately after sowing, followed by life irrigation on the third day. Irrigate at intervals of 7 to 10 days depending upon soil and climatic conditions. Flowering and pod formation stages are critical periods when irrigation is a must. Avoid water stagnation at all stages. Apply KCl at 0.5 per cent as foliar spray during vegetative stage if there is moisture stress.

8. PRUNING TECHNIQUE

A spacing of about 10 feet between lines and four feet between plants are adopted. Pits are dug and two to three seeds are sown in the middle of the pit. One healthy seedling is allowed to grow and the rest removed. The vine is propped with a stick. When the vine reaches the pandal, the terminal bud is nipped. Allow the branches to trail over the pandal. Each branch may be pruned at three feet length so that the pandal is covered with vines. Branches arising on the main vine below the pandal are removed. When flowering starts, prune the tip of the branches bearing inflorescence having three nodes from the productive axil. Continue this procedure throughout the reproductive phase.

9. HARVESTING

Pick the pods when they are completely dry. Thresh the pods and clean the beans. Pick the tender pods once in a week for vegetable purpose.

CROP PROTECTION

A. Pest management

Economic threshold level for important pests

Pests	ETL
Aphids	20/2.5 cm shoot length
Spotted pod borer	3 larvae/plant
Gram caterpillar	10% of affected pods

Pest management strategies

Pests	Management strategies
Aphid *Aphis craccivora*	**Spray any one of the following :** Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha
Spotted pod borer *Maruca vitrata*	Pheromone traps for *Helicoverpa armigera* 12/ha • Mechanical collection of grown up larva and blister beetle • Ha NPV 3 x10^{12} POB/ha in 0.1% teepol • **Apply any one of the following insectcides:** Azadirachtin 0.03%WSP 2500-5000 g/ha *Bacillus thuringiensis* serovar kurstaki (3a,3b,3c) 5%WP 1000-1250 g/ha Emamectin benzoate 5%SG 220 g/ha Indoxacarb 15.8%SC 333 ml/ha NPV of *H. armigera* 2% AS 250-500 Quinalphos 25%EC 1400 ml/ha Spinosad 45%SC 125-162 ml/ha Phosalone 0.07%(Spray fluid 625 ml/ha) (Note : Insecticide / Ha NPV spray should be made when the larvae are upto third instar)
Gram caterpillar *Helicoverpa armigera*	
Blister beetle *Mylabris pustulata*	
Pod bug *Riptortus pedestris* *Clavigralla gibbosa*	**Spray any one of the following insectcides** (Spray fluid 500 l/ha) Dimethoate 30% EC 500ml/ha

Aphid *Aphis craccivora*	Methyl demeton 25%EC 500ml/ha Imidacloprid 17.8 SL 100-125 ml/ha Thiamethoxam 25% WG 100 g/ha
Storage pests Bruchid - *Callosobruchus chinensis*	• Dry the seeds adequately to reduce moisture level to 10%. • Use pitfall traps or two in one model trap to assess the time of emergence of field carried over pulse beetle in storage and accordingly sun-dry the produce. • **Seed: Mix any one of the following for every 100 kg** : Malathion 5 D 1 kg Pungam oil 1 lit. Pack in polythene lined gunny bags for storage

B. DISEASE MANAGEMENT

Seed treatment: Talc formulation of *T. viride* @ 4g or *P. fluorescens* @ 10 g/kg seed (or) Carbendazim @ 2 g/kg or Thiram @ 4 g/kg of seed.

Anthracnose and die-back: *Colletotrichum lindemuthianum*	Spray Mancozeb 1000g or Carbendazim 250 g/ha soon after the appearance of the disease and if necessary, spray once again a fortnight later.

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified seed production leave a distance of 5 m all around the field from the same and other varieties of the crop.

Pre-harvest sanitation spray

- Spray malathion 0.07% or endosulfan @ 0.07 % before harvesting the pods for seed crop.

Harvest

- Harvest the pods as they turned straw yellow in color.
- Discard the terminal pods for seed as they invariably contain immature and diseased seeds.
- The seed moisture content at the stage will be about 15% and the green colour of the seed coat will turn to chocolate brown colour.
- Dry the pods to 15-18% moisture content.

Drying

- Dry the seeds to 8 -10% moisture content.

Seed grading

- Grade the seed using 18/64" (aperture width 7.28 mm) round perforated metal sieve.
- Remove the broken and immature seeds.
- Dry the seed dried to 7 to 8 per cent moisture content.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} of seed along with carbaryl @ 200 mg kg^{-1} of seed (or).
- Slurry treat seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) @ 3g kg^{-1} as eco – friendly treatment .

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8-9 %.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 9 %.

- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 8%.

Other management practices

- As in crop management technique

FIELD LAB-LAB (MOCHAI)
(*Lab lab purpureus* (L.) var. *lignosus*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

DISTRICT/SEASON	VARIETIES
All districts except The Nilgiris All through the year	Co 2

II. DESCRIPTION OF MOCHAI VARIETIES

Particulars	**Co 2**
Parentage	Derivative of Co 8 X Co 1
Year of release	1984
50% flowering (days)	35 - 45
Duration (days)	105
Grain yield (Kg/ha)	
Rainfed	900
Irrigated	1400
Habit	Erect and bushy determinate photo insensitive
Height (cms)	60
Colour of flowers	Purple
Colour of pod	Green
Shape of pod	Flat
Colour of grain	Black
100 seed weight (g)	20.0

III. SEED RATE

Particulars	Quantity of seed required kg/ha	
	Sole crop	Mixed crop
CO 1	20	10.0
CO 2	25	12.5

CROP MANAGEMENT

IV. MANAGEMENT OF FIELD OPERATIONS

1. FIELD PREPARATION

Prepare the land to fine tilth.

2. SEED TREATMENT WITH FUNGICIDES

Treat the seeds with Carbendezim (or) Thiram @ 2g/kg of seed 24hrs before sowing (or) with talc formulation of *Trichoderma viride* @ 4 g/kg seed (or) *Pseudomonas fluorescens* @ 10 g/kg seed.

- Biocontrol agents are compatible with biofertilizers.
- First treat the seeds with biocontrol agents and then with Rhizobium.
- Fungicides and biocontrol agents are incompatible.

3. SEED TREATMENT WITH BACTERIAL CULTURE

Fungicide treated seeds should be again treated with bacterial culture. There should be an interval of atleast 24 hours between fungicidal and bacterial culture treatments. Three packets of bacterial culture are sufficient for treating seeds required for one hectare. The bacterial culture may be prepared with rice kanji. Dry the inoculated seeds in shade for 15 minutes, before sowing.

4. FERTILIZER APPLICATION

a)Apply fertilizers basally before sowing.

Rainfed : 12.5 kg N + 25 kg P_2O_5 + 12.5 kg K_2O +10 kg S*/ha

Irrigated : 25 kg N + 50 kg P_2O_5 + 25 kg K_2O + 20 kg S*/ha

*Note : Applied in the form of gypsum, if Single Super Phospate is not applied as a source of phosphorus

b) Soil application of 25 kg $ZnSo_4$/ha under irrigated condition

5. SOWING

Dibble the seeds, adopting the following spacing.

Strain	Sole crop	Mixed crop
CO 1	90 cm x 30 cm	200 cm x 30 cm
CO 2	45 cm x 15 cm	200 cm x 15 cm

6. WEED MANAGEMENT

i) Pre emergence application of Pendimethalin @ 2 litres/ha on 3 days after sowing using Backpack/ Knapsack/Rocker sprayer fitted with flat fan nozzle using 500 l of water for spraying one ha. After this, one hand weeding on 40-45 days after sowing gives weed free environment throughout the crop period.

ii) If herbicides are not applied, give two hand weedings on 25^{th} and 45^{th} days after sowing.

7. WATER MANAGEMENT

Irrigate immediately after sowing, followed by life irrigation on the third day. Irrigate at intervals of 7to 10 days depending upon soil and climatic conditions. Flowering and pod formation stages are critical periods when irrigation is a must. Avoid water stagnation at all stages. Apply KCl at 0.5 per cent as foliar spray during vegetative stage if there is moisture stress.

8. HARVESTING

Dry pods may be collected for grain purposes. Green mature pods may be collected for vegetable purpose.

CROP PROTECTION

Seed treatment: Talc formulation of *T. viride* @ 4g or *P. fluorescens* @ 10 g/kg seed or Carbendazim @ 2 g/kg or Thiram @ 4 g/kg seed

Anthracnose and die-back: *Colletotrichum lindemuthianum*

- Spray Mancozeb 1000g or Carbendazim 250 g/ha soon after the appearance of the disease and if necessary, spray once again a fortnight later.

SOYBEAN (*Glycine max* (L.) Merr.)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Adipattam (June - July)	Co 1 (Irrigated), Co 2, Co(Soy) 3
Purattasipattam (Sep. - Oct.)	Co 1 (Irrigated), Co 2, Co(Soy) 3
Masipattam (February - March)	Co 1 (Irrigated), Co 2, Co(Soy) 3
Rice fallows	Co 1, Co 2*

* Under protected irrigation.

II. DESCRIPTION OF THE VARIETY

Variety	Co 1	Co 2	Co (Soy) 3
Parentage	Re-selection from a Thailand variety	Cross derivative of UGM 21 x JS 335	Cross derivative of UGM 69 x JS 335
Year of release	1980	1995	2005
50% flowering	37 days	30-40 days	39 – 41 days
Duration (days)	90-100	80-90	90-100
Grain yield (Kg/ha)			
Rainfed	1080	1340	-
Irrigated	1640	1650	1700
Height (cm)	58	30 - 40	53.5
Branches	6	-	5 - 6
Flower colour	Pink	Pink to purple	Pink
Colour of grain	Cream	Creamy yellow	Creamy yellow with brown hilum
100 seed weight (g)	12.5	13 - 14	10.95 – 11.75

III. SEED RATE

CO 1 - 80 kg/ha. Optimum plant population 6,66,000/ha.
CO 2 (irrigated) Pure crop : 60-70 Kg/ha; Inter crop : 25 Kg/ha
CO(Soy) 3 Pure crop : 50 Kg/ha

CROP MANAGEMENT

IV. MANAGEMENT OF FIELD OPERATIONS

1. FIELD PREPARATION

Prepare the land to get fine tilth and form beds and channels.

2. SEED TREATMENT WITH FUNGICIDES

a) Treat the seeds with Carbendezim or Thiram @ 2g/kg of seed 24hrs before sowing or with talc formulation of *Trichoderma viride* @ 4 g/kg seed (or) *Pseudomonas fluorescens* @ 10 g/kg seed.

- Biocontrol agents are compatible with biofertilizers.
- First treat the seeds with biocontrol agents and then with Rhizobium.
- Fungicides and biocontrol agents are incompatible.

b) Coat the seeds with $ZnSO_4$ @ 300 mg/kg using 10% maida solution as adhesive (250 ml/kg) or gruel and arappu leaf powder (250 g/kg) as carrier to increase the field stand.

3. SEED TREATMENT WITH BIOFERTILIZER

a) Treat the seeds atleast 24 hours before sowing.

Treat the seeds with 3 packets (600 g/ha) of Rhizobial culture (COS-1) and 3 packets (600 g/ha) of Phosphobacteria developed at TNAU using rice kanji as binder. If the seed treatment is not carried out apply 10 packets of Rhizobium (2000 g/ha) and 10 packets (2000 g) of Phosphobacteria with 25 kg of FYM and 25 kg of soil before sowing. Dry the bacterial culture treated seeds in shade for 15 minutes before sowing.

4. FERTILIZER APPLICATION

i) Apply 20 kg N and 80 kg P_2O_5 and 40 kg K_2O per ha 40 kg of S as gypsum (220 kg/ha) / ha as basal dressing. Soil application of 25 kg $ZnSo_4$/ha under irrigated condition

ii) Foliar spray of NAA 40 mg/litre and Salicylic acid 100 mg/litre once at pre-flowering and another at 15 days thereafter

iii). Foliar spray of DAP 20 g/litre or urea 20 g/litre once at flowering and another at 15 days thereafter

5. SOWING

Dibble the seeds at a depth of 2 - 3 cm adopting a spacing of 30 x 5 cm. In Erode district, Soybean + Castor (60 cm apart) cropping system gives high net return.

6. WATER MANAGEMENT

Irrigate immediately after sowing. Give life irrigation on the 3rd day. Further irrigations at intervals of 7 - 10 and 10 - 15 days during summer and winter season respectively may be given depending on soil and weather conditions. Soyabean is very sensitive to excess moisture and the crop is affected, if water stagnates in the fields. The crop should not suffer due to water stress from flowering to maturity. To alleviate moisture stress spray of either Kaolin 3% or liquid paraffin at 1% on the foliage. In Erode district Soybean + castor with irrigation at 0.60 IW/CPE ratio (i.e.) once in 10 to 12 days is recommended to realise maximum benefits.

7. WEED MANAGEMENT

i) Alachlor may be applied to the irrigated crop at 4 litres/ha or Pendimethalin 3.3 litre ai/ha after sowing followed by one hand weeding on 30 days after sowing.

ii) If herbicide spray is not given two hand weedings on 20 and 35 days after sowing may be given.

iii) Imazythypur @ boqaitha may be applied as post emergence on 20 DAS with one hand weeding on 30 days after sowing.

8 HARVESTING

Yellowing of leaves and shedding, indicate the maturity of the crop. Cut the entire plant when most of the pods have turned yellow, drying and processing.

SOYABEAN IN RICE FALLOWS

Soyabean can be sown in rice fallows from middle of January to middle of March. Seeds can be dibbled at 75 kg/ha.

SPECIAL SITUATIONS

1. Optimum time of sowing Soyabean CO 1 - 2nd fortnight of June in Kharif
2. Intercropping of Soyabean CO 2 in Sugarcane is recommended for North Western Zone.
3. Intercropping of Soyabean in coconut gardens of more than 10 years is recommended.
4. Vermipelleting (50 g/kg) and adopting spacing of 30 x 10 cm and two foliar sprays of 2% DAP during flowering is recommended to achieve higher yield.

RAINFED SOYABEAN

i. VARIETIES

CO 1

ii. SEASON

The crop can be grown in South-West and North-East monsoon seasons. The middle of July is the optimum time of sowing for rainfed Soyabean in North Western Zone.

3. SEED TREATMENT WITH THE FUNGICIDES AND BIOFERTILIZERS

a) Treat the seeds with Carbendezim or Thiram @ 2g/kg of seed 24hrs before sowing or with talc formulation of *Trichoderma viride* @ 4 g/kg seed or *Pseudomonas fluorescens* @ 10 g/kg seed.

- Biocontrol agents are compatible with biofertilizers.
- First treat the seeds with biocontrol agents and then with Rhizobium.
- Fungicides and biocontrol agents are incompatible.

b) Treat the seeds required for ha. with three pockets of Rhizobium and 3 packets of Phosphobacteria

4.FERTILIZER APPLICATION

i) Apply NPK as per soil test recommendation as far as possible. If soil test recommendation is not available adopt blanket recommendation of 20:40:20:20 NPKS kg/ha, if adequate moisture is available.

ii) Apply entire dose of N, P, K and S as basal.

5. SPACING

Adopt a spacing of 30 cm between rows and 5 cm between plants in the row.

6. SOWING

Dibble or drill the seeds.

7. WEED MANAGEMENT

i) If sufficient moisture is available, Alachlor may be applied to the irrigated crop at 4.0 litres/ha or Pendimethalin 3.3 litres/ha after sowing followed by one hand weeding on 30 days after sowing.

ii) If herbicide spray is not given, two hand weeding on 20 and 35th day after sowing.

iii) Imazythypur @ 40 g ai/ha applied as per amergence on 20 days after sowing with one hand weeding on 30 DAS.

CROP PROTECTION

Seed treatment: Talc formulation of *T. viride* @ 4g or *P. fluorescens* @ 10 g/kg seed (or) Carbendazim @ 2 g/kg or Thiram @ 4 g/kg.

Rust: *Phakopspora pachyrhizi*	• Spray Triadimefon - 0.1 % or Propiconazole – 0.1% or Hexaconazole - 0.1% at flowering stage or at the onset of disease.
Virus Diseases **Yellow Mosaic** (*Geminivirus*) Vector -*Bemisia tabaci* **Bud blight (*Ilarvirus*)** Vector- *Thrips palmi*	• Rogue out infected plants up to 30 days • Spray Monocrotophos 500 ml or Methyldemeton 25EC 500 ml/ ha twice on 15 and 30 days after sowing

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 3 m all around the field from the same and other varieties of the crop.

Pre-sowing seed treatment

- Pellet the seeds with $ZnSO_4$ @ 0.25 to 0.3 g kg^{-1} of seed using 2% CMC or 10% maida as adhesive @ 250 ml kg^{-1} of seed and arappu leaf powder / vermicompost as filler @ 300g kg^{-1} for better field establishment.

Harvest

- ***Seeds attained physiological maturity 27 –30 days after flowering.***
- Harvest the pods as they turn yellow in colour.

Threshing

- Thresh the pods either manually or mechanically using pliable bamboo sticks.

Seed grading

- Grade the seeds using 14/64"(5.6mm) to 12/64"(4.8mm) round perforated metal sieve based on varieties.

Drying

- Dry the seeds to 7- 8% moisture content.

Seed treatment

- Slurry treat with carbendazim @ 2g kg^{-1} of seed along with carbaryl @ 200 mg kg^{-1} of seed. (or)
- Slurry treat seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) @ 3g kg^{-1} as eco – friendly treatment.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 10-12%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 10%.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 7%.

Other management practices

- As in crop management technique.

SWORD BEAN (*Canavalia gladiata L.*)

CROP IMPROVEMENT

Sword bean SBS 1 is an introduction and is one of the vegetables with photo-insensitivity. It matures in 110 - 120 days. It can be grown throughout the year and gives good response to irrigation. Tender pods are ready for harvest from 75 days after sowing. As a pure crop it gives an average grain yield of 1356 kg/ha and green pod yield of 7500 kg/ha. This can also be grown as border crop, intercrop and a shade crop.

I. SEASON

June - July (Rainfed), September - October (Rabi), February - March (Summer).

II. DESCRIPTION OF VARIETY - SBS 1

Year of release	1990
Plant habit	Dwarf, erect, bushy
Pigmentation	Green
Branches (No)	4 - 6
Inflorescence	Axillary raceme
Flower	Bold, light purple
Pods	Long, pendulous, green, flat and fleshy (for vegetable use). Becomes very hard on maturity.
100 seed weight (g)	131.6
Seed colour	Milky white
Days to 50% bloom	45 - 50
Salient features	Early duration (110 - 120 days) Vegetable cum grain crop Free from beany odour Highly nutritious and delicious (25.9% protein) No major pests and diseases

III. MANAGEMENT OF FIELD OPERATIONS

- Seed rate (kg/ha) : 110-120 (Pure crop)
- Fertilizers (kg/ha) : 25 N 50 P_2O_5
- Spacing : 45 x 30 cm (irrigated), 30x20 cm rainfed

INTEGRATED PEST MANAGEMENT FOR PULSE PESTS

1. Stem fly

- It attacks blackgram, greengram and cowpea.
- Adult fly is blackish and lay eggs on the young leaves
- Affected plants get dried
- Immature stage will be inside the stem
- Economic threshold level is 10% damage

2. Aphids

- Attacks blackgram, greengram, lab lab, cowpea and redgram.
- Congregated on the growing shoots, leaves, flowers and pods.
- Affected plants will be weak and stunted
- Because of honeydew ant movements will be there

3. Whiteflies

- Attacks blackgram, greengram, cowpea and soyabean
- Act as vector for yellow mosaic virus disease

4. Bugs

- Desap the flowers and pods
- Affected pods show shriveled grains

5. Pod borers

- Gram pod borer, spotted pod borer, blue butterflies, pod fly and blister beetles are the major borers
- Blister beetles feed on flower buds, flowers and young pods
- Spotted pod borers web the flowers and young pods
- Gram pod borer, plume moth and blue butterflies bore into the pods
- Pod fly feed on the seeds of redgram.

IPM

- Take up the sowing of blackgram from September to November with increased seed rate (25 kg/ha) in stem fly endemic areas.
- Remove alternate hosts
- Use of pheromone traps @ 12/ha for Gram pod borer
- Spray insecticides like methyl demeton or dimethoate or monocrotophos @ 500ml/ha to reduce the sucking insects
- Spray Neem seed kernel extract (25 kg/ha) against pod borers
- Avoid insecticidal spray when parasitoids and predators activity is high.

6. Storage pests

- Dry the seeds adequately to reduce moisture level to 10 %.
- Use pitfall traps or two in one model trap to assess the time of emergence of field carried over pulse beetle in storage and accordingly sun-dry the produce.
- Seed: **Mix any one of the following for every 100 kg** :

Activated kaolin	1 kg
Malathion 5 D	1 kg
TNAU Neem oil 60 EC (C)	1lit.
Pungam oil	1lit.
Monocrotophos 36 SL	400 ml

- Pack in polythene lined gunny bags for storage

OILSEEDS

GROUNDNUT (*Arachis hypogaea*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone/ District/Season	Sowing Month	Varieties
I. Western Zone (Irrigated)		
Coimbatore, Thiruppur		
Chithiraipattam	April-May	TMV 7, CO 3, COGn 4, VRI 2, VRI 3,TMVGn 13
Erode,Theni,Dindigul		
Margazhipattam	Dec- Jan	TMV 7, CO 3, COGn 4, VRI 2, VRI 3, ALR 3, VRIGn5, VRIGn 6, TMVGn 13
Western Zone (Rainfed)		
Coimbatore,Thiruppur, Erode, Theni, Dindigul		
Anippattam	June- July	TMV 7, VRI 2, VRIGn 5, VRI Gn 6,TMVGn 13
II. Southern Zone (Irrigated)		
Ramanathapuram, Thirunelveli		
Thaippattam	Jan- Feb	TMV 7, CO 3, COGn 4, VRI 2, VRI 3, ALR 3, VRIGn5, VRIGn 6, TMVGn 13
Karur, Pudukkottai, Madurai, Virudhunagar		
Margazhipattam	Dec- Jan	TMV 7, CO 3, COGn 4, VRI 2, VRI 3, ALR 3, VRIGn5, VRIGn 6, TMVGn 13
Sivagangai		
Ayppasipattam	Oct- Nov	TMV 7, CO 3, COGn 4, VRI 2, VRI 3, ALR 3, VRIGn5, VRIGn 6, TMVGn 13
Southern Zone (Rainfed)		
Karur, Pudukkottai, Madurai, Sivagangai		
Anippattam	June-July	TMV 7, VRI 2, VRIGn 5, VRI Gn 6,TMVGn 13
Virudhunagar		
Adippattam	July-Aug	TMV 7, VRI 2, VRIGn 6,TMVGn 13
Ramanathapuram, Thirunelveli		
Purattasipattam	Sep- Oct	TMV 7, VRI 2, VRIGn 6,TMVGn 13
Thoothukudi		
Karthigaipattam	Nov- Dec	TMV 7, VRI 2, VRIGn 6,TMVGn 13
III. North Eastern Zone (Irrigated)		
Villupuram		
Chithiraipattam	April-May	TMV 7, CO 3, COGn 4, VRI 2, VRI 3,TMVGn 13
Thiruvallur, Kancheepuram		
Margazhipattam	Dec- Jan	TMV 7, CO 3, COGn 4, VRI 2, VRI 3, ALR 3, VRIGn5, VRIGn 6, TMVGn 13
Cuddalore		
Ayppasipattam	Oct- Nov	TMV 7, CO 3, COGn 4, VRI 2, VRI 3, ALR 3, VRIGn5, VRIGn 6, TMVGn 13
Vellore, Thiruvannamalai		
Karthigaipattam	Nov- Dec	TMV 7, CO 3, COGn 4, VRI 2, VRI 3, ALR 3, VRIGn5, VRIGn 6, TMVGn 13

North Eastern Zone (Rainfed)		
Thiruvallur, Cuddalore, Vellore		
Anippattam	June-July	TMV 7, VRI 2, VRIGn 5, VRI Gn 6,TMVGn 13
Kancheepuram		
Adippattam	July-Aug	TMV 7, VRI 2, VRIGn 6,TMVGn 13
Thiruvannamalai		
Purattasipattam	Sep- Oct	TMV 7, VRI 2, VRIGn 6,TMVGn 13
Villupuram		
Karthigaipattam	Nov- Dec	TMV 7, VRI 2, VRIGn 6,TMVGn 13
IV. North Western Zone (Irrigated)		
Perambalur, Ariyalur		
Margazhipattam	Dec- Jan	TMV 7, CO 3, COGn 4, VRI 2, VRI 3, ALR 3, VRIGn5, VRIGn 6, TMVGn 13
Namakkal, Dharmapuri		
Vaigasipattam	May- June	TMV 10, COGn 5, TNAU CO 6, VRIGn 7,
Salem, Krishnagiri		
Karthigaipattam	Nov- Dec	TMV 7, CO 3, COGn 4, VRI 2, VRI 3, ALR 3, VRIGn5, VRIGn 6, TMVGn 13
North Western Zone (Rainfed)		
Namakkal		
Vaigasipattam	May- June	TMV 10, COGn 5, TNAU CO 6, VRIGn 7,
Salem, Dharmapuri, Krishnagiri		
Anippattam	June-July	TMV 7, VRI 2, VRIGn 5, VRI Gn 6,TMVGn 13
Perambalur, Ariyalur		
Adippattam	July-Aug	TMV 7, VRI 2, VRIGn 6,TMVGn 13
V. Delta Zone (Irrigated)		
Thiruchirapalli, Thanjavur, Thiruvarur, Nagapattinam		
Margazhipattam	Dec- Jan	TMV 7, CO 3, COGn 4, VRI 2, VRI 3, ALR 3, VRIGn5, VRIGn 6, TMVGn 13
Delta Zone (Rainfed)		
Thiruchirapalli		
Anippattam	June-July	TMV 7, VRI 2, VRIGn 5, VRI Gn 6,TMVGn 13
Thanjavur, Nagapattinam		
Margazhipattam	Dec- Jan	TMV 7, CO 3, COGn 4, VRI 2, VRI 3, ALR 3, VRIGn5, VRIGn 6, TMVGn 13

II. DESCRIPTION OF GROUNDNUT VARIETIES

Particulars	TMV 7	TMV 10	TMVGn 13	CO 3	COGn 4
Parentage	Pureline selection from Tennessee white	Spontaneous mutant from Argentina	Selection from Pollachi red	Derivative of VG 55 X JL 24	Derivative of TMV 10 X ICGV 82
Duration (days)	100-105	120-130	100-105	115-120	115-120
Average Yield of Pods kg/ha					
Rainfed	1100	1700	1613	1750	1500
Irrigated	1900	-	2580	2150	1950
Shelling %	74	77	71.4	70	70
100-seed weight (g)	36	43	44	65	60
Oil content %	49.6	54.4	50	49.2	52.7

Special features	Seed dormancy for 10 days	High pod yield and Oil content	Red kernel, high yield and tolerant to terminal drought	Bold 1-2 seeded, HPS kernals, low bud necrosis incidence	Bold pod, kernel and high oil content
Growth habit	Bunch	Semi-spreading	Bunch	Bunch	Bunch
Leaf colour	Green	Dark green	Green	Green	Dark green
Seed colour	Light rose	Red blotched with white	Red	Rose	Rose

Particulars	COGn 5	TNAU CO 6	ALR 3	VRI 2	VRI 3
Parentage	Multiple cross derivative	Derivative of CS 9 X ICGS 5	Derivative of (R33-1 X ICGV 68) X (NCAC 17090 X ALR 1)	Derivative of JL 24 X CO 2	Derivative of J11 X R 33-1
Duration (days)	125-130	125-130	110-115	100-105	90
Average Yield of Pods kg/ha					
Rainfed	1585	1914	2095	1790	1670
Irrigated	-	-	2720	2060	1830
Shelling %	70	73.5	69	74.8	73
100-seed weight (g)	47	48.5	46	49.0	35
Oil content %	51	49.5	50	48	48
Special features	Dark green foliage, tolerant to foliar diseases	Dark green foliage, tolerant to foliar diseases	Suitable for rainfed,rust resistant, tolerant to late leaf spot	Suitable for Irrigation	Early and suitable for intercropping
Growth habit	Semi-spreading	Semi-spreading	Bunch	Bunch	Bunch
Leaf colour	Dark green	Dark green	Dark green	Ashy green	Light green
Seed colour	Red testa	Tan testa	Rose	Light rose	Light rose

Particulars	VRIGn 5	VRIGn 6	VRIGn 7
Parentage	Derivative of CG 26 X ICGS 44	Derivative of ALR 2 X VG 9513	Derivative of TMV 1 X JL 24
Duration (days)	105-110	120-125	120-125
Average Yield of Pods kg/ha			
Rainfed	2133	1916	1865
Irrigated	2384	2403	-
Shelling %	75	75	72
100-seed weight (g)	46	36	46
Oil content %	51	50	48
Special features	High reproductive efficiency. Dormancy 45 days	Small pods, moderately resistant to late leaf spot, rust and PBND diseases. Resistant to early season drought, high	Moderately resistant to late leaf spot and rust diseases. Moderately resistant to leaf miner

		harvest index (34.6%)	
Growth habit	Bunch	Bunch	Semi-spreading
Leaf colour	Dark green	Light green	Dark green
Seed colour	Red testa	Light Rose	Rose

CROP MANAGEMENT

I. Rainfed

1. FIELD PREPARATION

i) Plough with tractor using a disc followed by harrow, once or twice with iron plough or 3 - 4 times with country plough till all the clods are broken and a fine tilth is obtained.

ii) Chiselling for soils with hard pan: Chisel the soils having hard pan formation at shallow depth with chisel plough first at 0.5 m interval in one direction and then in the direction perpendicular to the previous one, once in three years. Apply 12.5 t/ha of FYM or composted coir pith besides chiselling.

iii) Amendments for soil surface crusting: a) To tide over the surface crusting, apply lime @ 2 t/ha along with FYM or composted coir pith @ 12.5 t/ha. b) Coir pith at 12.5 t/ha converted to compost by inoculating with *Pleurotus* and applied serves as a good source of nutrients.

2. APPLICATION OF FERTILIZERS

Apply NPK fertilizers as per soil test recommendation. If soil test is not done, follow the blanket recommendation.

N	P	K	
10	10	45	Kg/ha

For rainfed groundnut –castor intercropping system, apply the recommended dose of 10:10: 45 kg NPK ha^{-1} to the main crop of groundnut and for castor apply the recommended dose of 40 kg N ha^{-1} in two splits (30 and 40 DAS).

3. FORMING BEDS

i) Form beds of size 10 m^2 to 20 m^2 depending upon the slope of the land and type of soil.

ii) Wherever tractor is engaged, bed former may be used.

Or Ridges and furrows may be laid at 60cm spacing between ridges and sowing taken on both sides of the ridge

Or Raised bed with a width of 60cm and with a furrow of 15cm on either side may be formed and sowing taken on the raised bed

4. APPLICATION OF MICRONUTRIENTS

Apply TNAU MN mixture @ 7.5 kg /ha as Enriched FYM (Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade). Broadcast evenly on the soil surface immediately after sowing. Do not incorporate micronutrient mixture in to the soil.

5. NUTRITIONAL DISORDER

Zinc deficiency: Apply 25 kg $ZnSO_4$/ha as basal.

If soil analysis shows less than 1.3 ppm of zinc, soil application of 25 kg $ZnSo_4$ is recommended.

Reduce $ZnSO_4$ application from 25.0 kg ha^{-1} to 12.5 kg ha^{-1} if FYM is applied @ 12.5 t ha^{-1}.

For the standing crop, less than 39.4 ppm of zinc in leaves, foliar spray of 0.5% $ZnSo_4$ is recommended.

Iron deficiency: Foliar of spray 1% $FeSo_4$ on 30, 40 and 50 days after sowing.

Boron deficiency: Apply Borax 10 kg + Gypsum 400 kg/ha as soil application at 45th day after sowing.

6. SEED RATE

Use 120 kg/ha of kernels, 175 kg/ha of kernels for bold seeded varieties.

7. SPACING

Adopt a spacing of 30 cm between rows and 10 cm between plants. Wherever groundnut ring mosaic (bud necrosis) is prevalent, adopt a spacing of 15cm x 15 cm.

8. SEED TREATMENT

i) Treat the seeds with talc formulation of *Trichoderma viride* @ 4 g/kg seed or *Pseudomonas fluorescens* @ 10 g/kg seed.

Biocontrol agents are compatible with biofertilizers.

Treat the seeds with biocontrol agents first and then with *Rhizobium*.

Fungicides and biocontrol agents are incompatible.

ii) Treat the seeds with *Trichoderma* @ 4g/kg. This can be done just before sowing. It is compatible with biofertilizers. SUCH SEEDS SHOULD NOT BE TREATED WITH FUNGICIDES (or)

iii) Treat the seeds with Thiram or Mancozeb @ 4 g/kg of seed or Carboxin or Carbendazim at 2 g/kg of seed.

iv) Treat the seeds with 3 packets (600 g)/ha of Rhizobialculture TNAU14 + 3 packets of Azospirillum (600 g/ha) and 3 packets(600 g/ha) of Phosphobacteria or 6 packets of Azophos(1200 g/ha)developed at TNAU using rice kanji as binder. If the seed treatment is not carried out apply 10packets of Rhizobium (2000g/ha) + 10 packets of Azospirillum (2000 g/ha) and 10 packets(2000 g) of Phosphobacteria with 25 kg of FYM and 25 kg of soil before sowing.

9. SOWING

- Use Kovai seed drill/gorru to sow the seeds in lines.
- Put one seed in each hole. Protect the seeds from crows and squirrels.

10. INTERCROPPING

i) Raise one row of cowpea for every five rows of groundnut wherever red hairy caterpillar is endemic.

ii) Raise intercrops like redgram, blackgram, sunflower, gingelly or other pulses.

iii) Cumbu can be raised as intercrop.

iv) Groundnut + Gingelly or Groundnut + Blackgram in the ratio of 4:1 or Groundnut + Cowpea at 6:1 ratio and Groundnut + Sunflower at 6:2 ratio may be raised.

11. WEED MANAGEMENT

i) **Pre-sowing**: Fluchloralin @ 2.0 l/ha soil applied and incorporated.

ii) **Pre-emergence**: Fluchloralin 2.0 l/ha or pendimethalin @3.3l/ha applied through flat fan nozzle with 900 l of water/ha followed by irrigation. After 35 - 40 days one hand weeding may be given.

iii) If no herbicide is applied two hand weeding and hoeing are given on 20th and 40th day after sowing.

12. EARTHING UP

Accomplish earthing up during second hand weeding/late hand weeding (in herbicide application).

NOTE: i) Earthing up provides medium for the peg development ii) Use the improved hoe with long handle which can be worked more efficiently in a standing position. iii) Do not disturb the soil after 45th day of sowing as it will affect pod formation adversely.

13. APPLICATION OF CALCIUM SULPHATE (GYPSUM)

i) Apply gypsum @ 400 kg/ha by the side of the plants on 40th to 70th day depending upon soil moisture.

ii) Apply gypsum, hoe and incorporate it in the soil and then earth up.

iii) Avoid gypsum in calciferous soils.

iv) Gypsum is effective in soils deficient in calcium and sulphur.

NOTE: Application of gypsum encourages pod formation and better filling up of the pods.

Application of gypsum at the rate of 50 % basal both in rainfed and irrigated condition reduces Khadhasty malady and pod scab nematode

Combined nutrient spray

Pod filling is a major problem especially in the bold seed varieties. To improve pod filling spraying of nutrient solution is to be given. 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. The next day morning it can be filtered and about 32 litre of mixture can be obtained and 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. This can be sprayed on 25th and 35th day after sowing.

14. HARVESTING

i) Observe the crop, considering its average duration. Drying and falling of older leaves and yellowing of the top leaves indicate maturity.

ii) Pull out a few plants at random and shell the pods. If the inner shell is brownish black and not white, then the crop has matured.

iii) Irrigate prior to harvest, if the soil is dry, as this will facilitate easy harvesting. If there is enough moisture in the soil, there is no need for irrigation for harvesting.

iv) If water is not available for irrigating the field prior to harvest, work a mould board plough or work a country plough, so that the plants are uprooted. Engage labour to search pods left out in the soil, if necessary.

NOTE: Do not keep the pulled out plants in heaps when they are wet, especially the bunch varieties, as the pods will start sprouting.

v) Strip off the pods from the plants. Groundnut stripper developed by TNAU can be used.

vi) Dry the pods in the sun for 4 or 5 days. Repeat drying for 2 or 3 more days after an interval of 2 or 3 days to ensure complete drying. When temperature is very high, avoid direct sun drying. Collect the pods in gunnies and store on the ground over a layer of sand to avoid any moisture coming in contact with dry pods.

I. Irrigated

1. FIELD PREPARATION

i) Plough with tractor using a disc followed by harrow, once or twice with iron plough or 3 - 4 times with country plough till all the clods are broken and a fine tilth is obtained.

ii) Chiselling for soils with hard pan: Chisel the soils having hard pan formation at shallow depth with chisel plough first at 0.5 m interval in one direction and then in the direction perpendicular to the previous one, once in three years. Apply 12.5 t/ha FYM or composted coir pith besides chiselling.

iii) Amendments for soil surface crusting: a) To tide over the surface crusting, apply lime @ 2 t/ha along with FYM or composted coir pith @ 12.5 t/ha. b) When coir pith at 12.5 t/ha is converted into compost by inoculating with *Pleurotus* and applied, it serves as a good source of nutrien

2. APPLICATION OF FERTILIZERS

If soil test is not done, follow the blanket recommendation.

N	P	K	Sulphur sludge
25	50	75 kg/ha	60 kg/ha

N and K in three splits *viz.*, 50 % N & K as basal + 25 % N and K at 20 DAS + 25 % N and K at 45 DAS is recommended.

Soil test crop response based integrated plant nutrition system (STCR- IPNS) recommendation may be adopted for prescribing fertilizer doses for specified yield targets. (ready reckoners are furnished)

Groundnut (1)

Soil : Red Sandy loam (Irugur series)
Season : Kharif
Target : 25 q ha^{-1} dry pod

FN = 6.54 T – 0.56 SN – 0.69 ON
FP_2O_5 = 3.80 T – 3.32 SP – 0.77 OP
FK_2O = 8.35 T - 0.65 SK – 0.87 OK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
160	10	160	34	42	65
180	12	180	23	35	52
200	14	200	13*	29	39
220	16	220	13*	22	26
240	18	240	13*	15	13

*maintenance dose

Groundnut (2)

Soil: Red Sandy loam (Somayanur series)
Season: Rabi
Target: 25 q ha^{-1} dry pod

FN = 6.54 T – 0.51 SN – 1.10 ON
FP_2O_5 = 4.19 T – 2.95 SP – 0.77 OP
FK_2O = 5.47 T - 0.33 SK – 0.87 OK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
160	10	160	42	55	44
180	12	180	32	49	38
200	14	200	22	44	31
220	16	220	13*	38	24
240	18	240	13*	32	18

*maintenance dose

Groundnut (3)

Soil : Sandy clay loam (Laterite)
Season : Kharif
Target : 25 q ha^{-1} dry pod

FN = 5.97 T - 0.45 SN
FP_2O_5 = 3.80 T - 3.32 SP
FK_2O = 7.08 T - 0.58 SK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
160	10	120	37	42	67
180	12	140	28	35	56
200	14	160	19	29	44
220	16	180	13*	22	32
240	18	200	13*	15	21

*maintenance dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

3. FORMING BEDS

- Form beds of size 10 m^2 to 20 m^2 depending upon the availability of water, slope of the land and type of soil.
- Wherever tractor is engaged, bed former may be used. or
- Ridges and furrows may be laid at 60cm spacing between ridges and sowing taken on both sides of the ridge
- Raised bed with a width of 60cm and with a furrow of 15cm on either side may be formed and sowing taken on the raised bed

4. POLYTHENE FILM MULCHING

Broad beds and furrows method of groundnut cultivation is a proven technology from ICRISAT. Considering the favourable environment in the Broad beds and furrows system for the development of groundnut pods, with a little modification in the size, beds are to be formed for the polyethylene film mulched groundnut. Make the beds at a width of 60 cm, leaving 15 cm on the either side for the furrows. In a plot size of 4.5 m x 6.0 m, five beds can be made. After the formation of the bed and fertilizer application, spread black polythene sheet (90 cm width) over the soil surface. The edges of the polyethylene can be sheet Seven micron polythene film sheet @50 kg/ha is required. Holes can be made at required spacing of 30 x10 cm before spreading of the sheets. The seed requirement is similar to normal groundnut cultivation

5. APPLICATION OF MICRONUTRIENTS

- Apply TNAU MN mixture @ 12.5 kg /ha as Enriched FYM . (Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade).
- Broadcast evenly on the soil surface immediately after sowing. Do not incorporate the micronutrient mixture to the soil.
- To increase flower retention, pod filling and to induce drought tolerance apart from yield improvement, 2 sprays of groundnut rich @ 5.0 kg/ha (for each spray) at 35 DAS (50 per cent flowering) and 45 DAS (Pod developing stage) in 500 litres of water is recommended

6. NUTRITIONAL DISORDER

Zinc deficiency: Apply 25 kg $ZnSO_4$/ha as basal.

If soil analysis shows less than 1.3 ppm of zinc, soil application of 25 kg $ZnSo_4$ is recommended.

Reduce $ZnSO_4$ application from 25.0 kg ha^{-1} to 12.5 kg ha^{-1} if FYM is applied @ 12.5 t ha^{-1}.

For the standing crop, less than 39.4 ppm of zinc in leaves, foliar spray of 0.5% $ZnSo_4$ is recommended.

Iron deficiency : Spray 1% $FeSO_4$ on 30, 40 and 50 days after sowing.

Boron deficiency: Apply Borax 10 kg + Gypsum 200 kg/ha at 45th day after sowing as soil application

7. SEED RATE

Use 125 kg/ha of kernels. Increase the seed rate by 15% in the case of bold seeded varieties.

8. SPACING

Adopt a spacing of 30 cm between rows and 10 cm between plants. Wherever groundnut ring mosaic (bud necrosis) is prevalent, adopt a spacing of 15cm x 15 cm.

9. SEED TREATMENT

i) Treat the seeds with *Trichoderma viride* @ 4 g/kg seed or *Pseudomonas fluorescens* @ 10 g/kg seed.

Biocontrol agents are compatible with biofertilizers.

First treat the seeds with biocontrol agents and then with *Rhizobium*.

Fungicides and biocontrol agents are incompatible.

ii) Treatment with *Trichoderma* can be done just before sowing. SUCH SEEDS SHOULD

NOT BE TREATED WITH FUNGICIDES. (or)

iii) Treat the seeds with Thiram or Mancozeb @ 4 g/kg of seed or Carboxin or Carbendazim at 2 g/kg of seed.

iv) Treat the seeds with 3 packets (600 g)/ha of Rhizobial culture TNAU14 developed at TNAU using rice kanji as binder. If the seed treatment is not carried out, apply 10 packets/ha (2000 g) with 25 kg of FYM and 25 kg of soil before sowing.

Seed treatment will protect the young seedlings from root-rot and collar rot infection.

10. SOWING

a) Dibble the seeds at 4 cm depth along with fertilizer.

11. WEED MANAGEMENT

i. **Pre-sowing**: Fluchloralin at 2.0 l/ha soil applied and incorporatede followed by light irrigation.

ii. **Pre-emergence**: Fluchloralin 2.0 l/ha or Pendimethalin @ 3.3l/ha applied on third day after sowing through flat fan nozzle with 500 l of water/ha followed by irrigation. After 35 - 40 days one hand weeding may be given.

iii. Spray Imazethapyr @ 750 ml/ha at 20-30 days after sowing based on weed density as post emergence spray

iv. If no herbicide is applied two hand hoeing and weeding are given on 20th and 40th day after sowing.

v. Apply, PE Oxyfluorfen @ 200 g/ha on 3rd DAS and followed by one hand weeding on 40-45 DAS

vi. Apply, PE Oxadiazon @ 0.8 kg ha^{-1} followed by one earthing up using hoes (or) working star type weeder

vii. Apply, PE Metalachlor @ 1.0 kg ha^{-1} followed by one hand weeding on 40 DAS

12. EARTHING UP:

Accomplish earthing up during second hand weeding/late hand weeding (in herbicide application).

NOTE: i) Earthing up provides medium for the peg development. ii) Use the improved hoe with long handle which can be worked more efficiently in a standing position. iii) Do not disturb the soil after the 45th day of sowing as it will affect pod formation adversely.

13. APPLICATION OF CALCIUM SULPHATE (GYPSUM)

- Apply gypsum @ 400 kg/ha by the side of the plants on the 40th to 45th day of sowing. Apply gypsum, hoe and incorporate in the soil and then earth up.
- Avoid gypsum in calciferous soils.
- Gypsum is effective in soils deficient in calcium and sulphur.

NOTE: Application of gypsum encourages pod formation and better filling up of the pods.

Application of gypsum at the rate of 50 % basal both in rainfed and irrigated condition reduces Khadhasty malady and pod scab nematode

Combined nutrient spray

Pod filling is a major problem especially in the bold seed varieties. To improve pod filling spraying of nutrient solution is to be given. 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. The next day morning it can be filtered and about 32 litre of mixture can be obtained and 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. This can be sprayed on 25th and 35th day after sowing. or Spray TNAU Groundnut rich @ 5.5 kg/ha for 2 sprays at 35 (50 per cent flowering) and 45 DAS Pod developing stage).

14. WATER MANAGEMENT

Schedule the irrigation at 0.40 and 0.60 IW/CPE ratio during vegetative and reproductive phases respectively. Regulate irrigation according to the following growth phase of the crop.

Pre-flowering phase : 1 to 25 days
Flowering phase : 26 to 60 days
Maturity phase : 61 to 105 days

Regulate irrigation based on physiological growth phases. Pegging, flowering and pod development phases are critical for irrigation during which period adequate soil moisture is essential. Apply irrigation as follows:

i) Sowing or pre-sowing
ii) Life irrigation, 4 - 5 days after sowing if sowing irrigation given to break the surface crust.
iii) 20 days after sowing
iv) At flowering give two irrigations
v) At pegging stage give one or two irrigations
vi) In pod development stage, 2 - 3 irrigations depending on the soil type

Note: *Spraying 0.5% Potassium chloride during flowering and pod development stages will aid to mitigate the ill effects of water stress. Sprinkler irrigation will save water to the tune of about 30%. Borderstrip irrigation is recommended in command areas in light textured soils. Composted coir pith increases moisture availability and better drainage in heavy textured soil.*

15. HARVESTING

i) Observe the crop, considering its average duration. Drying and falling of older leaves and yellowing of the top leaves indicate maturity.
ii) Pull out a few plants at random and shell the pods. If the inner shell is brownish black and not white, then the crop has matured.
iii) Irrigate prior to harvest, if the soil is dry, as this will facilitate easy harvesting. If there is enough moisture in the soil, there is no need for irrigation for harvesting.
iv) If water is not available for irrigating the field prior to harvest, work a mould board plough or work a country plough, so that the plants are uprooted. Engage labour to search pods left out in the soil, if necessary.

NOTE: Do not keep the pulled out plants in heaps when they are wet, especially the bunch varieties, as the pods will start sprouting.

v) Strip off the pods from the plants. Groundnut stripper developed by TNAU can be used.
vi) Dry the pods in the sun for 4 or 5 days. Repeat drying for 2 or 3 more days after an interval of 2 or 3 days to ensure complete drying. When temperature is very high, avoid direct sun drying. Collect the pods in gunnies and store on the ground over a layer of sand to avoid any moisture coming in contact with dry pods.

CROP PHYSIOLOGY

Foliar spray of TNAU Groundnut Rich @ 2 kg/acre in 200 litres of water at peak flowering and at pod development stages increases flower retention, pod filling and improves moisture stress tolerance and pod yield.

CROP PROTECTION

Pest management

Economic threshold level for important pests

Pests	ETL
Leaf miner	1 larvae /meter row
Tobacco cutworm	8 egg masses/100 m row

Pests	Management strategies
Red hairy caterpillar	• Dig out and destroy the pupae from the field bunds and shady

Amsacta albistriga	spots prior to summer rains. • Set up 3 to 4 light traps and bonfires immediately after receipt of rains, after sowing in the rainfed season to attract and kill the moths and also to know brood emergence. • Collect and destroy gregarious, early instar larvae on lace-like leaves of intercrops such as redgram and cowpea. • Collect and destroy egg masses in the cropped area. • Avoid migration of larvae by digging a trench 30 cm deep and 25 cm wide with perpendicular sides around the infested fields. **Apply any one of the following insecticides at 25 kg/ha (for young caterpillars) :** Phosalone 35 EC 750 ml/ha in 375 l of water. Dichlorvos 76 EC 627 ml/ha **Virus multiplication** Collect medium sized larvae of *Amsacta albistriga* from the field and starve them over night. Make a pure suspension of virus with the nucleus culture, in water. Dip *Calotropis* leaves in virus suspension, shade dry and feed them to starved larvae for 1 or 2 days. From third day, normal, untreated leaves can be fed to these larvae. From 5th day, the treated larvae will start dying. Virus infected larvae can be diagnosed by their pinkish ventral surface, their head hanging downwards with white body contents oozing out through ruptured body wall in the late stage. Collect the dying larvae, keep in fresh potable water for a few days, grind the larvae and filter through several layers of fine cloth and collect filtrate (Crude virus suspension). Use virus suspension obtained from 750 medium sized larvae for spraying one hectare along with a sticker 250 ml or Triton in 350 l of water. Use potable water for mixing and spray in the evening hours.
Tobacco cut worm *Spodoptera litura*	• Grow castor as border or intercrop in groundnut fields to serve as indicator or trap crop. • Monitor the emergence of adult moths by setting up light and pheromone traps. • Collect egg masses and destroy. • Collect the gregarious larvae and destroy them as soon as the early symptoms of lace-like leaves appear on castor, cowpea and groundnut. **Apply anyone of the following insecticides to control the early instar (1st to 3rd instar) larvae** Carbaryl 50 WP 2.0 kg/ha Quinalphos 25 EC 750 ml/ha Dichlorvos 76 WSC 750 ml/ha Diflubenzuron 25 WP 300-400g/ha **Spray any one of the following insecticides to control the 4^{th} to 6th instar larvae :** Neem oil (2%) 20 lit /ha Prepare a bait with the following materials to cover one ha. Rice bran 12.5 kg; Molasses or brown sugar 1.25 kg or carbaryl 50 WP 1.25 kg. Mix the ingredients to obtain a homogeneous mixture, Sprinkle water (7 lit.) gradually and bring the bait to a dough consistency. Distribute the above bait on the soil, around the field and inside in the evening hours immediately after preparation. • Apply Nuclear Polyhedrosis Virus 1.5 x 1012 POBs/ha with crude sugar 2.5 kg/ha and Teepol 250 ml/ ha. Methods of mass culturing and application are the same as for *Amsacta* NPV.

Leaf hopper *Empoasca kerri*	• Intercrop lab lab with groundnut 1:4 ratio **Spray any one of the following insecticides:** Imidacloprid 17.8% SL 100 -125 ml/ha Quinalphos 25%EC 1400 ml/ha
Leaf miner *Aproaerema modicella*	• Set up light traps between 8 and 11 p.m at ground level **Apply anyone of the following insecticides** Dimethiate 30 EC 660 ml/ha Malathion 50 EC 1.25 l/ha Methyl demeton 25% EC 1000 ml/ha
Pod borer (Earwig) *Anisolabis stali*	**Apply any one of the following to the soil prior to sowing in endemic areas :** Malathion 5 D 25 kg/ha Carbofuran 3% CG 50 kg/ha • Repeat soil application of any one of the above dust formulations on the 40th day of sowing and incorporate in the soil during the earthing up.
Leafwebber	**Apply anyone of the following insecticides** Diflubenzuron 25%WP 300-400 g/ha Phosalone 35%EC 1428 ml/ha
White grub *Holotrichia consanguinea,* *H. serrata*	**Apply anyone of the following insecticides** Carbofuran 3%CG 33.3 kg/ha Chlorpyrifos 20%EC 1125 ml/ha Phorate 10%CG 25 kg/ha
Aphid *Aphis craccivora*	**Apply anyone of the following insecticides** Chlorpyrifos 20%EC 1000 ml/ha Imidacloprid 17.8% SL 100 -125 ml/ha Methyl demeton 25% EC 1000 ml/ha
Thrips *Scirtothrips dorsalis*	**Apply anyone of the following insecticides** Quinalphos 25%EC 1400 ml/ha

B.DISEASE MANAGEMENT

Seed treatment: Treat the seeds with any one of the following Thiram @ 4g/kg of seed, Mancozeb @ 4g/kg of seed,Carboxin @ 2g/kg of seed Carbendazim @ 2g/kg of seed.Talc formulation of *T. viride* @ 4g/kg of seed *P. fluorescens* @10g/kg of seed,

Rust: *Puccinia arachidis*	Spray any one of the following: Mancozeb 1000g /ha Chlorothalonil 1000g /ha Wettable sulphur 2500g /ha Tridemorph 500 ml/ha If necessary, repeat the spray 15 days later.
Early leaf Spot: *Cercopora arachidicola, Mycosphaerella arachidis* **Late leaf Spot:** *Phaeoisariopsis personata, Mycosphaerella berkeleyii*	Spray any one of the following: Carbendazim 500 g/ha Mancozeb 1000 g/ha Chlorothalonil 1000 g/ha If necessary give the second round 15 days later. **Combined infection of rust and Leaf spot** Spray any one of the following: Spray 10% *Calotropis* leaf extract Spray Carbendazim 250 g + Mancozeb 1000g/ha Chlorothalonil 1000g/ha. If necessary give the

	second round 15 days later.
Root rot: *Macrophomina phaseolina* (*Rhizoctonia bataticola*)	• Soil application of *P. fluorescens* @ 2.5g /ha mixed with 50 kg of well decomposed FYM / sand at 30 DAS. • Spot drench with Carbendazim 1 g / l
Groundnut Bud Necrosis: (*Peanut Bud Nercrosis Virus*) **vector:** *Thrips tabaci, Frankliniella schultzeii*	• Adopt a close spacing of 15 x 15 cm. Remove infected plants up to 6 weeks after sowing and spray Monocrotophos 36 WSC 500 ml/ha, 30 days after sowing either alone or in combination with antiviral principles. Antiviral principles from sorghum or coconut leaves. • AVP are extracted as follows: Sorghum or coconut leaves collected, dried, cut into small bits and powdered to one kg of leaf powder two litres of water is added and heated to 60°C for one hour. It is then filtered through muslin cloth and diluted to 10 litres and sprayed. To cover one ha 500 litre of fluid will be required. Two sprays at 10 and 20 days after sowing will be needed.

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 3 m all around the field from the same and other varieties of the crop.

Season

- June – July and December – January.

Spacing

- 25 x 15 cm

Pre-sowing seed treatment

- Obtain seeds only from healthy pods.
- Discard shrivelled and disfigured seeds.

Pre-sowing seed hardening

- Harden the graded seeds by soaking in 0.5% $CaCl_2$ (50% seed volume) for 6 h. After 6 h soaking, incubate the seeds in between moist gunny bags for 12 – 18 h. Observe the sprouting of radicle periodically at 2 h interval after 12 h of incubation.
- Separate the seeds with sprouted radicle (just visible expression of radicle) and dry under shade.
- Soak the seeds in 3 % spent wash, half of the volume of the solution for 2 h in areas of availability.

Fertilizer requirement

- Apply NPK @ 25:50:75 kg ha^{-1} as blanket
- In boron deficient soils, apply borax as basal application @ 10 kg ha^{-1}
- At peg formation stage, apply gypsum @ 400 kg ha^{-1} and earth up the plants.

Pre-harvest spray to arrest *in situ* germination

- Spray with MH (Maleic Hydrazide) @ 1250 ppm at 60 days after sowing

Harvest

- Harvest the pods as and when the colour of the inner side of the shell turn black and dry to 10 – 12 per cent moisture.
- Reject mechanically injured pods for seed purpose.
- Remove all discolored pods.
- Practice pod verification based on varietal characteristic before grading to remove genetically impure seed.

Drying

- Stake the plants as the pods are exposed outside for easy drying of pods.
- Dry the pods to 15 – 20 % moisture content under sun.

Decortication

- Dry the pods to 16 per cent moisture content and decorticate either manually or using hand operated decorticator with proper adjustment.
- Dry the kernels to 7 to 8 per cent moisture.

Seed treatment

- Treat the pods with carbendazim @ 2 g kg^{-1} at 6 -7 % moisture content.

Seed Storage

- Store the pods in closed plastic container or gunny bags with Calcium chloride @ 250g/30 kg of pods.
- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 - 9%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 6-8 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content less than 5%.

Other management practices

- As in crop management technique.

SESAME (*Sesamum indicum*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone/ District/Season	Sowing Month	Varieties
I. Western Zone (Irrigated)		
Coimbatore, Thiruppur, Erode		
Masipattam	Feb- March	TMV 3, TMV 4, TMV 6, TMV 7, CO 1, VRI (SV) 1, SVPR 1, VRI (SV) 2
Western Zone (Rainfed)		
Coimbatore,Thiruppur, Erode, Dindigul		
Anippattam	June- July	CO 1, TMV 3,TMV 7
Theni		
Karthigai	Nov- Dec	CO 1, TMV 3, TMV 5, TMV 7, SVPR 1, VRI(SV) 2
II. Southern Zone (Irrigated)		
Thirunelveli, Karur		
Chithiraipattam	Apr- May	TMV 3, TMV 4, TMV 6, TMV 7, CO 1, VRI (SV) 1, SVPR 1, VRI (SV) 2
Pudukkottai		
Margazhi	Dec- Jan	TMV 3, TMV 4, TMV 6, TMV 7, CO 1, VRI (SV) 1, SVPR 1, VRI (SV) 2
Southern Zone (Rainfed)		
Madurai		
Anipattam	June-July	CO 1, TMV 3,TMV 7
Virudhunagar, Pudukkottai,		
Adippattam	July-Aug	CO 1, TMV 3,TMV 7
Karur		
Purattasipattam	Sep- Oct	CO 1, TMV 3, TMV 5, TMV 7, SVPR 1, VRI(SV) 2
Ramanathapuram, Sivagangai, Thirunelveli, Thoothukudi		
Karthigaipattam	Nov- Dec	CO 1, TMV 3, TMV 5, TMV 7, SVPR 1, VRI(SV) 2
III. North Eastern Zone (Irrigated)		
Kancheepuram, Cuddalore, Vellore		
Margazhipattam	Dec- Jan	CO 1, TMV 3, TMV 5, TMV 7, SVPR 1, VRI(SV) 2
Thiruvannamalai		
Masipattam	Feb- March	TMV 3, TMV 4, TMV 6, TMV 7, CO 1, VRI (SV) 1, SVPR 1, VRI (SV) 2
Villupuram		
Chithiraipattam	Apr- May	TMV 3, TMV 4, TMV 6, TMV 7, CO 1, VRI (SV) 1, SVPR 1, VRI (SV) 2
Thiruvallur		
Anipattam	June-July	CO 1, TMV 3,TMV 7
North Eastern Zone (Rainfed)		
Vellore, Thiruvannamalai		
Anippattam	June-July	CO 1, TMV 3,TMV 7
Kancheepuram, Cuddalore		
Adippattam	July-Aug	CO 1, TMV 3,TMV 7
Thiruvallur		
Purattasipattam	Sep- Oct	CO 1, TMV 3, TMV 5, TMV 7, SVPR 1, VRI(SV) 2
Villupuram		
Karthigaipattam	Nov- Dec	CO 1, TMV 3, TMV 5, TMV 7, SVPR 1, VRI(SV) 2

IV. North Western Zone (Irrigated)		
Namakkal		
Margazhipattam	Dec- Jan	TMV 3, TMV 4, TMV 6, TMV 7, CO 1, VRI (SV) 1, SVPR 1, VRI (SV) 2
Salem, Perambalur, Ariyalur		
Masipattam	Feb- March	TMV 3, TMV 4, TMV 6, TMV 7, CO 1, VRI (SV) 1, SVPR 1, VRI (SV) 2
North Western Zone (Rainfed)		
Salem,Namakkal, Dharmapuri, Krishnagiri		
Anippattam	June-July	CO 1, TMV 3,TMV 7
Perambalur, Ariyalur		
Adippattam	July-Aug	CO 1, TMV 3,TMV 7
V. Delta Zone (Irrigated)		
Thanjavur, Thiruchirapalli		
Masipattam	Feb- March	TMV 3, TMV 4, TMV 6, TMV 7, CO 1, VRI (SV) 1, SVPR 1, VRI (SV) 2
Thiruvarur		
Chithiraipattam	Apr- May	TMV 3, TMV 4, TMV 6, TMV 7, CO 1, VRI (SV) 1, SVPR 1, VRI (SV) 2
Delta Zone (Rainfed)		
Thanjavur, Thiruvarur, Nagapattinam		
Thaippattam	Jan- Feb	VRI(SV) 1
Thiruchirapalli		
Purattasipattam	Sep- Oct	CO 1, TMV 3, TMV 5, TMV 7, SVPR 1, VRI(SV) 2

I. DESCRIPTION OF SESAME VARIETIES

Particulars	CO 1	TMV 3	TMV 4	TMV 5	TMV 6
Parentage	Derivative of (TMV 3 X SI 1878) X SI 1878	Derivative of South Arcot local X Malabar	Pureline selection from Sattur local	Pureline selection from Srivaikundam local	Pureline selection from Andhra Pradesh Variety
Duration (days)	85-90	80-85	85-90	80-85	85-90
Average Yield (kg/ha)					
Rainfed	450-650	400-650	-	450-650	
Irrigated	750-790	625-750	700-850	-	700-950
Oil content %	51	51	50	51	54
Habit	Erect with profuse branching and short internodes on the main stem	Bushy with profuse branching	Bushy with profuse branching	Erect with moderate branching	Erect with moderate branching
Capsules	4 loculed	4 loculed	4 loculed	4 loculed	4 loculed
Seeds	Intense dark brown almost black	Dark brown	Brown	Brown	Brown

Particulars	TMV 7	VRI(SV) 1	VRI(SV) 2	SVPR 1
Parentage	Derivative of SI 250 X ES 22	Pureline selection from Tirukattupalli local	Derivative of VS 9003 X TMV 6	Pureline selection from Western Ghat White
Duration (days)	80-85	70-75	80-85	75-80
Average Yield (kg/ha)				
Rainfed	850	450-650	650-700	600
Irrigated	920	650-900	700-750	800
Oil content %	50	51	51.9	53.8
Habit	Erect, indeterminate with Profuse branching	Erect with moderate branching	Profuse branching	Erect with moderate branching
Capsules	4 loculed	4 loculed	4 loculed	4 loculed
Seeds	Brown	Brown	Reddish brown	White

CROP MANAGEMENT

1. FIELD PREPARATION

a) Plough the field with tractor twice or with mould board plough thrice or five times with a country plough.

b) Break the clods in between ploughings and bring the soil to a fine tilth to facilitate quick germination as the seeds are small.

c) Chiselling for soils with hard pan: Chisel the soils having hard pan formation at shallow depth with chisel plough first at 0.5 m interval in one direction and then in the direction perpendicular to the previous one once in three years. Apply 12.5t FYM/composted coir pith besides chiselling.

d) For irrigated gingelly, form beds of size 10 m^2 or 20 m^2 depending upon the availability, inflow of water and slope of the land. Level the beds perfectly without any depressions to prevent water stagnation, which will affect the germination adversely.

e) In rice fallows, field is ploughed once with optimum moisture, seeds are sown immediately and covered with one more ploughing.

2. APPLICATION OF FERTILIZERS

i) Spread FYM or composted coir pith or compost @ 12.5 t/ha evenly on the unploughed field and plough it in.

ii) If the manure is not applied before commencement of ploughing, spread 12.5 t/ha of FYM or compost evenly on the field before the last ploughing and incorporate in the soil.

iii) If soil tests are not available, follow the blanket recommendations. **Rainfed:** Apply 23:13:13 kg NPK/ha or 17:13:13 kg NPK/ ha + 3 packets of Azospirillum (600 g/ha) and 3 packets (600 g/ha) of Phosphobacteria or 6 packets of Azophos(1200 g/ha). **Irrigated:** Apply 35:23:23 kg NPK/ha or 21:23:23 kg NPK/ha + 3 packets of Azospirillum (600 g/ha) and 3 packets(600 g/ha) of Phosphobacteria or 6 packets of Azophos(1200 g/ha)

iv) Apply full dose of N, P and K basally. Add 5 kg of Manganese sulphate per hectare. Apply 50% of the recommended P_2O_5 and K_2O with full recommended dose of N to irrigated gingelly raised after groundnut fertilized with 100% of recommended NPK.

Soil test crop response based integrated plant nutrition system (STCR- IPNS) recommendation may be adopted for prescribing fertilizer doses for specified yield targets. (ready reckoners are furnished for irrigated gingelly)
Soil: Black alluvium (Adanur series) FN = 13.7 T - 0.46 SN

Season : Kharif FP_2O_5 = 6.3 T - 1.79 SP
Target : 10 q ha^{-1} FK_2O = 12.8 T - 0.47 SK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + ***Azospirillum*** @2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
180	10	180	18*	13	12*
200	12	200	18*	12*	12*
220	14	220	18*	12*	12*
240	16	240	18*	12*	12*
260	18	260	18*	12*	12*

*maintenance dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

Open furrows to a depth of 5 cm and 30 cm apart and place the fertilizer mixture along the furrows and cover to a depth of 3 cm with soil before sowing.

v) If furrow application is not done, broadcast the fertilizer mixture evenly on the beds before sowing.

vi) Apply TNAU MN mixture @ 7.5 kg ha^{-1} as enriched FYM for rainfed sesame and TNAU MN mixture @ 12.5 kg ha^{-1} as enriched FYM for irrigated sesame. (Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade)

3. APPLICATION OF AZOSPIRILLUM

25% of the N can be substituted by 3 packets of Azospirillum (600 g/ha) and 3 packets (600 g/ha) of Phosphobacteria or 6 packets of Azophos (1200 g/ha) by seed treatment and 10 packets of Azospirillum (2000 g/ha) and 10 packets (2000 g/ha) of Phosphobacteria or 20 packets of Azophos(4000 g/ha)as soil application.

4. NUTRITIONAL DISORDERS

a) **Manganese deficiency** : Leaves develop interveinal chlorosis, chlorotic tissue, later develop light brown or husk coloured necrotic lesions. Mix 5 kg / ha $MnSO_4$ with 45 kg of soil and broadcost evely in the beds after sowing.

b) **Zinc deficiency**: Middle leaves develop chlorosis in the interveinal areas and necrosis along the apical leaf margins. Mix 5 kg/ha of Zinc sulphate with 45 kg of soil and broadcast evenly in the beds after sowing.

Note: Do not incorporate the micronutrient in the soil.

5. SEED RATE

Adopt a seed rate of 5 kg/ha.

6. SPACING

a) Give a spacing of 30 cm between rows and 30 cm between plants. b) For rice fallows, seeds are broadcasted and thinned to maintain 11 plants/m^2.

7. QUALITY OF SEEDS

Select mature, good quality seeds free from pest and fungal damage.

8. SEED TREATMENT

Treat the seed with *Trichoderma*@ 4g/kg. This can be done just before sowing. SUCH SEEDS SHOULD NOT BE TREATED WITH FUNGICIDES or treat the seed with Thiram 4 g or Carbendazim at 2 g/kg of seeds before sowing.

9. SOWING

a) Sow the seeds preferably in lines.
b) Mix the seeds with four times its volume of dry sand and drop the mixture evenly along the furrows in which fertilizers are applied.
c) Sow the seeds to a depth of 3 cm and cover with soil.
d) The optimum time of sowing for VRI (SV) 1 sesame is second fortnight of February to first fortnight of March under summer irrigated conditions.

10. WATER MANAGEMENT

i) Irrigate at sowing and give life irrigation 7 days after sowing depending on the soil and climatic condition and allow excess water to percolate.
ii) Give one pre-flowering irrigation (25 days): One at flowering and one or two at pod setting. An irrigation at flowering period is critical.

NOTE: *The critical stage for moisture requirement is the flowering phase i.e, between 35th to 45th days of sowing. During the maturity phase, moisture status should be low. If more water is given during this phase, maturity of seeds is affected and filling up of the capsules will be poor. Therefore, stop irrigation after 65 days of sowing.*

11. THINNING

Thin out the seedlings to a spacing of 15 cm between the plants on the 15th day of sowing and 30 cm on 30th day of sowing. This operation is very important for the crop in order to induce basal branches.

12. WEED MANAGEMENT

i. Apply, PE application of Pendimethalin 3.3 l/ha followed by me hand weeding on 25th DAS
ii. For irrigated sesame, apply PE alachlor @ 1.5 kg (or) Metolachlor @ 1.0 kg ha^{-1} followed by one hand weeding on 25th DAS

13. HARVESTING

a) Decide when to harvest

i. Observe the crop, considering the average duration of the crop.
ii. Twenty five per cent of the leaves from the bottom are shed and the top leaves loose their colour and turn yellow at maturity.
iii. The colour of the stem turns yellow.
iv. The colour of the capsules turn yellow upto the middle.
v. Harvest before the bottom capsules turn brown.
vi. Examine the 10th capsule from the bottom by opening. If the seeds attained the full color of the variety harvest may be taken up.
vii. If harvest is delayed/ the capsules will dehisce resulting in yield reduction.

b) Harvest

i. Pull out the plants from the bottom.
ii. Stack in the open, one over the other in a circle with the stems pointing out and the top portion pointing inside.
iii. Cover the top with straw, so that humidity and temperature increases.
iv. Cure like this for 3 days, shake the plants. About 75 per cent of the seeds will fall off.
v. Dry the plants for one more day and again shake the plants. All the mature seeds will fall off.
vi. Winnow the seeds and dry in the sun for 3 days. Stir once in 3 hours to give uniform drying.
vii. Collect the seeds and store in gunnies.

CROP PROTECTION

A. Pest management

Economic threshold level for important pests

Pests	ETL
Shoot webber - Shoot damage	2 larvae /m^2 or 10% plant damage
Leaf amage	10 larvae/m^2 in the vegetative stage and 2 larvae/m2 during the reproductive stage

Pests	Management strategies
Shoot and Leaf webber *Antigastra catalaunalis*	Two sprayings with neem formulation 0.03% **Spray any one of the following :** Carbaryl 50 WP 1000 g/ha in 500 litre of water Neem seed kernels extract (5%). Neem oil 2% (two rounds) Use alternate insecticides each time and avoid the usage of same insecticide every time.
Pod borer *Elasmolomus (= Aphanus) sordidus*	
Gall fly *Asphondylia ricini*	
Leaf webber *Antigastra catalaunalis*	**Dust any one of the following :** Carbaryl 10% DP 25 kg/ha
Whitefly	**Spray any one of the following :** Methyl demeton 25% EC 1200 m l/ha Quinalphos 25%EC 2000 ml/ha
Leaf hopper	
Storage pests *Triboilum castaneum* *Corcyra cephalonica*	**Dust any one of the following on gunny :** Malathion 5 D Carbaryl 10 D Mix one kg of activated clay with 100 kg of seeds after adequate drying of seeds

A. DISEASE MANAGEMENT

Seed treatment: Treat the seeds with any one of the following *P. fluorescens* @ 10g/kg of seed, *T. viride* @ 4g/kg of seed, Thiram @ 4g/kg of seed, Carbendazim @ 2g/kg of seed

Powdery mildew: *Erysiphe cichoracearum*	Apply any one of the following Sulphur dust 25 kg/ha Wettable sulphur 25 kg/ha
Alternaria blight: *Alternaria sesami*	Spray Mancozeb 1000g/ha
Cercospora leaf spot: *Cercospora sesami*	Spray Mancozeb 1000g/ha
Root rot: *Macrophomina phaseolina (Rhizoctonia bataticola)*	• Soil application of *P. fluorescens* or *T. viride* – 2.5 Kg / ha + 50 Kg of well decomposed FYM or sand at 30 days after sowing. • Spot drench Carbendazim – 1 gm/ litre
Phyllody: Phytoplasma **Vector**: *Orosius albicinctus*	• Remove and destroy infected plants. • To control vector, spray Monocrotophos 36 or Dimethoate 30 EC 500 ml/ha combined with intercropping of Sesamum + Redgram (6 : 1)

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 200 m all around the field from the same and other varieties of the crop.

Fertilizer

- Apply NPK @ 50:25:25 kg ha^{-1} and manganese sulphate @ 5 kg ha^{-1} as basal application.

Foliar application

- Spray 1% DAP at the time of first flowering and again 10 days after the first spray.

Harvest

- Harvest the crop when 75 – 80% of the pods started yellowing and bottom 1 or 2 pods have dehisced. At this stage, the pod moisture content will be 50 – 60% and seed moisture content will be 25 – 30% and the seeds will be chocolate brown colour.
- Stack the plants in inverted position and are allowed for 3-4 days of drying.

Threshing

- Beat the staked plants with pliable bamboo stick for removal of seeds.

Seed grading

- Grade the seeds with 4/64" (1.6mm) round perforated metal sieve.

Drying

- Dry the seeds to 7- 8% moisture content.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} along with carbaryl @ 200 mg kg^{-1} of seed (or)
- Slurry treat seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara)* leaf powder mixed in the ratio of 5:4:1) @ 3g kg^{-1} as eco – friendly treatment.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 - 9%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 6-7%.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content less than 5 %.

Other management practices

- As in crop management technique

CASTOR (*Ricinus communis*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

DISTRICT/SEASON	VARIETIES
A. Rainfed	
1. Adipattam (Jun-July)	
All districts	Variety : TMV 5, TMV 6 Hybrid : TMVCH 1, YRCH 1
B. Irrigated	
1. Vaigasi pattam (May - June)	
All distiricts	Hybrid : YRCH 1
2. Karthigaipattam (Nov - Dec)	
All districts	Hybrid : YRCH 1
3. Panguni pattam (March- Apr)	
All districts	Hybrid : YRCH 1
C. Gardenland (border)	
1. Perennial	
All districts	Variety : CO 1

I. DESCRIPTION OF CASTOR VARIETIES

Particulars	CO 1	TMV 5	TMV 6	Hybrid TMVCH 1	Hybrid YRCH 1
Parentage	Pureline selection from Anamalai perennial	Derivative of SA 2 X S 248/2	Derivative of VP 1 X RC 962	LRES 17 X TMV 5	DPC 9 X TMV 5
Duration (days)		120	160	160 -170	150-160
Yield (kg/ha)					
Rainfed (mixed crop)	-		500	600	
Rainfed (pure crop)	2.5 kg/tree/year	850	950	1300	2000
Irrigated (pure crop)	-	-	-	-	3000
Oil content (%)	57	50	51.9	51.7	49
Special features					
Stem colour	Pinkish green	Rose	Red	Red	Light red
Bloom (waxy coat)	No bloom	Triple	Double	Triple	Triple
Receme/ capsule	Bold, sparse setting, non dehiscent	Spiny, non dehiscent, resistant to leaf hopper	Medium, lengthy , spiny capsule	Semi compact, spiny capsule	Spiny, non dehiscent, resistant to leaf hopper
Suitability	Bund crop and fit for raising in vacant areas	Pure and mixed crop	Pure and mixed crop	Pure and mixed crop	Pure and mixed crop

CROP MANAGEMENT

1. PREPARATION OF THE FIELD

Plough two-three times with country or mould board plough.

2. APPLICATION OF FERTILIZERS

Spread 12.5 t/ha of FYM or compost evenly on the main field before last ploughing and incorporate in to soil by working a country plough. Apply 30 kg sulphur/ ha through gypsum at the time of last ploughing for higher castor yield.

NOTE: Do not leave FYM or compost exposed to sunlight as nutrients will be lost.

3. SEED RATE

Adopt a seed rate of 10 kg/ha for varieties and 5 kg/ha for hybrid.

4. SPACING

Adopt the following spacing.

	Rainfed situation	**Irrigated situation**
Varieties	90 cm x 60 cm	90 cm x 90 cm
Hybrids	120 cm x 90 cm	150 cm x 120 cm

In irrigated conditions, for clay soils wider spacing of 150 x 150 cm can also be adopted. For TMV 5 short duration variety 60 x 30 cm may be adopted.

5. APPLICATION OF FERTILIZERS

Apply NPK fertilizers basally as per soil test recommendations as far as possible.

If soil test recommendations are not available, follow the blanket recommendation as follows

Rainfed conditions	**Recommended NPK kg/ ha**
Varieties	45 : 15 : 15 NPK kg / ha
Hybrids	60 : 30 : 30 NPK kg / ha
Irrigated condition	
Varieties	60 : 30 : 30 NPK kg / ha
Hybrids	90 : 45 : 45 NPK kg / ha

In rainfed situations apply 100% P & 50% N&K basally & remaining quantity may be applied in one or two top dressings based on the soil moisture availability.

In irrigated situations apply 100% P & 50% N&K as basal & remaining quantity N&K may be applied in two equal splits at 30th & 60th DAS.

Apply 12.5 kg $ZnSO_4$ ha^{-1} (if the soil available Zn is < 1.2 ppm) and 25 kg $FeSO_4$ ha^{-1}(if the soil available Fe is < 3.7 ppm for non calcareous soil and < 6.3 ppm for calcareous soil)

If soil test values are not available,

Rainfed conditions	**Recommended TNAU MN mixture kg/ ha**
Varieties	7.5
Hybrids	10.0
Irrigated condition	
Varieties	12.5
Hybrids	15.0

(Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade).

6. PRE TREATMENT OF SEEDS

a) Treat the seeds with Carbendazim @ 2 g/kg of seed. b) Soak the seeds in water for 20 hours.

b) In rainfed situations, seed priming with 1% Kcl for 3 hours and sowing a week before onset of monsoon is recommended.

7. SOWING

a) Sow the seeds adopting the recommended spacing. b) Place the seeds at depth 4 - 6 cm. c) Put two seeds in each hole.

8. GAP FILLING

Gap fill on the 15th day of sowing and simultaneously thinning may be done leaving one healthy plant.

9. WEED MANAGEMENT

Apply pre emergence herbicide Pendimethalin @ 3 lit/ha or Fluchloralin @ 2 lit/ha on 3 DAS followed by hand weeding twice on 20th & 40th DAS.

10. INTERCROPPING

Raise one row of castor for every six rows of groundnut. In the case of late receipt of monsoon blackgram + castor at 6:1 ratio is recommended. Or Intercropping of castor with Blackgram or Greengram in 1:2 ratio is recommended for rainfed situation.

Intercropping of castor with onion in 1:2 ratio by adopting 1.5 m x 1.0 m spacing is recommended for irrigated situation.

11. HARVESTING THE CROP

Observe the crop considering the average duration of the variety. i) One or more capsules show sign of drying. ii) Cut the matured racemes without damaging the secondaries. iii) Dry the capsule in the sun without heaping it in the shade. iv) Use castor sheller to separate the seeds or beat the dried capsule with wooden planks, winnow and collect the seeds.

CROP PROTECTION

A. Pest management

Pests	Management strategies
Capsule borer *Conogethus punctiferalis*	▪ **Spray any one of the following insecticides, thrice from flowering at three weeks interval** : Malathion 50 EC 2.0 l /ha Carbaryl 50 WP 2.0 kg / ha in 1000 l of water
Semiloopers *Achaea janata* *Paralellia algira*	▪ **Spray any one of the following insecticides thrice from flowering at three weeks interval** : Malathion 50 EC 2.0 l / ha Carbaryl 50 WP 2.0 kg / ha in 1000 l of water ▪ Apply neem seed kernel extract 5% + Neem oil 2%

Botrytis ricini

- Removal and destruction of affected spikes.

During cloudy weather and rainy season, prophylactic spray of carbendazim 2g/l of water twice at 15 day interval (or) Prophylactic spray of *P. fluorescens* @ 2g/l and second spray after a fortnight.

SEED PRODUCTION

Varietal seed production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 155 m all around the field from the other varieties / hybrids of the crop.

Season

- June-July and September-October.

Pre-sowing seed treatment

- Harden the seed with 2 % KH_2PO_4 for 16 h (seed to solution ratio 1:1) and coat with pink polymer @ 3 g + carbendazim @ 2 g + imidachloprid@ 5 ml + *Pseudomonas fluorescens* @ 10 / kg of seed.

Fertilizer requirement

- Apply NPK @ 90:70:70 kg ha^{-1}as basal.

Spacing

- 90 cm X 30 cm.

Harvesting

- Seeds attained physiological maturity at 45 days after 50% flowering. At that time seed coat is mottled with well developed caruncle and the capsules split slightly.
- Harvest the crop as once over harvest after drying of capsules (browning) in 80% of plants.

Threshing

- Thresh the capsules either using power operated thresher or manually by trampling or beating with pliable bamboo stick.

Seed grading

- Grade the seeds at 10% moisture content using 18/64" (7.2 mm) round perforated sieve.
- Do not select the broken and immature seed purpose.

Drying

- Dry the seed using thin layer drying at 60^0C to reduce the moisture content to 8- 7% .

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} of seed (or)
- Slurry treat seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) @ 3g kg^{-1} as eco – friendly treatment.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 7 -8%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 7 - 8 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content less than 5%.

Other management practices

- As in crop management technique.

Hybrid seed production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 150 m all around the field from the other varieties / hybrids of the crop.

Planting ratio

- Sow the female and male in the ratio of 3:1 or 4:1 for certified seed production.

Border rows

- Sow the male parents in four rows around the field for the availability of adequate pollen.

Season

- Sow the female line at first fortnight of September for production of more pistillate inflorescence , one week earlier than male line.

Fertilizer requirement

- Apply NPK @ 90:70:70 kg ha^{-1}as basal application.

Spacing

- 90 X 30 cm.

Harvesting

- The seeds attained physiological maturity at 45 days after 50% flowering. At that time seed coat will be mottled with well developed caruncle and the capsules will show the symptom of splitting.
- Harvest the racemes as once over harvest after drying of capsules (browning) in 80% of plants.
- The seeds from secondary raceme are better than primary and others.

Threshing

- Shell the seeds either using power operated thresher or manually by beating with pliable bamboo stick.
- Avoid hand operated thresher to reduce the mechanical damage

Seed grading

- Grade the seeds using two screen cleaner cum grader with top screen of 7.2mm (18/64") round perforated metal sieve for obtaining higher recovery of quality seeds

Drying

- Reduce the moisture content to 8- 10 per cent using thin layer drying at 60^0C

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} of seed (or)
- Slurry treat seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) @ 3g / kg of seed as eco – friendly treatment (or)
- Dry mix the seeds with *Achorus calamus* rhizome powder at the ratio of 1:100 for grain cum seed storage.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 7 - 8%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 7 – 8 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 5%.
- The seeds of female parent are poor storer than male and hybrid

Other management practices

- As in crop management technique.

SAFFLOWER (*Carthamus tinctorius*)

CROP IMPROVEMENT

DISTRICT/SEASON	VARIETIES
A. Rainfed	
1. Karthigaipattam (Nov-Dec)	
All districts	K 1, CO 1

I. DESCRIPTION OF SAFFLOWER VARIETIES

Particulars	K 1	CO 1
Parentage	Pureline selection from American spiny variety	Pureline selection from CTS 7403 (Non spiny)
Duration (days)	120	125
Yield (kg/ha)		
Rainfed	700	800
Oil content (%)	32	33
Special features	spiny florets, suitable for Southern districts	Non-spiny, tolerant to Alternaria, moderately resistant to wilt

CROP MANAGEMENT

III. PREPARATION OF THE FIELD

1. FIELD PREPARATION

a) Plough with tractor 2-3 times with a mould board plough or 5 times with a country plough.
b) Break the clods in between the ploughings and bring the soil to a fine tilth.

2. APPLICATION OF FYM

a) Spread 12.5 t of FYM or compost or composted coir pith per ha evenly and incorporate in the soil. b) If the manure is not applied before commencement of ploughing, spread the manure evenly before the last ploughing and incorporate in the soil.
NOTE: Do not leave the organic manure exposed to sunlight as nutrients will be lost.

3. APPLICATION OF FERTILIZERS

Apply N at 20 kg/ha basally.

4. SEED RATE

Adopt a seed rate of 10 kg/ha.

5. SPACING

Adopt a spacing of 45 cm between rows and 15 cm between plants.

6. SELECTION OF GOOD QUALITY SEEDS

Select mature good quality seeds, free from pest damage and fungal attack.

7. PRE-TREATMENT OF SEEDS WITH FUNGICIDES

a) Treat with Carbendazim or Thiram at 4 g/kg of seed in a polythene bag and ensure a uniform coating of the fungicide over the seed. b) Treat the seeds 24 hours prior to sowing.
NOTE: Seed treatment will protect the young seedlings from root rot disease in the early stage.

8. SOWING

a. Sow the seeds in line at a depth of 2 to 3 cm and cover with soil. b. Sow using gorru or country plough.

NOTE: First week of November is the best sowing time.

9. THINNING OUT SEEDLINGS

Thin out the seedlings to a spacing of 15 cm between plants on the 15th day of sowing.

10. WEED MANAGEMENT

Weeding with have hoe on 25 and 40 days after of sowing (DAS)

11. HARVESTING

i. Observe the crop considering the average duration of the crop.
ii. The leaves and entire plant loose their colour and turn brown at maturity.
iii. Cut the plants at the bottom.
iv. Keep the plants in the threshing floor and beat the plants (heads) with sticks till the mature seeds are separated.
v. Winnow the seed and dry in the sun.
vi. Collect and store the seeds in gunnies.

CROP PROTECTION

Treat with Carbendazim or Thiram at 4 g/kg of seed in a polythene bag and ensure a uniform coating of the fungicide over the seed. Treat the seeds 24 hours prior to sowing.

NOTE: Seed treatment will protect the young seedlings from root rot disease in the early stage.

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 200 m all around the field from the same and other varieties of the crop.

Spacing

- 60 x 20 m

Fertilizer

- Apply NPK @ 60:60:20 kg ha^{-1}as basal application.

Harvest

- Seeds attain physiological maturity 35 days after anthesis.
- Harvest the pods as once over harvest.

Seed grading

- Grade the seeds using BSS 6 x 6 wire mesh sieve.

Seed treatment

- Treat the seeds with halogen mixture @ 3g kg^{-1} of seed along with carbendazim @ 2 g kg^{-1} of seed.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 - 9%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 7-8 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 7%.

Other management practices

- As in crop management technique.

SUNFLOWER (*Helianthus annuus*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

DISTRICT/SEASON	VARIETIES
A. Rainfed	
1. Adipattam (Jun-July) Coimbatore, Erode, Salem, Namakkal, Tirunelveli, Dindigul, Dharmapuri, Tiruchirapalli, Perambalur, Karur	Variety : TNAUSUF 7 (CO 4), COSFV 5 Hybrid : KBSH 1, TNAU Sunflower Hybrid CO 2
2. Karthigaipattam(Oct- Nov) Cuddalore, Villupuram, Virudhunagar, Sivagangai , Ramanathapuram, Madurai, Dindigul, Theni, Tiruchirapalli, Perambalur, Karur, Tirunelveli	Variety : TNAUSUF 7 (CO 4), COSFV 5 Hybrid : KBSH 1, TNAU Sunflower Hybrid CO 2
B. Irrigated	
1. Adipattam (June-July) Coimbatore, Erode, Salem, Namakkal,Tirunelveli, Dindigul, Dharmapuri, Tiruchirapalli, Perambalur, Karur	Variety : TNAUSUF 7 (CO 4), COSFV 5 Hybrid : KBSH 1, KBSH 44, DRSH 1, TNAU Sunflower Hybrid CO 2
2. Karthigaipattam (Oct - Nov) Cuddalore, Villupuram, Virudhunagar, Sivagangai , Ramanathapuram, Madurai, Dindigul,Theni, Tiruchirapalli, Perambalur, Karur, Tirunelveli	Variety : TNAUSUF 7 (CO 4), COSFV 5 Hybrid : KBSH 1, KBSH 44, DRSH 1, TNAU Sunflower Hybrid CO 2
3. Margazhipattam (Dec-Jan) Salem, Namakkal, Dharmapuri, Erode, Coimbatore, Madurai, Dindigul, Theni, Tirunelveli, Thoothukudi	Variety : TNAUSUF 7 (CO 4), COSFV 5 Hybrid : KBSH 1, KBSH 44, DRSH1, TNAU Sunflower Hybrid CO 2
4. Chithiraipattam (April - May) Coimbatore, Erode, Dharmapuri, Salem, Namakkal, Tiruchirapalli, Perambalur, Karur	Variety : TNAUSUF 7 (CO 4), COSFV 5 Hybrid : KBSH 1, KBSH 44, DRSH1, TNAU Sunflower Hyrbid CO 2

I. DESCRIPTION OF SUNFLOWER VARIETIES

Particulars	TNAUSUF 7 (CO 4)	COSFV 5	TNAU Sunflower Hybrid CO 2
Parentage	Cross derivative of Dwarf X Surya	Cross derivative of *Helianthus annus X H. preacox*	COSF 1A X CSFI 99
Duration (days)	80-85	85-90	90-95
Yield (kg/ha)			
Rainfed	1500	1500	1950

Irrigated	1700	1700	2250
Oil content (%)	37-39	40-42	38-40
Ray floret	Light Yellow	Yellow	Light Yellow
Plant height (cm)	145-175	145-165	160-175
Seed size & colour	Black	Dark brown	Dark brown
1000 seed weight (g)	45-60	48-50	50-60
Volume weight (g/100ml)	40-42	45-48	40-45

CROP MANAGEMENT

1. FIELD PREPARATION

Plough once with tractor or twice with iron-plough or three to four times with country-plough till all the clods are broken and a fine tilth is obtained.

2. APPLICATION OF FERTILIZERS

i) Spread 12.5 t/ha of FYM or compost or composted coir pith evenly on the field before the last ploughing and incorporate in the soil by working a country plough.

If soil test recommendations are not available, follow the blanket NPK/ha for both irrigated and rainfed crops.

	Season	Blanket recommendation of Nutrients (kg/ha)		
		N	**P_2O_5**	**K_2O**
Hybrids	**IRRI**	60	90	60
	RF	*40*	*50*	*40*
Varieties	**IRRI**	60	30	30
	RF	*40*	*50*	*40*

Soil test crop response based integrated plant nutrition system (STCR- IPNS) recommendation may be adopted for prescribing fertilizer doses for specified yield targets. (ready reckoners are furnished for irrigated sunflower)

Soil : Mixed black calcareous (Perianaickenpalayam series)
Season : Rabi
Target : 20 q ha^{-1}

$FN = 9.60\,T - 0.49\,SN - 0.68\,ON$
$FP_2O_5 = 4.20\,T - 1.87\,SP - 0.80\,OP$
$FK_2O = 9.24\,T - 0.45\,SK - 0.64\,OK$

Initial soil tests (kg ha^{-1})			**NPK (kg ha^{-1}) + FYM @12.5 t ha^{-1} + *Azospirillum* @2 kg ha^{-1}**		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
160	10	200	62	43	55
180	12	220	52	40	46
200	14	240	42	36	37
220	16	260	32	32	30*
240	18	280	22	28	30*

*maintenance dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

iii) Biofertilizer : Soil application - Mix 10 packets (2000 g/ha) of Azospirillum and 10 packets(2000 g/ha) of Phosphobacteria or 20 packets of Azophos(4000 g/ha) with 25 kg FYM and 25 kg soil and apply before sowing.

3. APPLICATION OF MICRONUTRIENTS

a) Mix 12.5 kg/ha of micronutrient mixture formulated by the Department of Agriculture, Tamil Nadu with enough sand to make total quantity of 50 kg/ha.
(or)

b) For ***rainfed sunflower*** apply TNAU MN mixture @ 7.5 kg ha^{-1} as enriched FYM for variety and 10 kg ha^{-1} as enriched FYM for hybrid and for ***Irrigated sunflower*** apply TNAU MN mixture @ 12.5 kg ha^{-1} as enriched FYM for variety and 15 kg ha^{-1} as enriched FYM for hybrid (Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade).

c) Apply the mixture over the furrows and top two thirds of the ridges before sowing.

d) Do not incorporate the mixture in the soil.

i) To overcome manganese deficiency, foliar spray of 0.5% $MnSO_4$ on 30, 40 and 50th day after sowing.

ii) For zinc deficiency, apply 25 kg/ha $ZnSO_4$ as basal, or 0.5% $ZnSO_4$ spray on 30, 40 and 50th day after sowing.

4. FORMING RIDGES AND FURROWS

i. Form ridges and furrows 6 m long.
ii. Use bund-former or ridge plough to economise and
iii. Form irrigation channels across and ridges according to the topography of the field.

5. SEED RATE

	Rainfed	Irrigated
Varieties	7 kg/ha	6 kg/ha
Hybrids	5 kg/ha	4 kg/ha

6. SEED TREATMENT

Soaking seeds in 2% $ZnSO_4$ for 12 hrs and shade drying is recommended for rainfed sowing.

i) Treat the seed with *Trichoderma* @4g/kg. This can be done just before sowing. It is compatible with biofertilizers. Such seeds should not be treated with fungicides.

ii) Treat the seeds with Carbendazim or Thiram at 2 g/kg of seed.

iii) Treat the seeds 24 hours prior to sowing.

iv) Azospirillum : Use 3 packets of Azospirillum (600 g/ha) and 3 packets (600 g/ha) of Phosphobacteria or 6 packets of Azophos (1200 g/ha) for treating seeds using rice kanji as binder. Dry the treated seeds in shade for 15 minutes and sow immediately.

v) Moist hydration for 24 hours in moist gunny bags followed by drying and seed dressing with Thiram @ 2g/kg to enhance field emergence.

vi) Seeds dried to 8 - 9% moisture content, treated with Thiram @ 2g/kg and packed in polylined (300 guage) cloth bag can store upto 9 months with 70% germination.

7. SOWING

Spacing : Hybrids : 60 cm x 30cm
Varieties : 45 cm x 30cm

i) Place the seeds at a depth of 3 cm along the furrows in which the fertilizer mixture is placed and cover with soil. Put two seeds per hole.

ii) Irrigate the crop according to the different growth stages. Regulate irrigation according to the following growth phase.
Pre-sowing irrigation; Life irrigation; 20th day after sowing; Early bud development; Flowering-2 irrigations and Seed development-2 irrigations; Flowering period is critical.

8. THINNING

Thin out seedlings leaving only one healthy and vigorous seedling in each hole on the 10th day of sowing.

9. WEED MANAGEMENT

i) Apply Fluchloralin @ 2.0 lit/ha before sowing and incorporate or apply as pre-emergence spray on 3rd day after sowing followed by irrigation or apply Pendimethalin @ 3.3 lit/ha as pre-emergence spray 3 days after sowing. The spray of these herbicides has to be accomplished with Back Pack/Knapsack/Rocker sprayer fitted with flat fan nozzle using 900 lit water/ha as spray fluid.
All the herbicide application is to be followed by one late hand weeding 30 - 35 days after sowing.

ii) Hoe and hand weed on the 15th and 30th day of sowing and remove the weeds. Allow the weeds to dry for 2 - 3 days in the case of irrigated and then give irrigation.

10. WATER MANAGEMENT

Irrigate immediately after sowing followed by an irrigation on 4 - 5th day and later at intervals of 7 to 8 days according to soil and climatic conditions, seeding, flowering and seed development stage (ie) two weeks before and after flowering.

11. SPRAYING NAA

i) Spray the hormone Napthalene Acetic Acid (NAA) at 20 ppm concentration (280 g NAA in 625 litres of water per ha) on the 30th and 60th day of sowing.
ii) Use a high volume sprayer and give a thorough coverage of the entire plant.
iii) Do not use brackish water.

12. SULPHUR FERTILIZATION

Apply sulphur @ 20 kg/ha through ammonium sulphate or single super phosphate. Or apply gypsum@ 200kg/ha as basal

13. Boron application

Spray borax @ 0.2 % (2g/l of water) to capitulum at ray floret opening stage to improve seed set and seed filling.

14. IMPROVING SEED SET BY MECHANICAL MEANS

a. During the mid flowering phase, improve pollination by :
   i. Mild rubbing of the capitulum with the hand covered with soft cloth or
   ii. Rubbing two flowers face to face gently.
b. The mid-flowering phase are: 58 to 60 days of planting for long duration varieties, 45 to 48 days of planting for short duration varieties.
c. Do this operation in the morning hours between 9.0 and 11.00 am when pollen shedding is high.
d. Keeping bee hives at the rate of 5/ha improves seed setting.

15. JUDGE WHEN TO HARVEST

Observe the bracts on the backside of the capitula. When they turn lemon yellow, the heads harden and the crop is ready for harvest.

Bird damage: Use of reflective ribbons scares the birds effectively and thus prevents loss of grain.

16. HARVESTING

i. Cut the capitula (flower heads) only

ii. Thresh and clean

a. Immediately after harvest, dry the heads in the sun for 3 days.

b. Spread the heads in thin layer and give turning once in 3 hours.

NOTE: Do not heap or store the heads before drying properly as mould fungi will develop and spoil the grain quality.

c. Thresh using a mechanical thresher, or beat with a stick and separate the grains.

d. Winnow and clean the seeds

e. Dry the seeds again in the sun for another two days

f. Store in gunny bags

CROP PROTECTION

A. Pest management

Pests	Management strategies
Weevil *Myllocerus* spp.	▪ Hand pick the *Helicoverpa* larvae and destroy. ▪ **Spray any of the following insecticides :** Dichlorvos 76EC 500 ml/ha Phosalone 35 EC 1000 ml/ha ▪ **Dust any one of the following :** Phosalone 4 D 25 kg/ha ▪ Insecticidal application at the time of bee visit is toxic to honey bees. So, apply the insecticides after 4 pm when the bee activity is minimum. ▪ Do not spray insecticides on the same day when NAA is sprayed
Tobacco cut worm *Spodoptera litura*	
Gram pod borer *Helicoverpa armigera*	
Leaf hopper *Amrasca devastans*	▪ Treat seed with imidacloprid 70 WS at 7 g/kg protected the sunflower plants from leaf hopper upto 7 weeks. ▪ Spray Imidacloprid 70% WS 490 ml/ha Imidacloprid 17.8%SL 100 ml/ha
Whitefly	▪ Spray Imidacloprid 70% WS 490 ml/ha Imidacloprid 17.8%SL 100 ml/ha Malathion 50 EC 500 ml/ha
Thrips	▪ Spray Imidacloprid 17.8%SL 100 ml/ha

B. Disease management

Seed treatment: Treat the seeds with any one of the following:
T. viride @ 4g/kg of seed,Thiram @ 4g/kg of seed,Carbendazim @ 2g/kg of seed

Alternaria leaf spot: *Alternaria helianthi*	Spray Mancozeb 1000 g/ha
Rust: *Puccinia helianthi*	Spray Mancozeb 1000 g/ha
Charcoal rot: *Macrophomina phaseolina (Rhizoctonia bataticola)*	• Soil application of *P. fluorescens* or *T. viride* – 2.5 Kg / ha + 50 Kg of well decomposed FYM or sand at 30 days after sowing. • Spot drenching with Carbendazim @ 1 gm/ litre
Head rot: *Rhizopus sp*	• Spray Mancozeb 1000g/ha in case of intermittent rainfall at the head stage, directing the spray to cover the capitulum. • Repeat fungicidal application after 10 days if humid weather continues
Necrosis virus disease: *Tobacco streak*	• Raise sorghum as border crop (One month prior

virus (Ilarvirus) Vector: Thrips	to sunflower sowing) • Imidacloprid seed treatment 2g/kg % Imidacloprid foliar spray at 30 & 45 DAS.

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 200 m all around the field from the same and other varieties /hybrids of sunflower

Spacing

- 45 x 30 cm

Pre-sowing seed treatment

- Soak the seeds in water at 1:1 seed to solution ratio by volume for 16h and dry dress with thiram @ 2.5g kg^{-1} of seed for enhanced seed germination and field establishment (or)
- Soak the seeds with 2% KH_2PO_4 for 16 h and dry back to original moisture content and coat with polymer @ 3 ml/kg + imidachloprid@ 5 ml / kg + carbendazim @ 2 g / kg + *Pseudomonas fluorescens* @ 10 g/kg (or)
- Soak seeds in 2 % KNO_3 for 6 h in 1:1 seed to solution ratio and dry back to original moisture content.

Fertilizer

- Apply NPK @ 60:45:45 kg ha^{-1} as basal application.

Foliar application

- At the stage of button opening, spray 0.5% borax for increased seed set.

Supplementary pollination

- During flowering (7-10 days), rub the heads with muslin cloth between 8 – 11 AM at alternate days till the completion of flowering.

Harvesting

- Harvest the heads when the drooping peduncular receptacle (thalamus) turns lemon or pale yellow in colour. At this stage the seed moisture content will be 25 % and the seeds will be black in colour.
- Harvest the heads and dry immediately until the seed moisture content reduced to 15 – 16 %.
- Separate the seeds either with mechanical thresher or by manual labour.

Seed grading

- Grade the seeds using 9/64" (3.6 mm) round perforated metal sieve or BSS 7 x 7 wire mesh sieve.
- Upgrade the size graded using specific gravity separator.
- Remove the broken and dehulled seed from the lot.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} of seed along with carbaryl @ 200 mg kg^{-1} of seed.

- Slurry treat the seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu leaf powder mixed in the ratio of 5:4:1) @ 3g kg^{-1}as eco – friendly treatment.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 - 9%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 7 – 8 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content less than 7%.

Hybrid Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 400 m all around the field from the same and other varieties / hybrids of sunflower.

Planting ratio

- Sown the female and male in the ratio of 4:1 or 3:1 for certified seed production.

Border rows

- Sow the male parents in four rows around the field for the availability of adequate pollen.

Harvesting

- Harvest the crop, as once over harvest, but harvest 'R' lines first and remove from the field before harvesting the (hybrid) female plants.

Other management practices

- The techniques recommended for varieties can be adopted.

COCONUT (*Cocos nucifera*)

1. VARIETIES AND HYBRIDS

a. Varieties

i. East Coast Tall
ii. West Coast Tall
iii. VPM-3 (Selection from Andaman Ordinary Tall)
iv. ALR (CN -1) (Selection from Arasampatty Tall)
v. COD (Dwarf for tender coconut purpose only)

b. Hybrids

Tall x Dwarf

(To be grown under well managed conditions)

i. VHC 2 - ECT X MYD
ii. VHC 3 - ECT X MOD

(Besides, the hybrids of ECT x COD, WCT x COD and WCT x MYD are also produced by the State Department of Agriculture. The dwarf x tall type (COD x WCT) which has to be grown under well-managed conditions with assured irrigation is also produced by State Department of Agriculture).

Particulars of new varieties and hybrids

Sl.No.	Characters	VHC 2	VPM 3	VHC 3	ALR (CN) 1
1.	Year of release	1988	1994	2000	2002
2.	Parentage	T X D hybrid ECT X MYD	Selection from Andaman Ordinary Tall	T X D hybrid ECT X MOD	Selection from Arasampatti Tall
3.	Time taken for first flowering (months)	43	63	46	48
4.	Shape of the nut	Medium oblong nuts	Big oblong nuts	Medium to oblong big nuts	Small to medium oblong nuts
5.	Nut yield (nuts/palm/year)	142	92	156	126
6.	Copra content (g/nut)	152	176	162	131
7.	Copra yield (kg/palm/year)	21.5	16.2	25.2	16.5
8.	Oil content (%)	70.2	70.0	70.0	66.5
9.	Special features	High yield and oil content	High copra content Drought tolerant Suitable for rainfed and irrigated condition	High nut & copra yield and oil content	Drought tolerant. Suitable for rainfed and irrigated condition

2. CROP MANAGEMENT

a. Soil

Red sandy loam, laterite and alluvial soils are suitable. Heavy, imperfectly drained soil is unsuitable.

b Planting seasons

June-July, December - January. The planting can also be taken up in other seasons wherever irrigation and drainage facilities are available.

c. Spacing

Adopt a spacing of 25' x 25' (7.5 x 7.5 m) with 175 plants/ha. For planting in field border as a single row, adopt 20' spacing between plants.

d. Planting

Dug pit size of 3' x 3' x 3'. In the pits, sprinkle Lindane 1.3 % D to prevent white ant damage. Fill the pit to a height of two feet (60 cm) with FYM, red earth and sand mixed in equal proportions. At the center of the pit, remove the soil mixture and plant the seedling after removing all the roots. Press the soil well around the seedling and provide the seedling with shade by using plaited coconut leaves or palmyrah leaves. Keep the pits free from weeds. Remove soil covering the collar region. As the seedlings grow and form stem, fill up the pits gradually by cutting the sides.

e. Water management

From 5th year onwards, adopt the following irrigation schedule based on pan evaporation for drip irrigation and basin irrigation.

Western region

Months	Normal condition (for best yield)	Moderate water scarcity condition	Severe water scarcity condition
A. Drip irrigation			
February to May	65 lit / day	45 lit/ day	22 lit / day
January, August and September	55 lit / day	35 lit / day	18 lit/day
June and July, October to December	45 lit / day	30 lit/ day	15 lit / day
B. Basin irrigation			
February to May	410 lit / 6 days *		
January, August and September	410 lit /7 days*		
June and July, October to December	410 lit /9 days*		

Eastern region

Months	Normal condition (for best yield)	Moderate water scarcity condition	Severe water scarcity condition
A. Drip irrigation			
March - September	80 lit / day	55 lit / day	27 lit/day
October – February	50 lit / day	35 lit/ day	18 lit /day
B. Basin irrigation			
March – September	410 lit / 5 days*		
October – February	410 lit /8 days*		

* Quantity of water to be applied in the basin. Add 30-40 % Of the above quantity of water (135 -165 litres/palm) to meet the conveyance loss.

For drip irrigation, open four pits size of 30 x 30 x 30 cm opposite to each other at one meter distance from the trunk. Place 40 cm long PVC conduit pipe (16 mm) in a slanting position in each pit and place the drippers inside the conduit tube and allow the water to drip 30 cm below the soil surface. Fill the pits with coir pith to prevent evaporation.

In the first year, irrigate on alternate days and from the second year to the time of maturity irrigate twice in a week based on the water requirement.

Drought management and soil moisture conservation

a. Mulching with coconut husks/leaves/coir pith

Apply coconut husks with convex surface facing upwards (100 Nos.) or dried coconut leaves

(15 Nos) or coir pith up to a height of 10 cm in the basin of 1.8 m radius around the palms as mulch for soil moisture conservation particularly during summer season.

b. Burial of coconut husk or coir pith

Husk burial can be done in coconut basins or in the interspaces to overcome drought and button shedding. Bury husks @ 100 Nos. with concave surface facing upwards or 25 kg of coir pith /palm in circular trenches, dug 30 cm width and 60 cm depth at 1.5 metres radius. The husk can be also buried in the trenches at a distance of 3 m from the palm with a size of 45 cm deep and 150 cm width in between two rows of coconut. The soaking of the coconut husk or coir pith as the case may be preserves the monsoon rains.

c. Manuring

From 5 th year onwards, apply 50 kg of FYM or compost or green manure. 1.3 kg urea (560 g N), 2.0 kg super phosphate (320 g P_2O_5) and 2.0 kg muriate of potash (1200 g K_2O) in two equal splits during June – July and December – January. Apply manures and fertilizers in circular basins of 1.8 m from the base of the palm, incorporate and irrigate. During 2nd, 3rd and 4th year ¼, ½ and ¾ doses of the above fertilizer schedule should be adopted respectively. Sufficient moisture should be present at the time of manuring. Fertigation may be done at monthly intervals with 75% of the recommended dose of the above fertilizers. Phosphorous may be applied as super phosphate in the basins and incorporated or as DAP through drip when good quality of water is available. TNAU micronutrient mixture is recommended @ 1.0kg/tree/year.

TNAU Coconut Tonic Nutrition

For nut bearing coconut, root feed TNAU coconut tonic @200ml/palm once in six months.

Bio-fertilizer recommendation

- 50 g of Azospirillum
- 50 g of Phosphobacteria (or) 100 g Azophos
- 50 g of VAM

Mix all the contents in sufficient quantity of compost or FYM and apply near feeding roots once in 6 months / palm starting from planting. Don't mix with chemical fertilizers and pesticides

Organic recycling

Any one of the green manure crops like sunnhemp, wild indigo, calapagonium or daincha may be sown and ploughed *in situ* at the time of flowering as a substitute of compost to be applied. Sow sunnhemp @ 50 g/palm in the basin and incorporate before flowering. Coir pith compost/vermicompost made from coir pith/ coconut leaves/ other wastes from coconut grove can be applied.

7. INTER-CULTURAL OPERATION WEED MANAGMENT

The inter-space in the coconut garden has to be ploughed twice in a year in June-July and December - January. Intercultural operation is essential to keep weed population under check, to enhance the utilisation of the applied plant nutrients by the coconut trees, to facilitate proper aeration to the roots of coconut, to induce fresh root growth.

Weed management

For the broad-leaved weeds, pre-emergence spraying of atrazine @1.0 kg a.i./ ha for the control of grasses and sedges. Post emergence spraying of glyphosate @ 10 ml and 20 g ammonium sulphate/litre of water.

8. INTER CROPPING

Inter/mixed crops may be selected based on the climatic requirement of the inter/mixed crop, irrigation facilities and soil type. The canopy size, age and spacing of the coconut are also to be considered. Market suitability should be taken into consideration before selecting an intercrop.

A. Below 7 years of age: Any suitable annual crop for particular soil type and climatic condition may be raised as intercrops upto 5 years after planting depending upon the canopy coverage. Groundnut, sesamum, sunflower, tapioca, turmeric and banana can be grown. Avoid crops like paddy and sugarcane etc.

B. 7 – 20 years of age: Green manure crops and fodder crops (Napier grass and guinea grass) alone can be grown.

C. Above 20 years of age (20 years of age has to be adjusted based on the sunlight transmission of above 50% inside the canopy): The following crops can be grown depending on the soil and climatic suitability.

(i) Annuals	:	Groundnut, bhendi, turmeric, tapioca, sweet potato, sirukizhangu, elephant foot yam, ginger, pineapple
(ii) Biennials	:	Banana. Varieties Poovan and Monthan are suitable.
(iii)Perennials	:	Cocoa*, pepper* (Panniyur 1 or Panniyur 2 or Panniyur 5 or Karimunda), nutmeg* and vanilla*

*Suitable areas in Pollachi tract of western region and Kanyakumari district. For vanilla, use disease free planting material and maintain high vigilance to maintain a disease free crop.

Multiple cropping system

Coconut + banana + sirukizhangu + bhendi is suitable system for the eastern region. Crops like banana, pepper, cocoa, nutmeg, vanilla can be tried under multiple cropping system in suitable areas in the western region. In all the systems, apply recommended quantity of water and manures and fertilizers to the intercrops separately.

CROP PHYSIOLOGY

Root feeding of TNAU Coconut Tonic @ 200 ml / palm twice a year at six months interval decreases button shedding and increases the number and size of nuts.

CROP PROTECTION

3. PEST AND DISEASE MANAGMENT
A. Pest management

Pests	Management strategies
Rhinoceros beetle *Oryctes rhinoceros*	▪ Remove and burn all dead coconut trees in the garden (which are likely to serve as breeding ground) to maintain good sanitation. ▪ Collect and destroy the various bio-stages of the beetle from the manure pits (breeding ground of the pest) whenever manure is lifted from the pits. ▪ Incorporate the entomopathogen i.e, fungus (*Metarrhizium anisopliae*) in manure pits to check the perpetuation of the pest. ▪ Soak castor cake at 1 kg in 5 l of water in small mud pots and keep them in the coconut gardens to attract and kill the adults. ▪ Treat the longitudinally split tender coconut stem and green petiole of fronds with fresh toddy and keep them in the garden to attract and trap the beetles. ▪ Examine the crowns of tree at every harvest and hook out and kill the adults. ▪ For seedlings, apply 3 naphthalene balls/palm weighing 3.5 g each at the base of inter space in leaf sheath in the 3 inner most leaves of the crown once in 45 days. ▪ Set up light traps following the first rains in summer and monsoon

	period to attract and kill the adult beetles. ▪ Field release of Baculovirus inoculated adult rhinoceros beetle @ 15/ha reduces the leaf and crown damage caused by this beetle. ▪ Apply mixture of either neem seed powder + sand (1:2) @150 g per palm or neem seed kernel powder + sand (1:2) @150 g per palm in the base of the 3 inner most leaves in the crown ▪ Place phorate 10 G 5 g in perforated sachets in two inner most leaf axils for 2 times at 6 months intervals. ▪ Set up rhinolure pheromone trap @ 1/ 2 ha to trap and kill the beetles.
Black headed caterpillar *Opisina arenosella*	▪ The incidence of the pest is noticed from the month of November to May and from August to November after rainfall. The coconut trees of all ages are attacked. • Release the larval (*Bethylid, Braconid* and *Ichneumonid*) and pupal (*Eulophid*) on (chalcid) parasitoids and predators periodically from January, to check the build up of the pest during summer. ▪ Among the larval parasitoids, the bethylid *Goniozus nephantidis* is the most effective in controlling the pest. The optimum level of release is 1:8 of host-parasitoid ratio. The parasitoid should be released @3000/ha under the coconut trees when the pest is in the 2nd or 3rd instar larval stage. Parasitoid release trap may be used to release the parasitoid at the site of feeding. Parasitoids should not be released in the crown region since they will be killed by predators like spiders and reduviid bugs. ▪ Remove and burn all affected leaves/leaflets. ▪ Spray malathion 50 EC 0.05% (1mi/lit) to cover the undersurface of the leaves thoroughly in case of severe epidemic outbreak of the pest in young palms. ▪ **Root feeding for the control of coconut Black headed caterpillar:** Select a fresh and live root, cut sharply at an angle and insert the root in the insecticidal solution containing monocrotophos 36 WSC 10 ml + water 10 ml in a 7 x 10 cm polythene bag. Secure the bag tightly to the root with a cotton thread. Twenty four hours later, check whether there is absorption. If there is no absorption select another root. These methods should not be resorted to as a routine practice and it is suggested only for cases of severe epidemic outbreak of the pest and when the survival of the tree is threatened.
Red palm weevil *Rhynchophorus ferrugineus*	▪ Remove and burn all wilting or damaged palms in coconut gardens to prevent further perpetuation of the pest. ▪ Avoid injuries on stems of palms as the wounds may serve as oviposition sites for the weevil. Fill all holes in the stem with cement. ▪ Avoid the cutting of green leaves. If needed, they should be cut about 120 cm away from the stem. ▪ Fill the crown and the axils of top most three leaves with a mixture of fine sand and neem seed powder or neem seed kernel powder (2:1) once in three months to prevent the attack of rhinoceros beetle damage in which the red palm weevil lays eggs. ▪ Setting up of attractant traps (mud pots) containing sugarcane molasses 2½ kg or toddy 2½ litres + acetic acid 5 ml + yeast 5 g + longitudinally split tender coconut stem/logs of green petiole of leaves of 30 numbers in one acre to trap adult red palm weevils in large numbers. ▪ Install pheromone trap @1/2 ha ▪ **Root feeding**: As under black headed caterpillar
Termites *Odontotermes obesus*	▪ Locate termite mounds in or near the coconut nursery or garden and destroy. ▪ Swabbing with neem oil 5% once on the base and upto 2 m height of

	the trunk for effective control. ▪ Spray copper sulphate 1% or cashew nut shell oil 80% or spray chlorphyriphos @ 3ml/lit of water, neem oil 5% or NSKE 20% to preserve plaited coconut leaves from the termite attack.
Scale insect *Aspidiotus destructor*	▪ Pluck mature nuts and spray monocrotophos 36 WSC 1 ml/ha. ▪ Do not harvest nuts for 45 days after spraying.
Mealy bugs *Pseudococcus longispinus*	▪ Remove leaflets harbouring these insects and destroy them ▪ **Spray any one of the following :** Malathion 50 EC 2 ml/lit Dimethoate 30 EC 1 ml/lit Methyl demeton 25 EC 1 ml/lit Phosphamidon 40 SL 1.25 ml/lit Monocrotophos 36 WSC 1 ml/lit Neem oil 30ml/lit.
Leaf caterpillars *Turnaca acuta* **Nut caterpillar** Nut coreid bug	▪ Collect and destroy the immature stages of the insects by conducting study (or neem compaign) wherever possible and spray carbary 50 WP 2 gm/lit . ▪ Root feeding with monocrotophos 36 WSC @ 10 ml + 10 ml water at 45 days interval for 3 times for control of leaf caterpillar. ▪ Set up light trape to trap and collect adult moths ▪ Spray Dichlorvas 76 WSC 2 ml / lit.
Slug caterpillar *Contheyla rotunda*	**Spray any one of the following:** ▪ Dichorvos 76 WSC 2 ml/lit ▪ *Bacillus thuringiensis* 2 g/lit, ▪ Triazophos 40 EC 5 ml ▪ Methyl demeton 25 EC 4 ml/lit ▪ Root feeding with monocrotophos 15 ml + 15 ml of water
Scolytid bark borer beetles *Xyleborus parvulus*	▪ Stem injection through a stove wick soaked in 0.2% dichlorvos and plugging the hole and repeating the treatment using the same wick and hole a month after.
Palm civet *Vivera zibatha*	▪ Poison baiting with ripe banana fruit sandwiched with 0.5 g carbofuran 3 G granules.
Rat *Rattus rattus wroughtoni*	▪ Tree banding with inverted iron cones or Prosophis thorns. Baiting with bromodialone 0.005% at 10 g/tree at crown region twice at an interval of 12 days.

Special problem : Coconut eriophyid mite (*Aceria guerreronis*)

Package of recommendations for the management of the coconut eriophyid mite

- **Manurial and fertilizer recommendation (Soil application/tree/year)**
  Urea 1.3 kg
  Super phosphate 2.0 kg
  Muriate of potash* 3.5 kg
  * Increased quantity is recommended to increase the plant resistance to the mite.
  Neem cake application @ 5 kg
  Organic manure (well rotten FYM) @ 50 kg

- **Micronutrients** (Soil application / tree / year)
  Borax 50 g
  Gypsum 1.0 kg
  Magnesium sulphate 500g
  Grow sunnhemp as intercrop twice a year (Seed rate 30 kg/ha)

Spot application of ecofriendly Botanicals

Round	Eco-friendly Botanical	Quantity / tree
1.	Azadirachtin 1%	5 ml in one lit. of water
2.	Neem oil + Teepol	30 ml in one lit. of water
3.	Azadirachtin 1%	5 ml in one lit. of water

Method of application

- The botanicals should be applied in the sequence indicated above at 45 days interval using a one litre hand sprayer. Rocker or Pedal sprayer can be used for spraying small trees.
- The spray should be applied at the crown region by a climber covering only the top six bunches during non rainy season.
- The bunches must be covered well by the spray fluid and approximately one litre of spray fluid may be required per tree

Precautions and safety measures

- Spraying should be avoided during windy season to prevent contamination.
- At the time of spraying, protective mask and clothing should be used.
- Wash face and hands cleanly with soap after spraying.

Basal stem rot: *Ganoderma lucidum*	• Soil application of *Pseudomonas fluorescens* (Pf1) @ 100 g/palm + *Trichoderma viride* @ 100 g/palm/year (or) *Bacillus subtilis* (TNAU-Bs 1 mixture) @300g/ palm at 3 months interval. • Apply 200g phosphobacteria and 200 g Azotobactor mixed with 50 kg of FYM/palm • Green manure crops must be raised and ploughed *in situ* • Neem cake 5 kg/tree must be applied along with fertilizers • Aureofungin-sol 2 g + 1 g Copper sulphate in 100 ml water or 2 ml of Tridemorph in 100 ml water applied as root feeding (The active absorbing root of pencil thickness must be selected and a slanting cut is made. The solution to be taken in a polythene bag or bottle and the cut end of the root should be dipped in the solution). • Forty litres of 1% Bordeaux mixture should be applied as soil drench around the trunk in a radius of 1.5 metre
Bud rot: *Phytophthora palmivora*	• The infected tissues from the crown region should be removed and dressed with Bordeaux paste. • Spray 1% Bordeaux mixture or 0.25% copperoxy chloride on the crown region as pre-monsoon spray.

Stem bleeding disease: *Thielaviopsis paradoxa*	• The bark of the trunk should be removed in the bleeding area and Bordeaux paste should be applied.
Lethal leaf blight (LLB): *Lasiodiplodia theobromae*	• Spray 1.0 per cent Bordeaux mixture or 0.25 per cent Copper oxychloride or 0.2 per cent Mancozeb (4 times at monthly interval during February, March, April and May). • Root feeding with 2 ml of Tridemorph in 100 ml water for grown up trees.

Preparation of 1% Bordeaux mixture

A quantity of 400 g of copper sulphate should be dissolved in 20 litres of water and 400 g of lime in another 20 litres of water separately. The copper sulphate solution should be added to the lime solution constantly stirring the mixture. Earthen or wooden vessels alone should be used and metallic containers should not be used. To find out whether the mixture is in correct proportion, a polished knife should be dipped in the mixture for one minute and taken out. If there is reddish brown deposit of copper, additional quantity of lime should be added till there is no deposit in the knife.

Preparation of Bordeaux paste

Take 200 g of Copper sulphate and dissolve it in one litre of water and 200 g of lime in one litre of water separately. Both are mixed simultaneously in a third vessel and the resultant mixture can be used as a paste.

SPECIAL PROBLEMS IN COCONUT

1. Rejuvenation of existing garden

The low yield in vast majority of gardens is due to thick population, lack of manuring and irrigation. These gardens could be improved if the following measures are taken.

i. **Thinning of thickly populated gardens**: In the farmer's holdings where thick planting is adopted, many trees give an yield of less than 20 nuts/palm/year. By cutting and removal of these trees, the yield could be increased. Besides, there is saving in the cost of cultivation and increase in net profit. After removal of low yielding trees, the populations should be maintained at 175 palms/ha.

ii. **Ensuring adequate manuring and irrigation**: The yield can be increased in the existing gardens when manuring + irrigation + cultural practice is adopted as per recommendation.

2. Pencil point disorder (Micronutrient deficiency)

Because of micronutrient deficiency, the stem will taper towards its tip with lesser number of leaves. The leaf size will be greatly reduced and the leaves will be pale and yellow in colour. Along with the recommended fertilizer dose, 225 g each of Borax, Zinc sulphate, Manganese sulphate, Ferrous sulphate, Copper sulphate and 10 g of Ammonium molybdate may be dissolved in 10 litres of water and poured in the basin of 1.8 m radius. This disorder can be corrected if noticed early. Severely affected palms may be removed and replanted with new seedlings.

3. Button shedding

Shedding of buttons and premature nuts may be due to any one of the following reasons:

i) Excess acidity or alkalinity
ii) Lack of drainage
iii) Severe drought
iv) Genetic causes
v) Lack of nutrients

vi) Lack of pollination
vii) Hormone deficiency
viii) Pests
ix) Diseases

The following remedial measures are suggested.

a. Rectification of soil pH

Excess acidity or alkalinity of soil may cause button shedding. If the soil pH is less than 5.5, it is an indication of excess acidity. This could be rectified by adding lime. Increase in alkalinity is indicated by soil pH higher than 8.0. This situation could be rectified by adding gypsum.

b. Providing adequate drainage facilities

Lack of drainage results in the roots of coconut trees getting suffocated for want of aeration. Shedding of buttons occur under such condition. Drainage channels have to be dug along the contours to drain the excess water during rainy season.

c. Management of young coconut gardens under waterlogged conditions

(i) A trench between two rows of young coconut palms should be dug during onset of the monsoon rains. The size of the trench is 3 m width, 30 – 45 cm depth to entire length of field. The soil excavated from the trench should be placed along the rows of palms to make a raised bed.
(ii) Form mound around the young palms to a radius of 1.2 m width with height of 30 –45 cm.

d. Genetic causes

In some trees button shedding may persist even after ensuring adequate manuring, irrigation and crop pest and disease management. This is an indication of inherent defect of the mother palm from which the seed material was obtained. This underlines the need for proper choice of superior mother palm for harvesting seed coconut to ensure uniformly good yielding trees.

e. Lack of nutrition

Button shedding occurs due to inadequate or lack of manuring. The recommended dose of manurial schedules and proper time of application are important to minimise the button shedding. Apply extra 2 kg of muriate of potash with 200 g of Borax/palm over and above the usual dosage of fertilizer to correct the barren nuts in coconut for period of 3 years.

Boron deficiency or crown choke disorder : Apply 200 g of borax/palm/year in two splits.

f. Lack of pollination

Button shedding also occurs due to lack of pollination. Setting up of beehives @ 15 units/ha may increase the cross pollination in the garden. Further the additional income obtained through honey, increases the net profit per unit area.

g. Hormone deficiency

The fertilised female flowers i.e., buttons shed in some cases. By spraying 2, 4- D at 30 ppm or NAA 20 ppm (2,4-D 30 mg or NAA 20 mg per litre of water) on the inflorescence one month after opening of the spathe, the setting percentage could be increased.

h. Pests

Button shedding may happen due to the attack of bug. Spraying of systemic insecticides like Methyldematon 0.025% (1ml/lit) or Dimethoate 0.03% (1ml/lit) may reduce the occurrence.

i. Diseases

Button shedding also occurs due to disease incidence such as basal stem rot. Adoption of control measures suggested for the disease reduces not only spread of the disease but also prevents shedding of buttons.

COCONUT MOTHER PALM SELECTION AND NURSERY MANAGEMENT

The need collecting seed materials from high yielding coconut palms is highly essential in a perennial crop like coconut.

The following points may be remembered.

Mother palm selection

1. Select seed gardens, which contain large proportion of high yielding trees with uniformity in yielding ability. Trees growing closer to households, cattle shed, compost pits and other favorable conditions should be avoided.
2. High yielding mother palms giving not less than 100 nuts/palm/annum should be chosen for collecting seednuts. Alternate bearers should be avoided. The age of the palm chosen be middle age i.e., from 25 to 40 years. Even trees with 15 years age can be selected, if it is high yielding and has stabilized yield.
3. The mother palm should have straight trunk, spherical or semi spherical crown, high rate of leaf and spathe production, short and stout petiole, more number of female flowers regular bearing habit, non – buckling bunches, high setting parentage, medium in nut size, high copra outturn and free from pest and diseases. A good regular bearing mother palm produces on an average one leaf and an inflorescence in its axil every month. So, there will be twelve bunches of varying stages of maturity at any one time. Avoid trees producing habitually barren nuts.
4. Harvest seednuts during the months of February - August to get maximum germination and good quality seedlings. Harvest the bunches intended for seednut by lowering them to the ground using a rope to avoid injury to seednuts
5. The seednuts should be round in shape and when tapped by finger should produce metallic sound. Fully ripe nuts develop twelve months after fertilisation.
6. To get more quality seedlings, the seednuts of tall and hybrid are to be air cured for one month followed by sand curing for two months. For dwarf varieties, the air curing should be lesser than one month followed by sand curing for two months.

Nursery management

1. Select nursery area in a well drained plot with coarse texture soil near water source for irrigation. Nursery can be raised in the open space with artificial shade or in the adult coconut garden.
2. Plant seednuts in a long and narrow beds at a spacing of 30 x 30 cm either horizontally or vertically in deep trenches with 20-25 cm depth. Five rows of nuts may be planted in each bed accommodating 50 nuts per row.
3. Irrigate the nursery beds once in three days.
4. Keep the nursery free of weeds. To manage the weed problem in coconut nursery, growing sunnhemp 2 times (each harvested at flowering stage) followed by one hand weeding at 6th month was found to be very effective besides yielding green manure for manuring the adult coconut palms.
5. Provide shade to the nursery by raising Sesbania or Leucaena on the sides of beds.
6. The seednuts start germination 6 – 8 weeks after planting and germination continues upto six months. Select seedlings that germinate before 5 months after planting. Remove those nuts which do not germinate 5 months after sowing.
7. Regularly survey for pest and diseases
8. Select seedlings 9 to 12 months after planting. Seedlings, which have germinated earlier, having good girth at collar and early splitting of leaflets, should be selected for planting. Do not select the so called Kakkamukku Pillai i.e., seednuts which have just germinated. Eliminate the seedlings which are deformed or having stunted growth.
9. Remove the seedlings from the nursery by lifting with spade. Do not pull out the seedlings by pulling leaves or stem.
10. Select quality seedlings with a minimum of 6 leaves and girth of 10 cm at collar.

OILPALM

INTRODUCTION

Oil palm requires evenly distributed annual rainfall of 2000 mm without a defined dry season. In areas with dry spell, a deep soil with high water holding capacity and a shallow water table augmented with copious irrigation will satisfy the water requirement of the palm.

Temperature can be a limiting factor for oil palm production Best oil palm yields are obtained in places where a maximum average temperature of 29-33 ^{o}C and minimum average temperature of 22-24 ^{o}C are available. Higher diurnal temperature variation causes floral abortion in regions with a dry season.

The crop requires 1800-2000 sunlight hours annually, more than 300 cal/cm^2 / per day, constant sunlight of atleast 5 hours per day for better oil palm yield.

Moist, deep and well drained medium textured soils rich in humus content are considered ideal. Gravelly and sandy soils, particularly the coastal sands are not ideal for oil palm cultivation. Heavy clay soils with poor drainage properties may pose problems of aeration during rainy seasons.

NURSERY AND ITS MANAGEMENT

Nursery is raised by planting germinated sprouts initially in a pre-nursery bed or in polybags in a primary nursery and transplanting them at five leaf stage to a secondary nursery of large sized polybags. Raising seedlings in large polybags without a pre-nursery stage is also being practiced.

The potting mixture is made by mixing top soil, sand and well decomposed cattle manure in equal proportions. Smaller polybags of 250 guage and 23 x 13 cm size, preferably black are used for raising primary nurseries. These bags are filled with the potting mixture leaving one cm at the top of the bag. A healthy germinated sprout is placed at the centre at 2.5 cm depth. While placing the sprout, care must be taken to keep the plumule of the sprout facing upwards and the radicle downwards in the soil. It is better to plant sprouts soon after the differentiation of radicle and plumule. The seedlings are to be watered daily. Application of a fertilizer mixture containing one part of ammonium sulphate, one part of super phosphate, one part of muriate of potash and two parts of magnesium sulphate is recommended at 15 g at one month stage, 45 g at three months stage and 60 g at six months stage per seedling. This has to be applied 6 - 8 cm away from seedlings during the first application, 10-12 cm away during second and 15-20 cm away during the third application in primary nursery. Surface soil is slightly scratched at the time of fertilizer application.

SINGLE STAGE POLY BAG NURSERY AND SECONDARY NURSERY

The germinated seeds can be directly planted into large black polybags with the advantage of avoiding the pre-nursery stage. At present the single stage polybag nursery is recommended in India. Since the plants are to remain in these polybags for more than one year, good quality polybags of 500 gauge and 40 x 45 cm size are to be used. On the lower half of the bag, perforations are made at an interval of 7.5 cm for drainage. A bag can carry 15 - 18 kg of nursery soil depending on the type of soil mixture used.

The water requirement for different stages of growth of seedlings are as follows: 0 - 2 months at 4 mm/day, 2 - 4 months at 5 mm/day, 4 - 6 months at 7 mm/day and 6 - 8 months at 10 mm/day. It is better to supply if feasible the daily requirement in two halves to prevent overflow and wastage caused by one time application. Application of 9 - 18 lit. of water per seedling per week according to the stage of growth and soil type.

FIELD PLANTING

Prepare the land for oil palm plantings at least 3 months before transplanting the seedlings to the main field. In soils with low permeability, drainage channels are to be constructed to prevent water stagnation in upper layer of soil.

AGE OF SEEDLINGS AT TRANSPLANTING

It is advisable to plant well grown seedlings of 12 - 14 months old. At this stage, a well developed tenera seedling will have a height of 1-1.3 m from base and will have more than 13 functional leaves. These seedlings were found to maintain higher leaf production, bear earlier, produce heavy bunches, give higher fruit/bunch ratio and a higher oil to mesocarp in the first year of harvest.

SELECTION OF SEEDLINGS

All deformed, diseased and elongated seedlings are to be discarded. Differences in the height of healthy seedlings ranging from 90 to 159 cm tend to even up after 14 months of transplanting to maintain.

TIME OF TRANSPLANTING

Transplanting to the main field has to be done during the onset of rainy season. In very impermeable soils and where there is chance for the seedlings to suffer severely during rainy season, proper drainage has to be ensured.

SPACING AND METHOD OF PLANTING

The optimum planting density for oil palm is the density of population that gives maximum production from unit area. Triangular system of planting with 9 x 9 x 9 m spacing accommodates 143 palms/ha. is being recommended. For efficient utilization of solar energy the rows are to be oriented in the North-South direction. Equilateral triangular system of planting with 9 m spacing between palms will allow each plant to occupy the centre of a hexagon thus allowing better use of the area.

TRANSPORTING SEEDLINGS AND PREPARING PITS

While transporting seedlings to the planting site one hand is placed at the bottom of the bag while holding the plant collar with the other one. Leather gloves can be used to avoid injury with spines of the leaves.

Pits of 60 cm^3 are taken prior to planting and filled with surrounding top soil and allowed to settle. Rock phosphate is applied at 200 g per planting pit. Nitrogen is not usually applied in the planting pits as the application of fertilizers may damage the root system and affect survival of the plants if there is a dry period soon after planting. Nitrogen and potassium are usually applied 4 - 6 weeks after planting. In Mg deficient soils, magnesium is applied at 100 g as anhydrous $MgSO_4$ or 200 g epsum salt per seedling.

REPLACEMENT AND GAP FILLING

Field inspection is carried out one to two months after planting to gap fill dead plants. Replanting is carried out during the onset of next monsoon. These palms are to be given special care so that they can catch up with the rest of the plantations. Early production of more female inflorescences in the initial 30 months, is an indication of high yielders and all those that fail to produce female bunches will remain as poor yielders. However, replacements are found to be affected to some extent by the vigorous growth of the neighbouring palms which will shade the replanted palms.

FERTILIZER REQUIREMENT

Based on the fertilizer experiments conducted under rainfed conditions in India, the following fertilizer schedule is recommended for oil palm until specific results are derived from multilocational fertilizer trials.

Fertilizer recommendation for oilpalm

Age	Nutrients (gram/palm/year)		
	N	P	K
First year	400	200	400
Second year	800	400	800
Third year onwards	1200	600	2700

METHOD OF FERTILIZER APPLICATION

The fertilizers are preferably applied in two equal split doses during May - June and September -October by uniformly spreading them within a 2 metre circle around the base of the palm and forking to incorporate them into the soil. Supply of sufficient quantity of green leaves or compost is advantageous especially where the soil is poor in organic matter content. Mg deficiency can be corrected through the application of 500 g of $MgSO_4$ /palm/year. Borax @ 100g per palm per year is also recommended.

Urea is found to be the most economic nitrogen source if losses by volatilization and leaching are minimised. Rock phosphate and muriate of potash are the best source for phosphorus and potassium respectively. During the initial years fertilizers may be applied within the area covered by the crown canopy. In the case of older palms, fertilizers are applied depending on the concentration of roots and are usually applied in the weeded circle. Appropriate soil conservation methods such as growing cover crops and platform cutting (on sloppy lands) enhance the efficiency of fertilizers by preventing losses through run off.

NUTRIENTS - FUNCTIONS AND DEFICIENCY SYMPTOMS

The effect of major nutrients on growth and yield of oil palm has been studied in most of the oil palm growing countries in Asia and Africa.

a) Nitrogen: In oil palm, characteristic yellowing symptoms are developed under N deficiency conditions. Nitrogen is found to be essential for rapid growth and fruiting of the palm. It increases the leaf production rate, leaf area, net assimilation rate, number of bunches and bunch weight. Excessive application of nitrogen increases the production of male inflorescence and decreases female inflorescence thereby reducing the sex ratio.

b) Phosphorus: In oil palm seedlings, P deficiency causes the older leaves to become dull and assume a pale olive green colour while in adult palms high incidence of premature desiccation of older leaves occurs. Phosphorus application increases the bunch production rate, bunch weight, number of female inflorescences and thereby the sex ratio. However, lack of response to P due to P fixation in soils is very common in the tropics. Eventhough the main effect of phosphorus on the productivity of the palm has not been significant in most studies, it gives a positive interaction with nitrogen and potassium.

c) Potassium: When potassium is deficient, growth as well as yield is retarded and it is translocated from mature leaves to growing points. Under severe deficiency, the mature leaves become chlorotic and necrotic. Confluent orange spotting is the main K deficiency condition in oil palm in which chlorotic spots, changing from pale green through yellow to orange, develop and enlarge both between and across the leaflet, veins and fuse to form compound lesions of a bright orange colour. Necrosis within spots is common, but irregular. Mid crown yellowing is another prominent K deficiency condition of the palm in which leaves around the 10th position on the phyllotaxy become pale in colour followed by terminal and marginal necrosis. A narrow band along the midrib usually remains green. There is a tendency for later formed leaves to become short and the palm has an unthrifty appearance with much premature withering.

Potassium removal is large compared to the normal exchangeable K content in most top soils. It is mostly required for the production of more number of bunches, maximum number of female inflorescences, increased bunch weight and also for increasing the total dry matter production and yield.

d) Magnesium: In adult oil palm and in seedlings in the field, severe Mg deficiency symptoms are most striking and have been named as 'orange frond'. While the lower most leaves are dead, those above them show a gradation of colouring from bright orange on the lower leaves to faint yellow on leaves of young and intermediate age. The youngest leaves do not show any discolouration. The most typical Mg-deficiency symptom is the shading effect in which the shaded portion of the leaflet will be dark green while the exposed portion of the same leaflet is chlorotic. Heavy rates of K applications induce Mg-deficiency, particularly on poor acid soils.

Among the secondary nutrients, calcium and sulphur, and probably chlorine, may not pose much problems to oilpalm cultivation in the country.

e) Micronutrients: Micronutrient elements, iron, manganese, copper and zinc are not generally found limiting in the nutrition of oil palm on acid soil conditions. Boron deficiency is occasionally found on young palms in the field showing a reduction of leaf area in certain leaves producing incipient 'little leaf', advanced 'little leaf' with extreme reduction of leaf area and bunching and reduction in the number of leaflets and 'fish-bone' leaf. The 'fish-bone' leaves are abnormally stiff with leaflets reduced to projections. Leaf malformations including 'hook leaf' and corrugated leaflets are some other associated symptoms. Soil application of 50 - 200 g borax, per palm, depending on age, and severity of symptoms is practiced for correcting the malady.

WATER REQUIREMENT

Continuous soil moisture availability encourages vigorous growth and increased yield of oil palm. Adequate supply of water, good soil depth and water holding capacity contribute to water availability. In oil palm as water deficiency increases, stomata will remain closed and the development and opening of spear will be inhibited. Water deficiency adversely affects flower initiation, sex differentiation and therefore, results in low sex ratio due to production of more male inflorescences. It is established that oil palm needs 120 - 150 mm of water to meet its monthly evapo-transpiration needs. In areas where perennial water source is available, basin irrigation is possible. But where the terrain is undulating and water is scarce during summer months, drip irrigation is recommended to keep four drippers per palm in the weeded palm circle to supply atleast 90 litres of water per palm per day during summer months which will vary according to the ETP values in a locality.

FERTGATION

Drip fertigation with the recommended dose of fertilsers at bimonthly interval was found to increase the yield of FFB

WEED CONTROL

The basin area of oil palm is kept free of weed growth through ring weeding. It is more important for young palms, roots of which are to be kept free from competition from weed. Depending on the extent of weed growth and rainfall, hand weeding is carried out even upto four times in a year during early years of the plantation which is progressively reduced to two rounds a year.

Herbicide application has become common in recent years. Care must be taken in the choice of herbicide and its application to prevent the damage of young palms. It is recommended to preferably apply contact herbicides rather than translocated herbicides. Translocated herbicides like Paraquat which is inactivated when contacted with soil are also used. Herbicides such as 2, 4-D, 2, 4-5-T, halogenated aliphatic acids Dalapon and TCA are found to produce abnormalities in oil palm seedlings and are to be avoided. Herbicide mixtures of 2 kg a.i. of Paraquat with 3 - 4 kg Atrazine Monuron and Diuron per ha sprayed/ground applied twice a year has been found to give control of weeds.

MAINTENANCE OF PATHS

In young plantation, the maintenance of paths is important for inspection and in later years for harvesting. This is carried out by timely weed control as done in the case of ring weeding.

ABLATION

The bunches produced initially will be very small and have low oil content. Removal of such inflorescences is called ablation or castration. Removal of all inflorescences during the initial three years is found to improve vegetative growth of young palms so that regular harvesting can commence after three and half years of planting. Ablation is done at monthly interval by pulling out the young inflorescence using gloves or with the help of devices such as narrow bladed chisels. Ablation improves drought resistance capacity of young palms by improving shoot and root growth especially in low production areas where dry condition exists.

PRUNING OF LEAVES

In oil palm two leaves are produced per month. Therefore, it becomes necessary to prune excess leaves so as to gain access to bunches for harvest. Severe pruning will adversely affect both growth and yield of palm, cause abortion of female flowers and also reduce the size of the leaves. It was suggested that palms aged 4 - 7 years should retain 6 - 7 leaves per spiral (48 - 56), those aged 8 - 14 years 5 - 6 leaves per spiral (40 - 49) and those above 15 years should have 4 - 5 leaves per spiral (32 - 40). Leaf pruning is carried out in India using chisels so that leaf base that is retained on the palm is as short as possible or otherwise it may catch loose fruits, allow growth of epiphytes and the leaf axils form a potential site for pathogens. The leaf petioles are removed by giving a clear cut at a sufficient distance from the base of the petiole using a sharp chisel for young palms and with the long sickle in taller palms.

Pruning is preferably carried out at the end of the rainy season. It is also better to carry it out during the low crop season when labourers are also available. Pruning is confined to only lower senile leaves during initial harvests but when canopy closes in later years, leaves are cut so as to retain two whorls of fronds below the ripe bunch.

Insect pollination in oil palm

The oil palm, hitherto though to be wind pollinated, has been now proved to be an a insect pollinated species. From West Africa, the original home of oil palm, eight species of pollinating weevils were reported. Occurence of ***Eldeidobius kamerunicus*** in the oil palm plantations of Kerala was introduced during 1985 from where it was introduced and got established in little Andamans during 1986.

The weevils are dark brown in colour. Adult weevils feed on the anther filament. Eggs are deposited inside the male flowers and larva feeds on the spent flowers. Life-cycle is completed within 11 to 13 days. Males live longer than females. The activity of the insects is in accordance with the receptivity of the male and female inflorescences. It was roughly estimated that 40 palms in a grove might be the minimum to sustain a sufficiently high continuous population of pollinators to pollinate. All are receptive female inflorescences. The weevils carry maximum pollen during the third day of antheses. Antennae, rostrum, thorax, legs etc. are the main sites of pollen land. E.kamerunicushas a fairly good searching ability. It can survive in dry as well as in wet seasons.

Introduction of weevil in India increased the fruit let from 36.8 percent to 56.1 percent resulting in 40 per cent increase in F/B ratio. The maximum attainable pollination potential was as much as to cent percent with 57 percent increase in FFB weight.

For introduction, male flowers cut from palms which have the weevils are transferred to a plantation where one wishes to introduce. In order to make sure that they are not carrying any plant pathogens to other area/countries, we have to breed them under laboratory conditions for seven or eight generations before introduction.

Pest Management

In India, since the import of germplasm is in the form of seeds/sprouts, possibilities for introduction of the pest species from other countries are limited. But many of the pest species of related palm species such as coconut and areca palm, have got adapted to oil palm. Among the 49 species of insects infesting adult oilpalms, 14 species are known pests of coconut and 19 species are known pests of areca palms. Insect pests of oilpalm in India are more or less same as those reported from Malaysia and other South-East Asian countries.

PEST OF ADULT PALMS

The rhinoceros beetle

The rhinoceros beetle is primarily a serious pest of coconut palm, and in recent years has attained the pest status in oilpalm also. The adult beetle which bores through into the spear leaves, resulting in snapping of the fronds at the feeding sites. In oil palm plantations failed female inflorescences, dead palm trunks, persistent leaf axils and empty bunch heaps, act as breeding sites for the pest.

The red palm weevil

Infestation by the red palm weevil Chynchophorus ferrungineus was noticed in majority of oil palm plantations resulting in the death of the palms. Damage is due to the feeding activity of the grubs, usually 12-87 per palm, which bore through and feed on the softer tissues of stem and meristem. Palms infested by R.ferrugineus show gradual wilting and drying of outer whorl of fronds. In some cases roofing of spear was also noticed.

Biological control

In nature, the rhinoceros beetle is suppressed by entomophogens like *Baculovirus oryctusvirus* and *Metarhizium anisopliae*. Release of *Baculovirusoryctes minimise* the pest incidence.

Cultural control

i) Field sanitation and elimination of breeding sites like dead palm trunks, empty bunch heaps etc., within the plantations are essential for the management of both red palm weevil and rhinoceros beetle.
ii) When the infestation by rhinoceros beetle is very high, especially in young plantations, Hand picking of the adult beetles using hooks is very effective.
iii) For red palm weevils, use of attractants incorporating fermented sugarcane juice, acetic acid, yeast etc., to collect and kill the adult weevils is recommended.

Chemical control

i) For rhinoceros beetles, placing 3-4 napthalene balls in the youngest spear axils at weekly intervals is recommended.
ii) For palms with advanced stage of infestation by red palm weevil, stem injection of 5-8 ml of monocrotophos is advised.

Fruit bunch covering against avian pests

Covering the bunches with different materials such as noirenets, reed baskets, plaited coconut leaf baskets and senile oil palm leaf are effective in preventing the fruit damage. But senile oil palm leaf covering is more practical and economical as the material is readily available and involves only the labour charges and cost of rope bits.

Rodent control

Among rats, the burrowing type is more serious which tunnel into the bole of the seedlings. Different baits such as acute poison baits (Zinc phosphide, Aluminium phosphide etc.) anticoagulants (warfarin, fumarin, bromadiolone) and traps such as iron like traps, snap traps, deathfall trap, boro trap etc. may be used as an integrated approach to minimise the rodent damage to the crop.

Disease

Oil palm, a new crop to the country is reported to be affected by a number of diseases and disorders. Among these, bud rot causes considerable economic losses.

Bud rot

- Higher disease incidence is noticed in young plantations. Rotting initiates at the basal portion of the spear closure to the meristem and extends to the whole spear. The spear could be easily pulled off.
- Cleaning the affected tissues and drenching the crown with carbendazim 0.1 percent cures the disease.
- The leaves emerging immediately after the application of fungicides are shorter and successively emerging ones are normal.

Leaf spots

- Leaf spots caused by *Curvularia* noticed on the inner whirl and young leaves. The fungal spots enlarge with a yellow ring around spots. As these spots enlarge the leaf will be scorched.
- *Pestalotiopsis* fungal spots are irregular with grey to brown centre. Numerous black dots, the acervuli of the fungus, are seen on the lesions.

Management

Affected leaves must be cut and burnt

Spray Mancozeb @ 0.2%.

HARVESTING

Proper and timely harvesting of fruit bunches is an important operation which determines the quality of oil to a great extent. The yield is expressed as fresh fruit bunches (FFB) in kg per hectare per year or as oil per hectare per year. The bunches usually ripen in six months after anthesis. Unripe fruits contain high water and carbohydrate and very little oil. As the fruit ripens oil content increase to 80 - 85% in mesocarp. Over ripe fruit contains more free fatty acids (FFA) due to decomposition and thus increases the acidity. Usually the ripe fruits, attached to the bunches contain 0.2 to 0.9% FFA and when it comes out of extraction plant the FFA content is above 3%.Ripeness of the fruit is determined by the degree of detachment of the fruit from bunches, change in colour and change in texture of the fruit. Ripening of fruits start from top downwards, nigrescens fruits turning reddish orange and the virescens (green) to reddish brown. Fruits also get detached from tip downward in 11 - 20 days time. Ripeness is faster in young palms than in older palms for the bunches of equal weight. The criteria used in determining the degree of ripeness based on the fruit detachment are as follows:

a) fallen fruits: 10 detached or easily removable fruits for young palms and 5 for adult palms,
b) number of fruits detached after the bunch is cut; 5 or more fruits/kg of bunch weight,
c) quantity of detachment per bunch; fruit detachment on 25% of visible surface of bunch.

These criteria could be applied with flexibility.

FREQUENCY OF HARVESTING

Harvesting rounds should be made as frequent as possible to avoid over ripening of bunches. A bunch which is almost ripe but not ready for harvest for a particular harvesting round should not be over-ripe by next round. In lean period of production, harvesting can be made less frequent and it should be more frequent in peak periods. Harvesting rounds of 7 - 14 days are generally practiced. Other factors determining frequency are, extraction capacity of the mill, transportation facilities, labour availability and skill of the workers. In India, harvesting is usually carried out with a chisel of 6 - 9 cm wide attached to a wooden pole or light hollow aluminium pipe, Bunches are cut without damaging the petiole the leaf that supports it. Use of narrow chisel is usually carried out till the palm reaches two meters above the ground. For taller palms upto 4 meters, a wider chisel of 14 cm is used. The curved knife is attached to a long bamboo or aluminium pole with screws or steel wires to harvest from taller palms. In uneven stands, an adjustable, telescopic type of pole is in use.

Yield of Oilpalm

In well maintained garden the yield of oilpalm will be as furnished below :

Age of oilpalm	Yield Ton/ha/year
3-4 years	5
4-5 years	12
5-6 years	25
6-25 years	30

ECONOMICS

A detailed account of the economics of oilpalm cultivation in India has been furnished. The data furnished therein is modified using current labour charges and oil price and the details on various investments and returns from one hectare adult plantation. This excludes the cost of land as we expect government owned land, leased land, or already owned property will be used for oilpalm cultivation. From the fourth year, the yield of bunches increases upto tenth year, and a stabilized bearing is attained thereafter. The investment during first year under irrigation will be almost three times of that under rainfed conditions mainly on account of the initial expenditure required to install the drip irrigation system. With irrigation the annual returns will exceed the annual expenses from the first harvest itself, i.e, during the fourth year after planting. By the end of sixth year the total returns will be more than total investments including all the expenditure for installing pumpset and the drip irrigation system. A minimum of 22 FFB per hectare can be expected from the tenth year onwards.

TABLE 1 - COST OF PRODUCTION AND (Rs.) PER HECTARE

S.No.	Particulars	Cost of production
1	Labour cost for 200 Nos. @ Rs.120/- per day as casual labour	24,000
2	Fertilizer cost	5000
3	Plant Protection cost	500
	Total cost of production	**29,500**

TABILE 2 : INCOME FROM OILPALM GARDEN DEPENDING UPON THE BUNCH PRODUCTION

S.No.	No. of Bunches/ tree/year	FFB yield t/ha/year	Gross Income Rs./ha/year	Net income (Gross income – cost) Rs./ha/year
1	10 bunches @ 10kg/tree/year	14.3	1,02,960	73,460
2	12 bunches @ 15kg/tree/year	25.7	1,85,040	1,55,540
3	12 bunches @ 20kg/tree/year	34.3	2,46,960	2,17,460

Cost of one tonne of FFB is Rs.7200

NIGER (Guizotia abyssinica)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

DISTRICT/SEASON	VARIETIES
A. Rainfed	
1. Adippattam (June- July)	
Dharmapuri, Krishnagiri, Hilly regions of Shevroy, Kolli hills, Jawad hills and Thalavadi hills	Paiyur 1
2. Purattasipattam (Sep-Oct)	
Dharmapuri, Krishnagiri, Hilly regions of Shevroy, Kolli hills, Jawad hills and Thalavadi hills	Paiyur 1

II. DESCRIPTION OF NIGER VARIETIES

Particulars	Paiyur 1
Parentage	Mass selection from Composite II
Duration (days)	80
Yield (kg/ha)	
Rainfed	260
Oil content (%)	44.6
Plant height (cm)	80-85
Branches	Profuse
Days to 50 % flowering	50
Seed size	Bold
Seed colour	Brown

CROP MANAGEMENT

III. PREPARATION OF THE FIELD

1. FIELD PREPARATION

a) Plough with tractor 2-3 times with a mould board plough or 5 times with a country plough.

b) Break the clods in between the ploughings and bring the soil to a fine tilth.

2. APPLICATION OF FYM

a) Spread 12.5 t of FYM or compost or composted coir pith per ha evenly and incorporate in the soil. b) If the manure is not applied before commencement of ploughing, spread the manure evenly before the last ploughing and incorporate in the soil.

NOTE: Do not leave the organic manure exposed to sunlight as nutrients will be lost.

3. APPLICATION OF FERTILIZERS

Apply N at 20 kg/ha basally.

4. SEED RATE

Adopt a seed rate of 5 kg/ha.

5. SPACING

Adopt a spacing of 30 cm between rows and 10 cm between plants.

6. SELECTION OF GOOD QUALITY SEEDS

Select mature good quality seeds, free from pest damage and fungal attack.

7. PRE-TREATMENT OF SEEDS WITH FUNGICIDES

a) Treat with Carbendazim or Thiram at 4 g/kg of seed in a polythene bag and ensure a uniform coating of the fungicide over the seed. b) Treat the seeds 24 hours prior to sowing.

NOTE: Seed treatment will protect the young seedlings from root rot disease in the early stage.

8. SOWING

a. Sow the seeds in line at a depth of 2 to 3 cm and cover with soil. b. Sow using gorru or country plough.

9. THINNING OUT SEEDLINGS

Thin out the seedlings to a spacing of 10 cm between plants on the 15th day of sowing.

10. WEED MANAGEMENT

Hoe and weed on 20th and 35th day of sowing.

11. HARVESTING

i) Observe the crop considering the average duration of the crop.
ii) The leaves and entire plant loose their colour and turn brown at maturity.
iii) Cut the plants at the bottom.
iv) Keep the plants in the threshing floor and beat the plants (heads) with sticks till the mature seeds are separated.
v) Winnow the seed and dry in the sun.
vi) Collect and store the seeds in gunnies.

CROP PROTECTION

Pre-Treatment of Seeds with fungicides

Treat with Carbendazim or Thiram at 4 g/kg of seed in a polythene bag and ensure a uniform coating of the fungicide over the seed. Treat the seeds 24 hours prior to sowing.

NOTE: Seed treatment will protect the young seedlings from root rot disease in the early stage.

SEED PRODUCTION

Varietal seed production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 200 m all around the field from the same and other varieties of niger.

Spacing

- 30 x 30 cm

Fertilizer

- Apply NPK @ 40 : 40 : 20 kg ha^{-1} as basal application.

Harvesting

- Harvest the crop as whole plants at 85 days after sowing, when the seeds attained physiological maturation.

Seed grading

- Grade the seeds using BSS 16 x 16 wire mesh sieve.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} of seed (or)
- Slurry treat seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) @ 3g kg^{-1} of seed as eco – friendly treatment.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 - 9%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 7 – 8 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 5%.

Other management practices

- As in crop management techniques.

COTTON

CROP IMPROVEMENT

I. SEASON AND VARIETIES

District/Season		Varieties/Hybrids
Irrigated (Main) **Winter Irrigated (Aug – Sep)**		
Coimbatore, Erode, Madurai, Dindigul, Theni	:	MCU 5, MCU 5 VT, Suvin, TCHB 213*, MCU 12, MCU 13, Surabhi
Dharmapuri	:	MCU 5, TCHB 213*, MCU 12, MCU 13, Surabhi
Salem, Namakkal	:	MCU 5, Suvin, TCHB 213*, MCU 12, MCU 13, Surabhi
Cuddalore, Villupuram	:	LRA 5166, SVPR 2, SVPR 4, Surabhi,
Summer – Irrigated (Feb – Mar)		
Erode	:	MCU 5, MCU 5 VT, MCU 12, MCU 13, Surabhi
Madurai, Dindigul, Theni	:	MCU 5, MCU 5 VT, SVPR 2, SVPR 4, Surabhi
Ramanathapuram, Virudhunagar, Sivagangai, Tirunelveli, Thoothukudi	:	MCU 5, MCU 5 VT, SVPR 2, SVPR 4, Surabhi
Rainfed (Sep – Oct)		
Madurai, Dindigul, Theni	:	LRA 5166, K11, KC 2, SVPR 2,KC 3
Ramanathapuram, Virudhunagar, Sivagangai	:	LRA 5166, K 11, KC 2, SVPR 2,KC 3
Tirunelveli, Thoothukudi, Dharmapuri	:	LRA 5166, K 11, KC 2, SVPR 2,KC 3
Rice Fallow		
Thanjavur, Tiruvarur, Nagapattinam, Parts of Trichirapalli, Perambalur, Karur, Cuddalore and Villupuram	:	MCU 7, SVPR 3, Anjali

* Hybrid

II. PARTICULARS OF COTTON VARIETIES/HYBRIDS

Varieties/ Hybrids	Parentage	Season	Irrigated/ Rainfed	Mean yield of seed (kg/ha)	Special features
MCU 5	Multiple cross	Aug-Oct Feb-Mar	Irrigated	1850	Extra long staple (29 mm MHL), Can spun upto 70s, ginning 34%
MCU 7	X ray irradiation of X L 1143 EE	Jan-Feb	Rice fallows	1330	Medium staple (23.7 mm MHL), Can spun upto 30s, early maturing with 33.2% ginning outturn. Tolerant to Black arm
MCU 12	Derivative from the cross LRA 5166 x MCU 11	Aug-Oct	Irrigated	2000	Shorter in duration than MCU 5, GOT 34.8% Can spun upto 50s
MCU 13	It is a multiple cross derivative involving the parents of [(TCH 665 x LS 149) x (TCH 665 x TCH 21)] x (TCH 21 x	Aug- Oct Jan-Feb	Irrigated	2200	Early duration Can spun upto 50s

	EECH) x (TCH 92-7 x EECH)				
LRA 5166	Laxmi x Reba B.50 x AC 122	Aug-Oct Jan –Feb	Irrigated Rainfed	1800 725	Medium staple (29 mm), Can spun upto 40s, ginning 36.2%
MCU 5 VT	Reselection from MCU 5	Aug-Oct Jan –Feb	Irrigated	2000	Extra long staple, *Verticillium* wilt tolerant
Anjali	LRA 5166 x (Khandwa 2 x Reba B 50) BC 2	Jan –Feb	Irrigated (Rice fallows)	1800	Dwarf, semi compact plant type
Surabhi	MCU 5 VT (MCU 5 x *G.mexicanum*)	Aug-Oct	Irrigated	2200	Exta long staple, *Verticillium* wilt resistant
K 11	(0794-1-DX H 876) x (0794-1-DX H 450) Multiple Hybrid derivative	Sept – Oct	Rainfed	1100	Better fibre properties with lesser pest incidence than K10
Suvin	Hybrid derivative from the cross Sujatha x St. Vincent	Aug-Oct	Irrigated	1020	Extra long staple cotton with 28% ginning outturn and 32 mm MHL, spins 100s
TCHB 213	Interspecific Hybrid of TCH 1218 (*G.hirsutum*) and TCB 209 (*G.barbadense*)	Aug-Sep	Irrigated	2215	High yielding, early maturing, Tolerant to leaf spot diseases
SVPR 2	TSDT 22 x JR 36	Feb - Mar Sep-Oct	Irrigated Rainfed	2000	High ginning out turn of 36.4%, medium staple (24.3 mm), can spin 30's, suited to summer irrigated, winter rainfed tracts.
SVPR 3	Selection from L.H 900 x 1301 D.D	Jan-Feb	Rice fallows	1800	Suitable for rice fallow tract. early duration (135-140 days). Tolerant to drought, leafhopper, alternaria spot, black arm disease.
KC 2	MCU 10 x KC 1	Sep - Oct	Rainfed	1000	High ginning out turn of 37.5%, medium staple cotton - 24.4 mm, Suited for rainfed black cotton soil of Tirunelveli, Thoothukudi and Virudhunagar Districts.
KC 3	Hybrid derivative of TKH 97x KC1	Sep- Oct	Rainfed	1080	Resistant to leaf hoppermedium staple cotton – 26.4 mim, suited to southern districts of Tuticorin, Tirunelveli and Virudhu Nager district.
SVPR 4	Hybrid derivative of MCU 5x S4727	Feb-Mar Sep- Oct	Irrigated Rainfed	1800	Superior medium staple cotton with good fibre strength. suitable for spinning 40’s yarn.

CROP MANAGEMENT

I. PREPARATION OF FIELD FOR IRRIGATED COTTON CROP

1.1 .FIELD PREPARATION

1.1.1PREPARATION OF THE FIELD

i) Prepare the field to get a fine tilth.
ii) Chiselling for soils with hard pan: Chisel the soils having hard pan formation at shallow depths with chisel plough at 0.5 M interval, first in one direction and then in the direction perpendicular to the previous one, once in three years. Apply 12.5 t farm yard manure or composted coir pith/ha besides chiselling to get increased yield
iii) If intercropping of Greengram/Soyabean is proposed, prepare the main field, so as to provide ridges and furrows to take up sowing 20 days prior to cotton sowing.

1.1.2 APPLICATION OF FYM OR COMPOST

Spread 12.5 t of FYM or compost or 2.5 t of vermicompost per ha if available, uniformly on the unploughed soil.

Azophos 2kg/ha or Azospirillum + Phosphorus Solubilising Bacteria + Pink Pigmented Facultative Methylotropics @ 2.2 kg/ha each apply as basal application.

1.1.3 APPLICATION OF BIOFERTILIZER

Seed treatment with 3 packets of Azospirillum (600 g/ha) and 3 packets (600 g/ha) of Phosphobacteria or 6 packets of Azophos(1200 g/ha). In addition apply and 10 packets of Azospirillum (2000 g/ha) and 10 packets(2000 g/ha) of Phosphobacteria or 20 packets of Azophos(4000 g/ha)mixed with 25 kg FYM and 25 kg of soil on the seed line. This saves 25% nitrogen besides increasing yield.

1.1.4 FORMATION OF RIDGES AND FURROWS

i) Form ridges and furrows 10 m long with appropriate spacing depending upon the variety.
ii) Use ridge plough or bund former to form ridges so as to economise on cost of cultivation.
iii) In fields with ragi stubbles, just dibble cotton seeds at the specified spacings.
v) Adopt the following spacing between ridges for different varieties/hybrids.

Varieties/Hybrids	**Spacing between ridges (cm)**
MCU 5, SVPR 2, LRA 5166, MCU 12, MCU 13	75
TCHB 213	120
Suvin	90
MCU 7	60

NOTE: Adopt higher spacing rows in fertile soils by 15 to 30 cm.

1.1.5 APPLICATION OF INORGANIC FERTILIZERS

i) If soil test recommendations are not available, follow the blanket recommendation for the different varieties.

Varieties / Hybrids	Quantity of fertilizers (Kg/ha)		
	N	**P_2O_5**	**K_20**
MCU 7, SVPR 3	60	30	30
MCU 5, MCU 5 VT, MCU 12, MCU 13,Suvin, SVPR 2	80	40	40
TCHB 213,	120	60	60

iii) If basal application could not be done, apply on the 25th day after sowing.
iv) Apply 50 per cent of N and K full dose of P_2O_5 as basal and remaining ½ N and K at 40 – 45 DAS for varieties. For hybrids apply N in three splits *viz*., basal, 45 and 65 DAS.

Soil test crop response based integrated plant nutrition system (STCR- IPNS) recommendation may be adopted for prescribing fertilizer doses for specified yield targets. (ready reckoners are furnished)

Cotton (1)

Soil : Mixed black calcareous (Perianaickenpalayam series)
Season : Rabi
Target : 30 q ha^{-1} kapas

FN = 8.81 T – 0.62 SN
FP_2O_5 = 2.53 T – 1.36 SP
FK_2O = 4.92 T - 0.25 SK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + *Azospirillum* @2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
180	10	300	101	30	33
200	12	340	88	28	23
220	14	380	76	25	20*
240	16	420	63	22	20*
260	18	460	51	20*	20*

*maintenance dose

Cotton (2)

Soil : Red sandy loam (Irugur series)
Season : Rabi
Target : 30 q ha^{-1} kapas

FN = 7.66 T - 0.43 SN - 0.71 ON
FP_2O_5 = 3.22 T - 3.27 SP - 0.87 OP
FK_2O = 5.97 T - 0.50 SK - 0.66 OK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + *Azospirillum* @2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
180	10	180	101	32	49
200	12	200	92	26	39
220	14	220	83	20*	29
240	16	240	75	20*	20*
260	18	260	66	20*	20*

*maintenance dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

v) Foliar application of 2% DAP + 1% KCl or polyfeed and Multi k may be sprayed to improve kapas yield

vi) Apply the fertilizers in a band, two-thirds of the distance from the top of the ridge, and incorporate.

1.1.6 APPLICATION OF MICRONUTRIENT MIXTURE

TNAU MN mixture 12.5 kg/ha for variety and 15 kg/ha for hybrid apply as enriched FYM. Enriched FYM is prepared at 1.10 ratio of MN mixture and FYM, mixed at friable moisture and for one month in shade. Need based foliar spray of 2% $Mgso_4$ + 1% urea during boll formation stage.

Mix 12.5 kg of micronutrient mixture formulated by the Department of Agriculture, Tamil Nadu with enough sand to make a total quantity of 50 kg for one ha.

Yield Maximization and reducing reddening in Bt cotton

Irrigated

Application of TNAU MN mixture (12.5 kg ha^{-1} as EFYM for variety and 15 kg ha^{-1} as EFYM for Bt cotton) and TNAU PGR foliar formulation @1.25 % concentration at square and boll formation stages along with the recommended NPK to obtain the maximum seed cotton yield with reduced extent of leaf reddening..

1.1.7 NUTRITIONAL DISORDERS' CORRECTION

a) In the case of Zinc deficient soils $ZnSO_4$ @ 50 kg/ha as basal or $ZnSO_4$ 0.5% spray thrice at 45, 60 and 75 DAS.

b) When reddening occurs in leaves apply 0.5% $MgSO_4$ Urea (1.0%) and $ZnSO_4$ (0.10%) as foliar spray on 50th and 80th day to correct this malady.

c) Need based foliar spray of 2% MgSo4 + 1% Urea during boll formation stage.

II. MAIN FIELD OPERATIONS

1.2.1 SEED RATE

Adopt the following seed rates for different varieties/hybrids

Varieties / Hybrids	Quantity of seed (Kg/ha)		
	With fuzz	Delinted	Naked
MCU 5, MCU 5 VT, MCU 7, MCU 12, MCU 13	15.00	7.50	..
SVPR 2	15.00	..	..
KC 2	20.00	15.00	..
SUVIN	..	..	6.00
TCHB 213	2.5	2.0	..

1.2.2. SPACING

In a pure crop of cotton, adopt the spacing as below for the different varieties.

Varieties / hybrids	Spacing (cm)	
	Between rows	Between plants
MCU 5, MCU 5 VT, MCU 12, MCU 13	75	30
LRA 5166, SVPR 2		
KC 2	45	15
SUVIN	90	45
TCHB 213	120	60
MCU 7, SVPR 3	60 or 75 *	30

* Fertile soils

a. If cotton intercropped with other crops, one paired row of cotton is alternated with three rows of intercrop and the total population of cotton crop is maintained at the same level as in the case of pure crop.

b. For intercropping with Greengram / Soyabean, complete the sowing and irrigation 20 days prior to cotton sowing on one side of the ridge.

Varieties/hybrid	Spacing for cotton crop (cm)		
	Within Paired row	Between Paired rows	Between plants
MCU 5, MCU 5 VT, MCU 12,MCU13	60	90	30
SUVIN	80	100	45
TCHB 213	100	140	60

Plant two rows of intercrop between each paired row of cotton

Intercrop	Seed rate(kg/ha)	Spacing (cm)

		Rows	Plants
Blackgram	12.5	30	10
Greengram	12.5	30	10
Cowpea	7.5	30	20
Soyabean	20.0	30	10

For higher returns, advance sowing of either greengram or soyabean 20 days before sowing of cotton in winter season.

1.2.3. ACID-DELINTING OF COTTON SEEDS

i) Choose plastic bucket bucket for acid delinting of seeds.
ii) Do not use earthen wares, metal vessels, porcelain wares or wooden drum for acid delinting as concentrated sulphuric acid will corrode them.
iii) Put the required quantity of seeds in the container and add commercial concentrated sulphuric acid at the rate of 100 ml per kg of fuzzy seed.
iv) Stir vigorously and continuously with a wooden stick for 2 to 3 minutes till the fuzz sticking to the seeds is completely digested and the seed coat attains a dark brown colour of coffee powder.
v) Add water to fill the container. Drain the acid water and repeat the washing 4 or 5 times to remove any trace of acid.
vi) Remove the floating, ill-filled and damaged seeds while retaining the healthy and good seeds which remain at the bottom.
vii) Drain the water completely and dry the delinted seeds in shade.

Advantages of Acid delinting

i) Eliminates some externally seed borne pathogenic organisms.
ii) Kills eggs, larvae and pupae of pink boll worm.
iii) Helps to remove immature, ill-filled, cut and damaged seeds.
iv) Makes seed dressing more effective and easy
v) Facilitates easy sowing and good germination.

1.2.4.1. PRE-TREATMENT OF ACID DELINTED SEEDS WITH FUNGICIDES

i) Treat the delinted seeds with talc formulation of Trichoderma viride @ 4g/kg of seed or with Carbendazim (or) Thiram @ 2g/kg of seed.
Biocontrol agents are compatible with biofertilizers.
First treat the seeds with biocontrol agents and then with biofertilizers.
Fungicides and biocontrol agents are incompatible.
ii) Treat the delinted fungicide treated seeds with 3 packets (600 g) of Azospirillum and 3 packets of phosphobacteria 600g (or) 6 packets of Azophos (1200 g) and sow immediately.

1.2.4.2. SEED HARDENING

Soak the seeds in equal volume of Pungam leaf extract (1%) for 8 hours and dry back to original moisture to increase germination and vigour. Dry the seeds in shade.

Seed pelleting: Seeds coated with arappu leaf powder (100 g/kg) along with DAP (40 g/kg), micronutrient mixture (15 g/kg) and Azospirillum (200 g/kg) phosphobacteria (200 g/ha) or Azophos (400 g/ha) using 5% maida solution or gruel as adhesive (300 ml/kg) to increase the germination and vigour.

1.2.5. SOWING

i) Dibble the seeds at a depth of 3-5 cm on the side of the ridge 2/3 height from the top and above the band where fertilisers and insecticides are applied, maintaining the correct spacing and then cover seeds with soil.
ii) In the case of intercropping, sow the seeds of the intercrop in between the paired rows of cotton in a row of 5 cm apart and cover the seeds.
iii) Sow the required number of seeds in each hole.

Varieties / hybrids	No. of seeds / hole

	Fuzzy seeds	Delinted seeds
Hybrids	2	1
Varieties	3	2

1.2.6. WEED MANAGEMENT

i) Apply Pendimethalin @ 3.3 l/ha three days after sowing or Fluchloralin 1.0 kg a.i /ha on 3DAS + power weeding on 45 DAS followed by earthing up or Trifloxy salfuron @ 10 g/ha on 15 DAS for broad leave weeds and sedges. Sufficient moisture should be present in the soil at the time of herbicide application. This will ensure weed free condition upto 40 days.

ii) One hand weeding on 45 DAS will keep weed free environment upto 60 DAS.

iii) Hoe and hand weed between 18th to 20th day of sowing, if herbicide is not applied at the time of sowing.

1.2.7. GAP FILLING

a. Take up gap filling on the 10th day of sowing.

i) In the case of TCHB 213, raise seedlings in polythene bags of size 15 x 10 cm.

ii) Fill the polythene bags with a mixture of FYM and soil in the ratio of 1:3.

iii) Dibble one seed per bag on the same day when sowing is taken up in the field.

iv) Pot water and maintain.

v) On the 10th day of sowing, plant seedlings maintained in the polythene bags, one in each of the gaps in the field by cutting open the polythene bag and planting the seedling along with the soil intact and then pot water.

b. In the case of all other varieties, dibble 3 to 4 seeds in each gap and pot water.

1.2.8. THINNING

Thin out the seedlings on the 15th day of sowing. In the case of fertile soils, allow only one seedling per hole, whereas in poor soil allow two seedlings per hole.

1.2.9. TOP DRESSING

i) Top dress 50% of the recommended dose of N and K on 40 – 45 DAS for varieties.

ii) Top dress 1/3rd of recommended dose of N on 40-45 DAS and the remaining 1/3rd on 60-65th DAS for hybrids.

1.2.10. RECTIFICATION OF RIDGES AND FURROWS

Reform the ridges and furrows after first top dressing in such a way that the plants are on the top of the ridges and well supported by soil.

1.2.11. SPRAYING OF NAPTHALENE ACETIC ACID (NAA)

Spray 40 ppm NAA at 60 and 90 days after sowing on the crop to prevent early shedding of buds and squares and to increase the yield.

NOTE: 40 mg of NAA dissolved in one litre of water will give 40 ppm.

1.2.12. MANAGEMENT STRATEGIES FOR DELAYED SUMMER IRRIGATED COTTON SOWING

KCl 1% spray, twice on 50 and 70 DAS for delayed sowing (first fortnight of March) of summer irrigated cotton in rice-cotton cropping system for Srivilliputhur region.

1.2.13. ARRESTING TERMINAL GROWTH

Nip the terminal portion of the main stem as indicated below:

For varieties having less than 160 days duration nip the terminal portion of the main stem beyond the 15th node (75 to 80 DAS) and for varieties and hybrids having more than 160 days duration beyond the 20th node (85 - 90 DAS).

III. WATER MANAGEMENT

Regulate irrigation according to the following growth phases of the crop.

Stages	No. of Irrigations	Days after dibbling seeds	
		Light soil	**Heavy soil**
Germination Phase(1-15 days)			
Irrigate for germination	1	Immediately after sowing	Immediately after sowing
and establishment	2	Give a life irrigation on	Give a life irrigation on
		5th day of sowing to	5th day of sowing to
		facilitate the seedlings	facilitate the seedlings
		to emerge out	to emerge out
Vegetative phase (16-44 days)			
Regulate	1	Irrigate on the 20th or	Irrigate on the 20th or 21st day
		21st day of sowing, three	of sowing, three days after
		days after hoeing and	hoeing and weeding
		Weeding	
	2	Irrigate again on	Irrigate again on
		the 35th or 36th	the 40th day of
		day of sowing	Sowing
Flowering phase (45-100daysfor hybrids and 87 days for varieties)			
Irrigate copiously	1	48th day	55th day
	2	60th day	70th day
	3	72nd day	85th day
	4	84th day	100th day
	5	96th day	**

** For TCHB 213 and Suvin only.

Maturity phase (beyond 100 days for hybrids and 88 days for varieties)		For all varieties other than Suvin, and TCHB 213	
Control irriga	1	108th day	115th day
tion during	2	120th day	130th day
maturity phase	3	130th day	
	4	144th day	
	Stop Irrigation after 150th day		
	For Suvin, TCHB213		
	1	108th day	115th day
	2	120th day	130th day
	3	132nd day	145th day
	4	144th day	160th day
	5	158th day	...
Stop irrigation after 160th day			

NOTE: i.	*If irrigation is given on climatological approach, Schedule the irrigation at 0.40 and 0.60 IW/CPE ratio during vegetative and reproductive phases respectively.*
ii)	*The irrigation schedule given above is only a guideline and regulate the irrigation*
	depending upon the prevailing weather condition and receipt of rains.
iii)	*Adopt alternate furrow or skip furrow irrigation to save irrigation water.*

The features of the methods are furnished below:

Skip furrow irrigation

a) Suited to heavy soils like clay and loam
b) Alternate furrows should be skipped and may be converted to ridges having a wide bed formation.
c) Short term crops like pulses may be raised in wider bed without exclusive irrigation.
d) Water saving is 50% when compared to control.

Alternate furrow irrigation

a) During any one run of irrigation a particular set of alternate furrows is irrigated.
b) The interval of irrigation should be shortened when compared to the conventional furrows.
c) During the next run, the left over furrows be irrigated.
d) Suited to heavy soils like clay and loam.

IV. HARVESTING

a) Harvest at frequent intervals, at less than 7 days interval.
b) Harvest in the morning hours upto 10 to 11 a.m only when there is moisture so that dry leaves and bracts do not stick to the kapas and lower the market value.
c) Pick kapas from well burst bolls only.
d) Remove only the kapas from the bolls and leave the bracts on the plants.
e) After kapas is picked, sort out good puffy ones and keep separately.
f) Keep stained, discoloured and insect attacked kapas separately.

NOTE: Do not mix stained, discoloured and insect damaged kapas with good kapas, as they will spoil the good kapas also and lower the market value of the produce.

V. POST HARVEST OPERATIONS

1) Immediately after picking, dry the kapas in shade. If it is not dried immediately the colour will change which will lower the market value.
2) Do not dry the kapas under direct sun as the fibre strength and luster will be lost.
3) Grade the kapas into good and second quality ones, if it is not sorted out at the time of picking.
4) Spread a thin layer of dry sand on the ground and keep the kapas over it.

RICE FALLOW COTTON

2.1. PREPARATION OF THE FIELD

i) If the soil is in waxy condition, instead of Zero tillage, the seed rows may be tilled and the seed dibbled in Virudhunagar district.
ii) If the soil is dry and not in condition to take up sowing, let in water and then allow the soil to dry till soil comes to waxy condition.
iii) At the lower level of the field dig a trench 15 cm wide and connect this trench to the outside channel to drain off the excess water.

2.2. PRE-TREATMENT OF ACID DELINTED SEEDS WITH FUNGICIDES

i) Same as for the irrigated crop.
ii) Treat the acid delinted and fungicide treated seeds with 3 packets (600g) of Azospirillum and sow immediately.

2.3. SOWING THE SEEDS

Particulars			MCU 7	SVPR 3
a) Seed rate (kg/ha)				
	i)	Fuzzy seed	15.0	15
	ii)	Acid delinted	7.5	7.5
b) Spacing (cm)				
	i)	Between rows	60	60 or 75*
	ii)	Between plants	30	30
c) Number of seeds / hole				
	i)	Fuzzy seeds	4	4
	ii)	Acid delinted	2	2
d) Depth of sowing (cm)			3	3

* In fertile soils

2.4. FILLING UP GAPS

i) Fill up gaps on the 10th day of sowing.

ii) Dibble 2 to 3 acid delinted seeds or 4 to 5 fuzzy seeds in the gaps in the case of MCU 7 and SVPR 3

2.5. THINNING SEEDLINGS

i) Thin out seedlings on the 20th day of sowing

ii) Leave only one healthy and vigorous seedling per hill.

2.6. WEED MANAGEMENT

i) Pre-emergence application of Pendimethalin 3.3 l/ha ensures weed free condition for 40 - 45 days. This should be followed by one hand weeding and earthing up during 40 - 45 days.

ii) Take up hoeing and weeding 20 days after sowing.

iii) Take up this operation when the top soil dries up and comes to proper condition.

2.7. APPLICATION OF FERTILIZERS

a) Apply NPK fertilisers as per soil test recommendations. If soil test is not done follow the blanket recommendation of 60:30:30 kg NPK/ha.

b) Apply half the dose of N and K full dose of P_5O_5 at 35th day in old delta and balance in 55 days the rows of cotton plants. In the case New delta apply full P and 1/3 of N and K at 20 DAS and 2/3 N and K at 40 DAS.

2.8. APPLICATION OF MICRONUTRIENTS

Apply basally12.5 kg/ha micronutrient mixture prepared by Department of Agriculture. Apply $MgSo_4$ basally @ 20 kg/ha to prevent reddening.

2.9. FORMATION OF RIDGES

Old delta

a) If soil is in condition, give a hoeing with mammutti and form ridges and incorporate the fertilizer in the soil around the plants between 30th to 35th day of sowing.

b) If soil is not in condition, give one hoeing and weeding and cover the fertilizers.

c) Form long ridges and furrows from one end of the field to the other without forming any separate channels for carrying water to prevent excessive soaking of water.

d) Form ridges and furrows on alternate rows of plants. Skip furrow method of irrigation to prevent excessive irrigation

New delta

a) Give a hoeing with mummutti and form ridges and incorporate the fertiliser in the soil around the plants on the 40th day of sowing.

b) If soil is not in condition give one hoeing and weeding and cover the fertilizers.

c) Form long ridges & furrows on alternate rows of plants to adopt skip furrow irrigation.

Note: In case of zinc deficient soils, apply 50 kg ZnSo4 /ha

2.10. APPLYING OF NAA

Spray 40 ppm of NAA (40 mg of NAA dissolved in one litre of water) at 40/45th day using high volume spray. Repeat the same dose after 15 days of first spraying.

2.11. TOPPING

Arrest terminal growth by nipping the terminal 15[th] node for controlling excessive vegetative growth. (70-75 DAS)

2.12. WATER MANAGEMENT

Regulate irrigation according to the growth phases of the crops.

Stages	No. of	Days after dibbling seeds	
	Irriga		
	tions	Old delta	New delta
1. Vegetative Phase			
Regulate irrigation	1	One wetting on the 30th	One irrigation on the 20th day
during the germination		to 35th day of sowing after	after the application of fertilisers
phase		the application of fertilisers	
	2	...	One irrigation on the 40th day after the application of N
2. Flowering Phase			
Irrigate more frequently	1	45th day of sowing after the	45th day
		application of 2nd dose of N	
	2	55th day	51st day
	3	65th day	56th day
	4	75th day	61st day
	5	85th day	66th day
	6	...	71st day
	7	...	76th day
	8	...	81st day
	9	...	86th day
	10	...	91st day
3. Control	1	99th day	98th day
Irrigation during	2	113th day	105th day
maturity phase	3	...	112th day

Stop irrigation from the 113th day onwards.

Note: 1) *The irrigation schedule given above is only a guideline and regulate irrigation depending upon the prevailing weather conditions and receipt of rains.*
2) *Observe the crop and if the plants show wilting symptoms in the afternoon and in the evening hours, give an additional irrigation.*

2.13. Harvesting |
2.14. Post harvest operation | As that of the irrigated cotton.
2.15. Pest and disease management |

RAINFED COTTON

Follow water harvesting techniques and raise a successful crop of cotton.

3.1. SEASON AND VARIETIES

For Thirumangalam in Madurai district, Sattur in Virudhunagar district and parts of Kovilpatti in Thoothukudi district, where the seasonal rainfall is 375 mm and most of it is received during September or first week of October, select LRA 5166 (or) SVPR 2 (or) KC 2,KC3.

In places, where rains are received during October or November, Select K 11 for Ramanathapuram, Virudhunagar, Tirunelveli and Thoothukudi districts.

3.2. PREPARATION OF LAND

3.2.1. PREPARATION OF THE FIELD

i) Start preparation of the land immediately after harvest of the previous crop.
ii) Adopt permanent broad ridges system.

3.2.2. APPLICATION OF FYM OR COMPOST

i) Spread 12.5 t of FYM or compost or composted coir pith or 2.5t of vermicompost per ha uniformly on the unploughed soil.
ii) Incorporate the manure in the soil by working the multipurpose implement or country plough.
iii) Apply TNAU MN mixture @ 7.5 by as enriched Fym.

3.2.3. APPLICATION OF INORGANIC FERTILIZERS

i) Apply NPK fertilizers as per soil test recommendation as far as possible.
ii) If soil tests are not done, follow the blanket recommendations for the different varieties.

Varieties	Quantity of fertilizers (Kg/ha)		
	N	P_2O_5	K_2O
K 11	20	0	0
SVPR 2	40	20	40
KC 2	40	20	40

3.2.4. APPLICATION OF MICRONUTRIENT MIXTURE

i) Mix 12.5 kg of micronutrient mixture formulated by the Department of Agriculture, Tamil
Nadu with enough sand to make a total quantity of 50 kg.
(or)
Apply TNAU MN mixture @ 7.5 kg /ha as Enriched FYM (Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade).

ii) Apply uniformly over the furrows after sowing and cover the seeds.
Do not incorporate in the soil.

Yield Maximization and reducing reddening in Bt cotton
Rainfed
Application of TNAU MN mixture (7.5 kg ha^{-1} as EFYM for variety and 10 kg ha^{-1} as EFYM for Bt cotton) and TNAU PGR foliar formulation @ 1.5% concentration at square and boll formation stages along with the recommended NPK to obtain the maximum seed cotton yield with reduced extent of leaf reddening..

3.2.5. SEEDS AND SOWING

i) Adopt the following seed rates for different varieties/hybrids.

Varieties	Quantity of seeds (kg/ha)	
	Fuzzy seeds	Delinted seeds
K11	20	..
LRA 5166, SVPR 2	20	15

Note: Delint only LRA 5166 and SVPR2 seeds. Do not delint seeds of K 9, K10 & K 11

ii) In the case of mixed crop of cotton, maintaining the same seed rates as for a pure crop and adopt the following seed rate for the pulses crop.

Blackgram/greengram	10 kg/ha
Cowpea	7.5 kg/ha

3.2.6. SPACING

i) In the case of pure crop of varieties/hybrids, a spacing of 45 cm between rows and 15 cm between plants may be adopted.

ii) In the case of cotton, intercropped with pulses, one paired row of cotton is alternated with two rows of pulses and the total population of cotton crop is maintained at the same line as that for a pure crop of cotton.

Varieties	Spacing for cotton crop (cm)		
	Within Paired row	Between Paired rows	Between plants
K 11, LRA 5166, SVPR 2	30	60	15

iii) Adopt a spacing of 30 x 10 cm for the pulse crop in between each paired row of cotton. APK 1 Blackgram is best suited for this situation.

3.2.7. ACID DELINTING

Adopt procedure for acid delinting as for an irrigated crop.

3.2.8. PRETREATMENT OF ACID DELINTED SEEDS WITH FUNGICIDES

Same as for the irrigated crop.

3.2.9. SOWING

i) Use the multipurpose farming implement to sow the seeds and to apply basal fertilizers simultaneously.

ii) Fill the hopper in the implement with the fertilizer mixtures and work the implement.

iii) Engage 3 persons for dropping the seeds, 2 for cotton and one for pulses.

In one operation, placement of fertilizer, sowing of seeds and covering will be completed.

NOTE: Cotton and pulses can be sown at a depth of 5 cm in black cotton soil even before the onset of monsoon rains in dry bed sowing. When light rains are received, the moisture will not penetrate deeper and the seeds will not germinate and die away. Only when good rains are received, the moisture level will be sufficient to penetrate to the level of the seed and facilitate germination and proper establishment.

3.2.10. WEED MANAGEMENT

i) Pre-emergence application of Pendimethalin 3.3 l/ha followed by one hand weeding on 40 days after crop emergence. At the time of herbicide application sufficient soil moisture must be there.

ii) If sufficient soil moisture is not available for applying herbicides hand weeding may be given at 10 - 20 days after crop emergence.

3.2.11. GAP FILLING

Dibble 3 to 4 seeds in each gap if sufficient moisture is available.

3.2.12. THINNING SEEDLINGS

i) Allow two seedlings per hole and thin out on 15th day of sowing, adopting proper spacing between plants.

ii) Thin the pulse crop on the 20th day of sowing, adopting a spacing of 15 cm between plants for cowpea and 10 cm for other pulse crop.

3.2.13. FOLIAR FERTILIZATION

Spray 0.5% urea and 1% KCl on the 45th and 65th day of sowing if sufficient moisture is available.

3.2.14. INTERCULTIVATION WITH DHANTHULU/BLADE HARROW

Work dhanthulu or blade harrow on the 30th and 45th day of sowing.

NOTE: Other cultivation practices, plant protection measures, harvest etc., are the same as for the irrigated crop.

CROP PHYSIOLOGY

Foliar spray of TNAU Cotton Plus @ 2.5 kg/acre in 200 litres of water at flowering and at boll formation stages reduces flower and square shedding, improves boll bursting, increases seed cotton yield and imparts drought tolerance.

C. CROP PROTECTION

CROP PROTECTION

A. PEST MANAGEMENT

- Remove the cotton crop and dispose off the crop residues as soon as harvest is over.
- Avoid stacking of stalks in the field.
- Avoid ratoon and double cotton crop.
- Adopt proper crop rotation.
- Use optimum irrigation and fertilizers.

Grow one variety throughout the village as far as possible.

- Treat the seeds with imidacloprid or use designer seed (Delinted seed + polykote @ 3g/kg + carbendazim @ 2g/kg + imidacloprid @ 7g/kg + *Pseudomonas fluorescens* 10g/kg + Azophos 40g/kg). When the treated seeds are used, it protects against sucking pests upto 45 days after sowing and promotes early vigour of the crop
- Synchronise the sowing time in the villages and complete the sowing within 10 to 15 days.
- Avoid other Malvaceous crops in the vicinity of cotton crop.
- Timely earthing up and other agronomic practices should be done.
- Hand pick and burn periodically egg masses, visible larvae, affected and dropped squares, flowers and fruits and squash pink bollworm in the rosettes.
- Use locally fabricated light traps (modified Robinson type) with 125 Watt mercury lamps to determine the prevalence and insect population fluctuations.
- The magnitude of the activity of the moths of the cotton pink bollworm, the cutworm (*Spodoptera litura*) and the American bollworm can be assessed by setting up the species-specific sex pheromone trap each at the rate of 12 per ha.
- Apply insecticides only where it is absolutely necessary when pest population or damage reaches ET level.
- Intercropping with pulses viz., cowpea, greengram, blackgram, soybean and maize reduces the bollworm incidence and population of sucking pests of cotton, *viz*., aphid and leafhopper with the highest activity of natural enemies *viz*., spiders and predatory lady bird beetles.

Economic threshold level for important pests

Pests	ETL
Thrips	50 nymphs or adults/50 leaves
Aphids	15% of infested plant
Leafhopper	50 nymphs or adults/50 leaves
Mite	10 mites/cm2 leaf area
Boll-worms	
Spotted	10% infested shoots / squares / bolls
Spiny	10% infested shoots / squares / bolls

Pink	10% infested fruiting parts
Helicoverpa	One egg or one larva /plant
Whiteflies	5 - 10 /leaf
Stem weevil	10% infestation
Tobacco cutworm	8 egg masses/100 m row

Pest management strategies

Pests	Management strategies
American bollworm *Helicoverpa armigera*	**Monitoring :** Pest monitoring through light traps, pheromone traps and *in situ* assessments by roving and fixed plot surveys has to be intensified at farm, village, block, regional and State levels. For management, an action threshold of one egg per plant or 1 larva/ plant may be adopted. **Cultural practices :** < Synchronised sowing of cotton preferably with short duration varieties in each cotton ecosystem. < Avoid continuous cropping of cotton both during winter and summer seasons in the same area as well as ratooning. < Avoid monocropping. Growing of less preferred crops like greengram, blackgram, soyabean, castor, sorghum etc., along with the cotton as intercrop or border crop or alternate crop to reduce the pest infestation. < Removal and destruction of crop residues to avoid carry over of the pest to the next season, and avoiding extended period of crop growth by continuous irrigation. Optimising the use of nitrogenous fertilizers which will not favour mthe multiplication of the pest. < Judicious water management for the crop to prevent excessive vegetative growth and larval harbourage. **Biological control :** < Application of Nuclear Polyhedrosis Virus (NPV) at 3 x 10^{12} POB /ha in evening hours at 7th and 12th week after sowing. < Conservation and augmentation of natural predators and parasitoids for effective control of the pest. < Inundative release of egg parasitoid, *Trichogramma* spp., at 6.25 cc/ha at 15 days interval 3 times from 45 DAS < Egg-larval parasitoid, *Chelonus blackburnii* and Predator *Chrysoperla carnea* at 1,00,000/ha at 6th, 13th and 14^{th} week after sowing. < ULV spray of NPV at 3 x 10^{12} POB /ha with 10% cotton seed kernel extract, 10% crude sugar, 0.1% each of Tinopal and Teepol for effective control of *Helicoverpa*.

	Note: Dicofol, methyl demeton, monocrotophos and phosalone are comparatively safer to *Chrysoperla* larva recording low egg mortality. **Chemical control :** < Discourage the indiscriminate use of insecticides, particularly synthetic pyrethroids. < Use of proper insecticides which are comparatively safer to natural enemies such as endosulfan, phosalone, etc., at the correct dosage and alternating different groups of insecticides for each round of spray. < Avoid combination of insecticides as tank mix. < Adopt proper delivery system using spraying equipments like hand compression sprayer, knapsack sprayer and mist blower to ensure proper coverage with required quantity of spray fluid and avoid ULV applications or Akela spray applications. < Proper mixing and preparation of spray fluid for each filling of spray fluid tank. **At early stages of square formation apply one of the following insecticides** Acephate 75%SP 780 g/ha Azadirachtin 0.03% EC 500 ml/ha Carbaryl 10%DP 25 kg/ha Chlorantraniliprole 18.5% SC 150 ml/ha Chlorpyriphos 20% EC 1250 ml/ha Diflubenzuron 25%WP 300 g/ha Emamectin benzoate 5% SG 190-220 g/ha Fipronil 5%SC 2000 ml/ha Flubendiamide 20%WG 250 g/ha Flubendiamide 39.35%SC 100-125 ml/ha Indoxacarb 14.5%SC 500 ml/ha Lufenuron 5.4%EC 600 ml/ha Novaluron 10%EC 1000 ml/ha NPV of *H. armigera* 0.43% AS 400-600 ml/ha Profenofos 50% EC 1750-2500 ml/ha Pyridalyl10%EC 1500-2000 ml/ha Spinosad 45.0%SC 165-220 ml/ha Thiodicarb 75%WP 1000 g/ha **During bolling and maturation stage, apply any one of the following insecticides (1000 l of spray fluid/ha):** Quinalphos 25 EC 2.0 l/ha Carbaryl 50 WP 2.5 kg/ha Pyraclofos 50 EC 1.5 l/ha **Biological control:** *Bacillus thuringiensis*-k 750-1000 g/ha *Bacillus thuringiensis* serovar kurstaki (3a,3b,3c) 5%WP 500-1000 g/ha *Beauveria bassiana* 1.15% WP 400 g/ha
Spotted bollworm *Erias vitella, E. insulana*	**Spraying any one of the following insecticides** Carbaryl 5%DP 20 kg/ha Chlorantraniliprole 18.5% SC 150 ml/ha Flubendiamide 39.35%SC 100-125 ml/ha Indoxacarb 14.5%SC 500 ml/ha Phosalone 35%EC 1714ml/ha Profenofos 50% EC 1500-2000 ml/ha Triazophos 40%EC 1500-2000 ml/ha

	Biological control: *Bacillus thuringiensis* serovar kurstaki (3a,3b,3c) 5%WP 750-1000 g/ha
Pink bollworm *Pectinophora gossypiella*	< Use pheromone trap to monitor the adult moth activity < Three weekly releases of egg parasitoid *Trichogrammatoidea bactrae* @ 1,00,000/ha per release coinciding the incidence of the pest. Dust carbaryl 5%D 20 kg/ha **Spraying any one of the following insecticides:** Phosalone 35%EC 2000 ml/ha Triazophos 40EC 2.5l/ha
Tobacco cutworm *Spodoptera litura*	*Use of light trap to monitor and kill the attracted adult moths. *Set up the sex pheromone trap at 12/ha to monitor the activity of the pest and to synchronise the pesticide application, if need be, at the maximum activity stage. *Growing castor along border and irrigation bunds. *Removal and destruction of egg masses in castor and cotton crops. *Removal and destruction of early stage larvae found in clusters which can be located easily even from a distance. *Collection and destruction of shed materials. *Hand picking and destruction of grown up caterpillars. **Spray any one of the following insecticides per ha using, a high volume sprayer covering the foliage and soil surface :** Chlorpyriphos 20 EC 2.0 l Chlorpyriphos 20 EC 1.25 l Chlorantraniliprole 18.5% SC 150 ml Diflubenzuron 25%WP 300-350 g Spraying of insecticides should be done either in the early morning or in the evening and virus in the evening. Use of poison bait pellets prepared with rice bran 12.5 kg, jaggery 1.25 kg, carbaryl 50% WP 1.25 kg and water 7.5 litres. This bait can be spread in the fields in the evening hours so that the caterpillars coming out of the soil, feed and get killed. Spraying nuclear polyhedrosis virus at 1.5 x 10^{12} POB per ha.
Stem weevil *Pempherulus affinis*	Basal application of FYM 25 t/ha and 250 kg/ha of neem cake. Seed treatment with chlorpyriphos 20 EC @ 10ml/kg of seed+ Drenching collar region with chlorpyriphos 20 EC @ 2.5ml/ l on 15 and 30 DAS+ Earthing up. **Spray any one of the following insecticides** Carbaryl 10%DP 25 kg/ha Carbofuran 3%CG 33.3 kg/ha
Whitefly *Bemisia tabaci*	< Avoid the alternate, cultivated host crops of the white fly in the vicinity of cotton crop. < Growing cotton only once a year either in winter or summer season in any cotton tract. < Adopting crop rotation with non-preferred hosts such as sorghum, ragi, maize etc., for the white fly to check the

build up of the pest.

- Removal and destruction of alternate weed hosts like *Abutilon indicum*, *Chrozophore rottlari*, *Solanum nigrum* and *Hibiscus ficulensus* from the fields and neighbouring areas and maintaining field sanitation.
- Timely sowing with recommended spacing, preferably wider spacing and judicious application of recommended dose of fertilizers, particularly nitrogenous and irrigation management is essential to arrest the excessive vegetative growth and pest build up. Late sowing may be avoided and the crop growth should not be extended beyond its normal duration.
- Field sanitation may be given proper attention.
- Cultivation of most preferred alternate host crops like brinjal, bhendi, tomato, tobacco and sunflower may be avoided. In case their cultivation is unavoidable, plant protection measures should be extended to these crops also.
- Monitoring the activities of the adult white flies by setting up yellow pan traps and sticky traps at 1 foot height above the plant canopy and also in situ counts.
- Collection and removal of whitefly infested leaves from the plants and those which were shed due to the attack of the pest and destroying them.

Chemical control : Acetamiprid
20%SP 100 g/ha Azadirachtin 0.15%
500-1000 ml/ha Buprofezin 25% SC
1000 ml/ha Chlorpyriphos 20% EC
1250 ml/ha Clothianidin 50%WDG 40-
50 g/ha Diafenthiuron 50%WP 600
g/ha Fipronil 5%SC 250-340 ml/ha
Imidacloprid 17.8% SL100 -125 ml/ha
Profenofos 50% EC 1000 ml/ha
Thiacloprid 21.7% SC 500-600 ml/ha
Thiamethoxam 25%WG 100 g/ha
Triazophos 40%EC 1500-2000 ml/ha

Spray any one of the following plant products alone or in combination with the recommended dose of insecticide (at 2 ml/l of water)

Neem seed kernel extract 5% (50 kg) and neem oil at 5 ml/l of water
Fish oil rosin soap 25 kg at 1 kg in 40 lit of water
Notchi leaves 5% extract *Catharanthus rosea* extract 5%

Spray any one of the following in early stage (500 l of spray fluid/ha)

Phosphamidon 40 SL 600 ml/ha

Spray any one of the following in mid and late stages (1000 l spray liquid/ha)

Triazophos 40 EC 2.0 l/ha

- In the early stages with high volume sprayer, use a goose neck nozzle to cover the under surface of the foliage to get good control of the pest. If high volume sprayers are not available, 375 litres of spray fluid may be used per hectare for application in the low volume motorised knapsack mist blower.

	< The use of synthetic pyrethroids should be discouraged in cotton to avoid the problem of whitefly. Cypermethrin, fenvalerte and deltamethrin cause resurgence of whiteflies. So avoid repeated spraying of pyrethroids. < The plant protection measures should be adopted on a community basis in a specified cotton areas. **Biological control:** *Verticillium lecanii* 1.15% WP 2500 g/ha
Thrips *Thrips tabaci*	Seed treatment with imidacloprid 70 WS at 7 g/kg protect the crop from aphids, leafhoppers and thrips upto 8 weeks. **Spray any one of the following insecticides** (500 l spray fluid/ha) Methyl demeton 25 EC 500ml/ha Dimethoate 30 EC 500ml/ha Buprofezin 25% SC 1000 ml/ha Diafenthiuron 50%WP 600 g/ha Dimethoate 30%EC 660 ml/ha Fipronil 5%SC 1500-2000 ml/ha Imidacloprid 70% WG 30-35 g/ha Imidacloprid 48% FS/100kg seed 500-900 g/ha Imidacloprid 17.8% SL 100 -125 ml/ha Profenofos 50% EC 1000 ml/ha Thiacloprid 21.7% SC 100-125 ml/ha Thiamethoxam 70% FS 430 g/ha Thiamethoxam 25%WG 100g/ha
Aphids *Aphis gossypii*	Seed treatment with imidacloprid 70 WS at 7 g/kg protect the crop from aphids, leafhoppers and thrips upto 8 weeks. **Spray any one of the following insecticides** (500 l spray fluid/ha) Methyl demeton 25 EC 500ml/ha , Dimethoate 30 EC 500ml/ha Acetamiprid 20%SP 50 g/ha Azadirachtin 0.03% EC 500 ml/ha Buprofezin 25% SC1000 ml/ha Carbosulfan 25%DS 60g/kg seed Chlorpyrifos 20% EC 1250 ml/ha Diafenthiuron 50%WP 600 ml/ha Dimethoate 30%EC 660 ml/ha Fipronil 5%SC 1500-2000 ml/ha Imidacloprid 70% WG 30-35 kg/ha Imidacloprid 17.8% SL 100 -125 ml/ha Malathion 50% EC 1000 ml/ha Methyl demeton 25% EC 1200 ml/ha Profenofos 50% EC 1000 ml/ha Thiacloprid 21.7% SC 100-125 ml/ha Thiamethoxam 25%WG 100 g/ha
Leafhopper *Amrasca devastans*	Apply carbofuran 3%CG 25 kg/ha **Spray any one of the following insecticides** Imidacloprid 200 SL at 100 ml/ha Phosphamidon 40 SL 600 ml/ha Acetamiprid 20%SP 50 g/ha Azadirachtin 0.03%WSP 500-1000 g/ha Buprofezin 25% SC 1000 ml/ha Clothianidin 50%WDG 30-40 kg/ha Diafenthiuron 50%WP 600 g/ha Dimethoate 30%EC 660 ml/ha

	Fipronil 5%SC 1500-2000 ml/ha Methyl demeton 25% EC 1200 ml/ha Phosalone 35%EC 857 ml/ha Profenofos 50% EC 1000 ml/ha Thiacloprid 21.7% SC 100-125 ml/ha Thiamethoxam 30% FS 10 kg/ha Thiamethoxam 25%WG 100 g/ha NSKE 5% 25 kg/ha Where the leafhopper is a big menace apply Neem oil formulation 0.5 % or neem oil 3% thrice at fortnightly intervals.
Cotton mealybug	< Remove the alternate weeds hosts < Monitor the incidence regularly and look for crawler emergence < Take up the management at intial stage to get maximum control < Wherever necessary use botanical insecticides like neem derivatives such as neem oil 2% NSKE 5% and Fish oil rosin soap 25g/litre of water.(Consult the specialists for effective chemicals for individual species) < Use of Encyrtid parasitoids, *Acerophagus papayae* @ 100 per village against *Paracoccus marginatus* and *Aenasius bambawaeli* against *Phenococcus solenopsis* are recommended. < Use of dimethoate or profenophos @ 2ml / lit. may be adopted as an alternative
Yellow mite	Dicofol 18.5%SC 2700-4050 ml/ha
Red spider mite *Tetranychus cinnabarinus*	**Apply any one of the following:** Phosalone 35%EC 1714 ml/ha Dicofol 18.5%SC 2700-4050 ml/ha

Insecticide resistance

In case of control failures monitor the insecticide resistance with following discriminating dose screen.

A. *Helicoverpa armigera*

(Topical assay with III instar larva weighing 30-40 mg)
1. Cypermethrin 0.1 µg/µl
2. Cypermethrin 1.0 µg/µl
3. Fenvalerate 0.2 µg/µl
4. Quinalphos 0.75 µg/µl
5. Chlorpyriphos 1.0 µg/µl

B. Tobacco caterpillar - *Spodoptera litura*

(early III instar 8 day old larva weighing 30-40 mg and measuring 12+0.5 mm length)
1. Profenofos topical 3.0 µg
2. Chlorpyriphos topical 0.15 µg
3. Fenvalerate topical 0.2 µg/µl

C. Cotton leafhopper- *Amrasca devastans* (Distant)

(III instar larva of 0.14 mg weight, 1.30mm length)
1. Dimethoate IRAC method VIII (leaf disc) 400 ppm
2. Methyl demeton IRAC method VIII (leaf disc) 800 ppm
3. Acephate IRAC method VIII (leaf disc) 850 ppm

Resurgence

Repeated application of the following insecticides can cause resurgence of the insect pest of Cotton

< *Aphis gossypii :* Carbaryl, cypermethrin, deltamethrin, endosulfan, fenpropathrin, fenvaerate, flucythrinate, fluvalinate, monocrotophos, permethrin, phorate
< *Amrasca devastans :* Deltamethrin, dimethoate, disulfoton, methylparathion, phorate
< *Bemisia tabaci :* Cypermethrin, deltamethrin, dimethoate, endosulfan, fenvalerate, monocrotophos, phosalone
< *Ferrisia virgata :* Cypermethrin, deltamethrin, fenvalerate, permethrin
< *Tetranychus urticae :* Acephate, carbaryl, cypermethrin, deltamethrin, endosulfan, fenvalerate, fluvalinate, phosphamidon.

RAINFED COTTON

CROP PROTECTION
A. PEST MANAGEMENT
< The control measures recommended for irrigated cotton will hold good.
< **When water is not available, use any one of the following insecticides for the control of bollworms at 25 kg/ha :**
Carbaryl 5 D
Phosalone 4 D

C. DISEASE MANAGEMENT
D. DISEASE MANAGEMENT

Name of the Disease	*Management*
Bacterial leaf blight ***Xanthomonas axonopodis* pv. *malvacearum***	▪ ***Avoid stacking of infected plants*** ▪ Spray Streptomycin sulphate + Tetracycline mixture 100g + Copper oxychloride 1250g/ha ▪ Repeat spraying at 10 days interval twice or thrice if drizzling continues.
Alternaria leaf spot ***Alternaria macrospora***	➢ **Spray any one of the following:** ▪ Copper Oxychloride 1250g ▪ Mancozeb 1000g ▪ Chlorothalonil 500g/ha ▪ Difenaconazole- 0.05% 60, 90 and 120 days after sowing. ▪ Krexoxym methyl – 0.1% on 60, 90 and 120 days after sowing. ▪ Tebuconazole – 1ml/litre 60, 90 and 120 days after sowing. ▪ Trifloxystrobin+Tebuconazole – 0.6g/litre 60, 90 and 120 days after sowing. ▪ *Bacillus subtilis* (BSC 5) – 0.04% on 60, 90 and 120 days after sowing.

Grey Mildew ***Ramularia areola***	▪ Spray Carbendazim 250 g/ha ▪ Mancozeb 1000g ▪ Chlorothalonil 500g/ha ▪ Difenaconazole- 0.05% 60, 90 and 120 days after sowing. ▪ Krexoxym methyl – 0.1% on 60, 90 and 120 days after sowing. ▪ Tebuconazole – 1ml/litre 60, 90 and 120 days after sowing.
Boll rot *Fusarium moniliforme, Colletotrichum capsici, Aspergillus flavus, A. niger, Rhizopus nigricans, Nematospora, Botryodiplodia*	➢ **Spray any one of the following:** ▪ Carbendazim 500g, ▪ Mancozeb 2000g, ▪ **Copper oxychloride 2500g/ha along with an insecticide recommended for bollworm from 45th day at fortnightly interval.**
Root rot *Macrophomina phaseolina* *Rhizoctonia bataticola*	❖ **Cultural Method** ▪ Apply Neem cake @ 150 kg/ha to the soil and treat the seeds with talc based *T. viride* @ 4 g/kg to reduce the root rot incidence. ❖ **Biological control** ▪ Seed treatment with *T. viride* @ 10 g/kg followed by basal application of zinc sulphate @ 50 kg/ha ▪ Seed treatment with *Bacillus* (BSC 5) @ 10g/kg followed by soil application @ 2.5 kg/ ha in 250kg of compost at the time of sowing. ▪ Seed treatment with *Pseudomonas* (PF1) @ 10g/kg and soil application @ 2.5 kg/ha in 250 kg of compost at the time of sowing. ❖ **Chemical** ▪ Spot drench Carbendazim @ 1 g/lit at the base of affected plants as well as surrounding healthy plants. ▪ Soil drenching with Trifloxystrobin+Tebuconazole – 0.75g/litre .

C.Nematode management

Seed treatment with *P.flouresecens* @20g/Kg and soil application @ 2.5 kg/ha

Application of consortia formulation of Pfbv 22 + Bbv 57@ 2.5 Kg/ha

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 30 m all around the field from the same and other varieties / hybrids of the crop.

Season

- February - July and August-September

Pre-sowing seed management

- Seed fortification with 1 % KCl for 6 hrs and drying back original moisture content + polymer @ 3 ml / kg + imidachloprid @ 2 ml / kg +carbendazium @ 2 g / kg + *P.fluorescens* @ 10 g / + Azophos @ 120 g / kg of seed
- Soak the seeds in 3 % cowpea sprout extract for 10 h in seed to solution ratio of 1:1. (or)
- Harden the seed with 2 % KCl for 10 h in the seed to solution ratio 1:1.
- For mine spoils, harden with 2 % KCl for 10 h (seed to solution ratio 1:1 and coat with pink polykote 3 g / kg + carbendazim 2 g/ kg + imidachloprid1 ml / kg + DAP 30 g + micro nutrient mixture 20 g / kg + Azospirillium 80 g / kg of seed.

Preparation of pulse sprout extract

- Cowpea seeds were soaked overnight and incubated in a wet cloth for 12 h to enable sprouting. Later, 100 g of sprouts were ground in a mixer grinder by using ice cubes of 100 ml of water to prepare extracts of 100 per cent concentration. The ground material was squeezed through cloth bag to extract the sprout extract

Acid delinting of fuzzy seeds

- Treat the fuzzy seeds with commercial sulphuric acid @ 100 ml/kg of seed for a duration of 2-5 minutes depending upon the variety (2 minutes for MCU.5 while it is 5 minutes for MCU.12. After acid treatment, wash the seed thoroughly for 3 to 4 times with fresh water and with 0.5% lime solution for removal of acid
- From the floaters, hand pick immatured and insect damaged seeds and use the sinkers with brown colour and good filling alone for sowing.

Foliar application

- Apply 1% Diammonium phosphate as three sprays on 70th, 80th and 90th day after sowing (or)
- Spray 0.5 % Nutrigold or 3 % cowpea sprout extract at vegetative and flowering stage.

Harvesting

- Seed attains physiological maturity 45 – 55 days after fertilization
- Select fully bursted kapas for picking. The kapas are picked periodically in six pickings at weekly intervals.
- Consider first five pickings in winter crop and first four pickings in the summer crop alone for seed purpose because the seed from the subsequent pickings are inferior in quality.
- Do not retaining the kapas unpicked in the field for more than a week as it reduces seed quality

Seed Treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} of seed.
- Slurry treat seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) @ 3g / kg of seed as eco – friendly treatment.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 - 10%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 7 – 8 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 6%.

Hybrid seed production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 30 m all around the field from the same and other varieties/hybrids of cotton.
- Between the parental lines leave an isolation distance of 5m.

Seeds and sowing

- In the case of TCHB 213 hybrid seed production, seed required for female parent (TCH 1218) is 800 g and for male parent (TCB 209) is 200g.
- Sow the seeds of male parent (TCB 209) on 1st August and female parent (TCH 1218) 10 to 15 days after sowing of male parent for synchronised flowering.

Fertilizer requirement

- Apply NPK @ 120 : 60 :50 kg ha^{-1} as basal application.

Top dressing

- Top dress @ of 12.5 kg N/ha at 60 d and 90 days after sowing
- Earth up the crop adequately after first top dressing.
- Irrigate the crop immediately after every top dressing.

Foliar spray

- Spray 100 ppm boric acid or 0.5 % zinc sulphate to the male parent at 1st flowering to improve the pollen viability and pollen production
- Spray salicylic acid @ 250 ppm at 90 days after sowing for increased seed set.
- Spray 2% DAP for 4 times at 10 days interval for better development of crossed bolls during boll development period.

Emasculation and Dusting for cross pollination

- Emasculate and dust as far as possible all buds appearing during the first six weeks of reproductive phase to ensure good setting and development of bolls.
- Restrict emasculation to each day evening to 3 PM to 6 PM and pollination to morning between 10 AM to 1 PM to ensure highest purity of hybrid seeds. Emasculation should be complete and perfect.
- Choose optimum size of bud and avoid too young or too old buds for emasculation.
- Cover the male bags with paper bags previous evening for their use next day.
- Cover emasculated buds with butter paper bags.
- Close the crossing programme after 9th week (from commencement of crossing) and remove all buds and flowers appearing subsequently to facilitate the development of crossed bolls.

Topping

- Top the plants either manually or spray MH @ 100 ppm at 90 and 105 days.

Harvesting

- Harvest fully bursted bolls alone.
- Harvest the crop as 4 - 6 picking depending on the cultivar.
- Avoid later pickings (after 4-5 pickings) for selection of seed.

Ginning

- Gin the crossed kapas in separate gins erected in seed processing units or farm gins under the close supervision of the authorities concerned to ensure purity
- After ginning, dry the seeds well and clean by hand picking to remove small, shriveled and broken seeds.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} of seed (or)
- Slurry treat the seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) @ 3g / kg of seed as eco – friendly treatment.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 9-10%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 7-8 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 6%.

Other management practices

- As in crop management technique.

JUTE (*Corchorus olitorius* & *Corchorus capsularis*)

CROP MANAGEMENT

Jute can be successfully grown in Coimbatore, Cuddalore, Villupuram, Vellore, Tiruvannamalai, Chengleput and parts of Thanjavur, Tiruvarur, Nagapattinam, Tiruchirapalli, Perambalur, Karur, Pudukkottai and Tirunelveli, Thoothukudi districts where assured supply of irrigation water is available for its cultivation and retting for fibre extraction.

Soil type: Alluvial sandy loam, clay loamy soils are best suited for jute production. Capsularis jute can grow even in standing water especially towards the latter part of its growth, but Olitorius jute will not thrive in standing water. The latter is more drought resistant and is therefore grown on lighter soils.

Season: February

Land Preparation: Fine tilth is required since the seeds are very small.

Manures and fertilizer application: Five tonnes of well decomposed farm yard manure is to be applied during last ploughing. Besides 20 kg per ha each of N, P_2O_5 and K_2O are to be applied. basally. Beds and channels are formed depending on water resources.

Varieties: Capsularis JRC 212, JRC 321, JRC 7447
Olitorius j JRO 524, JRO 878, JRO 7835

Crop duration 120 to 140 Days

Seed rate and sowing: Seeds can be sown either by broadcasting or by line sowing.

Jute type	Seed rate (kg/ha) Line Sowing	Seed rate (kg/ha) Broad Casting	Spacing (cm)	No. of Plants/ Sq. Mtr.
Olitorius	5	7	25 x 5	80
Capsularis	7	10	30 x 5	67

Weed management: Hand weeding twice on 20 - 25 DAS and 35 - 40 DAS. Fluchloralin can be sprayed at 3 days after sowing at the rate of 1.5 kg per hectare and is followed by irrigation. Further one hand weeding can be taken up at 30 - 35 DAS.

Top dressing of fertiliser: Apply 10 kg of N at 20 - 25 days after first weeding and then again on 35 - 40 days after second weeding as top dressing. During periods of drought and fertilizer shortage, spray 8 kg of urea as 2 per cent urea solution (20 g urea in one litre of water) on jute foliage on 40 - 45 as well as 70 - 75 DAS.

Water Management: Jute crop requires 500 mm of water. First irrigation is to be given after sowing and life irrigation on fourth day after sowing. Afterwards irrigation can be given once in 15 days.

Harvest: Jute crop can be harvested from 100 to 110 DAS but can be extended from 120 - 135 DAS depending on local cropping systems. Jute plants are left in the field for 3 - 4 days for leaf shedding. Then thick and thin plants are sorted out and bundled in convenient size.

Yield: The green plant weight yield is 45 to 50 tonnes per hectare whereas the fibre yield is 2.0 to 2.5 tonnes per hectare.

AGAVE – CULTIVATION

Among the under-exploited resources, 'Agave' - a fibre yielding drought tolerant plant is one which can prosper the life of the dry land farmers without any risk. Agave is a short stemmed plant bearing a rosette of long erect pointed fleshy leaves. Agave is noted for its strong, coarse fibre, superior too and more flexible than Manila hemp. It is widely used for making ropes, cordage, twine, fishing nets, door mats and rugs and the short fibres are used for making mops, brushes. The waste material left after decorticating the leaves is used for making craft paper and paper boards. The fibres also contain about 73-78% of lignified form of cellulose. Apart from these wax from agave wastes and Hecogenin acetate a steroid useful for the pharmaceutical industry in India is obtained from agave juice. The genus Agave has about 275 species of which *A. sisalana, A.cantala* and *A.Americana* commonly occur in India. Agave blossoms only once during its life time and then dies. Agave plants are grown along railway line, road sides, river banks and as a hedge plant in dryland areas throughout the country. Till date it is grown in patches and as border crop in a neglected condition. The crop comes up on dry soils unsuitable for crop cultivation but grow vigorously on dry, well drained sandy loam soils.

Nursery: Agaves are usually propagated from bulbils or suckers. Grown up suckers can be dug out and planted during rainy months. In case of bulbils they are first sown in mother beds at close spacing @ 5000 bulbils per bed of 1 x 20 M. After 6 months the seedlings are pulled out and planted in the transplanting bed of size 20 x 1 m @ 500 Plants. In the second stage it is kept for three months. After 9 months from the date of planting bulbils suckers weighing 1/4 to 1/2 kg and 9 to 12" height are ready for planting.

Main field planting: In the main field they are planted at a space of 2 x 2 m in pits of size 30 cm^3. Planting is usually carried out during the rainy seasons for better establishment otherwise initial watering is quite essential for establishment.

Harvesting: The leaves are ready for harvesting from 3rd year onwards. The older leaves of length not less than a metre is harvested in the 3rd year. Each plant yields 40-50 leaves/year. The life cycle of the plant is upto 8 years. The content of fibre varies with variety from 2.5 to 4.5% and the highest is reported under *A.sisalana* as 4.5%. Agave sisalana produces a better quality fibre than *Agave americana*. From 3rd year onwards leaf yield of 30-40 tonnes/acre could be harvested and a net profit of not less than Rs.2000/acre could be obtained out of this crop. Even as border crop Agave could fetch a revenue of not less than Rs.400/acre/year from 3rd year until 8th year. Instead of traditional hand scraping process now mechanical decorticators are available for the extraction of fibre. The extracted fibres are washed in water, cleaned and dried and packed in bales. As a precaution, fibre extraction is done on a bright sunny day and within 2 days of the harvesting of the leaves or else the quality of the fibre will be deteriorated. The fibre colour varies from milky white to golden yellow.

SUGARCANE (*Saccharum officinarum*)

CROP IMPROVEMENT

A. PLANTED (MAIN) CROP

1. SEASON AND VARIETIES

Sugarcane is grown chiefly in the main season (December - May) in the entire State. In parts of Tiruchirapalli, Perambalur, Karur, Salem, Namakkal and Coimbatore districts, it is also raised during the special season (June - September). The particulars in respect of each season are given below:

SEASON, PERIOD OF PLANTING

1. **Main season**

   i) **Early :** Dec - Jan ii) **Mid :** Feb - March iii) **Late:** April - May

2. Special season : June - July

Early season varieties are suitable for special season.

II. PARTICULARS OF VARIETIES

Variety	Duration (Month)	Cane yield (t/ha)	CCS%	CCS(t/ha)
COC 671	10	123.5	14.20	17.50
COC 771	10	140.0	13.10	18.30
COC 772	10	143.3	14.00	20.00
COC 773	10	97.5	13.20	12.60
COC 8001 (C 66191)	10 - 11	102.9	13.20	13.50
COC 774	11	159.8	11.90	17.90
COC 775	11	122.5	13.40	16.40
COC 776	11	112.3	14.00	15.50
COC 777	12	171.3	11.80	20.00
COC 778	12	165.5	11.00	18.10
COC 779	12	204.6	11.80	24.00
CO 419	12	112.5	10.50	11.80
CO 6304	12	115.0	13.50	15.50
COC 8001	10 - 11	102.5	13.20	13.50
COC 85061	10 - 11	128.5	12.90	16.60
COC 86062	10 - 11	133.5	12.60	16.80
COSi 86071	10 - 11	131.7	12.20	16.00
COC 90063	10 - 11	124.0	12.30	15.40
CO 8021	10 - 11	137.7	11.00	14.60
COC 91061	10 - 11	131.0	11.30	15.60
COC 92061	8 - 11	132.7	12.76	16.05
CO 8362	11 - 12	124.3	12.40	15.40
COG 93076	11 - 12	132.0	13.20	17.40
CO 8208	11 - 13	141.5	11.07	15.28
COG 94077	11	133.2	13.5	17.6
COG 95076	10 - 11	108.2	11.5	12.4
CO 85019	12	134.5	12.5	16.8
COSi 95071	10	152.0	12.9	21
COSi 96071	10	145.0	11.9	17.3
CO 86010	10 - 12	146.1	10.78	15.64
COC 98061	10 - 11	120.0	11.60	13.80
COSi 98071	12	144.7	12.3	17.7
CO 86249	10 - 12	128.7	11.3	14.3
COC 99061	10-12	130.3	11.9	15.6
CO 86032	10-12	110.0	13.0	14.3

COC (SC) 22	10-12	135.9	12.1	16.5
CO Si (SC) 6	10-11	142.0	13.1	18.6
COG (SC) 5	11-12	115.0	12.7	14.6
CoC 23	10-11	133.0	12.95	17.23
CoC 24	10-11	133.0	12.82	17.05
TNAU SC Si 7	10-11	156	13.4	20.9
TNAU SC Si 8	11-12	146	12.9	18.0

III. MORPHOLOGICAL CHARACTERS

Characters	**COC 671**	**COC 771**	**COC 772**	**COC 773**
Parentage	Q63xCO775	CO419xCO658	CO740xCO658	CO658XCO1305
Leaf size	Broad	Broad	Broad	Broad
Leaf colour	Green	Green	Green	Green
Sheath colour	Green with purple tinge	Green with purple tinge	Green with purple tinge	Green with purple tinge
Sheath				
Clasping	Loose	Loose	Loose	Loose
Spines	Present	Present	Present	Present
Ligular process	Present	Absent	Absent	Present
Stem colour	Green with purple tinge	Yellow with purple tinge	Yellow with Green tinge	Yellow with green tinge
Girth	Thick	Medium	Medium	Medium
Joint	Staggered	Straight	Staggered	Straight
Bud Groove	Absent	Present	Absent	Absent
Size	Medium	Medium	Medium	Medium

Character	**COC 774**	**COC 775**	**COC 776**	**COC 777**
Parentage	CO785x CO 658	CO658xCO1305	CO419xCO775	CO419XCO853
Leaf size	Broad	Broad	Broad	Broad
Leaf colour	Green	Green	Green	Green
Sheath colour	Green with purple tinge	Green with purple tinge	Green with purple tinge	Purple
Sheath				
Clasping	Tight	Tight	Tight	Loose
Spines	Present	Present	Present	Present
Ligular process	Present	Present	Present	Present
Stem colour	Purple	Green with purple tinge	Yellow with purple tinge	Purple with green tinge
Girth	Medium	Medium	Medium	Medium
Joint	Straight	Straight	Straight	Staggered
Bud Groove	Absent	Present	Absent	Absent
Size	Medium	Medium	Medium	Medium

Character	**COC 778**	**COC 779**	**CO 419**	**COC 85061**
Parentage	CO419xCO 853	CO419xCO853	Poj 2878xCO290	CO6304 GC
Leaf size	Broad	Broad	Broad	Medium
Leaf colour	Green	Green	Green	Light green
Sheath colour	Purple	Purple	Green with Green tinge	Green with pink tinge
Sheath				
Clasping	Loose	Loose	Loose	Tight
Spines	Present	Present	Present	Glabrous
Ligular process	Present	Present	Lanceolate	Present on one side
Stem colour	Purple	Purple with	Purple	Greenish yellow

		green tinge		turns to pink on exposure to sunlight
Girth	Medium	Medium	Thick	Medium
Joint	Staggered	Straight	Staggered	Staggered
Bud Groove	Absent	Absent	Present	Absent
Size	Medium	Medium	Medium	Medium

Characters	**COC86062**	**COSi 86071**	**CO6304**	**C66191(COC 8001)**
Parentage	MS68/47GC	CO775xCO842	CO419xCO605	PO2874XCO658
Leaf size	Medium	Broad	Broad	Broad
Leaf colour	Green	Dark green	Green	Green
Sheath colour	Dark pink	Yellowish green with pink tinge	Green with Purple tinge	Greenish
Sheath				
Clasping	Loose	Tight	Loose	Loose
Spines	Glabrous	Present	Present	Absent
Ligular process	Absent	Present on both sides	Present	Bow shape
Stem colour	Yellowish green turns to dark pink on exposure to sunlight	Purplish green turns to pink on exposure to sunlight	Green with purple tinge	Greenish with light yellowish tinge
Girth	Medium	Thick	Thick	Medium
Joint	Staggered	Staggered	Staggered	Straight
Bud Groove	Absent	Present	Present	**Indicated**
Size	Small	Big	Medium	Medium

Character	**COC 8201**	**COC 90063**	**CO 8021**	**COC 91061**
Parentage	CO740xCO62174	CO6304XCOC671	CO740xCO6806	COC779 G.C.
Leaf size	Medium	Medium	Medium	Medium
Leaf colour	Green	Green	Green	Green
Sheath colour	Green with Pink tinge	Green	Purple	Whitish Yellow
Sheath clasping	Loose	Loose	Loose	Tight
Spines	Glabrous	Present	Glabrous	Absent
Splits	..	Absent	Present	Absent
Ligular process	Lanceolate	Present on one side	Present on one side Lanceolate (4-5 cm)	Absent
Stem colour	Greenish yellow	Yellowish green	Purple with heavy wax deposition	Yellowish green
Girth	Medium	Medium	Medium	Medium
Joint	Thick	Staggered	Erect	Staggered
Bud Groove	Present	Absent	Present and Prominent	Absent
Size	Medium	Medium	Medium/Big	Small

Character	**COC 92061**	**CO 8362**	**COG93076**	**CO 8208**
Parentage	CO 7314 GC (Natural cross) Involving CO6314 as female	CO 6304X COC 671	COC 772X CO 419	CO 62198X COC 671
Leaf size	Broad	Medium	Medium	Medium
Leaf colour	Green	Green	Dark green	Dark green

Sheath Colour	Purple with heavy bloom	Green	Dark green	Greenish purple
Sheath clasping	Loose	—	Loose	—
Spines	Deciduous	Deciduous	Deciduous	Deciduous
Splits	Absent	Absent	Absent	—
Ligular process	One side indicated and the other side rudimentary	Present on both side	One side	Present Asymmetrical
Stem colour	Greenish yellow with pink tinge	Purple green	Greenish light yellow	Green with purple tinge
Girth	-	-	-	-
Joint	Slightly staggered	Straight	Slightly staggered	Straight
Bud Groove	Absent	Absent	Absent	Absent
Size	Medium	Medium	Medium	Small

Character	COG 94077	COG 95076	CO 85019	COSi 95071
Parentage	CO 740 x C0 775	COC 771 x CO 775	CO 7201 x CO 775	COC 671x MS 6847
Leaf size	Medium	Medium	Length 140 cm Medium width 6.0 cm	Medium
Leaf colour	Dark green	Green	Light green at harvest	Green
Sheath colour	Greenish with Purple tingle	Green	Green with purple tinge	Light greenish yellow
Sheath Clasping	Loose	Loose	Easily trashing	Loose
Spines	Absent	Present,deciduous	Hard few	Absent
Ligular process	Present on One side	one side lanceolate and one side dentoid	Absent	Present, Asymmetrical
Stem colour	Greenish yellow	Greenish yellow with purplish tinge	Exposed purple unexposed yellowish green with heavy waxy coating	Greenish yellow
Girth	Medium	Medium	Medium	Medium
Joint	Slightly staggered	Slightly staggered	Zig Zag	Staggered
Bud groove	Short, shallow	Indicated	Absent	Present
Size	Medium	Medium	Small	Medium

Character	CO Si 96071	CO 86010	COC 98061	CO Si 98071	CO 86249
Parentage	C 82061GC	CO 740xCo 7409	C80 172 GC	Bo 91/Co 62198	CO J 64 x CoA 7601
Leaf size	Medium	Broad	Medium	Broad	Medium
Leaf colour	Green	Light green	Green	Dark green	Green
Sheath colour	Light green with pink blotches	Light green with pink blotches	Green with pink tinge	Yellowish green	Light green
Spines	Present & deciduous	Absent	Absent	Deciduous	
Ligular	Asymmetrical	-	Absent on both sides	Short lanceolate	Small, present on one side

Stem colour	Purplish	Yellowish with green tinge	Greenish yellow with slight purple tinge	Yellowish green	Greenish yellow
Girth	Medium	Thick	Medium	Thick	Thick
Joint	Concave, convex	-	Cylindrical	Cylindrical	Cylindrical
Budgroove	Absent	Prominent	Absent	Numerous	Absent
Size	Small	Big	Medium	Big	Big

Character	**COC 99061**	**CO 86032**	**COC (SC) 22**
Parentage	CO 6806 X CO 740	CO 62198 XCOC 671	CO 8208 GC
Leaf size	Medium	Medium	Medium
Leaf colour	Green	Dark green	Green
Sheath colour	Green with pink tinge	Green with purple	Green with slight scarious border
Sheath clasping	Tight	Loose	Loose
Spines	Deciduous	Few, hard, deciduous	Absent
Splits	Absent	Present	Absent
Ligular process	Present, asymmetrical, lanceolate	“O”	Present asymmetrical
Stem colour	Dark green (Exposed) Yellowish green (Unexposed)	Reddish pink (exposed) Greenish yellow (unexposed)	Reddish Pink with purple (exposed) Greenish yellow(unexposed)
Girth	Medium	Medium	Medium
Joint	Cylindrical	Cylinderical	Cylindrical
Bud groove	Absent	Absent	Absent
Size	Medium	Medium	Medium

Character	**COC 23**	**COC 24**	**TNAU SC Si7**
Parentage	69A591 GC	CO 8371 x MS 6847	Co 99034xCoG 93076
Leaf size	Medium	Medium	Medium
Leaf colour	Light Green	Dark green	Dark Green
Sheath colour	Green	Green with purple tinge	Yellowish Green with purple tinge
Sheath clasping	Loose	Loose	Slightly tight
Spines	Absent	Absent	Present(de ciduous)
Splits	Absent	Absent	Absent
Ligular process	Present	Present	Present
Stem colour	Green with purple tinge (Exposed)	Green (exposed) Greenish yellow	Yellowish Green(exp

	Yellowish green (Unexposed)	(unexposed)	osed) pinkish yellow(unexposed)
Girth	Medium	Thick	Medium
Joint	Straight	Staggered	Straight
Bud groove	Absent	present	Absent
Size	Medium	Medium	Medium

Character	**TNAU SC Si8**
Parentage	CoC 90063xCo8213
Leaf size	Medium
Leaf colour	Green
Sheath colour	Green with purple stripes
Sheath clasping	Loose
Spines	Very few, soft and deciduous
Splits	Absent
Ligular process	Present(Asymmetrical)
Stem colour	Greenish Yellow (Exposed) Greenish Yellow (Unexposed)
Girth	Medium
Joint	Straight
Bud groove	Present, shallow
Size	Big

IV. DISTRICT/SEASON - SUITABLE VARIETIES

ALL DISTRICTS (except Kanniyakumari and Nilgiris)

Early		**Mid**		**Late**		**Special**	
Factory	Jaggery	Factory	Jaggery	Factory	Jaggery	Factory	Jaggery
CO 658	..	CO 658	CO 419	CO 6304	CO 62175	Early varieties are suitable for Special	..
CO 62174	COC 671	CO 62198	CO 449	COC 8201	CO 419	..	..
CO 62198	COC 771	CO 6304	CO 6304	COC 771	CO 6304	..	..
COC 671	COC 772	COC 774	COC 776	COC 778	COC 8201	..	..
COC 771	COC 773	COC 775	COC 8001	COC 779	CO 740	..	..
COC 772	COC 8001	COC 8001	..	CO 419	..	..	..
COC 8001	COC 85061	, ..	..	CO 740	..	..	..
COC 85061	COC 86062			CO 658	..	..	..
COC 86062	..	..	..	..	..	..	..
COSi 86071	COSi 86071	..	..	..	..	..	..
COC 90063	COC 90063	..	..	..	..		
COC 91061	COC	..	..	..	..	..	..

COG 94077	91061 COG 94077						
CO Si 95071 COC 98061 CO 86010 CO 86249 CoC 23, CoC 24, TNAU SC Si7		COG 93076 CO 85019 COC 99061 CO 86032 COC (Sc) 22 TNAU SC Si 8	..	COG 93076 CO 85019 COC 99061 CO 86032 COC (Sc) 22 TNAU SC Si8	..	..	..

Right seed

TNAU in collaboration with Sugar Cane Breeding Institute, Coimbatore released many high yielding varieties with high recovery to suit various eco systems and other biotic and abiotic problematic area and of which the following listed varieties can be recommended for higher cane productivity

Variety	Performance
Co 86032	Performs well in all soil types and extremely well in garden land condition. Good quality cane with higher yield. Has multi ratooning capacity. Can be grown throughout the year. Gives higher recovery. Self detrashing in nature. Amenable for wide row spacing.
CoV 92102	High quality variety with yield on par with Co 86032. Self stripping with good field habit. Non flowering. Performs well in red, clay and alkaline soils. Ratoon performance is satisfactory.
CoSi 95071	Performs well in December, January and February planting.
CoC 90063	Non lodging, high tillering, high yield and good quality. Drought and alkaline tolerant variety and good ratooner.
Co 86027	Suitable for mid late planting. Moderate yielder with high sugar. Non lodging and non flowering.
CoV 94101	Good ratooner. Non lodging. Suitable for early planting. Thick cane with good tillering.
Co 85019	Drought tolerant variety. Resistant to red rot.
Co 86249	Red rot resistant, Drought tolerant, high yielding
CoV 94102	Yield is on par with Co 86032 and quality is lower than Co 86032
Co Si(Sc)6	High yielder and high quality. Drought tolerant moderately resistant to red rot.
Co G (Sc)5	High yielder suitable for jaggary making and tannery effluent soils
Co C (Sc)22	High yielder and high quality drought tolerant moderately resistant to red rot.
CoC (SC) 23	High yielder and high quality, moderately resistant to red rot.
CoC (SC) 24	High yielder and high quality, drought and saline tolerant and moderately resistant to red rot.
TNAU SC Si7	High yielder and high quality, drought and saline tolerant and moderately resistant

	to red rot.
TNAU SC Si 8	High yielder and high quality, Tolerant to drought, water logging conditions and problem soils. moderately resistant to red rot. Suitable for mechanized cultivation.

Suitable varieties for Tamil Nadu

Place / District	Suitable Varieties	Salient features
Pudukkottai	CoV 92102, CoC 90063, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, TNAU SC Si7, TNAU SC Si 8	Drought tolerance
Erode	Co 86032, CoSi 95071, Co 86249, CoG 93076, CoV 94102, Co 85019 Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC(SC) 24	Drought tolerance, Good yielder
Vellore	CoV 92102, CoC 90063 Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC 24 TNAU SC Si7, TNAU SC Si 8	Good yielder even in drought suitable for late planting.
Sivaganga & Ramnad	Co 86032, Co 85019, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, Co V 94102, CoC 24 TNAU SC Si7, TNAU SC Si 8	Performing well in drought
Thiruvannamalai & Kancheepuram	CoC 90063, CoV 92102, Co 86032, CoG 94077, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC 24 TNAU SC Si7, TNAU SC Si 8	Drought tolerance and better yield.
Virudhunagar, Tirunelveli & Tuticorin	Co 86032, Co 85019, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC 24 TNAU SC Si7, TNAU SC Si 8	Performing well in drought
Dharmapuri & Krishnagiri	Co 86032, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, Co 97009, CoV 94101, CoC 90063, CoSi 95071, CoC 24 TNAU SC Si7, TNAU SC Si 8	Surviving better in drought. Drought tolerance and better yield.
Karur	Co V 92102, CoSi 95071, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22., CoC 24 TNAU SC Si7, TNAU SC Si 8	Drought tolerance
Trichy & Perambalur	Co Si 95071, CoC 671, CoV 92102, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC 24 TNAU SC Si7, TNAU SC Si 8	Drought resistant high yield.
Cuddalore	CoV 92102, CoC 90063, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC 24 TNAU SC Si7, TNAU SC Si 8	Drought tolerant
Villuppuram	Co 86032, CoV 92102, CoC 90063, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC 23, CoC 24 TNAU SC Si7, TNAU SC Si 8	Drought tolerance and high yield.

Thanjavur, Nagapattinam & Tiruvarur	Co V 92102, CoG 93076, CoG 94077, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC 24 TNAU SC Si7, TNAU SC Si 8	Dought tolerance and good yield
Coimbatore	Co 86032, CoV 92102, Co 86027, CoC 90063, Co 97009, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC 24 TNAU SC Si7, TNAU SC Si 8	Drought tolerance and good yield.
Tiruvallur	Co 85019, CoC 22, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC 24 TNAU SC Si7, TNAU SC Si 8	Drought tolerance and good yield
Theni, Madurai and Dindigul	Co 92012, Co 92008, Co 93001, Co 86032, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC 24 TNAU SC Si7, TNAU SC Si 8	Drought tolerance and better yield.
Namakkal & Salem	CoV 92102, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC 24 TNAU SC Si7, TNAU SC Si 8	Drought tolerance and better yield.
Chengalput	CoSi 95071, Co 85019, CoC 22, Co Si(Sc)6, Co G (Sc)5, Co C (Sc)22, CoC 24 TNAU SC Si7, TNAU SC Si 8	Drought tolerance and better yield.

Source of seed

For the varieties released from Tamil Nadu Agricultural University for supply of primary seed materials the Sugarcane Research Stations at Cuddalore, Sirugamani and Melalathur may be contacted. For other varieties promoted by the factories, for seed materials the concerned factories may be contacted.

CROP MANAGEMENT

V. MAIN FIELD PREPARATION FOR PLANTING SUGARCANE

1. PREPARATION OF THE FIELD

a) **Wetland (Heavy soils):** In wetlands, preparatory cultivation by ploughing the land and bringing the soil to fine tilth could not be done.

i. After harvest of the paddy crop, form irrigation and drainage channels of 40 cm depth and 30 cm width at intervals of 6 m across the field and along the field borders.

ii. Form ridges and furrows with a spacing of 80 cm between rows with spade.

iii. Stir the furrows with hand hoes and allow the soil to weather for 4 to 5 days.

b) Problem soils with excessive soil moisture:

In problem soils, with excessive moisture where it is difficult to drain water, form raised beds at 30 cm intervals with Length - 5 m, Width - 80 cm, and Height -15 cm.

c. Garden lands with medium and light soils:

In medium and light soil irrigated by flow or lift irrigation adopt the following:

i. The initial ploughing with two disc plough followed by eight disc plough and using cultivator for deep ploughing followed by one time operation of rotovator to pulverize the soil to get a fine tilth, free of weeds and stubbles.
ii. Level the field with laser leveler for effective and proper irrigation management.
iii. Open ridges and furrows with tractor operated victory plough with a depth of 30cm and spacing of 80 cm between the rows for normal planting with furrow irrigation.
iv. Open irrigation channels at 10 m intervals.

2. BASAL APPLICATION OF ORGANIC MANURES:

Apply FYM at 12.5 t/ha or compost 25 t/ha or filter press mud at 37.5 t/ha before the last ploughing under gardenland conditions. In wetlands this may be applied along the furrows and incorporated well.

Preparation of reinforced compost from sugarcane trash and pressmud:

Spread the sugarcane trash to a thickness of 15 cm over an area of 7 m x 3 m. Then apply pressmud over this trash to a thickness of 5 cm. Sprinkle the fertilizer mixture containing mussoorie rock phosphate, gypsum and urea in the ratio of 2:2:1 over these layers at the rate of 5 kg/100 kg of trash. Moist the trash and pressmud layers adequately with water. Repeat this process till the entire heap rises to a height of 1.5 m. Use cowdung slurry instead of water to moist the layer wherever it is available. Cover the heap with a layer of soil and pressmud at 1:1 ratio to a thickness of 15 cm.

Leave the heap as such for three months for decomposition. Moist the heap once in 15 days. During rainy season, avoid moistening the heap. After three months, turn and mix the heap thoroughly and form a heap and leave it for one more month. Then turn and mix the heap thoroughly at the end of the fourth month. Moist the heap once in 15 days during 4th and 5th month also. This method increases the manurial value of trash compost by increasing, N, P and Ca content. It also brings down the C:N ratio by 10 times as compared to raw cane trash.

Composition of cane trash, pressmud and cane trash compost

Major nutrients	Cane trash	Pressmud	Cane trash compost
		Percent	
Nitrogen (N)	0.40	1.90	1.60
Phosphorus (P)	0.13	1.50	1.10
Potassium(K)	0.40	0.50	0.40
Calcium (Ca)	0.56	3.00	1.00
Magnesium (Mg)	0.30	2.00	0.60
Sulphur (S)	0.12	0.50	0.48

Micronutrients	Cane trash	Pressmud	Cane trash compost
		PPM	
Iron (Fe)	360	2240	2710
Manganese (Mn)	110	400	450
Zinc (Zn)	90	360	370
Copper (Cu)	30	130	80
C:N ratio	113:1	16:1	22:1

2. BASAL APPLICATION OF PERTILIZER

(i) If soil test is not done, follow blanket recommendation of NPK @ 300:100:200 kg/ha Apply super phosphate (625 kg/ha) along the furrows and incorporate with hand hoe.

Soil test crop response based integrated plant nutrition system (STCR- IPNS) recommendation may be adopted for prescribing fertilizer doses for specified yield targets. (ready reckoners are furnished)

Sugarcane (1)

Soil : Mixed black calcareous (Perianaickenpalayam series)
Season : Annual
Target : 125 t ha^{-1}

FN = 4.17 T - 1.09 SN – 1.11 ON
FP_2O_5 = 1.01 T - 2.56 SP – 1.01 OP
FK_2O = 3.44 T - 0.84 SK – 1.03 OK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + *Azospirillum* @2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
200	15	300	223	43	113
220	17	350	201	37	71
240	19	400	179	32*	57*
260	21	450	158	32*	57*
280	23	500	138*	32*	57*

*maintenance dose

Sugarcane (2)

Soil : Red Coastal alluvium(Gadillum series)
Season : Annual
Target : 125 t ha^{-1}

FN = 4.06 T - 0.74 SN - 0.87 ON
FP_2O_5 = 0.71 T - 1.09 SP - 0.72 OP
FK_2O = 2.67 T - 0.57 SK - 1.3 OK

Initial soil tests (kg ha^{-1})			NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + *Azospirillum* @2 kg ha^{-1} + PSB @ 2 kg ha^{-1}		
SN	**SP**	**SK**	**FN**	**FP_2O_5**	**FK_2O**
200	15	200	280	32*	155
220	17	220	265	32*	144
240	19	240	251	32*	132
260	21	260	236	32*	121
280	23	280	221	32*	109

*maintenance dose

Sugarcane (3)

Soil : Red sandy loam (Irugur series)
Season : Annual
Target : 100 t ha^{-1}

FN = 3.42 T – 0.56 SN – 0.93 ON
FP_2O_5 = 1.15 T – 1.94 SP – 0.98 OP
FK_2O = 3.16 T - 0.73 SK – 0.99 OK

Initial soil tests (kg ha^{-1})	NPK (kg ha^{-1}) + FYM @ 12.5 t ha^{-1} + *Azospirillum* @2 kg ha^{-1} + PSB @ 2 kg ha^{-1}

SN	SP	SK	FN	FP_2O_5	FK_2O
200	14	200	150	43	105
220	16	220	139	39	90
240	18	240	138*	35	76
260	20	260	138*	32*	61
280	22	280	138*	32*	57*

*maintenance dose

Note: FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in t ha^{-1}; SN, SP and SK respectively are available N,P and K in kg ha^{-1} and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

(ii) Apply 37.5 kg Zinc sulphate/ha and 100 kg Ferrous sulphate/ha to zinc and iron deficient soils.

(iii) Application of sulphur in the form of Gypsum @ 500 kg /ha to sulphur deficient soils to increase the cane yield and juice quality

VI. MANAGEMENT OF MAIN FIELD OPERATIONS

1. PREPARATION OF SETTS FOR PLANTING

a. Take seed material from short crop (6 to 7 months age) free from pests and diseases incidence.
   - i) Detrash the cane with hand before setts preparation.
   - ii. Use sharp knife or sett cutting machine developed by TNAU to prepare setts without splits.
   - iii. Discard setts with damaged buds, sprouted buds, splits etc.
   - iv. Sett treatment with Azospirillum: Prepare the slurry with 10 packets (2000 g)/ha of Azospirillum inoculum with sufficient water and soak the setts in the slurry for 15 minutes before planting.

2. SETT TREATMENT

- Select healthy setts for planting.
- The setts should be soaked in 100 litres of water dissolved with 50g Carbendazim, 200ml malathion and 1 kg urea for 15 minutes.
- Treat setts with Aerated steam at 50°C for one hour to control primary infection of grassy shoot disease.

3. SEED RATE

75000 two-budded setts/ha.

4. PLANTING

Different systems of planting is not found to influence the millable cane population, commercial cane sugar per cent, cane and sugar yield.

a) Irrigate the furrows to form a slurry in wet land condition (Heavy soil)
b) Place the setts along the centre of the furrows, accommodating 12 buds/metre length. Keep the buds in the lateral position and press gently beneath the soil in the furrow.
c) Next day cover the exposed setts with soil to avoid exposure of setts to sunlight.
d) Plant more setts near the channel or double row planting at every 10th row for gap filling, at later stage.
e) In dry/ garden land dry method of planting may be followed. First arrange the setts along the furrows, cover the setts with soil and then irrigate.

Improved technologies on cane planting systems

Mechanisation of planting

- TNAU mechanical planter is useful for cost effective planting with saving of Rs.3750 / ha and it can cover an area of 1.5ha/day
- Reduces the human labour drudgery and seed rate up to 5 tones/ha.
- Paired row system of planting double side planting of sugarcane setts with 150 + 30 cm spacing for Astraf 8000 series (Mechanical harvester) operated areas and 150 + 30 cm spacing for New Holland 4000 series operated areas may be adopted with single row of cane planting.
- Sugarcane cultivates under subsurface drip system the laterals may be placed 20cm depth in the furrows and setts are placed 5cm above the laterals.
- For sustainable sugarcane initiative system (SSI) transplanting young chip bud seedling raised in portray (25-35 days old) in wide spacing (5x2 feet) in the main field with drip fertigation system.
- Daincha / Sunhemp intercropping in the wider spaced cane cultivated area for improving soil health and reduce the weed infestation. It also reduces early shoot borer incidences and increases cane yield.
- Plant the setts on one side of the ridge for 80 cm spacing in heavy soil to avoid sett rot resulted better germination
- Sow rhizobium treated green manure seeds @ 10kg/ha on the opposite side of ridge with 10cm. Spacing on or before 3 days after planting.
- Incorporate the green manure crop 50-60 days after planting in between interow of wider spaced crop and give partial earthing up with recommended dose of N fertilizer on 90 – 100 day after planting.
- Introduction of power weeder with rotovator for weeding and earthing up with ridger to save the cost on labour and also to reduce human drudgery.

5. FILLING UP GAPS

ii. Fill the gaps, if any, within 30 days after planting with sprouted setts.
iii. Gap filling with two budded setts/ poly bag seedlings within 15 to 20 days after planting to maintain optimum plant stand.
iv. Maintain adequate moisture for 3 weeks for proper establishment of the sprouted setts.

6. TRASH MULCHING

Mulch the ridges uniformly with cane trash to a thickness of 10 cm within a week after planting. It helps to tide over drought, conserves moisture, reduce weed population and minimise shoot borer incidence. Mulch the field with trash after 21 days of planting in heavy soil and wetland conditions. Avoid trash mulching in areas where incidence of termites is noticed.

7. RAISING INTER CROPS

In areas of adequate irrigation, sow one row of soybean or blackgram or greengram along the centre of the ridge on the 3rd day of planting. Intercropping of daincha or sunhemp along ridges and incorporation of the same on the 45th day during partial earthing up helps to increase the soil fertility, and also the cane yield. Especially Intercropping of Co.1 Soybean gives a yield of 800 kg/ha without any adverse effect on cane yield.

8. WEED MANAGEMENT

WEED MANAGEMENT IN PURE CROP OF SUGARCANE

i. Wherever weed menace is higher, one line weeding along the crop row and spade digging of ridges have to be done on 30, 60 and 90 DAP
ii. Spray Atrazine 2 kg or Oxyflurofen 750 ml/ha mixed in 600 liters of water as pre emergence herbicide on the 3rd day of planting, using deflector or fan type nozzle fitted with knapsack sprayer.
iii. The pre emergence application of atrazine @ 1.0 kg a.i. ha^{-1} on 3 DAP followed by post emergence directed application of glyphosate @ 1.0 lit ha^{-1}on 45 DAP with hood+ one hand

weeding on 90 DAP registered the maximum cane yield.

iv. If pre-emergence spray is not carried out, go in for post-emergence spray of Grammaxone 2.5 litre + 2,4-D sodium salt 2.5 kg/ha in 600 liter of water on 21st day of planting.

v. If the parasitic weed striga is a problem, post-emergence application of 2,4-D sodium salt @ 1.25 kg/ha in 500 litre of water/ha may be done. 2, 4-D spraying should be avoided when neighbouring crop is cotton or bhendi. Apply 20% urea also for the control of striga as direct spray.

vi. Pre- plant application of glyphosate at 2.0 kg ha^{-1} along with 2% ammonium sulphate at 21 days before planting of sugarcane followed by post emergence direct spraying of glyphosate at 2.0 kg ha^{-1} along with 2% ammonium sulphate with a special hood on 30 DAP suppressed the nut sedges (*Cyperus rotandus*) and provided weed free environment.

vii. If herbicide is not applied work the junior-hoe along the ridges on 25, 55 and 85 days after planting for removal of weeds and proper stirring. Remove the weeds along the furrows with hand hoe. Otherwise operate power tiller fitted with tynes for intercultivation.

viii. Control of creeper weeds post emergence directed application of fernoxone (2, 4 –D sodium salt) @ 2 gm + 10 gm of urea per liter of water may be sprayed over the creeper weeds.

Weed management in Sugarcane intercropping system

Premergence application of Thiobencarb @ 1.25 kg ai/ha under intercropping system in Sugarcane with Soybean, blackgram or groundnut gives effective weed control. Raising intercrops is not found to affect the cane yield and quality.

9. EARTHING UP

After application of 3rd dose fertilizer (90 days), work victory plough along the ridges for efficient and economical earthing up. At 150 days after planting, earthing up may be done with spade.

10. DETRASHING

Remove the dry cane leaves on 150th and 210th day to avoid borer infestation.

11. PROPPING

Do double line propping with trash twist at the age of 210 days of the crop.

12. TOP DRESSING WITH FERTILIZERS

a. Soil application

Apply 275 kg of nitrogen and 112.5 kg of K_2O/ha in three equal splits at 30, 60 and 90 days in coastal and flow irrigated belts (assured water supply areas).

In the case of lift irrigation belt, apply 225 kg of nitrogen and 112.5 kg of K_2O/ha in three equal splits at 30, 60 and 90 days (water scarcity areas). For jaggery areas, apply 175 kg of nitrogen and 112.5 kg of K_2O/ha in three equal splits on 30, 60 and 90 days.

NITROGEN SAVING

a. **Neem Cake Blended Urea**: Apply 67.5 kg of N/ha + 27.5 kg of Neem Cake at 30 days and repeat on 60th and 90th days.

Note: Neem cake blending: Powder the required quantity of neem cake and mix it with urea thoroughly and keep it for 24 hours. Thus, 75 kg of nitrogen/ha can be saved by this method.

b. **Azospirillum**: Mix 12 packets (2400 g)/ha of Azospirillum inoculant or TNAU Biofert –1 with 25 kg of FYM and 25 kg soil and apply near the clumps on 30th day of planting. Repeat the same on 60th day with another 12 packets (2400 gm). Repeat the above on the other side of the crop row on the 90th day (for lift irrigated belt).

c. **Band placement:** Open deep furrows of 15 cm depth with hand hoes and place the fertilisers in the form of band and cover it properly.

d. **Subsurface application:** Application of 255 kg of Nitrogen in the form of urea along with potash at 10cm depth with 15cm intervals by the side of the cane clump will result in the saving of 20 kg N/ha without any yield reduction.

Nutritional Disorders :

Nitrogen deficiency : All leaves of sugarcane exhibit a yellow – green colour and retardation of growth. Cane stalks are smaller in diameter and premature drying of older leaves. Roots attain a greater length but are smaller in diameter.

Phosphorus deficiency : Reduction in length of sugarcane stalks, diameters of which taper rapidly at growing points. The colour of the leaves is greenish blue, narrow and some what reduce length. Reduced tillering, decreased shoot / root ratio with restricted root development.

Potassium deficiency: Depressed growth, yellowing and marginal drying of older leaves and development of slender stalks. An orange, yellow colour appears in the older lower leaves which develop numerous chlorotic spots that later become brown with dead centre. A reddish discoloration which is confined to the epidermal cells of the upper surfaces and midribs of the leaves. The young leaves appear to have developed from a common point giving a "Bunched top" appearance. Poor root growth with less member of root hairs.

Zinc deficiency: Mild zinc deficiency exhibit a tendency to develop anthrocyanin pigments in the leaves. Pronounced bleaching of the green colour along the major veins and also striped effect due to a loss of chlorophyll along the veins. In acute cases of zinc deficiency there is evidences of necrosis and growth ceases at the growing point (meristem).

Iron deficiency: Symptoms of Iron deficiency are generally seen in young leaves where pale stripes with scanty chlorophyll content occur between parallel lines. In advanced stages of deficiency the young leaves turn completely white, even in the veins. Root growth also becomes restricted.

Boron deficiency : Boron deficiency could be seen in the cane by depressed growth, development of distorted and chlorotic leaves and the presence of definite leaf and stalks lesions. In extreme cases of boron deficiency the plant will die.

Importance of Balanced Nutrition

The soil fertility has declined in many sugarcane growing areas of the state due to improper and some times, distorted fertilizer schedules adopted over the years under intensive cultivation of the crop. Hence balanced application of fertilizer based on soil test values and crop requirement is essential.

How to Evaluate fertilizer requirement

How to Evaluate fertilizer requirement

Through STCR fertilizer prescription equations

a. Perianaickenpalayam series (Inceptisols) of Coimbatore and Erode STL Jurisdiction

$FN = 4.17\ T – 1.09\ SN – 1.11\ ON$

$FP_2O_5 = 1.01\ T – 2.56\ SP – 1.01\ OP$

$FK_2O = 3.44\ T – 0.84\ SK – 1.03\ OK$

b. Gadillum series (Red laterite) of Cuddalore STL Jurisdiction

$FN = 4.06\ T – 0.74\ SN – 0.87\ ON$

$FP_2O_5 = 0.71\ T – 1.09\ SP – 0.72\ OP$

$FK_2O = 2.67\ T – 0.57\ SK – 1.30\ OK$

c. Irugur series (Inceptisols) of Coimbatore, Erode, Trichy and Salem STL Jurisdiction

$FN = 3.42\ T – 0.56\ SN – 0.93\ ON$
$FP_2O_5 = 1.15\ T – 1.94\ SP – 0.98\ OP$
$FK_2O = 3.16\ T – 0.73\ SK – 0.99\ OK$

Micro nutrient fertilizers :

1. (a) Zinc deficient soils : Basal application of 37.5 kg/ha of zinc sulphate.
   (b) Sugarcane crop with zinc deficiency symptoms: foliar spray of 0.5% zinc sulphate with 1% urea at 15 days internal till deficiency symptoms disappear.

2. (a) Iron deficient soils: Basal application of 100 kg/ha of ferrous sulphate.
   (b) Sugarcane with Iron deficiency symptoms: foliar spray of 1% ferrous sulphate with 1% urea at 15 days interval till deficiency symptoms disappear.
3. Soil application of $CuSO_4$ @ 5 kg/ha in copper deficient soils. Alternatively foliar spray of 0.2% $CuSO_4$ twice during early stage of crop growth.

Common Micronutrient mixture : To provide all micronutrients to sugarcane, 50 kg /ha of micronutrient mixture containing 20 kg Ferrous sulphate,10 kg Manganese sulphate, 10 kg Zinc sulphate, 5 kg of Copper sulphate, 5 kg of Borax mixed with 100 kg of well decomposed FYM, can be recommended as soil application prior to planting.

(Or) Application of TNAU MN mixture @ 50 kg/ha as EFYM for higher cane yield.

Recommended dosage of macro and micronutrients
Macronutrients

a. Sugarcane – plant crop (meant for sugar mills)
   300:100:200 kg N, P_2O_5 and K_2O per ha
b. Sugarcane – Ratoon crop (meant for sugar mills)
   300 + 25% extra N : 100 : 200 kg N, P_2O_5 and K_2O per ha
c. Sugarcane for jaggery manufacture (plant as well as ratoon crop)
   225 : 62.5 : 112.5 kg N, P_2O_5 and K_2O per ha

13. BIOFERTILIZER FOR SUGARCANE

Azospirillum is the common biofertilizer recommended for N nutrition which could colonize the roots of sugarcane and fix atmospheric nitrogen to the tune of about 50 to 75 kg nitrogen per ha per year. Recently, another endophytic nitrogen fixing bacterium, *Gluconacetobacter diazotrophicus* isolated from sugarcane can able to fix more nitrogen than *Azospirillum*. It colonizes throughout the sugarcane and increases the total N content. In soil, it can also colonize the roots and able to solubilize the phosphate, iron and Zn. It can also enhance the crop growth, yield of sugarcane and sugar content of the juice. Since it is more efficient than *Azospirillum*, this new organism was test-verified in various centres and released as new biofertilizer Gluconacetobacter diazotrophicus TNAU Biofert-I. Phosphobacteria as P solubiliser are recommended for sugarcane crop.

Sett treatment with *Gluconacetobacter diazotrophicus*

Before planting the sugarcane setts can be treated with ten packets (2 kg) per ha of *Gluconacetobacter diazotrophicus* prepared as slurry with 250 L of water.

Soil application *Gluconacetobacter diazotrophicus*

Twelve packets (2.4 kg) per ha is recommended for soil application each at 30th, 60th and 90th day after planting under irrigated condition.

Same method of application can be followed for Phosphobacteria.

- If basal application is not followed apply the same with 30th day, 60th day and 90th day after planting and copiously irrigate the field.
- Biofertilizer treatment should be done just before planting.
- Immediately plant/ Irrigate after biofertilizer application
- Do not mix biofertilizer along with chemical fertilizer.
- Reduces 25% of the recommended N to reap the benefits of biofertilizer application

14. WATER MANAGEMENT

Irrigate the crop depending upon the need during different phases of the crop.

Germination phase (0 - 35 days):

Provide shallow wetting with 2 to 3 cm depth of water at shorter intervals especially for sandy soil for enhancing the germination. Sprinkler irrigation is the suitable method to satisfy the requirement, during initial stages.

Later, irrigation can be provided at 0.75, 0.75 and 0.50 IW/CPE ratio during tillering, grandgrowth and maturity phases respectively. The irrigation intervals in each phase are given below:

Stages	Days of irrigation interval Sandy soil	 Clay soil
Tillering phase (36 to 100 days)	8	10
Grand growth phase (101 - 270 days)	8	10
Maturity phase (271 - harvest)	10	14

Drip Irrigation:

- Planting setts obtained from 6-7 months old healthy nursery and planted in paired row planting system with the spacing of 30x30x30 / 150 cm. for manual harvest and 30/150 cm for machine harvest
- Eight setts per metre per row have to be planted on either sides of the ridge thus making it as four row planting system.
- 12 mm drip laterals have to be placed in the middle ridge of each furrow with the lateral spacing of 240 cm & 8 'Lph' clog free drippers should be placed with a spacing of 75 cm on the lateral lines. The lateral length should not exceed more than 30-40 m.
- Phosphorus @ 62.5 kg ha^{-1} has to be applied as basal at the time of planting.
- Nitrogen and Potassium @ 275:112.5 kg ha^{-1} have to be injected into the system as urea and muriate of potash by using "Ventury" assembly in 10-12 equal splits starting from 15 to 150-180 days after planting.
- Low or medium in nutrient status soil to be given with 50 per cent additional dose of Nitrogen and Potassium.
- Irrigation is given once in three days based on the evapo-transpiration demand of the crop.
- The double side planting of sugarcane with lateral spacing of 120+40 cm under subsurface drip fertigation system improves the yield.
- Application of 125 % recommended NPK (Rec NPK-275 :63:112.5 kg /ha) through fertigation under pit system of planting inprove the yield and yield attributes.

Concept of fertigation

- Fertigation is the judicious application of fertilizers by combining with irrigation water.
- Fertigation can be achieved through fertilizer tank, venturi System, Injector Pump, Non-Electric Proportional Liquid Dispenser (NEPLD) and Automated system.
- Recommended N & K @ of 275 and 112.5 kg. ha^{-1} may be applied in 14 equal splits with 15 days interval from 15 DAP.
- 25 kg N and 8 kg K_2O per ha per split.
- Urea and MOP (white potash) fertilisers can be used as N and K sources respectively
- Fertigation up to 210 DAP can also be recommended.

Advantages of Fertigation

- Ensures a regular flow of water as well as nutrients resulting in increased growth rates for higher yields

- Offers greater versatility in the timing of the nutrient application to meet specific crop demands
- Improves availability of nutrients and their uptake by the roots
- Safer application method which eliminates the danger of burning the plant root system
- Offers simpler and more convenient application than soil application of fertilizer thus saving time, labour, equipment and energy
- Improves fertilizer use efficiency
- Reduction of soil compaction and mechanical damage to the crops
- Potential reduction of environmental contamination
- Convenient use of compound and ready-mix nutrient solutions containing also small concentration of micronutrients.

15. Contingent plan

Gradual widening of furrow:

At the time of planting, form furrow at a width of 30 cm initially. After that, widen the furrow to 45 cm on 45th day during first light earthing up and subsequently deepen the furrow on 90th day to save 35% of water.

Drought Management:

i. Soak the setts in lime solution (80 kg Kiln lime in 400 lit) for one hour.
ii. Plant in deep furrows of 30 cm depth.
iii. Spray potash and urea each at 2.5 per cent during moisture stress period at 15 days interval.
iv. Spray Kaolin (60 g in 1 ltr. of water) to alleviate the water stress.
v. Under water scarcity condition, alternate furrow and skip furrow method is beneficial.
vi. Apply 125 kg of MOP additionally at 120 day of planting.
vii. Basal incorporation of coir waste @ 25 tonnes/ha at the time of last ploughing.
viii. Removal of dry trash at 5th month and leave it as mulch, in the field.

16. CROP PROTECTION

A. Pest Management:

Shoot borer

Chilo infuscatellus

Pests Management strategies

EarlyShoot borer,*Chilo infuscatellus*

Cultural: Early season planting (Dec-Jan) ;

Trash mulching on ridges on 3DAP

Intercropping with green gram, black gram, daincha effectively checks shoot borer.

Installation of early shoot borer sex pheromone traps @ 10/ha for monitoring of pest density

Spray Granulosis virus at 1.5 x 1012 PIB/ha twice on 35 and 50 days after planting (DAP) or release 125 gravid females of *Sturmiopsis inferens* /ha on 30 and 45 DAP

Apply any one of the following insecticides:

Soil application Lindane 10 G
12.5 kg Carbofuran 3 G 33 kg
Chlorpyriphos 10 G 12.5 Kg/ha

Spraying
Monocrotophos 36 WSC 1000 ml
Endosulfan 35 EC 1000 ml
Chlorpyriphos 20 EC 1000 ml
Phosalone 35 EC 1000 ml
NSKE 5 % 25 Kg/ha

Daincha intercropped sugarcane recorded the lowest early shoot borer incidence.

Note: The virus should be applied with teepol (0.05%) during evening hours. The granular application should be immediately followed by irrigation. 'Granulosis' virus spraying on sugarcane at 750 Nos. of diseased larvae, crushed and filtered mixed in 500 l of water has been found harmless to parasitoids and predators. A sticker like 'teepol' (250 ml for 500 l) can also be added to make the solution stick on to the surface of the crop and it is preferable to use high volume sprayer to be more effective. Need based spray of endosulfan 0.07% for lowest damage is recommended. On cost benefit ratio basis NSKE 5% is recommended.

Internode borer,*Chilo sacchariphagus indicus*

Release egg parasitoid, *Trichogramma chilonis* at the rate of 2.5 cc / release/ha. Six releases fifteen days interval starting from fourth month onwards will be necessary.

Installation of internode borer sex pheromone traps @ 10/ha for monitoring of pest density

During rainy weather and when ants are present, release the parasite through musquito net covered plastic disposable cups.

Detrash the crop on the 150th and 210th day after planting.

Top shoot borer,*Scirpophaga excerptalis*

- Collect and destroy the egg masses
- Release Ichneumonid parasitoid: *Isotima javensis* @ 125 females / ha (prepupal parasitoid)
- Installation of top borer sex pheromone traps @ 10/ha for monitoring of pest density

Pyrilla, *Pyrilla perpusilla*

- Avoid excessive use of nitrogenous fertilizers
- Set up light trap
- Detrash: 150 and 210th DAP
- Release lepidopteran parasitoid:
- *Epiricrania melanoleuca* @8000 -10,000 cocoon /ha (or) 8 - 10 lacs egg/ha.
- Spray any one of the following on the 150th and 210th day (1000 l spray fluid):
  - Malathion 50 EC 2000 ml
  - Endosulfan 35 EC 2000 ml
  - Monocrotophos 36 WSC 2000 ml

Aleurodids,*Aleurolobus barodensis*

- Avoid excessive use of nitrogenous fertilizers
- Detrash: 150 and 210th DAP
- Fenitrothion 50 EC @ 2 lit or moncrotohphos 36 SL @ 2 lit /ha

The pest generally occurs in ill drained soil.

Scale insect, *Melanaspis glomerata*

- Select scale insect free setts
- Bunds free from weeds
- Avoid repeated ratoons
- Detrash as per schedule
- Drain excess water
- Avoid water stagnation
- Presoak the setts in 0.1% malathion solution
- Spray of the following insecticides(120/150 day after detrashing)
    - Dimethoate 30 EC @ 2ml/lit of water

Mealy bug, *Kiritshenkella sacchari,*
Pink mealy bug: Sacchricoccus sacchari

- Avoid excessive use of nitrogenous fertilizers
- Drain excess water.
- Detrash as per schedule
- Spray malathion 50 EC@ 1 lit /ha.
    - methyl demeton 25 EC @ 2ml/lit of water

Wooly Aphid: *Ceratovacuna lanigera ; C. graminum*

- Field release of biocontrol agents like *Dipha aphidivora, Micromus and coccinellids*
- Avoiding transportation of aphid infested leaves from one location to another.
- Avoiding use of infested cane for seed purpose.
- Ensuring that the insecticides treated leaves are not used as fodder.
- Spray any one of the following insecticides once or twice in affected patches:
    - acephate 75SP @ 2gm/lit,
    - chlorpyrifos 25EC @ 2ml/lit,
    - monocrotophos 36WSC @ 2ml/lit,

Aphid, *Melanaphis sacchari, M.indosacchari*

- Detrash as per schedule
- Drain excess water
- Spray of the following insecticides(120/150 day after detrashing)
    - Dimethoate 30 EC @ 2ml/lit of water
    - methyl demeton 25 EC @ 2ml/lit of water

Termite, ***Odontotermes obesus***

Flood irrigate the furrows to avoid termite attack in the furrows at the time of planting

- Dip the setts in imidacloprid 70 WS 0.1% or Chlorpyriphos 20 EC 0.04 % for 5 min.
- **Soil application -** Apply lindane 1.3 D 125 kg/ha
- **Spray application of** Imidacloprid 200 SL at 250 ml in 250 l of water / ha

. **Root grub, *Holotrichia consanguinea*; *H. serrata, Leucopholis lepidophora***

- Set up light trap
- Deep ploughing during summer,
- Avoid ratoons in infested fields,
- Provide adequate irrigation, since under inadequate soil moisture
- conditions, the pest appears in the root zone.
- Crop rotation in endemic areas

- Collect and destroy the adult beetles present on neem, Ailanthus and Acacia
- Lindane 1.3 D @ 50 kg /ha near the root zo

IMPROVED TECHNIQUES IN BIOLOGICAL CONTROL

Improved adult feeding techniques for *Trichogramma*

Trichogramma adult feeding through cotton swabs will trap the adults which get entangled in the sticky cotton lint. To avoid this, a better adult feeding technique is developed.

Make small dotted holes in a thick mylar film sheet or old film negatives by using a sewing machine, leaving a gap of 1 cm between the dotted holes horizontally. One side of the sheet (7 x 6 cm) will be smooth and the other will be eruptive. Streak 50% honey solution on the smooth side by using a camel hair brush. Then fold the sheet in such a way that the honey-smeared surface is on the inside and the eruptive surface outside and staple it. The gap between the dotted holes will provide free movement for the adults, which imbibe the honey through eruptive surface. In this method, the adults do not get trapped in the honey solution.

Special problem: Woolly aphid (*Ceratovacuna lanigera*)

The sudden outbreak of a new woolly aphid, *Ceratovacuna lanigera* was noticed *in* Karnataka and Maharastra.

The incidence was first observed in July 2002 in Sangli district of Maharastra.

Though this is the first occasion of crop infestation by this pest, this has emerged as a pest of economic significance, having resulted in major crop loss in the sugarcane.

Attacked plants could be recognized from a distance by the following symptoms:

White appearance of the lower surface of colonized top leaves; sooty mould growth and the honeydew exudations deposited on the upper surface of lower or adjacent leaves; occasional white woolly deposition on the ground under severe colonization.

Established colonies, characterized by the presence of members most of which showed white woolly filaments, can be generally observed from the second leaf downward in the grown-up crop. At low numbers, colonization on leaves is restricted to a short perpendicular distance on either side of the midrib for a considerable length of the leaf.

Among the plants the attack is seen only in patches.

Since the infestation has become a major cause for concern, major initiatives have been started by the Department of Agriculture and ICAR.

Management strategies:

Enforcement of compulsory IPM measures against woolly aphid infestation in newly planted and ratoon sugarcane fields by invoking suitable provisions of the State Pest Act of the State.

Harvesting of the entire matured sugarcane crop on priority for crushing as well burning of the trash.

Application of granular systemic insecticides after two days of irrigation may reduce the infestation of aphids even up to 30 days.

Promotion of paired or wider row cultivation of sugarcane for taking effective control measures.

Conservation and augmentation of identified potential biocontrol agents like *Dipha aphidivora, Micromus and coccinellids* in woolly aphid infested fields.

Conservation of lepidopteran predator, *Dipha aphidivora* predator population in limited areas of sugarcane crop for further distribution and use thereof.

Regular surveillance and monitoring of sugarcane woolly aphid for timely forewarning and adoption of IPM measures including judicious use of recommended pesticides and bio-pesticides (*Metarhizium anisopliae*, *Beauveria bassiana*, *Verticillium lecanii*).

Avoiding transportation of aphid infested leaves from one location to another.

Avoiding use of infested cane for seed purpose.

Ensuring that the insecticides treated leaves are not used as fodder.

Insecticide application at low levels or at initial stages of infestation may be restricted to only attacked plants since the attack is seen only in patches

During acute incidence, spray any one of the following insecticides once or twice in affected patches:

Acephate 75SP 2gm/lit
Chlorpyrifos 25EC 2ml/lit
Monocrotophos 36WSC 2ml/lit
Endosulfan 35EC 2ml/lit

B) Disease management

Red rot *(Colletotrichum falcatum)*

1. Selection of setts from healthy nursery programme
2. Growing of recommended resistant and moderately resistant varieties *viz*., Co 86249, CoSi 95071, CoG 93076, CoC 22, CoSi 6 and CoG 5
3. Adopt sett treatment with Carbendazim before planting (Carbendazim 50 WP @ 0.05% or Carbendazim 25 DS @ 0.1% along with 1.0% Urea for 5 minutes)
4. The irrigation interval in a red rot affected field must be lengthened. Once in 15 days during tillering, growth phases and once in 25 days during maturity phase which restricts the spread
5. Removal of the affected clumps at an early stage and soil drenching with 0.1 % Carbandazim 50 WP or 0.25 % lime.

6. The trash of red rot affected field after harvest may be uniformly spread and burnt
7. The red rot affected field must be rotated with rice for one season and other crops for two seasons.

Sett rot *(Ceratocytis paradoxa)*

1. Sett treatment with Carbendazim before planting (Carbendazim 50 WP @ 0.05% or Carbendazim 25 DS @ 0.1% along with 1.0% Urea for 5 minutes)
2. Proper drainage and planting of setts in 1-2 cm depth.

Smut *(Ustilago scitaminea)*

1. Growing of resistant and moderately resistant varieties viz., Co 86249, CoG 93076, CoC 22, CoSi 6 and CoG 5
2. Sett treatment with fungicides *viz*., Triadimefon @ 0.1% or Carbendazim @ 0.1% for 10 minutes.
3. Treating the seed setts with Areated Steam Therapy (AST) at 50 ºC for 1 hour or in hot water at 50 ºC for 30 minutes or at 52 ºC for 18 minutes
4. Roguing of smut whips with gunny bags/polythene bag and burnt
5. Discourage ratooning of the diseased crops having more than 10 per cent infection

Grassy shoot disease (GSD)

1. Rogue out infected plants in the secondary and commercial seed nursery.
2. Treat setts with aerated steam at 50°C for 1 hour to control primary infection.
3. Growing resistant varieties viz., Co 86249, CoG 93076 and Coc 22
4. Spray dimethoate @ 0.1 % to control insect vector
5. Avoid ratooning if GSD incidence is more than 15 % in the plant crop

Leaf spot (*Cercospora longipes*) : Spray Mancozeb 2.0 kg or Carbendazim 500 g/ha.
Rust (*Puccinia erianthi)* : Spray Tridemorph 1.0 litres or Mancozeb 2.0 kg/ha.

General:

1. Select healthy setts for planting. In the seed crop, select plants which do not show symptoms of red rot, smut, grassy shoot and ratoon stunting. Setts showing red colour at the cut end and hollows should be rejected and burnt.
2. Set fire to residues of previous crop to eliminate debris of fungal pathogens.
3. In fields which had shown high level of red rot disease, follow crop rotation with rice.
4. The setts should be soaked in 0.1% Carbendazim or 0.05% Triademefon for 15 minutes.
5. Treat setts with aerated steam at 50°C for one hour to control primary infection of grassy shoot disease.
6. Clumps infected by grassy shoot, smut and ratoon stunting diseases should be immediately uprooted and destroyed.
7. Use resistant varieties for the following diseases:

a. Red rot CO 62198, CO 7704 (Resistant), COC 8001, CO 8201 (Moderately resistant)
b. Smut CO 7704 (Resistant) COC 85061, COC 8201 (Moderately resistant)

C) Nematode management

Nematode pest Control measures
Lesion nematode,
Pratylenchus coffeae
Lance nematode,
Hoplolaimus indicus
Reniform nematode
Rotylenchulus reniformis
Root knot nematode,
Meloidogyne spp.
Apply carbofuran 3 G at 33 kg/ha at the time of planting or 2 months after or Cartop 1.5 kg ai/ha or apply pressmud at 15 t/ha or poultry manure at 2 t/ha or neem cake 2 t/ha or apply pressmud at 15 t/ha or poultry manure at 1 t/ha before last ploughing in garden lands. Under wetland conditions, intercropping sunnhemp or marigold or daincha coupled with application of pressmud 25 t/ha or neem cake 2 t/ha.

17. PRE-HARVEST PRACTICES

a. Apply cane ripeners

i. Spray Sodium metasilicate 4 kg/ha in 750 litres of water on the foliage of crop at 6 months after planting.
ii. Repeat the same twice at 8th and 10th months to obtain higher cane yield and sugar percentage.

b. Assessing maturity of crops

i. Assess the maturity by hand refractometer brix survey and 18 to 20 per cent brix indicates optimum maturity for harvest.
ii. Top-bottom ratio of H.R.Brix reading should be 1:1.

18. HARVESTING

i. Early varieties have to be harvested at 10 to 11 months age and mid-season varieties at 11 to 12 months age.
ii. Harvest the cane at peak maturity. Cut the cane to the ground level for both plant and ratoon crops.

B. RATOON CROP

I. MANAGEMENT OF THE FIELD AFTER HARVEST OF THE PLANT CROP

Complete the following operations within 10 days of harvest of plant crop to obtain better establishment and uniform sprouting of shoots.

1. Remove the trash from the field. Do not burn it. Irrigate the field copiously.
2. Follow stubble shaving with sharp spades to a depth of 4 - 6 cm along the ridges at proper moisture.
3. Work with cooper plough along with sides of the ridges to break the compaction.
4. The gappy areas in the ratoon sugarcane crop should be filled within 30 days of stubble shaving. The sprouted cane stubbles taken from the same field is the best material for full establishment. The next best method is gap filling with seedlings raised in polybags.
5. Apply basal dose of organic manure and super phosphate as recommended for plant crop.

II. MANAGEMENT OF THE CROP

1. 25% additional N application on 5-7 days after ratooning.
2. Spray Ferrous sulphate at 2.5 kg/ha on the 15th day. If chlorotic condition persists, repeat twice further at 15 days interval. Add urea 2.5 kg/ha in the last spray.
3. Hoeing and weeding on 20th day and 40th to 50th day.
4. First top dressing on 25th day, 2nd on 45th to 50th day.
5. Final manuring on 70th to 75th day.
6. Partial earthing up on 50th day. If junior-hoe is worked two or three times upto 90th day, partial earthing up is not necessary.
7. Final earthing up on 90th day.
8. Detrashing on 120th and 180th day.
9. Trash twist propping on 180th day.
10. Harvest after 11 months.

C. SHORT CROP (NURSERY CROP)

SELECTION OF PROPER PLANTING MONTHS FOR RAISING NURSERY CROP IN RELATION TO MAIN FIELD PLANTING

Raise six to seven months old nursery crop prior to main field planting as follows:

Raise nursery crop during	Main field planting

June	December - January (early season)
July	February - March (Mid season)
August	April - May (Late season)
Dec - Apr	June - September (Special season)

II. PRECAUTIONS IN MAINTAINING NURSERY CROP

Adopt similar production techniques for raising short crop with the following modifications.

1. Do not detrash
2. Do not prop
3. Harvest at 6 to 7 months age
4. Remove trash by hand while preparing setts
5. Avoid bud damage
6. Transport the seed material to other places in the forms of full canes with trash intact.
7. Apply 50 kg of urea as top dressing additionally before one month of cutting the seed cane.

CROP PHYSIOLOGY

Foliar spray of TNAU Sugarcane Booster @ 1.0, 1.5 and 2 kg/acre in 200 litres of water at 45,60 and 75 days after planting enhances cane growth and weight, internodal length, cane yield, sugar content and offers drought tolerance.

CROP PROTECTION

A. Pest Management: Economic threshold level for important pests

Economic threshold level for important pests

Pests	ETL
Shoot borer *Chilo infuscatellus*	15 % dead heart

Pests	**Management strategies**
Shoot borer *Chilo infuscatellus*	< Cultural: Early season planting (Dec-Jan) ; < Trash mulching on ridges on 3DAP < Intercropping with green gram, black gram, daincha effectively checks shoot borer. < Spray Granulosis virus at 1.5 x 10^{12} PIB/ha twice on 35 and 50 days after planting (DAP) or release 125 gravid females of *Sturmiopsis inferens* /ha on 30 and 45 DAP **Apply any one of the following insecticides:** **Soil application** Lindane 10 G 12.5 kg Carbofuran 3CG 33 kg **Spraying** Chlorantraniliprole 18.5%SC 375 ml/ha Fipronil 5%SC 1500-2000 ml/ha Fipronil 0.3%GR 25-33.3 Kg/ha Quinalphos 25%EC 2000 ml/ha Phosalone 35 EC 1000 ml NSKE 5 % 25 Kg/ha < Daincha intercropped sugarcane recorded the lowest early shoot borer incidence.

	Note: The virus should be applied with teepol (0.05%) during evening hours. The granular application should be immediately followed by irrigation. 'Granulosis' virus spraying on sugarcane at 750 Nos. of diseased larvae, crushed and filtered mixed in 500 l of water has been found harmless to parasitoids and predators. A sticker like 'teepol' (250 ml for 500 l) can also be added to make the solution stick on to the surface of the crop and it is preferable to use high volume sprayer to be more effective. On cost benefit ratio basis NSKE 5% is recommended.
Internode borer *Chilo sacchariphagus indicus*	< Release egg parasitoid, *Trichogramma chilonis* at the rate of 2.5 cc/release/ha. Six releases fifteen days interval starting from fourth month onwards will be necessary. < During rainy weather and when ants are present, release the parasite through musquito net covered plastic disposable cups. < Detrash the crop on the 150th and 210th day after planting.
Top shoot borer *Scirpophaga excerptalis*	**Spraying any one of the following insecticides:** Carbofuran 3%G 33.3 kg/ha Chlorantraniprole 18.5%SC 375 ml/ha Phorate 10%G 30 kg/ha **Biocontrol:** Release *Isotima javensis* at 100 pairs/ha
Pyrilla *Pyrilla perpusilla*	**Spray any one of the following on the 150th and 210th day (1000 l spray fluid):** Chlorpyrifos 20% EC 1500 ml/ha Dichlorvos 76% EC 376 ml/ha < Detrash on the above days < Avoid excess use of nitrogen.
Aleurodids *Aleurolobus barodensis*	< **Spray any one of the following when the incidence is noticed (1000 l spray fluid):** Fenitrothion 50 EC 2000 ml Monocrotophos 36 WSC 2000 ml < The pest generally occurs in ill drained soil.
White grub *Holotrichia consanguinea*	< Crop rotation, < Deep ploughing during summer, < Avoid ratoons in infested fields, < Provide adequate irrigation, since under inadequate soil moisture conditions, the pest appears in the root zone.

Termite *Odontotermes obesus*	Flood irrigate the furrows to avoid termite attack in the furrows at the time of planting < **Sett treatment:** Dip the setts in imidacloprid 70 WS 0.1% or Chlorpyriphos 20 EC 0.04 % for 5 min. < **Soil application:** Apply lindane 1.3 D 125 kg/ha < **Spray:** Chlorantraniliprole 18.5%SC 500-625 ml/ha Imidacloprid 17.8% SL 350 ml/ha Chlorpyriphos 20%EC 750 ml/ha
Root borer	**Spraying any one the following insecticides:** Fipronil 5% SC 1500-2000 ml/ha Fipronil 0.3% GR 25-33.3 kg/ha Phorate 10% CG 25 kg/ha
Black bug	**Apply any one of the following insecticides** Chlorpyriphos 20% EC 750 ml/ha Quinalphos 25% EC 2000 ml/ha
Mealy bug *Saccharicoccus sacchari*	< Detrash as per schedule < Drain excess water **Apply any one of the following insecticides when the incidence is noticed spray on the stem only:** Methyl parathion 50 EC 1000 ml/ha Malathion 50 EC 1000 ml/ha
Leaf hopper	**Spraying any one the following insecticides:** Quinalphos 25% EC 1200 ml/ha Carbofuran 3% CG 33.3kg/ha

IMPROVED TECHNIQUES IN BIOLOGICAL CONTROL

Improved adult feeding techniques for *Trichogramma*

< *Trichogramma* adult feeding through cotton swabs will trap the adults which get entangled in the sticky cotton lint. To avoid this, a better adult feeding technique is developed.

< Make small dotted holes in a thick mylar film sheet or old film negatives by using a sewing machine, leaving a gap of 1 cm between the dotted holes horizontally. One side of the sheet (7 x 6 cm) will be smooth and the other will be eruptive. Streak 50% honey solution on the smooth side by using a camel hair brush. Then fold the sheet in such a way that the honey-smeared surface is on the inside and the eruptive surface outside and staple it. The gap between the dotted holes will provide free movement for the adults, which imbibe the honey through eruptive surface. In this method, the adults do not get trapped in the honey solution.

Special problem: Woolly aphid (*Ceratovacuna lanigera*)
Attacked plants could be recognized from a distance by the following symptoms:

< White appearance of the lower surface of colonized top leaves; sooty mould growth and the honeydew exudations deposited on the upper surface of lower or adjacent leaves; occasional white woolly deposition on the ground under severe colonization.
< Established colonies, characterized by the presence of members most of which showed white woolly filaments, can be generally observed from the second leaf downward in the grown-up crop. At low numbers, colonization on leaves is restricted to a short perpendicular distance on either side of the midrib for a considerable length of the leaf.
< Among the plants the attack is seen only in patches.
< Since the infestation has become a major cause for concern, major initiatives have been started by the Department of Agriculture and ICAR.

Management strategies:

< Enforcement of compulsory IPM measures against woolly aphid infestation in newly planted and ratoon sugarcane fields by invoking suitable provisions of the State Pest Act of the State.
< Harvesting of the entire matured sugarcane crop on priority for crushing as well burning of the trash.
< Application of granular systemic insecticides after two days of irrigation may reduce the infestation of aphids even up to 30 days.
< Promotion of paired or wider row cultivation of sugarcane for taking effective control measures.
< Conservation and augmentation of identified potential biocontrol agents like *Dipha aphidivora, Micromus and coccinellids* in woolly aphid infested fields.
< Release of *Dipha aphidivora* @ 1000/ha or *Micromus igorotus* @ 2500/ha wherever possible.
< Conservation of lepidopteran predator, *Dipha aphidivora* predator population in limited areas of sugarcane crop for further distribution and use thereof.
< Regular surveillance and monitoring of sugarcane woolly aphid for timely forewarning and adoption of IPM measures including judicious use of recommended pesticides and bio-pesticides (*Metarhizium anisopliae*, *Beauveria bassiana*, *Verticillium lecanii*).
< Avoiding transportation of aphid infested leaves from one location to another.
< Avoiding use of infested cane for seed purpose.
< Ensuring that the insecticides treated leaves are not used as fodder.
< Insecticide application at low levels or at initial stages of infestation may be restricted to only attackednplants since the attack is seen only in patches

During acute incidence, spray any one of the following insecticides once or twice in affected patches:
Acephate 75SP 2gm/lit
Chlorpyrifos 25EC 2ml/lit
Monocrotophos 36WSC 2ml/lit

A. **DISEASE MANAGEMENT**

B. **DISEASE MANAGEMENT**

Red rot (*Colletotrichum falcatum*)	• Selection of setts from healthy nursery programme • Growing of recommended resistant and moderately resistant varieties *viz*., Co 86249, CoSi95071, CoG 93076, CoC 22, CoSi 6 and CoG 5
	• Adopt sett treatment with Carbendazim before planting (Carbendazim 50 WP @ 0.05% or Carbendazim 25 DS @ 0.1% along with 1.0% Urea for 5 minutes) • The irrigation interval in a red rot affected field must be lengthened. Once in 15 days during tillering, growth phases and once in 25 days during maturity phase which restricts the spread. • Removal of the affected clumps at an early

	stage and soil drenching with 0.1 % Carbandazim 50 WP or 0.25 % lime. • The trash of red rot affected field after harvest may be uniformly spread and burnt • The red rot affected field must be rotated with rice for one season and other crops for two seasons.
Sett rot *(Ceratocytis paradoxa)*	• Sett treatment with Carbendazim before planting (Carbendazim 50 WP @ 0.05% or Carbendazim 25 DS @ 0.1% along with 1.0% Urea for 5 minutes) • Proper drainage and planting of setts in 1-2 cm depth. •
Smut *(Ustilago scitaminea)*	• Growing of resistant and moderately resistant varieties viz., Co 86249, CoG 93076, CoC 22, CoSi6 and CoG 5 • Sett treatment with fungicides *viz*., Triadimefon @ 0.1% or Carbendazim @ 0.1% for 10 minutes. • Treating the seed setts with Aerated Steam Therapy (AST) at 50 ºC for 1 hour or in hot water at 50 ºC for 30 minutes or at 52 ºC for 18 minutes • Removal of smut whips with gunny bags/polythene bag and burnt • Discourage ratooning of the diseased crops having more than 10 per cent infection •
Grassy shoot disease (GSD)	Rogue out infected plants in the secondary and commercial seed nursery. 2. Treat setts with aerated steam at 50°C for 1 hour to control primary infection. 3. Growing resistant varieties viz., Co 86249, CoG 93076 and Coc 22 4. Spray dimethoate @ 0.1 % to control insect vector 5. Avoid ratooning if GSD incidence is more than 15 % in the plant crop
Leaf spot (*Cercospora longipes*)	Spray Mancozeb 2.0 kg or Carbendazim 500 g/ha
Rust (*Puccinia erianthi)*	Spray Tridemorph 1.0 litres or Mancozeb 2.0 kg/ha.

General:

- Select healthy setts for planting. In the seed crop, select plants which do not show symptoms of red rot, smut, grassy shoot and ratoon stunting. Setts showing red colour at the cut end and hollows should be rejected and burnt.
- Set fire to residues of previous crop to eliminate debris of fungal pathogens.
- In fields which had shown high level of red rot disease, follow crop rotation with rice.
- The setts should be soaked in 0.1% Carbendazim or 0.05% Triademefon for 15 minutes.
- Treat setts with aerated steam at 50°C for one hour to control primary infection of grassy shoot disease.
- Clumps infected by grassy shoot, smut and ratoon stunting diseases should be immediately uprooted and destroyed.

- Use resistant varieties for the following diseases:
  Red rot CO 62198, CO 7704 (Resistant),
  Smut CO 7704 (Resistant) COC 85061, COC 8201 (Moderately resistant)

C. NEMATODE MANAGEMENT

Nematode pest	Control measures
Lesion nematode, *Pratylenchus coffeae*	*Apply carbofuran 3 CG at 33 kg/ha at the time of planting or 2 months after or Cartop 1.5 kg ai/ha or apply pressmud at 15 t/ha or poultry manure at 2 t/ha or neem cake 2 t/ha or apply pressmud at 15 t/ha or poultry manure at 1 t/ha before last ploughing in garden lands. * Under wetland conditions, intercropping sunnhemp or marigold or daincha coupled with application of pressmud 25 t/ha or neem cake 2 t/ha.

SWEET SORGHUM (Sorghum bicolor)

CROP IMPROVEMENT

1. Season and Varieties

Sl. No.	Season	Variety (irrigated)	Districts
1.	Kharif (June- July)	SSV 84, CSV 19 SS (RSSV 9)	All Districts except Nilgris

Note: sowing should be avoided during July – August and November-January

2. Varietal particulars

S.No	Particulars	SSV84	RSSV9
1.	Parentage	Sel From IS 23568	RSSV X SPV 462
2.	Duration (days)	120-125	115-120
3.	Area (districts)	National level	National level
4.	Seasons (Pattam)	Kharif	Kharif
5.	Grain yield Kg/ha	1000-1200	800-1000
6.	Green cane yield (t/ha)	30-35	35-40
7.	Plant height (cm)	190-210	240-270
8.	Juice extractability (%)	25.4	26.2
9.	Brix (%)	17-19	18-20
10.	Total soluble solids (%)	11.6	13.6
11.	Reducing sugars (%)	3.18	1.81
12.	Sucrose (%)	9.6	11.4
13.	Ethanol yield (Kl/ha)	800-1000	1000-1200
14.	CCS (q / ha)	16.5	25.8
15.	Sheath color	NT	NT
16.	Node	9-10	11-14
17.	Midrib	Green	Dull Green
18.	Earhead shape	Oval	Oval
19.	Compactness	Semi-compact	Semi-compact
20.	Grain colour	White	Creamy
21.	Special features	Turtle grain	Round

CROP MANAGEMENT

1. TREATMENT OF SEED

Step 1: Treat the seeds 24 hours prior to sowing with Captan or Thiram 2 gm/kg of seed or Metalaxyl 4 gm / kg of seed to control downy mildew.

Step 2: Treat the seeds required for one hectare with 3 packets (600gm) of Azospirillum using rice gruel as binder.

Note: Dissolve 0.5 gm of gum in 20 ml of water. Add 4 ml of Chlorpyriphos 20 EC or Monocrotophos 35 WSC or Phosalone 35 EC. To this add 1.0 kg of seed, pellet and shade dry to control shootfly and stemborer.

2. FARM LAND PREPARATION

- Form ridges and furrows at a spacing of 45 cm apart

3. SOWING

- Seed rate of 10 kg/ha
- Adopt a spacing of 45 x 15 cm (population 1,48,000/ha)
- Sow the seeds at a depth of 2 cm and cover with soil

Note: Use increased seed rate upto 12.5 kg per hectare and remove the shoot fly damaged seedlings at the time of thinning or raise nursery and transplant only healthy seedlings.

4. IMPORTANCE OF INM

Application of inorganic nutrients alone in the long run will lead to soil and environmental pollution. Hence integration organic and inorganic fertilizer will sustain the soil heath and improve the cane yield of the sweet sorghum crop.

5. IMPORTANCE OF BALANCED NUTRITION

Application of balanced fertilizer at recommended dose in the right stage of the crop will not only improve the productivity but also improve the soil fertility and reduce the environmental pollution.

6. EVALUATION OF FERTILIZER REQUIREMENT

Soil testing is suggested tool for evaluating the fertilizer requirement. It has to be done before the cropping season well in advance so as to ascertain the native fertility of the soil and to recommend the correct dose of fertilizer which will reduce the fertilizer cost.

7. RECOMMENDED INM

- Apply 12.5 tons of FYM/ha at last ploughing.
- Soil application of Azospirillum @ 10 packets (2.0 kg/ha) after mixing with 25 kg of FYM + 25 kg of soil may be carried out before sowing/planting.
- 12.5 kg /ha of MN mixture mixed with enough sand to make a total quantity of 50 kg and applied over the furrows and on top 1/3 of the ridges.
- Apply NPK fertilizers as per soil test recommendations. If soil test recommendation is not available adopt a blanket recommendation of 120 : 40: 40 kg of NPK/ha

8. STAGES OF APPLICATION OF FERTILIZERS

- Apply azospirillum and MN mixtures as basal
- Apply half dose of N and full dose of P_2O_5 and K_2O basally before sowing.
- Apply the balance N in two splits of 25% each on 15^{th} and 30^{th} day of sowing.

CROP PROTECTION

Downy mildew

- Rogue downy mildew infected plants up to 45 days after sowing
- Spray any one of the fungicides like Metalaxyl 500 g or Mancozeb 1000g/ha after noticing the symptoms of foliar diseases, for both transplanted and direct sown crops.

Leaf diseases: *Cercospora* leafspot, Rust, *Colletotrichum* leaf spot

- Spray Mancozeb @ 1kg/ha. Repeat fungicidal application after 10 days if necessary

Grain mould

- Spray any one of the fungicides like Mancozeb @ 1000g/ha in case of intermittent rainfall during earhead emergence and repeat if necessary another spray 10 days later

Ergot

- Spray any one of the following fungicide at emergence of earhead (5 - 10% flowering stage) followed by a spray at 50% flowering and repeat the spray after a week if necessary

Mancozeb – 1000g/ha
Propiconazole 500ml/ha

TROPICAL SUGARBEET

PRODUCTION TECHNOLOGY

Introduction

Tropical sugarbeet (*Beta vulgaris* spp. *Vulgaris var altissima Doll*) is a biennial sugar producing tuber crop, grown in temperate countries. This crop constitutes 30% of total world production and distributed in 45 countries. Now tropical sugarbeet hybrids are gaining momentum in tropical and sub tropical countries including Tamil Nadu as a promising energy crop and alternative raw materials for the production of ethanol. Apart from sugar production, the value added products like ethanol can also be extracted from sugarbeet. The ethanol can be blended with petrol or diesel to the extent of 10% and used as bio-fuel. The sugarbeet waste material *viz.,* beet top used as green fodder, beet pulp used as cattle feed and filter cake from industry used as organic manure.

Tropical sugarbeet now emerged as commercial field crop because of the favourable characters like (i) tropical sugarbeet hybrids suitable for Tamil Nadu (ii) Shorter duration of 5 to 6 months (iii) needs moderate water requirement of 60-80 cm. (iv) higher sugar content of 12 – 15% (v) improve soil conditions because of tuber crop and (vi) grow well in saline and alkali soil. The harvesting period of sugarbeet coincides with March – June, the human resource of sugar factory in the off season may efficiently utilized for processing of sugarbeet in the sugar mills, which helps in continuous functioning of sugar mills.

Hybrids and duration

The tropical sugarbeet hybrids suitable for cultivation in Tamil Nadu are Cauvery, Indus and Shubhra. The duration of these tropical hybrids will be 5 to 6 months depending on climatic conditions prevailing during crop growth period.

Climate and season

Tropical sugarbeet require good sunshine during its growth period. The crop does not prefer high rainfall as high soil moisture or continuous heavy rain may affect development of tuber and sugar synthesis. Tropical sugarbeet can be sown in September– November coincide with North East monsoon with a rainfall of 300 – 350 mm well distributed across the growing period which favours vegetative growth and base for root enlargement. The optimum temperature for germination is 20 – 25^0C, for growth and development 30 - 35^0C and for sugar accumulation in 25– 35^0C.

Season

Tropical sugarbeet is sown in September to November and harvested during March and May.

Field preparation

Well drained sandy loam and clayey loam soils having medium depth (45” cm) with fairly good organic status are suitable. Tropical sugarbeet require deep ploughing (45 cm) and followed by 2 – 3 ploughing to obtain a good soil tilth condition for favorable seed germination. Ridges and furrows are formed at 50 cm apart.

Manures and Fertilizers

S.No	Manures and Fertilizers	Basal Application	Top dressing
1	**Manures**	12.5 tonnes /ha	-
2	**Biofertilizers** Azospirillum Phosphobacteria	 2 kg /acre (10 pockets) 2 kg /acre (10 pockets)	-

3.	**Fertilizers** Nitrogen Phosphorus Potassium	 75kg /ha 75kg /ha 75kg /ha	 37.5 kg / ha each at 25 & 50 DAS - -

Seeds and sowing

Optimum population is 1,00,000 - 1,20,000 /ha. Hence use only pellated seeds 1,20,000 Nos /ha which require 6 pockets (3.6kg / ha.-One pocket contains 20000 seeds (600 g)]. The recommended spacing is 50 x 20 cm. The pellated seed is dippled at 2 cm depth in the sides of ridges at 20 cm apart. 45 x 15 cm spacing found to be optimum for higher root yield.

Weeding and Earthing up

The crops should be maintained weed free situation upto 75 days. Pretilachlor 50 EC @ 0.5 Kg ai/ha or Pendimethalin @3.75lit /ha can be dissolved in 300 litres of water and sprayed with hand operated sprayer on 0- 2rd day after sowing, followed by hand weeding on 25th day and 50th day after sowing. The earthing up operations coincides with top dressing of N fertilizer. Pre-emergence application of metamitrone 70% EC @ 0.75 kg a.i ha-1 + pretilachlore 70% EC at 0.40 kg a.i ha-1 followed by hand weeding on 30 DAS.

Irrigation

Tripical sugarbeet is very sensitive to water stagnation in soil at all stages of crop growth. Irrigation should be based on soil type and climatic condition. Pre-sowing irrigation is essential since at the time of sowing, sufficient soil moisture is must for proper irrigation. First irrigation is crucial for the early establishment of the crop. For loose textured sandy loam soil irrigation once in 5 to 7 days and for heavy textured clay loam soil once in 8 – 10 days is recommended. The irrigation has to be stopped at least 2 to 3 weeks before harvest. At the time of harvest if the soil is too dry and hard it is necessary to give pre harvest irrigation for easy harvest. Light and frequent irrigation is recommended for maintaining optimum soil moisture. Water requirement 800 - 850 mm.

Pest and diseases

Pests - Aphids, Tobacco caterpillar and Flea beetles
Diseases- Root and crown rot, *Cercospora* leaf spot and Root knot nematode

Integrated pest and disease management

- Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg of seed
- Summer ploughing and exposing the field to sunlight
- Crop rotation for 3 years with Marigold or gingelly or sunnhemp for root rot and nematode
- Soil application of *Trichoderma viride* or *Pseudomonas fluorescens* @ 2.5 kg/ha mixed with 50 kg of FYM before planting
- Sow castor as trap crop around and within fields to attract adult *Spodoptera* moth for egg laying
- Set up light traps (1 mercury / 5 ha) for monitoring *Spodoptera litura*
- Setting up pheromone -Pherodin SL @ 12/ha for *Spodoptera litura*
- Removal and destruction of *Spodoptera* egg masses, early stage larvae formed in clusters
- Hand picking and destruction of grown up *Spodoptera* caterpillar

Need based

- Spraying *Spodoptera* nuclear polyhedrosis virus at 1.5 x 1012 POB/ha
- Spray NSKE 5% for aphids flea beetles and for early instar caterpillars
- Use of poison bait pellets prepared with rice bran 12.5 kg, jaggery 1.25 kg, carbaryl 50% WP - 1.25 kg in 7.5 lit water for *Spodoptera litura*
- Spray any one of the following insecticides using a high volume sprayer covering the foliage and soil surface

- Chlorpyriphos 20 EC - 2 ml / lit,Dichlorvos 76 WSC - 1 ml/lit,
  Fenitrothion 50 EC - 1 ml/lit
  Spray malathion 50 EC (2 ml/lit) for flea beetle and leaf webber
  Spray Imidacloprid 200 SL (0.2 ml/lit) or methyl demeton 25 EC (2 ml/lit) or dimethoate 30 EC (2 ml/lit) for aphids
- Applying neem cake @ 150 kg/ha for root rot
- Foliar spray of Mancozeb 2.5 g / lit or Chlorothalonil 2 g / litre of water for *Cercospora* leaf spot
- Neem cake @ 1 t/ha or carbofuran @ 33 kg/ha as spot application on 30 days after sowing for nematode management

Harvest and yield

The tropical sugarbeet crop matured in about 5 to 6 months. The yellowing of lower leaf whirls of matured plant, Nitrogen deficiency and root brix reading of 15 to 18% indicate the maturity of beet root for harvest. The average root yield of tropical sugarbeet is 80 – 100 tonnes / ha.

CROP PROTECTION

Integrated disease management

- Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg of seed
- Summer ploughing and exposing the field to sunlight
- Crop rotation for 3 years with Marigold or gingelly or sunnhemp for root rot and nematode
- Soil application of *Trichoderma viride* or *Pseudomonas fluorescens* @ 2.5 kg/ha mixed with 50 kg of FYM before planting

Harvesting should be timed so as the roots reach the factory within 48 hours for processing.
Till such time the roots should not be harvested.

TEMPLATE FOR TECHNOLOGY

CROP - TROPICAL SUGARBEET

Introduction

Tropical sugarbeet (*Beta vulgaris* spp. *Vulgaris var altissima Doll*) is a biennial sugar producing tuber crop, grown in temperate countries. Now tropical sugarbeet hybrids are gaining momentum in tropical and sub tropical belts including Tamil Nadu as a promising alternative energy crop for the production of ethanol and alternate sugar producing crop. The ethanol can be blended with petrol or diesel to the extent of 10% and used as bio-fuel. The bi-products of sugarbeet *viz.,* beet top can be used as green fodder, green leaf manure and raw material for vermi compost while beet pulp is used as cattle feed and filter cake used as manure.

Right seed

- Use pelleted seed
- Variety -Nil
- Hybrids - Cauvery, Indus and Shubhra
- At present no seed production in India, seeds source-
  Syngenta India Ltd., (Seeds division,) 1170 / 27, Revenue colony
  Shivaji nagar, Pune-411005 Phone: 020-2553 5996 Fax:020 -2553 7571

Right technology

- Seed Treatment : Already it is treated and marketed as pelleted seed.
- Seeds Rate / ha: One 1.2 lakh pelleted seeds(3.6Kg)
- Land Preparation:
- Thorough land preparation of 45 cm deep ploughing,
- Formation of ridges and furrows with a spacing of 50X20 cm and height of the ridges @15 - 20 cm.
- Sowing: Dibble the seed at 2 cm depth on the top of the ridge with a spacing of 20 cm between plants.
- Weed free environment up to 60th day
- Pre-emergence application of Pretilachlor 50EC 0.5 Kg ai / ha in 500 litre of water or Pendimethalin 30 EC 1.0 Kg ai/ha dissolved in 500 litre of water
- Hand weeding on 25th and 50th days after sowing

Right nutrition

- Balanced application of organic and inorganic fertilizers
- FYM 12.5 t/ha and basal application of 2 kg of Azospirillum and 2 kg of phosphobacteria
- Based on the soil test value, inorganic fertilizer has to be applied. In the absence of soil test value, blanket recommendation of 150:75:75 NPK kg/ha
- Stages of application of fertilizer: Basal 50% N, full P and full K. Remaining 25% N on 20 to 25 days after sowing and 25% N on 40 to 45 days after sowing.
- Timely and need based, placement of fertilizer and earthing up
- Excess N should be avoided

Right pest and diseases management

- Pests - Aphid, Tobacco caterpillar and Flea beetles
- Diseases- Root and crown rot, *Cercospora* leaf spot and Root knot nematode

Integrated pest and disease management

- Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg of seed
- Summer ploughing and exposing the field to sunlight
- Crop rotation for 3 years with Marigold or gingelly or sunnhemp for root rot and nematode

- Soil application of *Trichoderma viride* or *Pseudomonas fluorescens* @ 2.5 kg/ha mixed with 50 kg of FYM before planting
- Sow castor as trap crop around and within fields to attract adult *Spodoptera* moth for egg laying
- Set up light traps (1 mercury / 5 ha) for monitoring *Spodoptera litura*
- Setting up pheromone -Pherodin SL @ 12/ha for *Spodoptera litura*
- Removal and destruction of *Spodoptera* egg masses, early stage larvae formed in clusters
- Hand picking and destruction of grown up *Spodoptera* caterpillar

Need based

- Spraying *Spodoptera* nuclear polyhedrosis virus at 1.5 x 1012 POB/ha
- Spray NSKE 5% for aphids flea beetles and for early instar caterpillars
- Use of poison bait pellets prepared with rice bran 12.5 kg, jaggery 1.25 kg, carbaryl 50% WP - 1.25 kg in 7.5 lit water for *Spodoptera litura*
- Spray any one of the following insecticides using a high volume sprayer covering the foliage and soil surface
- Chlorpyriphos 20 EC - 2 ml / lit
- Dichlorvos 76 WSC - 1 ml/lit
- Fenitrothion 50 EC - 1 ml/lit
- Spray malathion 50 EC (2 ml/lit) for flea beetle and leaf webber
- Spray Imidacloprid 200 SL (0.2 ml/lit) or methyl demeton 25 EC (2 ml/lit) or dimethoate 30 EC (2 ml/lit) for aphids
- Applying neem cake @ 150 kg/ha for root rot
- Foliar spray of Mancozeb 2.5 g / lit for *Cercospora* leaf spot
- Neem cake @ 1 t/ha or carbofuran @ 33 kg/ha as spot application on 30 days after sowing for nematode management

Water management

- Optimum EC up to 1 ds/m
- It can be grown in water containing EC 1 to 2 ds/m
- Irrigation schedule: Life irrigation on 3rd day
- For vegetative stage(up to 45 DAS) - 4 irrigation, vegetative to tuber initiation (75 DAS) - 4 irrigation, tuber maturation(up to 125 DAS) - 4 irrigation and Maturity - 2 irrigation – up to 15-20 DAS maintain optimum soil moisture for good germination and population
- Fertigation - Yet to be studied. Good response to fertilization based on review of literature
- Drip fertigation with 100 % recommended dose of Fertilizer 150:75:75 Kg NPK ha-1 found to be better for tropical sugarbeet

Post harvest management

- Stop irrigation 15-20 days prior to harvest. This allows sugar accumulation
- Just hand pulling and keeping the tops, store in a shaded conditions
- Roots of sugarbeet reach the factory within 48 hours for processing
- Yield 80 to 100 t/ha, Sugar recovery- 15 -16%

FORAGE CROPS

FODDER CHOLAM

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/Season	Month	Varieties
Irrigated		
All Irrigated districts	Jan - Feb and Apr – May	CO 27 and CO (FS) 29 (Multicut Cholam)
Rain fed		
All Districts	(Jun - Jul)	CO 27
All Districts	(Sep - Oct)	CO 27 and K 11

II. PARTICULARS OF FODDER CHOLAM VARIETIES

PARTICULARS	CO 27	K 11	CO (FS) 29
Parentage	Derivative of the cross CO 11 x *Sorghum halepense*	K 7 x A 6552	Derivative of the cross TNS 30 x *Sorghum sudanense*
Duration (Days)	Single cut (60-65 days)	Single cut (95-100 days)	Multicut (3 years)
Average green fodder yield (t/ha)	35-40	30-45 Grain yield: 1500 kg	160-170 (5-6 cuts)
Morphological characters			
Plant height (cm)	262	260-300	220-250
Number of tillers	2-3	5-7	10-15
Number of leaves	18.66	17-20	80-105
Leaf length (cm)	78.43	90-100	75-90
Leaf breadth (cm)	6.18	7-8	3.5-4.6
Leaf stem ratio	0.18-0.22	0.45	0.2-0.25
Quality characters			
Protein content (%)	9.82	7.44	8.41
Dry matter (%)	24.17	-	23.60
Sugar (%)	7.40	-	-
Crude fibre (%)	25.97	35.6	25.60
IVDMD (%)	48.00	-	50.30

IRRIGATED FODDER CHOLAM

CROP MANAGEMENT

1. Ploughing

Plough with an iron plough once and with a country plough twice.

2. Application of FYM

Spread 25 MT/ha of FYM or compost on the unploughed field, along with 10 packets of *Azospirillum* inoculants (2000 g)and 10 packets of *Phosphobacteria* (2000g) or 20 packets of *Azophos* (4000g)

3. Forming ridges and furrows

Form ridges and furrows of 6 m long and 60 cm apart and plant on either side of the ridge

4. Nutrient management

CO 27

a. Apply NPK fertilizer as per soil test recommendation. If soil test is not done, follow the blanket recommendation of 60 : 40 : 20 kg N, P and K /ha.
b. Apply half the dose of N and full dose P and K basally before sowing.
c. Top dressing : 30 kg N/ha on 30 days after sowing
d. For the ratoon crop, apply 30 kg N/ha immediately after the harvest and irrigate

CO (FS) 29 (multicut variety):

- Apply 45 : 40 : 40 kg N,P, K/ha as basal and 45 kg N as top dressing on 30 DAS followed by the application of 45 kg N/ha after every cut. After 4th cut, apply 40 kg P and 40 kg K along with 45 kg N to sustain the fodder yield and quality.
- Application of *Azospirillum* (2000g/ha) and *Phosphobacterium* (2000g/ha) together as a mixture or *Azophos* (4000g/ha) along with 75% recommended dose of N and P fertilizer enhanced the yield besides saving of 25% of fertilizer dose.

5. Sowing

a. Seed rate: CO 27 -50 kg/ha and CO (FS) 29 – 5 kg/ha
b. Spacing: 30 x 10 -15 cm
c. Treat the seeds with 3 packets (600 g)/ha of *Azospirillum* and 3 packets (600g) of *Phosphobacteria* or *Azophos* 6 packets (1200g)
* CO (FS) 29 seed has one month seed dormancy.

6. Water management

Irrigate immediately after sowing. Life irrigation on the third day and thereafter once in 10 days, according to need based.

7. Weed management

First hand weeding on the 20th day of sowing and if necessary 2nd hand weeding between 35 - 40 days after sowing.

8. Plant protection

Generally not recommended for fodder crops. However, for seed production, the following insecticides are recommended

- Spray any one of the following insecticides on the 10th and 17th day of sowing to control shoot fly.

- Endosulfan 35 EC 500 ml/ha; Methyldematon 25 EC 500 ml/ha; Dimethoate 30 EC 500 ml/ha in 250 ltrs.of spray fluid.
- Apply any one of the following insecticides on the foliage on the 30th day of sowing.
  Endosulfan 35 EC 750 ml/ha; Carbaryl 50 WP 1.0 kg/ha

9. Harvesting

Harvest at 50% flowering for fodder

RAINFED FODDER CHOLAM

CROP MANAGEMENT

1. Application of FYM

Apply 12.5 t/ha and incorporated in the soil at the time of last ploughing.

2. Seed rate

40kg/ha for CO 27

3. Sowing

Sow the seeds well before the onset of monsoon

4. Spacing

30 x 15 cm

5. Nutrient management

30: 20: 20 kg N, P and K / ha for Alfisols (Red soil).
40:20 kg N and P/ ha for Vertisols (Black soil).

CROP PROTECTION

Pest management - for seed crop

Pests	Management strategies
Shoot fly *Atherigona soccata*	• **Spray any one of the following insecticides on the 10^{th} and 17^{th} day of sowing:** Endosulfan 35 EC 500 ml/ha Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha (Spray fluid – 250 l)
Stem borer *Chilo partellus*	• **Spray any one of the following insecticide on the foliage on 30th day of sowing:** Endosulfan 35 EC 750 ml/ha Carbaryl 50 WP 1.0 kg/ha • **Dusting the leaf whorl with any one of the following dusts mixed with sand to make up to 50 kg:** Carbaryl 10 D 10 kg/ha Endosulfan 4 D 10 kg/ha

FODDER CUMBU

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/ Season	Month	Varieties
Irrigated		
All Districts	Throughout the year	CO 8

II. PARTICULARS OF FODDER CUMBU VARIETIES

PARTICULARS	CO 8
Parentage	Derivative of 732 A x Sweet Giant Bajra
Duration (Days)	45-50 days
Average green fodder yeld (t/ha)	25 - 30
Morphological characters	
Plant height (cm)	180 -190
Number of tillers	6 - 8
Number of leaves	8 -10
Leaf length (cm)	60 - 70
Leaf breadth (cm)	2.5 - 3.0
Leaf stem ratio	0.54
Quality characters	
Protein content (%)	13.9
Dry matter (%)	18.2
Sugar (%)	9.9

CROP MANAGEMENT

1. Soil

All types of soils with good drainage.

2. Preparatory cultivation

Plough with an iron plough once and with a country plough twice.

3. Seed treatment

a) Removal of ergot affected seeds and sclerotic if any by soaking in 20% salt solution (2.5 kg of common salt in 12.5 litres of water).

b) Seed treatment with fungicides 24 hours prior to sowing.

4. Nutrient management

- Basal application : FYM: 25 t/ha; NPK: 25:20:12 kg/ha.
- Top dressing : 25 kg N/ha on 30 DAS
- Application of *Azospirillum* (2000g) and *Phosphobacterium* (2000g) or *Azophos* (4000g) along with 75% of recommended dose of N and P fertilizers enhanced the yield besides saving of 25% of fertilizer dose.

5. Seed rate

10 kg/ha

6. Spacing

25 x 10 cm.

7. After cultivation

First hoeing and weeding on 30th day after sowing.

8. Irrigation

Once in 10 days

9. Plant protection

Generally not recommended

10. Harvest

Harvest at boot leaf stage, 40 - 45 days after sowing.

11. Green fodder yield: 25-30 t/ha

Note:

CO 8 fodder cumbu can be intercropped with fodder cowpea varieties CO 5 or CO (FC) 8 that can be harvested together to provide a nutritious fodder to cattle.

FODDER MAIZE

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/Season	Month	Varieties
Irrigated		
All Districts	Throughout the year	African tall

II. PARTICULARS OF FODDER MAIZE VARIETIES

PARTICULARS	African Tall
Parentage	Composite
Duration (Days)	60-70
Green fodder yield (t/ha)	35-40
Morphological characters	
Plant height (cm)	302.00
Number of leaves	13.30
Leaf length (cm)	81.30
Leaf breadth (cm)	8.15
Stem thickness (cm)	1.77
Leaf-stem ratio	0.21
Quality characters	
Crude protein (%)	9.80
Dry matter (%)	17.65

1. GREEN FODDER PRODUCTION

CROP MANAGEMENT

1. Ploughing

Plough the field twice with an iron plough and three or four times with country plough.

2. Application of FYM

Apply and spread FYM or compost at 25 t/ha on unploughed field along with 10 packets of *Azospirillum* (2000 g) and 10 packets of *Phosphobacteria* (2000g) inoculums or 20packets of *Azophos* (4000g) and incorporate the manure into the soil during ploughing.

3. Forming ridges and furrows

Form ridges and furrows using a ridger, 30 cm apart are form beds of size 10 m^2 or 20 m^2 depending on the availability of water and slope of the land.

4. Nutrient management

Apply NPK fertilizers as per soil test recommendation as for as possible. If soil testing is not done, follow blanket recommendation of 30: 40: 20 kg N, P_2O_5 and K_2O / ha. Apply 30 kg N/ha at 30 days after sowing as top dressing.

5. Sowing

a. Spacing : 30 x 15 cm, Seed rate : 40 kg/ha
b. Treat the seeds with 3 packets (600 g) *Azospirillum* inoculant and 3 packets (600 g) of *Phosphobacteria* or 6 packets of *Azophos* (1200g) before sowing.

6. Water management

Irrigate immediately after sowing and give life irrigation on the third day and thereafter once in 10 days.

7. Weed management

Hoeing and weeding are done as and when necessary.

8. Harvesting

Harvest the crop when the cob is in the milky stage.

9. Green fodder yield:

Note:

* Fodder maize can be intercropped with fodder cowpea varieties CO 5 or CO (FC) 8 at 3:1 ratio and harvested together to provide balanced nutritious fodder.

TNAU vermicompost at 5 t/ha + 75% recommended dose of fertilizer for intercropping of maize and cowpea produces green fodder yield of 105 t/ha/yr (3 crops/ year) which is sufficient to maintain 7 adults and 3 young cattles. The dung obtained from these animals can be used for on farm production of 19.4 tonnes of vermicompost per year.

2. SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 200 m all around the field from the same and other varieties of the crop.

Spacing

- 60 x 20 cm

Fertilizer requirement

- Apply NPK @ 175 : 90 : 90 kg ha^{-1} + 25 kg $ZnSO_4$ ha^{-1} as basal application.

Harvest

- Seeds attained physiological maturity on 40^{th} day after anthesis.

Seed treatment

- Slurry treat the seeds with carbendazim @ 2g kg^{-1} of seed along with carbaryl @ 200 mg kg^{-1} of seed (or)
- Slurry treat the seeds with halogen mixture ($CaOCl_2$ + $CaCO_3$ + arappu leaf powder mixed in the ratio of 5:4:1) @ 3g kg^{-1} as eco – friendly treatment.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 10-12%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 10%.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 8%.

Other management practices

- As per fodder crop management techniques.

NEELAKOLUKATTAI (BLUE BUFFEL GRASS) - (*Cenchrus glaucus*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/Season	Month	Variety
Rain fed (Pasture grass)		
All Districts **North-East Monsoon**	Oct - Dec	CO 1

II. PARTICULARS OF NEELAKOLUKATTAI VARIETY

PARTICULARS	CO 1
Parentage	Clonal selection from Vellakoil local (FS 391)
Duration (Days)	Perennial
Green fodder yield (t/ha/year)	40 (4 cuts)
Seed yield (kg/ha/year)	55 - 60
Morphological characters	
Plant height (cm)	120-130
Number of tillers	60-65
Number of leaves	550--600
Leaf length (cm)	25-30
Leaf width (cm)	0.8-1.0
Leaf stem ratio	0.93
Quality characters	
Dry matter (%)	28.00
Crude protein (%)	9.06
Crude fibre (%)	34.6
Phosphorus (%)	0.26
Calcium (%)	0.58
Manganese (ppm)	56
IVDMD (%)	49.4

CROP MANAGEMENT

1. Soil type

Well drained soil with high calcium content is suitable.

2. Ploughing

Plough the field twice or thrice with an iron plough to ensure good tilth.

3. Application of FYM

5 t/ha

4. Application of fertilizer

a. Apply NPK fertilizers as per soil test recommendations. If the soil test is not done, follow the blanket recommendation of 25: 40: 20 kg N, P and K per hectare.

b. Basal dressing: Apply full dose of NPK before sowing.
c. Top dressing: After every harvest apply 25 kg N/ha during the rainy season.

5. Sowing

a. Seed rate: 6 - 8 kg/ha or 40,000 rooted slips/ha.
b. Spacing: 50 x 30 cm.

Fresh seeds have dormancy for 6 - 8 months. To break dormancy, soak the seeds in 1 % potassium nitrate solution for 48 hours prior to sowing.

6. Weed management

Hand weeding can be done as and when necessary.

7. Harvest

First cut on 70th or 75th day after sowing and subsequent 4 - 6 cuts depending on growth.

8. Green fodder yield: 40 t/ha

9. Inter cropping

Highly drought resistant legume fodder, Kolukattai grass can be intercropped with *Stylosanthes scabra* in the ratio of 3:1.

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 10 m all around the field from the same and other varieties of the crop.

Pre-sowing seed treatment

- Mechanically scarify the seeds with sand @ 2:1 ratio for 2 min. for improved seed germination.

Crop management

- Seeds produced after first cut are higher in seed quality.

Harvest

- Seed attain physiological maturity fifth week and sixth week after 50 per cent flowering in seed to seed method and slip to seed method respectively.

Seed grading

- Grade the seeds with BSS 14 x 14 wire mesh sieve.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 10-12%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 10%.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 8%.

Other management practices

- As per fodder crop management techniques.

GUINEA GRASS (*Panicum maximum*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/ Season	Month	Varieties
Irrigated		
All Districts	Throughout the year	CO 2 and CO (GG) 3
Rain fed		
All Districts	Jun – Sep / Oct - Nov	CO 2 and CO (GG) 3

II. PARTICULARS OF GUINEA GRASS VARIETIES

PARTICULARS	CO 2	CO (GG) 3
Parentage	CO 1 x Centenario	Clonal selection from Mumbasa
Duration (Days)	Perennial	Perennial
Green fodder yield (t/ha/year)	270 (7harvests)	340-360 (7harvests)
Morphological characters		
Plant height (cm)	150-200	210-240
Number of tillers/clump	80-100	40-50
Leaf length (cm)	65-75	97-110
Leaf width (cm)	2.5-2.9	3.2 - 4.5
Leaf-stem ratio	-	0.73
Quality characters		
Dry matter (%)	25.94	20.2
Crude protein (%)	8.92	6.35
Crude fibre (%)	34.6	30.3
Phosphorus (%)	0.29	0.19
Calcium (%)	0.59	-
Magnesium (ppm)	0.38	-
IVDMD (%)	49.5	-

1. Soil

All types of soil with good drainage.

2. Preparatory cultivation

Plough 2 to 3 times to obtain a good tilth and form ridges and furrows at 50 cm spacing.

3. Nutrient management

Basal: FYM 25 t/ha; NPK 50:50:40 kg/ha
Top dressing: 25 kg N/ha after each cut.

4. Seed rate

40,000 rooted slips/ha

5. Spacing

50x 50 cm

6. After cultivation

Hoeing and weeding on 30th day after sowing. Earthing up once after harvests.

7. Irrigation

Once in ten days or depending on soil condition.

8. Plant protection

Generally not recommended.

9. Harvest

First cut 75-80 days after germination or 45 days after planting of slips. Subsequent cuts at interval of 45 days.

10. Seed production

Rooted slips uprooted from 90 days old crop can be used for further propagation

Note:

Guinea grass can be intercropped with *Desmanthus* (Velimasal) at 3:1 ratio and can be harvested together and fed to the animals.

DEENANATH GRASS (*Pennisetum pedicellatum*)

CROP IMPROVEMENT

1. **VARIETY :** CO 1

2. SEASON

Can be grown throughout the year under irrigated condition. Suitable for growing in the monsoon season under rainfed condition

CROP MANAGEMENT

1. SOIL

All types of soil with good drainage. Does not come up well on heavy clay soil or flooded or waterlogged conditions.

2. PREPARATORY CULTIVATION

Plough 2-3 times to obtain good tilth and form beds and channels.

3. MANURING

Basal: FYM 25 t/ha
NPK 20 : 25 : 20 kg/ha
Top dressing: 20 Kg N on 30th day after sowing
50% of this has to be applied for rainfed crop

4. SEED RATE

2.5 kg/ha

5. SPACING

35 x 10 cm or solid sowing in lines 30 cm apart.

6. AFTER CULTIVATION

Hoeing and weeding on 30th day after sowing

7. IRRIGATION

Once in ten days or depending on soil condition

8. PLANT PROTECTION

Generally not recommended

9. HARVEST

55-60th day after sowing.

10. GREEN FODDER YIELD

Irrigated crop : 25-30 t/ha first crop.
Ratoon crop : 15-20 t/ha
Rainfed crop : 15-20 t/ha

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 10 m all around the field from the same and other varieties of the crop

Pre-sowing seed management

- Break the seed dormancy by mechanical scarification in a defluffer followed by soaking in a mixture of GA_3 (200 ppm) and KNO_3 (0.25%) (1: 1) for 16 hours.
- Pellet the seed with DAP @ 60 g/kg and arappu leaf (*Albizzia amara*) powder @ 500g/kg^{-1} of seed to enable easy handling of seed during sowing and also for better establishment.

Harvest

- Deenanath grass (cv Pusa 3) attained physiological maturity at fifth week after 50% flowering, while it took six weeks for cv. TNDN.1.
- Germination is higher for the seeds from the first and second formed tillers.
- Delayed harvesting resulted in shattering loss.
- The middle and proximal portions of the spike produce high quality seeds.

Seed Treatment

- Slurry treat the seeds with carbendazim @ 4g kg^{-1} of seed.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 - 10%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 8%.

Other management practices

- As in fodder crop management technique.

CUMBU - NAPIER HYBRIDS

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/Season	Month	Varieties
Irrigated		
All Districts	Throughout the year	KKM 1, CO 3 and CO (CN) 4

II. PARTICULARS OF GUINEA GRASS VARIETIES

PARTICULARS	KKM 1	CO 3	CO (CN)4
Parentage	Interspecific hybrid between Cumbu IP 15507 x FD 429	Interspecific hybrid between Cumbu PT 1697 x *Penneisetum purpureum*	Interspecific hybrid between Cumbu CO 8 x FD 461
Duration (Days)	Perennial	**Perennial**	**Perennial**
Green fodder yield (t/ha/yr)	288	350 (7harvests)	375-400 (7harvests)
Morphological characters			
Plant height (cm)	155-160	300 – 360	400-500
No. of leaves per clump	165-170	400-450	400-450
No. of tillers per clump	10-15	30 – 40	30 – 40
Leaf stem ratio	-	0.70	0.71
Leaf length (cm)	110-115	80 – 95	110-115
Leaf width (cm)	4.5-5.0	3.0 – 4.2	4.0-5.0
Quality characters			
Dry matter yield (t/ha/yr)	47.23	65.12	79.87
Crude protein yield (t/ha)	4.65	5.40	8.71
Dry matter (%)	16.4	17.0	21.3
Crude protein (%)	9.85	10.5	10.71
Oxalate (%)	1.50	2.51	2.48

I. PREPARATORY CULTIVATION

CROP MANAGEMENT

1. Ploughing

Plough with an iron plough two to three times to obtain good tilth.

2. Application of FYM

25 t/ha

3. Forming ridges

Form ridges and furrows using a ridger, 50 cm apart.

4. Nutrient Management

i. Apply NPK fertilizers as per soil test recommendation as for as possible. If soil testing is not done, follow the blanket recommendations of 150:50:40 of NPK in kg/ha.
ii. Apply full dose of P, K and 50% N basally before planting. Top dressing of 50% N on 30 DAS.
iii. Repeat the basal application of 75 kg N/cut for sustaining higher yield
iv. Application of *Azospirillum* (2000g) and *Phosphobacterium* (2000g) or *Azophos* (4000g) along with 75% of recommended dose of N and P fertilizers enhanced the yield besides saving of 25% of fertilizer dose.

5. Planting

i. Irrigate through the furrows and plant one rooted slip/stem cutting per hill.
ii. Spacing 60 x 50 cm and 33,333 planting material are required to plant one ha.

6. Water management

Immediately after planting, give life irrigation on the third day and thereafter once in 10 days. Sewage or waste water can also be used for irrigation.

7. Weed management

Hand weeding is done whenever necessary.

8. Harvesting

First harvest is to be done on 75 to 80 days after planting and subsequent harvests at intervals of 45 days yield around 400 t/ha.

NOTE:
1. Quartering has to be done every year or whenever the clumps become unwidely and large.
2. Wherever necessary to alleviate the ill effects of oxalates in this grass, the following steps are suggested.

i. Feeding 5 kg of leguminous fodder per day per animal along with these grasses or
ii. Providing calcium, bone meal or mineral mixture to the animal or
Iii.Gi-ving daily half litre of supernatant clear lime water along with the drinking water or sprinkling this water on the fodder

LUCERNE – KUDIRAI MASAL (*Medicago sativa*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/Season	Month	Variety
Irrigated		
Coimbatore, Thiruppur, Erode and Dharmapuri	Throughout the year	CO 1

II. PARTICULARS OF LUCERNE VARIETY

PARTICULARS	CO 1
Parentage	Mass selection from Coimbatore local
Duration (Days)	Perennial
Green fodder yield (t/ha/year)	80-90 (11-12 harvests)
Seed yield (kg/ha)	200 - 250
Morphological characters	
Plant height (cm)	60 - 70
No. of branches per plant	12 - 15
No. of pods per plant	22 - 25
No. of seeds per pod	4 - 6
Quality characters	
Protein content (%)	20 - 24
Dry matter (%)	18 - 20
Dry matter yield (t/ha/year)	16.15

CROP MANAGEMENT

1. Ploughing

Plough three or four times with country plough to obtain good tilth.

2. Application of FYM

Apply and spread FYM or compost at 12.5 t/ha

3. Forming beds

Form beds of size 10 m^2 or 20 m^2 depending on the availability of water and slope of land.

4. Nutrient management

a. Apply NPK fertilizers as per soil test recommendations as for as possible. If soil testing is not done, follow the blanket recommendation of 25:120:40 kg NPK/ha.

b. Apply the full dose NPK of 25:120:40 basally before sowing.

5. Seed rate

20 kg/ha

a. Good quality seeds without the seeds of *Cuscuta* should be used.

b. The seeds are to be treated with *Rhizobial* culture at 3 packets/ha (600 g).

6. Spacing

25 cm x continuous sowing

7. Water management

Irrigate immediately after sowing, life irrigation on the third day and thereafter once in a week.

8. Weed management

Hand weeding is given as and when necessary.

9. Plant protection

a) Generally not recommended
b) Wherever the parasite *Cuscuta* is observed uproot the affected plants along with the soil and burn

10. Harvesting

First harvest 75 - 80 days after sowing. Subsequent harvests are made at intervals of 25 - 30 days.

11. Green fodder yield: 80-90 t/ha

HEDGE LUCERNE - VELIMASAL (*Desmanthus virgatus*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/ Season	Month	Varieties
Irrigated		
All Districts	Throughout the year	Velimasal
Rain fed		
All Districts	June - October	Velimasal

II. PARTICULARS OF VELIMASAL VARIETY

PARTICULARS	Velimasal
Parentage	Introduction
Duration (Days)	Perennial
Green fodder yield (t/ha/year)	90-100 (7 harvests)
Seed yield (kg/ha)	200 - 250
Morphological characters	
Plant height (cm)	110-120
No. of branches per plant	15-20
No. of pods per plant	75-100
No. of seeds per pod	6-10
Quality characters	
Protein content (%)	20 - 22
Dry matter (%)	18 - 20
Dry matter yield (t/ha/year)	16.2-20.0

CROP MANAGEMENT

1. Ploughing

Plough two to three times with an iron plough to obtain good tilth.

2. Application of FYM

Apply and spread 12.5 t/ha of FYM or compost

3. Forming ridges and furrows

Form ridges and furrows 50 cm apart using ridger and irrigation channels across furrows.

4. Nutrient management

a. Apply NPK fertilizer as per soil test recommendations as far as possible. If the soil testing is not done, follow the blanket recommendations of 25: 40:20 kg NPK/ha.

b. Apply full dose of NPK basally before sowing.

5. Seed treatment

- To get better germination seeds must be treated in hot water at 80°C for 5 minutes (boiling water removed from the flame and kept for 4 minutes to attain 80°C). After hot water treatment, seeds should be washed with cold water and soaked in cold water over a night. Seeds should be shade dried before sowing.

6. Sowing

a) Pure crop

Sow the seeds at 20 kg/ha in solid stand on the side of the ridges

b) Velimasal seeds are to be treated with *Rhizobial* culture at 3 packets/ha (600 g).

7. Water management

Irrigate immediately after sowing, life irrigation on the third day and thereafter once in a week.

8. Weed management

Hoeing and weeding are given as and when necessary.

9. Harvesting

a. Pure crop

First cut on 90th day after sowing at 50 cm height and subsequent cuts at intervals of 40 days at the same height.

b. Mixed crop

First harvest on 60th day after sowing. Subsequent cuts at intervals of 45 days at 50 cm height of Velimasal which is maintained throughout.

10. Green fodder yield: 120 t/ha/yr

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Pre-sowing seed treatment

- Acid scarify the seeds with commercial sulphuric acid @ 200 ml kg^{-1} of seed for 15 min. to break the seed coat dormancy.

Spacing

- 60 x 20 cm

Fertilizer

- Apply NPK @ 25:40:20 kg/ ha^{-1} as basal for the first crop.
- After first cut again apply NPK @ 45:60:40 kg ha^{-1}

Foliar spray

- Spray 200 ppm salicylic acid thrice at 10 days interval after 50 per cent flowering

Harvest

- Seeds attain physiological maturity 35 days after anthesis, when the pods turn brown and seeds become shiny brown.

Picking

- Harvest the pods in pickings.
- Delayed harvest leads to 100% shattering loss.

Seed size

- Grade the seed using BSS 14 x 14 sieve.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 - 10%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 8%.

Other management practices

- As in fodder crop management techniques.

FODDER COWPEA

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/ Season	Month	Varieties
Irrigated		
Erode, Madurai, Dindigul, Theni, Cuddalore, Villupuram and Tiruvannamalai	June-July	CO 5 and CO (FC) 8

II. PARTICULARS OF FODDER COWPEA VARIETIES

PARTICULARS	CO 5	CO (FC) 8
Parentage	Gamma ray mutant of CO 1	Cross derivative from CO 5 x N 331
Duration (Days)	60-65	60-65
Green fodder yield (t/ha)	18-20	18-22
Seed yield (kg/ha)	600	625
Morphological characters		
Plant height (cm)	93.00	100-120
No. of branches	2 - 3	3-4
No. of leaves	12	13-15
Leaf length (cm)	12.1	13.5
Leaf width (cm)	8.2	9.1
Leaf stem ratio	0.83	0.95
Quality characters		
Dry matter content (%)	14.64	15.5
Crude protein content (%)	20.00	20.7

CROP MANAGEMENT

I. PREPARATORY CULTIVATION

1. Ploughing

Plough twice with an iron plough and three or four times with country plough to obtain good tilth.

2. Application of FYM

Apply and spread FYM or compost at 12.5 t/ha

3. Forming ridges and furrows

a. Form ridges and furrows of 6 m length and 30 cm apart.

b. If ridges and furrows are not made, form beds of size 20 m^2 depending on the availability of water

4. Nutrient management

Apply NPK fertilizers as per the soil test recommendations as for as possible. If soil testing is not done, follow the blanket recommendation of 25:40:20 kg NPK/ha.

5. Sowing

a. The seeds are to be treated with *Rhizobial* culture at 3 packets/ha (600 g) using rice kanji as binder.
b. Seed rate: 25 kg/ha.
c. Spacing: 30 x 15 cm

6. Irrigation management

Irrigate immediately after sowing, Life irrigation on third day and thereafter once in ten days.

7. Weed management

Hoeing and weeding are given as and when necessary.

8. Plant protection

Generally not recommended

9. Harvesting

Harvest 50 - 55 days after sowing (50% flowering stage).

CROP PROTECTION

Pests	Management strategies
Sucking pests	• **Spray any one of the following insecticides in 250 lit of water for one ha:** Methyl demeton 25 EC 500 ml Dimethoate 30 EC 500 ml Phosphomidon 40 SL 500 ml • Stop spraying 20 days before harvest.

MUYAL MASAL (STYLO) - (*Stylosanthes scabra*)

CROP IMPROVEMENT

1. SEASON

June - July to September - October.

2. VARIETIES

a. *S.hamata* (Annual)
b. *S.scabra* (Perennial)

CROP MANAGEMENT

I. PREPARATORY CULTIVATION

1. PLOUGHING

Plough the field two to three times to obtain good tilth.

2. APPLICATION OF FYM

Apply and spread 10 t/ha of FYM or compost

3. FORMING BEDS

Form beds of size 10 m^2 or 20 m^2

4. APPLICATION OF FERTILIZER

a. Apply NPK fertilizers as per soil test recommendation as for as possible. If the soil testing is not done, follow the blanket recommendation of 20:60:15 kg NPK/ha.
b. Apply full dose of NPK basally.

5. SOWING

a. Seed are to be treated with 3 pockets rhizobium culture (600 g/ha).
b. For line sowing (30 x 15 cm) the seed rate is 6 kg/ha and for broadcasting 10 kg/ha.
c. Stylo seeds possess hard seed coat. So acid scarification is to be done by dipping the seeds in concentrated sulphuric acid for three minutes and washing thoroughly with tap water and scarified seeds are again to be presoaked in cold water overnight. (or) Seeds can also be scarified in hot water by immersing the seeds for 4 minutes in hot water of 80º C and the seeds are again to be presoaked in cold water overnight.

6. WATER MANAGEMENT

It is a rainfed crop. But during the period of establishment, care should be taken to provide sufficient moisture.

7. WEED MANAGEMENT

Hand weeding may be given as and when necessary.

8. HARVESTING

First harvest can be taken 75 days after sowing at flowering stage and subsequent harvests depending upon the growth.

9. GREEN FODDER YIELD

It is to be noted that during the first year, the establishment after sowing is very slow and the yield is low. Later on when the crop establishes well due to self seeding, it yields about 30 to 35 t/ha/year from the third year onwards.

SEED PRODUCTION

Varietal Seed Production

Land requirement

- Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified / quality seed production leave a distance of 25 m all around the field from the same and other varieties of the crop

Sowing Season

- October to January

Pre-sowing seed treatment

- Scarify the seeds with conc. H_2SO_4 acid @ 200 ml / kg^{-1} for 4 min for removal of seed coat dormancy.
- Fortify the seed with KNO_3 0.25% for 3 h after dormancy breaking to improve germination.

Seed extraction

- Extract the seeds using paddy dehusker by maintaining 0.2 mm clearance between the rotating discs.

Seed grading

- Grade the seeds using BSS 16 x 16 wire mesh sieve.

Storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 - 10%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 8%.

Other management practices

- As in fodder crop management technique.

LEUCAENA – SOUNDAL (*Leucaena leucocephala*)

CROP IMPROVEMENT

1. SEASON AND VARIETIES

Season	Varieties
Jun - Jul	Hawaiian giant (Ivory coast), CO 1
Rainfed (Sep - Oct)	K 8, Giant Ipil - Ipil, CO 1

CROP MANAGEMENT

I. PREPARATORY CULTIVATION

1. PLOUGHING

Plough twice with an iron plough and 3 or 4 times with country plough to obtain good tilth.

2. APPLICATION OF FYM

Apply and spread 25 t/ha of FYM or compost

3. FORMING RIDGES AND FURROWS

Form ridges and furrows (using a ridger) 6 m along and 1 m apart and irrigation channels across the furrows.

4. APPLICATION OF FERTILIZER

a. Apply NPK fertilizers as per soil test recommendations as far as possible. If soil testing is not done, follow the blanket recommendation of 10:60:30 kg NPK/ha.

b. Apply full dose of NPK basally before sowing.

5. SOWING

a. Maintain a seed rate of 10 kg/ha for fodder and 1.25 kg for fuel.

b. Seeds are hard and require scarification to obtain high and uniform germination. Scarification of seeds can be done by pounding the seeds with sand in mortar. Acid scarification can also be done by dipping the seeds in concentrated sulphuric acid for three minutes and washing thoroughly with tap water. Another easiest method is hot water treatment by soaking the seeds in hot water (80^{o} C) for 4 minutes (boiling water removed from the flame and kept for 4 minutes comes down to 80^{o} C). A still simpler method would be to bring water to boil (100^{o}C) in a vessel, take it out of the flame and immediately pour it over the seeds and keep them for 3 to 4 minutes. Then, the hot water may be poured out and cold water added to steep the seeds over night. Seeds can also be simply soaked in plain water for 72 hrs before sowing.

c. After scarification, treat the seeds with Rhizobial inoculant using rice kanji as binder.

6. IRRIGATION MANAGEMENT

This may be done wherever the crop is raised under irrigation. Once established, this plant can withstand several months of dry weather. However, to ensure rapid seedling growth, the land should be adequately moist upto 5 - 6 months. In summer, irrigation once in 6 weeks is adequate.

7. HARVESTING

Plant can be harvested as short as 6 months after planting. However, the initial cutting should not be done until the trunk has attained atleast 3 cm diameter or the plant has completed one seed production cycle. Harvests can be repeated once in 40 - 80 days depending upon growth and season. In drought prone areas, allow the trees to grow for two years to ensure deep root penetration before commencing harvest. The trees can be cut at 90 to 100 cm height from ground level. For poles and fuel, allow the tree to grow straight without cutting for 2.5 or 5 years as the case may be.

8. GREEN FODDER YIELD

As green fodder under irrigated conditions, a pure crop yields about 80 to 100 t/ha of green fodder. Under rainfed conditions 40 t/ha of green fodder is obtained after 2 years of initial growth and pruning to a height of 100 cm.

PUDIA SOUNDAL (*Leucaena diversifolia*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Zone District/Season	Month	Varieties
Rain fed		
All Districts	June - October	CO 1 (*Leucaena leucocephala*) and Pudia Soundal (*Leucaena diversifolia*)

II. PARTICULARS OF SOUNDAL VARIETIES

PARTICULARS	CO 1	Pudia Soundal (*Leucaena diversifolia*)
Parentage	*Leucaena leucocephala*	*Leucaena diversifolia* K – 186 Introduced from Australia
Duration	Perennial tree	Perennial tree
Green fodder yield (t/ha/yr)	35	40
Morphological characters		
Tree height (cm)	35’	30’ in about six years
Leaf stem ratio	-	1.8
Quality characters		
Dry matter content (%)	24.94	25.02
Crude protein content (%)	26.12	26.00
Crude fat (%)	9.51	9.85
Phosphorous (%)	0.09	0.37
Potassium (%)	6.4	3.2
Calcium (%)	0.9	2.4
Magnesium (%)	0.88	1.32
IVDMD (%)	46.01	46.25
Mimosine content (%)	3.07	3.00
Tannin content (%)	3.04	1.95
Carotene content (mg/100g)	11.39	11.54
Resistance to pests	-	Resistant to Psyllids

1. Ploughing

Plough twice with an iron plough and 3 or 4 times with country plough to obtain good tilth.

2. Application of FYM Apply and spread 25 t/ha of FYM or compost

3. Forming ridges and furrows

Form ridges and furrows (using a ridger) 6 m along and 1 m apart and irrigation channels across the furrows.

4. Application of fertilizer

a. Apply NPK fertilizers as per soil test recommendations as far as possible. If soil testing is not done, follow the blanket recommendation of 10:60:30 kg NPK/ha.
b. Apply full dose of NPK basally before sowing.

5. Sowing

a. Maintain a seed rate of 10 kg/ha for fodder and 1.25 kg for fuel.

b. Seeds are hard and require scarification to obtain high and uniform germination. Scarification of seeds can be done by pounding the seeds with sand in mortar. Acid scarification can also be done by dipping the seeds in concentrated sulphuric acid for three minutes and washing thoroughly with tap water. Another easiest method is hot water treatment by soaking the seeds in hot water (80°C) for 4 minutes (boiling water removed from the flame and kept for 4 minutes comes down to 80°C). A still simpler method would be to bring water to boil (100°C) in a vessel, take it out of the flame and immediately pour it over the seeds and keep them for 3 to 4 minutes. Then, the hot water may be poured out and cold water added to steep the seeds over night. Seeds can also be simply soaked in plain water for 72 hrs before sowing.

c. After scarification, treat the seeds with *Rhizobial* inoculant using rice kanji as binder.

6. Irrigation management

This may be done wherever the crop is raised under irrigation. Once established, this plant can withstand several months of dry weather. However, to ensure rapid seedling growth, the land should be adequately moist upto 5 - 6 months. In summer, irrigation once in 6 weeks is adequate.

7. Harvesting

Plant can be harvested as short as 6 months after planting. However, the initial cutting should not be done until the trunk has attained at least 3 cm diameter or the plant has completed one seed production cycle. Harvests can be repeated once in 40 - 80 days depending upon growth and season. In drought prone areas, allow the trees to grow for two years to ensure deep root penetration before commencing harvest. The trees can be cut at 90 to 100 cm height from ground level. For poles and fuel, allow the tree to grow straight without cutting for 2.5 or 5 years as the case may be.

8. Green fodder yield

As green fodder under irrigated conditions, a pure crop yields about 80 to 100 t/ha of green fodder. Under rain fed conditions 40 t/ha of green fodder is obtained after 2 years of initial growth and pruning to a height of 100 cm.

I. PREPARATION OF SILAGE

CHAFFING

Crops should be harvested at optimum stage having the moisture content of 70-75 perce nt and dried in the field for 4-5 hours. Ensiling chaffed green fodder gives quality silage as it facilitates easier and compact packing and as a result the air pockets are reduced to a minimum. The forage material for ensiling has to be chaffed in a chaff cutter to pieces of 1-3 cm size.

PRESERVATIVES/FEED ADDITIVES

Salt and jaggery/ molasses, each at the rate of 1% on green weight basis is used as preservatives. A saturated solution has to be prepared by dissolving in limited quantity of water and sprinkled on the chaffed material and mixed wee.

FILLING THE SILOKUDIR

The prepared forage material should be filled layer by layer, 15-20 cm thickness at a time, in the silokudhir/silo and well pressed by manual trampling to remove air pockets. Filling must be completed quickly and the gunny stitched tight and the polythene sealed using a candle flame as tightly as possible.

OPENING THE SILOKUDIR

Silo can be opened for feeding 30-35 days after ensiling. It can be easily stored for 3-6 months or even more if anaerobiosis is maintained. In Kisan silo, comparatively better anaerobiosis is maintained and the storage life is much longer, even upto six months or more. Once the silo is opened then it has to be used as quickly as possible to avoid spoilage. To reduce spoilage due to aerobiosis, after opening the silo and removing the required quantity of silage, the top must be covered with the excess gunny and polythene and a small weight (brick) may be placed to reduce air entry and to retain compaction.

SILAGE FEEDING

Silage is normally fed during lean periods when green fodder availability is scarce. Usually one fourth of the green fodder ration is supplemented with silage and other roughage meets the rest. For example, an animal fed with 35 kg green fodder per day, 9 kg silage is sufficient and other roughage ad lib is recommended for better health and milk production. Feeding excessive silage or only silage may upset the stomach (rumen) conditions and cause ill effects. It is advisable to feed 6-9 kg silage depending on the animal weight and milk yield. Thus the silage prepared in one 125 kg silokudir will help to feed an animal for 14-21 days or the 180 kg Kisan silo will be enough for 20-30 days depending on the feeding rates 9 or 6 kg per day, respectively.

MUSHROOM CULTIVATION

Agriculture will continue to be the main strength of Indian economy. With the variety of agricultural crops grown today, we have achieved food security by producing about 240 million tonnes of food grains. However, our struggle to achieve nutritional security is still on. In future, the ever increasing population, depleting agricultural land, changes in environment, water shortage and need for quality food products at competitive rates are going to be the vital issues and secondary agricultural vocations are going to occupy a prominent place to fill the void quality food requirements. The demand for quality food and novel products is increasing with the changes in life style and income. To meet these challenges and to provide food and nutritional security to our people, it is important to diversify the agricultural activities in areas like horticulture. Diversification in any farming systems imparts sustainability. Mushroom are one such component that only impart diversification but also help in addressing the problems of quality food, health and environmental sustainability. The present century is going to be a century of functional foods from synthetic chemicals and mushroom cultivation fits very well into this category and is going to be an important vocation.

Mushrooms represent microbial technology that recycles agricultural residues into food and manure. It is a solid state fermentation system in which crop residues are converted into valuable food rich in microbial protein. These are important source of quality protein, minerals and various novel compounds of medicinal value, do not compete for land and have very high productivity per unit area and time. These are considered to be the highest protein producer per unit area and time due to utilization of vertical space and short crop cycle. Due to their cultivation under controlled conditions the water requirements is less than any other crop grown in the field and has all the potentials of being a major crop in coming years.

Mushroom farming today is being practiced in more than 100 countries and its production is increasing at an annual rate of 6-7%. In some developed countries of Europe and America, mushroom farming has attained the status of a high-tech industry with very high levels of mechanization and automation.. China leads in mushroom production and china alone is reported to grow more than 20 different types of mushroom at commercial scale and mushroom cultivation has become China's sixth largest industry. The USA is the second largest producer of mushroom sharing 16% of the world output. Presently, three geographical regions- Europe, America and East Asia contribute to about 96% of world mushroom production. With the rise in the income level, the demand for mushrooms at very low costs with the help of seasonal growing, state subsidies and capturing the potential markets in the world with processed mushrooms at costs not remunerative to the growers in other mushroom producing countries.

Commercial production of edible mushrooms represents unique exploitation of the microbial technology for the bio conversion of the agricultural, industrial, forestry and household waste into nutritious food (mushrooms). Our country can emerge as a major player in mushroom production in wake of availability of plenty of agricultural residues and labour. Integrating mushroom cultivation in the existing farming systems will not only supplement the income of the farmers but also will promote proper recycling of agro-residues thereby improving soil health and promoting organic agriculture. In India, mushroom research started in 60s and the cultivation picked up in 70s.

India has varied agro-climate, abundance of agricultural residues and plenty of manpower making it suitable for cultivating different mushrooms. Our country produces about 600 million tonnes of agricultural waste per annum and a major part of it let out to decompose naturally or burnt *in situ.* This can effectively be utilized to produce highly nutritive food such as mushrooms and spent mushroom substrate can be converted into organic manure/Vermi-compost. Mushrooms are grown seasonally as well as in state-of-art environment controlled cropping rooms all the year round in the commercial units. Mushroom growing is a highly labour oriented venture and labour availability is no constraint in the country and two factors, that is, availabilities of raw materials and labour make mushroom growing economically profitable in India. Moreover, scope for intense diversification by cultivation of other edible mushrooms like Oyster, Shiitake, Milky and other medicinal mushrooms are additional opportunities for Indian growers.

At present, four mushrooms *viz.,* Button mushroom (*Agaricus bisporus*), Oyster Mushroom (*Pleurotus* spp.), Paddy straw mushroom (*Volvariella* spp.) and milky mushroom (*Calocybe indica)* have been recommended for round the year cultivation in India.

India produces about 600 million tonnes of agricultural by products, which can profitably be utilized for the cultivation of mushrooms. Currently, we are using 0.04% of these residues for producing around 1.2 lakh tons of mushrooms of which 85% is button mushroom. India contributes about 3% of the total world button mushroom production. Even if we use 1% of the residues for mushroom production, we can produce 3.0 million tons of mushrooms, which will be almost equal to current global button mushroom production (current world production 3.4 million tons). To remain competitive it will be important to harness science and modern technologies for solving the problems of production and bio-risk management. Mushroom being an indoor crop, utilizing vertical space offers an solution to shrinking land and better water utility.

Mushrooms have been reported to be capable of transforming agro wastes like paddy straw into protein rich food and have been confirmed to be sources of single cell protein. Mushrooms contain rich source of carbohydrates, proteins, aminoacids and dietary fibre. Vitamins such as riboflavin, niacin and pantothenic acid, and the essential minerals selenium, copper and potassium are abundant in mushrooms. The foremost importance is that mushrooms do not have cholesterol, instead contain ergosterol that act as a precursor for vitamin D synthesis in human body. Mushrooms are believed to help fight against cancer, relieves hypertension, imparts protection from heart diseases. Mushroom crop is in fact a boon that can solve several problems like the protein malnutrition, unemployment issues and environmental pollution.

Mushrooms are cultivated indoors and do not require arable land and mushroom is a short duration crop with high yield per unit time. For Small farmers and landless workers mushroom cultivation is highly suitable for the economic and social security of this group.This hi-tech horticulture venture relieves the pressure on arable land, because its cultivation is indoors, and is also more suited to the women folk. Mushrooms supplement and complement the nutritional deficiencies and are regarded as the highest producers of protein per unit area and almost 100 times more than the conventional agriculture and animal husbandry.

At present, the annual production of mushroom is around 6,500 tonnes, button mushroom accounts for 4000 tonnes, Oyster accounts for 2000 tonnes and milky mushroom contributes 500 tonnes. During the past two decades, the Mushroom Research and Training Centre of the Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore has made tremendous efforts on transfer of mushroom cultivation technology by imparting trainings. By this way it has contributed for the establishment of about 50 spawn producers and 600 mushroom oyster producers accounting for 5- 6 tonnes / day, 70 button mushroom producers producing 10- 12 tonnes / day and 30 milky mushroom growers contributing 1-1.5 tonnes / day in Tamil Nadu. This account for around 6 per cent of total mushroom production of the country.

Mushroom varieties/ strains released from TNAU for commercial cultivation

Scientific Name	Variety/ strain name	Place of release
Oyster mushroom		
Pleurotus sajor- caju	M2	Dept. of Plant Pathology, TNAU, Coimbatore
P. citrinopileatus	Co1	Dept. of Plant Pathology, TNAU, Coimbatore
P. djamor	MDU 1	Dept. of Plant Pathology, AC&RI, Madurai
P. eous	APK 1	Regional Research Station, Aruppukottai
P. ostreatus	Ooty 1	Horticultural Research Station, Uthagamandalam
P. florida	Pf Pp	Dept. of Plant Pathology, TNAU, Coimbatore
P. platypus	MDU 2	Dept. of Plant Pathology, TNAU, Coimbatore
P. flabellatus	Co2	Dept. of Plant Pathology, AC&RI, Madurai
Hipsizygus ulmarius		Dept. of Plant Pathology, TNAU, Coimbatore
	APK 2	
Milky mushroom		Regional Research Station, Aruppukottai
Calocybe indica	Co3	Dept. of Plant Pathology, TNAU, Coimbatore
Tricholoma giganteum		
	Ooty1	Horticultural Research Station, Vijayanagaram
Button mushroom		
Agaricus bisporus	Ooty 2	Horticultural Research Station, Vijayanagaram

Mushroom Cultivation techniques for Oyster and Milky mushroom

Spawn production

Base spawn/ Nucleus spawn

Tissue culture technique is used to bring the edible mushroom to pure culture so that the mushroom fungus can further be used to prepare spawn, which is an essential material for mushroom cultivation.

- This nucleus culture is grown on Potato Dextrose Agar medium in test tubes.
- A small tissue from a well-grown mushroom is aseptically transferred to agar medium in a test tube in a culture room.
- The test tubes are incubated under room temperature for 10 days for full white growth of fungal culture. This is called base spawn/ nucleus spawn and further used for preparation of Mother spawn.

Mother spawn

Mother spawn is nothing but the mushroom fungus grown on a grain based medium. Among the several substrate materials tested by TNAU, Coimbatore, sorghum grains are the best substrate for excellent growth of the fungus. Well-filled, disease- free sorghum grains are used as substrate for growing the spawn materials. The various steps involving in preparation of mother spawn are listed below here under.

- The sorghum grains are washed in water thoroughly to remove chaffy and damaged grains.
- The grains are half cooked in an autoclave / vessel for 30 minutes to soften them.

- The half cooked grains are spread evenly over a hessian cloth on a platform to remove the excess water.
- Calcium carbonate is mixed thoroughly with the cooked, dried grains @ 20 g / Kg .
- The grains are filled in polypropylene bags up to 3/4th height (approximately 300-330 g / bag),
- A one inch diameter PVC ring is inserted on open end of the bag and plugged with non-absorbent cotton wool.
- The bags are arranged inside an autoclave and sterilize under 20-lbs. pressure for 2 hours.
- The bags after cooling are kept inside the culture room under the UV light. For 20 min.
- After 20 minutes the UV light is put off and the fungal culture is transferred in to the sterilized cholam bags .
- The inoculated bags are kept in a clean room under room temperature for 10 days for further use to prepare bed spawn.

Bed Spawn

The method of preparation of bed spawn was same as that of mother spawn. The cooking, filling and sterilization were similar to that of mother spawn. After sterilization, the bags are taken and the fully grown mother spawn is used for inoculation to prepare bed spawn. Thirty bed spawn can be prepared from a sinlge mother spawn. The bags are incubated at room temperature for 10 days and used as bed spawn.

Cultivation of Oyster mushroom

The oyster mushrooms can be grown indoors in a thatched shed where a temperature of 25-30° C and relative humidity of 80-85 per cent can easily be maintained.

- Paddy straw is used as the raw substrate which has to be soaked in water for 4 h and boiled for 45 minutes or steamed in autoclave for 45 min or by chemical sterilization (soaking in 7-10 g of carbendazim + 120 ml formalin/10 kg substrate /100 lit water in a drum) and shade dried until 65-70 % moisture.
- Cylindrical beds are prepared using 60 x 30 cm polythene bags with a thickness of 80 gauge.
- Paddy straw and spawn are filled as alternate layers in polythene bags and 10-12 holes are made in the beds.
- The bags are placed in the sheds in racks or in hanging rope system. After 15-16 days when the paddy straws in the bags are covered with white mycelial growth, pinheads start emerging where water spray is essential to prevent drying of buds.
- First harvest begins from 3-4 days after pinhead emergence and like wise at 5 -7 days interval three harvests can be done
- Total cropping cycle is around 40- 45 days.
- The average bioefficiency ranges (100- 150 per cent) depending on the variety.

Cultivation of Milky mushroom

The milky mushroom requires a temperature of 30-35 ° C and relative humidity of 85-90 per cent. For cultivation of this mushroom two shed are needed.

1. Thatched House (For spawn running).
2. A sunken poly houses (For Crooping)
   Three feet deep pit is dug out and sides are lined with hollow blocks and semi circular structure is built with GI pipe of L angle and covered with Blue silpauline sheet.

- Paddy straw is processed as in oyster mushroom cultivation and cylindrical beds are prepared with 90x 30 cm polythene bags and stored at 30 ^{0}C in thatched sheds
- After 18-20 days when the paddy straws in the bags are covered with white mycelial growth, the beds are cut in to two halves and casing soil (autoclaved garden soil) is layered on to the cut halves for 2 cm height and sprayed with water.
- The cased beds are placed in poly houses and the required temperature is maintained.
- The pinheads emerge from the cut halves over the casing soil on 25-26th day.

- First harvest begins on 28th day and like wise three- five harvests can be done. The total cropping cycle is around 45-50 days. The average bioefficiency ranges from 150- 160 per cent.

Economics of Spawn Production (100 spawn bags per day)

Sl.No.	Item	Quantity	Rate (Rs.)	Total (Rs.)
A.	**Capital investment**			
1.	Autoclave	1	40,000	40,000
2.	Boiler (GL drum 100 lit. Capacity)	2	2,500	5,000
3.	Culture room with work table (low cost)	1	15,000	15,000
4.	UV lamp with fittings	1	2,000	2,000
5.	Tube light fittings	1	200	200
6.	Advance for LPG gas	2	3,000	6,000
7.	Spawn storage room	1	22,000	22,000
8.	Bunsen burner	1	150	150
9.	Hear efficient chulah	1	600	600
10	Glass wares & chemicals			5000
	Total			**95,950**
B.	**Fixed cost**			
1.	Interest on capital investment @ 15%			14,392
2.	Depreciation (Item 3 & 7 @ 5%)			1,850
3.	Depreciation (Item1 2,4,5,8 & 9 ,10-10%)			5,895
	Total			**22,137**
C.	**Recurring cost (100 spawn x 300 days)**			
1.	Polypropylene bags	150 Kg	135	20,250
2.	Cholam grains	8000 Kg	14	1,12,000
3.	Calcium carbonate (commercial grade)	160 Kg	20	3200
4.	Non-absorbent cotton (400 g rolls)	600	110/roll	66,000
5.	Fungicides & Fumigants	--	--	2,000
6.	Electricity & Fuel	--	--	30,000
7.	Labour @ 2 men per day for 300 days	300	320/day	96,000
10.	Miscellaneous	--	--	5000
	Total			**3,34,450**

Total cost of Spawn production / Year (Rs)_
Working expenditure : **3,34,450**
Total fixed cost : **22,137**
Total Cost : **3,56,587**

Income (Rs.)
By sale of 30,000 spawn bags @ Rs.25 per bag : **7,50,000**
Total cost : **3,56,587**
Net income per year : **3,93,413**

Economics of Oyster mushroom production (10 Kg/day/300 days)
Low cost Investment

Sl.No.	Item	Quantity (nos.)	Rate (Rs.)	Total (Rs.)
A.	**Capital Investment**			
1.	Thatched House (15'x 25')	1	25,000	25,000
2.	Chaff cutter (Lever type)	1	1000	1000
3.	Boiler	1	2,000	2,000
4.	Drum	1	1,000	1,000
5.	Spraying systems	1	500	500
6.	Biomass stove		300	300
	Total			**29,800**
B.	**Fixed cost**			
1.	Interest on A @ 15%			4470
2.	Depreciation (Item 1 @ 30%)			7500
3.	Depreciation (Item 2,3,4,5 & 6 @ 10%)			480
	Total			**12450**
C.	**Recurring Cost**			
1.	Paddy straw cost + transport	3 .5 t	4500	15750
2.	Spawn @ Rs.25 / No.	2000	25	50,000
3.	Polythene bags for bed & packing	25 kg	130	3375
4.	Fungicides, Fumigants & Chemicals	--	--	1,000
5.	Labour @ 1 Per day	300	160/day	48000
6.	Others	--		1,000
	Total			**1,19,125**

Total cost of mushroom production / Year (Rs.)

Working expenditure : 1,19,125
Total fixed cost : 12,450
Total Cost : 1,31,575

Income(Rs.)
By sale of 10 Kg/day @ Rs.90 for 300 days : 2,70,000
Total cost : 1,31,575
Net Income per year : **1,38,425**

Economics of Milky mushroom production (10 Kg/day/300 days)
Low cost Investment

Sl.No.	Item	Quantity	Rate (Rs.)	Total (Rs.)
A.	**Capital Investment**			
1	Thatched House (15'x 20') Blue Poly house- 20'x50' area (1000 sq.ft)	1 1	20,000 30,000	50,000
2	Chaff cutter (Lever type)	1	1000	1000
3	Boiler	1	2,000	2,000
4	Drum	1	1,000	1,000
5	Spraying systems	1	500	500
6	Biomass stove		300	300
	Total			**54,800**
B.	**Fixed cost**			
1	Interest on A @ 15%			8,220
2	Depreciation (Item 1 @ 10%)			5000
3	Depreciation (Item 2,3,4,5, & 6 @ 10%)			480
	Total			**13,700**

C.	**Recurring Cost**			
1.	Paddy straw cost +transport	3 .5 t	4500	15750
2.	Spawn @ 25 / day	1600	25	40,000
3.	Polythene bags for bed & packing	25 kg	130	3375
4.	Fungicides, Fumigants & Chemicals	--	--	1,000
5.	Labour @ 1 Per day	300	160/day	48000
6.	Others	--		1,000
	Total			**1,09,125**

Total cost of mushroom production / Year(Rs.)

Working expenditure	:	1,09,125
Total fixed cost	:	13,700
Total	:	**1,22,825**
Income (Rs.)		
By sale of 10 Kg/day @ Rs120 for 300 days	:	3,60,000
Total cost	:	1,22,825
Net income per year	**:**	**2,37,175**

COMPOSTING OF SOLID WASTES

Coirpith Composting

Coirpith, the waste from coir industry contains not quickly degrading constituents like lignin (30%) and cellulose (26%), which can be decomposed by employing the fungus *Pleurotus sojar-caju* with urea supplementation. Five kg of urea and 5 spawn bottles (250g) of *Pleurotus sp.* are required to decompose 1 tonne of coir pith. In an elevated shady place or a thatched shed, level the area and mark an area of 5x3 meter. First spread 100 kg of coir pith on this marked area. Then spread one bottle of *Pleurotus* spawn over this layer. Again spread another 100 kg of coir pith and over this spread one kg of urea uniformly. Likewise repeat the alternate application of *Pleurotus sp* and urea over the each 100 kg of coir pith layer for the whole 1 tonne of pith. Sprinkle water to attain a moisture level of 50 to 60%. The compost will be ready in about two months. The height of the heap is to be above 1 meter while stacking. Sprinkle water when the moisture percent goes below 50%. At the end of the composting period, the coir pith is changed in to a well-decomposed black mass. The C : N ratio is reduced to nearly 24:1 and it is enriched with N from 0.26 to 1.06%.

Composting of Weeds and Commercially Non Utilized Plants (*Parthenium,* Water hyacinth, *Ipomea)*

Composting is one of the useful ways for utilizing the some of the weeds and non-commercial plants like *Parthenium*, Water hyacinth*, Ipomoea* etc. instead of their eradication. The plants can be composted using *Trichoderma viridi* and *Pleurotus sajor-caju* as a microbial consortium with supplementation of urea. Select an elevated shady area of a thatched shed and marks an area of 5x1.5 meter. Cut the composting materials into 10 – 15 cm size. Spread 100 kg of these materials over the marked area. Sprinkle 1 bottle of microbial consortia over this layer. Again spread another 100 kg of composting materials over this layer. Spread 1 kg of urea uniformly over this layer. Likewise repeat these processes of spreading composting materials, then microbial consortia, again composting materials followed by urea application until a minimum of 1-meter height is reached. Sprinkle water to attain a moisture level of 50% to 60%. The surface of the heap is covered with a thin layer of soil. Water should be sprinkled depending upon the necessity to maintain the moisture around 50%. A turning is given at the end 20 days to give a thorough mixing of outside material with that of the inside ones. The bio-converted compost will be ready in about 40 days time.

Bio-CROP – An Enriched Organic Manure from Coir Dust

Bio-CROP is a nutrient rich organic manure obtained by composting coir dust along with poultry manure, rock phosphate and microbial inoculants *Pleurotus sajor-caju*, *Bacillus* sp, *Trichoderma* sp and *Pseudomonas* sp. The production of Bio-CROP is a simple and rapid technique to compost coir dust within 60 days time. Bio- CROP is a composted coir dust. Bio-CROP is an acronym. Bio-stands for Bio-manure. C- for Coir dust, R- for Rock phosphate, O- for Organisms, P- for Poultry litter. The following materials are required to compost coir dust and produce “Bio-CROP”.

Inputs

Coir dust	=	1 tonne
Poultry manure	=	200 kg
Rock phosphate	=	10 kg
Pleurotus sajor-caju	=	2kg
Microbial inoculants	=	2 kg

(*Bacillus* sp + *Trichoderma* sp + *Pseudomonas* sp)

Methodology

A partially shaded area should be selected for composting of coir dust. The floor of the selected area must be hard to prevent leaching of water or nutrients from the compost. Spread one ton of coir dust over the floor selected for composting. A hard-cemented surface is ideal for composting. Other wise the floor should be hardened by putting stones and other hardy materials. Poultry manure (200 kg) and rock phosphate (10 kg), *Pleurotus sajor caju* (2 kg), microbial inoculum (2 kg) consists of *Bacillus, Trichoderma,* and *Pseudomonas* are added to the coir dust. All the above materials are mixed together thoroughly with coir dust. After thorough mixing it should be sprinkled with water and formed in to a heap. The moisture level should be maintained at 60% level through out the composting period. However water should not be dripped out of the composting material. For uniform composting of coir dust, the compost should be turned once in every 10 days. There will be reduction in volume of coir dust and all the material will be changed to black in color after 60th day with an earthy odor from the composted material. It will have high water holding capacity. The composted coir dust is called as "Bio-CROP' which contains the following nutrients.

Nutritive value of Bio-CROP

Parameters	Composition	Parameters	Composition
Carbon	28 %	Iron	1419 mg kg^{-1}
Nitrogen	1.82 %	Manganese	116 mg kg^{-1}
Phosphorus	2.34 %	Zinc	169 mg kg^{-1}
Potassium	0.91 %	Copper	115 mg kg^{-1}
Cellulose	4.20 %	C/N ratio	15.94
Lignin	15.39 %		

Advantages of Bio-CROP

1. The Bio-CROP is produced in a period of 60 days, whereas in other methods the compost is produced 90 to 120 days.
2. Bio-CROP is environment friendly organic manure, suitable for all soils and crops. It is processed from natural biomass adopting organic method and utilizing bio-agents for decomposition of coir dust.
3. Application of Bio-CROP improves the physico-chemical properties of the soil by increasing the nutrient availability in the soil and improving the soil structure, aggregation, porosity and water holding capacity. The soil fertility is enhanced.
4. Bio-CROP supplies macronutrients (Nitrogen, Phosphorus and Potassium) as well as micronutrients (Iron, Manganese, Copper and Zinc) to the corps.
5. It is an excellent organic medium and basal manure for application in planting pits for corps and forest trees especially in areas of water scarcity and drought.
6. Bio-CROP is an excellent soil ameliorant and soil conditioner for correcting soil problems. Hence it can be used as a component of biological reclamation system for bringing alkaline, saline and also ill drained soils back to remunerative farming.

TNAU Vermi Biocompost Technology

Degradation of organic wastes by earthworm is known as Vermicomposting.

Phase of vermicomposting

Phase 1	Processing involving collection of wastes, shredding, mechanical separation of the metal, glass and ceramics and storage of organic wastes.
Phase 2	Pre digestion of organic waste for twenty days by heaping the material along with cattle dung slurry. This process partially digests the material and fit for earthworm consumption. Cattle dung and biogas slurry may be used after drying. Wet dung should not be used for vermicompost production.
Phase 3	Preparation of earthworm bed. A concrete base is required to put the waste for vermicompost preparation. Loose soil will allow the worms to go into soil and also while watering, all the dissolvable nutrients go into the soil along with water.
Phase 4	Collection of earthworm after vermicompost collection. Sieving the composted material to separate fully composted material. The partially composted material will be again put into vermicompost bed.
Phase 5	Storing the vermicompost in proper place to maintain moisture and allow the beneficial microorganisms to grow.

VERMICOMPOST PRODUCTION METHODOLOGY

Selection of suitable earthworm

For vermicompost production, the surface dwelling earthworm alone should be used. The earthworm, which lives below the soil, is not suitable for vermicompost production. The African earthworm (*Eudrillus engenial),* Red worms (*Eisenia foetida)* and composting worm (*Peronyx excavatus)* are promising worms used for vermicompost production. All the three worms can be mixed together for vermicompost production. The African worm (*Eudrillus eugenial)* is preferred over other two types, because it produces higher production of vermicompost in short period of time and more young ones in the composting period.

Selection of site for vermicompost production

Vermicompost can be produced in any place with shade, high humidity and cool. Abandoned cattle shed or poultry shed or unused buildings can be used. If it is to be produced in open area, shady place is selected. A thatched roof may be provided to protect the process from direct sunlight and rain. The waste heaped for vermicompost production should be covered with moist gunny bags.

Containers for vermicompost production

A cement tub may be constructed to a height of 2½ feet and a breadth of 3 feet. The length may be fixed to any level depending upon the size of the room. The bottom of the tub is made to slope like structure to drain the excess water from vermicompost unit. A small sump is necessary to collect the drain water. In another option over the hand floor, hollow blocks / bricks may be arranged in compartment to a height of one feet, breadth of 3 feet and length to a desired level to have quick harvest. In this method, moisture assessment will be very easy. No excess water will be drained. Vermicompost can also be prepared in wooden boxes, plastic buckets or in any containers with a drain hole at the bottom.

Vermiculture bed

A vermiculture bed or worm bed (3 cm) can be prepared by placing after saw dust or husk or coir waste or sugarcane trash in the bottom of tub / container. A layer of fine sand (3 cm) should be spread over the culture bed followed by a layer of garden soil (3 cm). All layers must be moistened with water.

Waste selection for vermicompost production

Cattle dung (except pig, poultry and goat), farm wastes, crop residues, vegetable market waste, flower market waste, agro industrial waste, fruit market waste and all other bio degradable waste are suitable for vermicompost production. The cattle dung should be dried in open sunlight before used for vermicompost production. All other waste should be predigested with cow dung for twenty days before put into vermibed for composting.

Putting the waste in the container

The predigested waste material should be mud with 30% cattle dung either by weight or volume. The mixed waste is placed into the tub / container upto brim. The moisture level should be maintained at 60%. Over this material, the selected earthworm is placed uniformly. For one-meter length, one-meter breadth and 0.5-meter height, 1 kg of worm (1000 Nos.) is required. There is no necessity that earthworm should be put inside the waste. Earthworm will move inside on its own.

Watering the vermibed

Daily watering is not required for vermibed. But 60% moisture should be maintained throughout the period. If necessity arises, water should be sprinkled over the bed rather than pouring the water. Watering should be stopped before the harvest of vermicompost.

Enriching vermicompost

Vermicompost can be enriched with beneficial microorganism like *Azotobacter, Azospirillum, Phosphobacteria,* and *Pseudomonas.* This enrichment process will give high nutritive value and high biological value of vermicompost. In the enriched vermicompost, apart from high nutrient content, the number of beneficial organism is more. For one tonne of waste processing, one kg of Azophos (which contains both *Azospirillum* and Phosphobacteria) should be inoculated twenty days after putting the waste into the vermibed.

Harvesting vermicompost

In the tub method of composting, the castings formed on the top layer are collected periodically. The collection may be carried out once in a week. With hand the casting will be scooped out and put in a shady place as heap like structure. The harvesting of casting should be limited up to earthworm presence on top layer. This periodical harvesting is necessary for free flow and retain the compost quality. Other wise the finished compost get compacted when watering is done. In small bed type of vermicomposting method, periodical harvesting is not required. Since the height of the waste material heaped is around 1 foot, the produced vermicompost will be harvested after the process is over.

Harvesting earthworm

After the vermicompost production, the earthworm present in the tub / small bed may be harvested by trapping method. In the vermibed, before harvesting the compost, small, fresh cow dung ball is made and inserted inside the bed in five or six places. After 24 hours, the cow dung ball is removed. All the worms will be adhered into the ball. Putting the cow dung ball in a bucket of water will separate this adhered worm. The collected worms will be used for next batch of composting.

Nutritive value of vermicompost

The nutrients content in vermicompost vary depending on the waste materials that is being used for compost preparation. If the waste materials are heterogeneous one, there will be wide range of nutrients available in the compost. If the waste materials are homogenous one, there will be only certain nutrients are available. The common available nutrients in vermicompost is as follows

Organic carbon	=	9.5 – 17.98%
Nitrogen	=	0.5 – 1.50%
Phosphorous	=	0.1 – 0.30%
Potassium	=	0.15 – 0.56%
Sodium	=	0.06 – 0.30%
Calcium and Magnesium	=	22.67 to 47.60 meq/100g
Copper	=	2 – 9.50 mg kg^{-1}
Iron	=	2 – 9.30 mg kg^{-1}
Zinc	=	5.70 – 11.50 mg kg^{-1}
Sulphur	=	128 – 548 mg kg^{-1}

Storing and packing of vermicompost

The harvested vermicompost should be stored in dark, cool place. It should have minimum 40% moisture. Sunlight should not fall over the composted material. It will lead to loss of moisture and nutrient content. It is advocated that the harvested composted material is openly stored rather than packed in over sac. Packing can be done at the time of selling. If it is stored in open place, periodical sprinkling of water may be done to maintain moisture level and also to maintain beneficial microbial population. If the necessity comes to store the material, laminated over sac is used for packing. This will minimize the moisture evaporation loss. Vermicompost can be stored for one year without loss of its quality, if the moisture is maintained at 40% level.

Biocapsule

Biocapsule has been developed for precisely placing organic manure and biofertilizer inoculum in the rhizosphere of plants. Each biocapsule contains 0.5g of organic manure mix, which consists of composted coirdust, composted poultry manure and vermicompost. Each compost has been taken in equal quantity and mixed together. In that mixture, biofertilizer inoculum, Azophos (0.2%) is inoculated and allowed to multiply in the compost. When this biocapsule is placed along with the seed, the emerging root will have good contact with comprehensive nutrient source of organic manure mix and biofertilizer inoculum (Azospirillum and Phosphobacteria). The biocapsule outer coating will get dissolve with in 20 minutes after contact with water, and the entire content of capsule is with in the root region.

The performance of this biocapsule was evaluated by testing it on Zinnia with fifty percent of recommended dose of fertilizer. The zinnia plant raised from biocapsule applied pot recorded higher growth and increased the flower vase life for another by two days when compared to control plant where the recommended inorganic fertilizer was only applied.

Biofilm

Biofilm are solid substrate over which specific microorganism are grown. The solid substrate act as base material for fixing the microorganism on the surface itself without suffering of drifting from one place to another place in the aqueous medium. The solid substrate selected for making biofilm should hold more number of microorganisms in a unit area.

Among the solid waste screened for making biofilm, typha root pith accommodates more number of microorganisms in a unit area (413x10' CFU/g). So, select typha root pith for making biofilm. Inoculate *Bacillus* culture into the respective broth and put sterilized typha root pith inside the broth when Bacillus culture is growing, the cells also grow inside the root pith. After the maximum growth, take the typha root pith and put inside the dye effluent for removing the color. 44% of color can be removed from the dye effluent after treating with biofilm.

TNAU microbial consortium for composting municipal solid waste

A microbial consortium consists of efficient microorganisms that are responsible for degrading lignin, cellulose, hemi-cellulose, protein, fat etc. These microorganisms (bacteria, fungi, actinomycetes) should be grown separately in the respective broth, and the grown cultures should be mixed in the carrier material (lignite). Then all these cultures should be mixed together to form a consortium. This microbial consortium is sufficient to compost all the biodegradable waste including biodegradable municipal solid waste. This microbial consortium is designated as TNAU microbial consortium.

Methods of composting the Municipal Solid Wastes

- Biodegradable municipal solid waste should be separated and collected for composting. Five hundred kg of material should be heaped in the compost yard
- In that heaped waste, 1 kg of TNAU microbial consortium should be applied in the form of slurry to cover the full waste material. This 1 kg microbial consortium can be mixed with 5 litres of water to make slurry. This slurry is sufficient to cover 0.5 tonne of material
- Then, 50 kg of cowdung should be mixed with 30 litre of water to form cowdung slurry. This cow dung slurry should be sprayed over the heap of municipal solid waste
- Then, 1 kg of urea should be mixed with solid waste
- 60% moisture should be maintained through out the period of composting
- Compost should be turned up once in 15 days to create good aeration, and for thorough mixing. Because of this practice, a uniform composted material will be obtained
- Solid waste can be composted with in 90 days by this method with the indication of reduction in the volume, appearance of dark coloured materials and a small of earthy odour
- After the completion of composting, compost should be sieved through normal mesh to separate unwanted and partially composted material

Value addition of poultry waste compost

A known quantity of poultry droppings and coir pith @ 4:5 ratio should be mixed well to attain a C/N ratio of 25:1 to 30:1 which is considered to be the optimum C/N ratio for compositing. *Pleurotus sajor-caju,* a lignocellulolytic organism, should be inoculated into the mix @ 2 packets per tonne of waste in order to speed up the composting process. The mix should be heaped under the shade. The moisture content of the mix should be maintained within 40 – 50%. Periodical turning should be given on 21st, 28th and 35th day of composting. Another two packets of *Pleurotus sajor –*

caju is to be added when turning is given on the 28th day of composting. A good quality compost will be obtained in 45 days, which contains 2.08% N, 1.93 % P and 1.41 % K with C/N ratio of 10.16

Nitrogen conservation in poultry droppings

Poultry waste, which contains higher concentration of nitrogen, is one among the animal manures, which can highly contribute to agricultural production. But in poultry droppings, nearly 60% of nitrogen, which is present as uric acid and urea, is lost through ammonia volatilization by hydrolysis. Composting with suitable organic amendments such as sawdust, coir dust and paddy straw can reduce ammonia loss from poultry droppings and thereby nitrogen can be effectively conserved. Anaerobic method of composting found to be effective in reducing nitrogen loss from poultry droppings. Acidification with elemental sulphur inhibits the ammonia volatilization. So, poultry droppings, coir pith and elemental sulphur can be mixed in the ratio of 20:2:1 for composting. Anaerobic condition can be created by plastering of heaps with red earth and allowed for 60 days. This method of anaerobic composting of poultry droppings reduces the loss of nitrogen by 22% over control.

INDUSTRIAL WASTE UTILIZATION FOR LAND RECLAMATION AND CROP PRODUCTION

Application of Untreated Distillery Effluent (Spentwash) for the Reclamation of Sodic Soils

Amendments generally used to reclaim sodic soils are gypsum, phosphogypsum, iron pyrites and elemental sulphur. All these are inorganic in nature. Some of the organic amendments to reclaim the sodic soils are press-mud, farmyard manure (FYM), coir dust and green manures. The direct discharge of untreated distillery effluent (spentwash) to reclaim and improve the productivity of the sodic soils is now advocated. Untreated distillery effluent (spentwash) is acidic (pH: 3.8 – 4.2) with considerable quantity of potassium, calcium and magnesium and traces of micronutrients. Organic compounds, mainly the humic related melanoidins improve the bio-catalytic potential of the treated soil.

Hence, only one time application of 3.75 to 5.00 lakhs litres of untreated distillery effluent (spentwash) per hectare of sodic soils in summer months is recommended. Natural oxidation can be induced for a period of six weeks with two intermittent dry ploughing at a particular interval. Then, after 45 – 60th day of application, soil is to be irrigated with fresh water and drained. This treatment reduces the pH and exchangeable sodium percentage to normal level and increases the productivity of the sodic soils. After this reclamation practice, rice crop can be raised in the effluent applied field adopting the conventional cultivation technique. Application of this effluent again to the next crop/season or year after year and also to the land nearby drinking water sources is not advocated.

Application of Treated Distillery Effluent to Crops

- Treated distillery effluent contains nitrogen 1200 mg L^{-1}, phosphate 500 mg L^{-1}, potash 12000 mg L^{-1}, calcium 1800 mg L^{-1} and iron 300 mg L^{-1}. Since the effluent has higher dissolved salts, 50 times diluted effluent can be irrigated to sugarcane, banana, ragi, sunflower, grasses, cotton and soybean.
- It can also be used as one time application to fallow land at the rate 20,000 to 40, 000 litres per hectare. It should be allowed for complete drying over a period of 20 to 30 days. The effluent applied field is to be thoroughly ploughed two times for the natural oxidation and mineralization of organic matter. After that, crops can be raised in the effluent applied field adopting the conventional methods. Application of this effluent again to the next crop/season or year after year and also to the land nearby drinking water sources is not advocated.

Irrigation of Pulp and Paper Mill Effluents

Pulp and paper effluents contain lot of dissolved solids and stabilized organic matter. The properly treated effluent with EC less than 1.2 dSm^{-1} as such can safely be used for irrigation with appropriate amendments viz., pressmud @ 5 tonnes ha^{-1} (or) fortified pressmud @ 2.5 tonnes ha^{-1} or daincha as in -situ green manure (6.25 tonnes ha^{-1}).

Though there were perceptible changes in soil pH, EC, available NPK, exchangeable cations, exchangeable sodium per cent and sodium absorption ratio, there is no detrimental effect due to sodium either on soil or plants grown in sandy loam soils with good drainage facilities. This treated effluent can be used for irrigation in these soils for the following crops and varieties along with recommended doses of amendments viz., pressmud @ 5 tonnes ha^{-1}, or fortified pressmud @ 2.5 tonnes ha^{-1} or daincha as in situ green manure (6.25 tonnes ha^{-1}).

Crops		Varieties
Rice	:	IR 20, TRY 1, CO 43.
Maize	:	CO 1
Sunflower	:	CO 2
Groundnut	:	TMV 7
Soybean	:	CO 1
Sugarcane	:	CO 6304 (Ruling variety) COSi 86071, COC 95071, CO 86032
Tapioca	:	CO (TP) 4, CO 2, CO 3, MVD 1

However, irrigating this treated effluent to oil seed crops like gingelly and castor, pulses like greengram and blackgram is not advocated as they were found to be sensitive for this type of effluent irrigation.

Crops and Varieties Suitable for Tannery Waste Affected Soils

Based on the results of field trials conducted at Vellore district, the following crops, trees and their varieties are recommended for the tannery waste affected soils

Crops	Varieties
Cereals	: Rice (TRY 1, CO 43, Paiyur 1, ASD 16)
Millets	: Ragi (CO 12, CO 13)
Oilseeds	: Sunflower (CO 4, Morden) and Mustard
Cash crops	: Sugarcane (COG 94076, COG 88123, COC 771)
Vegetables	: Brinjal, Bhendi, Chillies, Tomato (PKM 1)
Flowering crops	: Jasmine, Neerium, Tuberose
Trees	: Eucalyptus, Casuarinas and Acacia

Reclamation of papermill effluent irrigated soil

Application of 7.25 t ha^{-1} of gypsum is recommended to reclaim the TEWLIS area soils of Karur district (Moolimangalam, Pandipalayam, Pazhamapuram, Thadampalayam and Ponniagoundanpudur) where the treated paper mill effluent is being continuously used for irrigation since 1995. Application of pressmud @ 6 t ha^{-1} along with Blue Green Algae (15 kg ha^{-1}) and Gypsum (50% Gypsum requirement) is also effective in reclaiming the saline sodic soil with continuous papermill effluent irrigation and to increase the green fodder yield of *Lucerne.*

TNAU constructed wetland technology

TNAU constructed wetland technology is recommended for treating the papermill effluent using species *viz., Typha latifolia, Pharagmitis australis* and *Cyperus pangorei* with plant density of 2.5 lakhs shoots ha^{-1} (25 shoots m^{-2}). Around 1 ha of wetland area is required to treat 1000 m^3 of wastewater per day with a retention time of 2 – 3 days.

The wetland beds should be lined with an impermeable liner made of PVC or high-density poly ethylene (HDPE). The bottom most layer of wetland should be filled with ½ to 1” pebbles to a depth of 6 cm followed by Pea gravel of 6 cm, coarse sand and fine sand each of 7 cm and the top layer with soil to a depth of 9 cm.

SERICULTURE

A. MULBERRY (*Morus* spp.) CULTIVATION

1. IRRIGATED

1.1 MULBERRY VARIETIES

Kanva 2 (M 5), MR 2, S 36, S 1635,DD, V1.

1.2 SOIL TYPE

Deep red soil or red loamy soil. Avoid saline, alkaline or highly acidic soils.

1.3 NURSERY

Select 800 m^2 area near water source for raising saplings required for planting one hectare of main field.
Apply 1600 kg of FYM.
Raise nursery beds of 4 m x 1.5m size. The length can be of convenient size depending upon the slop and irrigation source.
Semi-hardwood cuttings of 10 to 12 mm diameter, free from pests and diseases are selected from 6 to 8 months old well established garden.
The cutting should be of 15 to 20 cm length with 3 to 4 active buds and should have 45° slanting sharp clean cut (without splitting the bark) at the bottom end.
Use power operated mulberry cutter (TNAU stem cutting machine) for quick cutting of propagation material with an output of 1000 cuttings per hour.
Mix one kg of *Azospirillum* (A_ZP_2 culture) in 40 l of water and keep the bottom ends for 30 minutes in it.
Apply VAM @ 100 g/m^2 of nursery area and irrigated.
Plant the cuttings in the nursery at 15 cm x 7 cm spacing at an angle of 45°
Ensure exposure of atleast one active bud in each cutting.
Dust one kg endosulfan 4D or malathion 5D or quinalphos 1.5D to prevent termite attack.
Drench the soil with carbendazim 50 WP (2 g/l) or apply *Trichoderma viride* 0.5 g/m^2 to prevent root rot and collar rot.
After weeding, apply 100 g of urea/m^2 of nursery between 45 and 50 days after planting.
Transplant 90 to 120 days old saplings.

1.4 MAIN FIELD

Plough the land with disc plough or mould board plough followed by cultivator and rotavator.
Use chisel plough to break open hard pan by operating the plough in criss-cross direction at 50 cm distance.
During the last plough, apply 20 tonnes of FYM /ha or 5.63 tonnes of vermicompost / ha.

1.4.1. Planting

Plant the saplings in ridges and furrows at 90 cm x 90 cm spacing (normal row) or at 75/105 cm x 90 cm spacing under paired row system.
Planting should coincide with onset of monsoon. Gaps should be filled up to maintain a population of 12,345 plants/ha.

1.4.2. Nutrient management

Manures and Fertilizers
FYM : 20 t/ha/yr
Fertilizers : 300 : 120 : 120 kg NPK/ha/yr
Apply in split doses after every pruning

Application after pruning	Nitrogen (kg)	Phosphorus (kg)	Potassium (kg)
1st	60	60	60
2nd	60	--	--
3rd	60	60	60
4th	60	--	--
5th	60	--	--
Total	**300**	**120**	**120**

For the variety V1, apply 375 : 140 : 140 kg NPK / ha / yr (in equal splits as above)
Note: Apply the fertilizers based on the Soil Test recommendations to optimize the NPK requirement.

Nitrogen

- Apply *Azospirillum* in five split doses at 4 kg/ha, each time, after every pruning to compensate 25% of inorganic N fertilizer.
- *In situ* growing and incorporation of sunnhemp, combined with bio-fertilizer can save 50% of N.

Phosphorus

- Apply phosphorus solubilizing bacteria at 10 kg/ha/yr in two equal splits.
- Apply phosphorus as Enriched FYM (EFYM) in two equal splits along with first and third application of nitrogen.

Preparation of Enriched Farmyard Manure (EFYM)

Mix 375 kg Single Super Phosphate with 750 kg FYM, moisten and keep it in an anaerobic condition for 45 days.

Micronutrients

Spray 1% $FeSO_4$ or 0.5% $ZnSO_4$ or both whenever the deficiency symptoms are noticed.

1.4.3. Inter Crop

After every pruning, grow short duration crops like greens, greengram, blackgram, coriander, cowpea, horsegram and sunnhemp.

1.4.4. Weed Management

Weeding should be done manually or chemically after pruning, based on need.
Apply glyphosate at 7.5 ml with 10 g of ammonium sulphate / litre of water.

1.4.5. Water Management

Irrigate the field once in seven to eight days based on the need. Drip irrigation, if followed, can save 40% of water requirement.

1.4.6. Pruning

Once in a year, bottom pruning is done leaving a stem of 10 cm height. Other prunings are done at a height of 30-35 cm from ground level. Totally, five prunings are practiced every year.

1.4.7. Harvesting

First leaf harvest can be made six months after planting. Subsequent leaf harvests can be taken 45 days after pruning. Five harvests can be had in an year.

Varieties	Leaf yield (t/ha/yr)
Kanva 2, MR 2, S 36, S 1635	35 - 40
DD	40 – 45
V 1	55 - 60

2. Chawki garden

Maintain a separate Chawki garden for rearing young age worms. Otherwise, a part of the main field (5% area) can be allotted for this purpose.

Varieties : S 36 (More suitable because of high carbohydrate and protein content)
FYM : 40 t/ha/yr
Fertilizers : 225:150:150 Kg NPK /ha/yr in eight splits
Irrigation : Once in five days
Yield : 25 t/ha/yr in 12 harvests.

Note: V 1 is also suitable for chawki rearing with high nutrient input.

3. RAINFED

Varieties : S 13, S 34, S 1635, RFS 135, RFS 175,MR2
Spacing : 90 cm x 90 cm in pit system of planting
Manures and Fertilizers :
FYM : 20 t/ha/yr
Fertilizer : 100:50:50 kg NPK/ha/yr

Apply in split doses after pruning

Time of application	Nitrogen (kg)	Phosphorus (kg)	Potassium (kg)
1st Crop	50	50	50
2nd Crop	50	-	-
Total	**100**	**50**	**50**

Leaf yield: 12 -15 t/ha/yr

4. Pest and Disease management

4.1. Pests

4.1.1. Tukra,Pink mealy bug (*Maconellicoccus hirsutus)*

Cut and burn the affected shoots
Spot application of endosulfan 4D or malathion 5D around the bushes to kill the phoretic ants.
Spray dichlorvos 76 WSC @ 1 ml/litre (safe waiting period – 10 days)
Release predatory coccinellids, *Cryptolaemus montrouzieri* @ 750 beetles / ha or *Scymnus coccivora* @ 1000 beetles / ha, *Chrysoperla carnea* @ 2500 eggs/ha.
Spray 3 % neem oil with 0.5 % wetting agent.

4.1.2. Thrips (*Pseudodendrothrips mori*)

Spray dichlorvos 76 WSC @ 2 ml/litre or malathion 50 EC @ 2 ml/litre.
Spray 3 % neem oil with 0.5 % wetting agent

4.1.3. Leaf webber (*Diaphania pulverulentalis*)

Irrigate the mulberry field immediately after pruning to expose the leaf webber pupae.
Release pupal parasitoid, *Tetrastichus howardi* @ 50,000/ha next day after pruning
Egg parasitoid, *Trichogramma chilonis* @ 5cc/ha at 10 days after pruning.
Spray dichlorvos 76 WSC @ 1 ml/litre (500 ml/ha) on 30 days after pruning.
Clip and burn the affected shoots.

4.1.4. Black Scale (*Saissetia nigra*)

Scrap with a plate to dislodge the insects.
Spray malathion 50 EC @ 2ml/litre.

4.2. Diseases

4.2.1 Root rot (*Macrophomina phaseolina, Fusarium spp.*)

Apply neem cake @ 1 t/ha in five split doses

Uproot and burn the diseased plants

Apply copper oxychloride @ 2 g/ litre in the affected areas

Application of *Pseudomonas fluorescens* + *Trichoderma viride* + *Trichoderma harzianum* + FYM (1:1:1:20) @100 g/ plant.

4.2.2 Powdery mildew (*Phyllactinea corylea*)

Spray wettable sulphur or carbendazim @ 2g/litre.

B. SILKWORM (*Bombyx mori*) REARING

1. Silkworm races

Multi X Bivoltine (cross breeds):

Irrigated areas : BL24 x NB4D2, PM x CSR2, PM x NB4D2, APM1 x APS8 (Swarnaandhra), BL43 x NB4D2

Rainfed areas : PM x C.Nichi, BL23 x NB4D2

Bivoltine hybrids : CSR2 x CSR 4, CSR 18 x CSR 19, KSO1 x NP 2

Double hybrids : DH1- [(CSR 6 X CSR 26) (CSR 2 X CSR 27)], DH2- [(CSR 2 X CSR 27) (CSR 6 X CSR 26)].

2. Rearing house

A well ventilated CSB model rearing house with separate ante room, Chawki room, late age worm rearing room and spinning hall should be used for silkworm rearing.

Avoid rearing in dwelling house and in thatched sheds.

3. General disinfection

Spray 2% formalin with 0.3% slaked lime or 2.5% chlorine dioxide with 0.5% slaked lime @ 2 litres/m^2 area for disinfecting the rearing house.

Dip the rearing equipments in 2% bleaching powder solution and sundry before use.

Dust 5% bleaching powder with slaked lime powder @ 200 g/m^2 around the rearing house and the passages, and sprinkle water @ 1 litre/m^2 floor area.

4. Incubation of eggs

Incubate the eggs at 25°C temperature and 80% humidity.

At head pigmentation stage (about 48 hours before hatching), keep in dark condition by wrapping in black paper or by keeping them in a box (black boxing)

5. Optimum rearing conditions

Instar	Period (days)	Temp (°C)	Humidity (%)	Leaf size (cm^2)	Size of the cleaning net (mm)	Quantity of leaves (kg) required for 100 DFLs	
						Cross breeds	Bivoltines
Early							
I	3-4	27-28	85-90	0.5-2.0	2	4-5	6-7
II	2-3	26-27	80-85	2.0-4.0	2	6-8	9-10
Late							
III	4-5	25-26	75-80	4.0-6.0	10	30-35**	35-40**
IV	4-5	24-25	70-75	Entire	20	80-90**	120-150**
V	7-9	22-24	70-75	Entire	20	700-800**	800-950**
Total						**820-938**	**1070-1157***

***New CSR breeds / hybrids require 15 to 20% higher quantity of leaves.**

** Note: The ratio between stem and leaves in the shoot ranges from 3:2 to 1:1. The shoots can be harvested and used accordingly for shoot rearing.

6. **Chawki rearing and cleaning:**

In a tray of 120 cm x 90 cm x 10 cm size, 20 DFLs are brushed and reared till the end of second age.

From brushing to the end of second age, the larvae are fed with tender leaves.

The leaves are selected from the largest glossy leaf, 3rd and 4th from the top for I instar larvae.

The 5th to 8th leaves are used to rear the second instar larvae.

In the first age, one cleaning is given just a day before the worms settle for moult.

In the second age, two cleanings are given, one after resumption of feeding and the other a day before the second moult.

7. Shoot rearing for late age worms

Provide separate rearing house for shoot rearing in shady areas.

Fabricate the rack stand with wood or steel and the rearing seat with wire mesh/bamboo mat.

Shoot rearing rack of 1.2m x 11m size is sufficient to rear 50 DFLs.

Provide 15cm border on all sides of the shelf to prevent the dispersal of the larvae.

Arrange the shelves in three tier system with 50 cm space between the tiers. Clean the bed once in each instar.

For cleaning, place two ropes parallelly on the bed and place the new shoots over the ropes. After all the worms have moved on to the new shoots, take the rope from the bed and remove the remains and refuses.

8. Shoot harvesting and feeding

Harvest the shoots at 1 m height from ground level at 60 to 70 days after pruning.

Store the shoots vertically upwards in dark cooler room.

Provide thin layer of water (3cm) in one corner of storage room and place the cut ends of shoots in the water for moisture retention.

Provide a layer of newspaper in rearing shelf.

Spread the shoot in perpendicular to width of the bed.

Place top and bottom ends of the shoots alternatively to ensure equal mixing of different qualities of leaves.

Transfer the third instar larvae to shoots immediately after moulting.

Apply soya flour twice @ 5g / kg of shoots on first day of first feeding during fourth and fifth instars during first feeding.

9. Pest and diseases management

9.1 Pest

9.1.1. Uzi fly (*Exorista bombycis*)

Provide physical barriers like wire mesh or nylon net in the doors and windows of the rearing rooms.

Spray uzicide (1 % benzoic acid) over the larvae to dislodge the eggs.

Dissolve “uzi tables” in water (2 tablets /l) or Asiphor 15 ml/l of water in white bowls to attract the adults (uzitrap). Keep them near windows or at the entrance of rearing room.

Release hyperparasitiod, *Nesolynx thymus* @ 20,000 adults / 100 dfls.

Spray uzifly ovo repellant @ 5 ml/ 5 litres on 3rd, 4th and 5th instar larvae to ward off uzifly from laying eggs on silkworm larvae.

9.2. SILKWORM DISEASES

9.2.1 General precautionary measures to be taken

Proper disinfection of rearing room and appliances.

Providing good ventillation

Maintenance of proper temperature and humidity in the rearing room or avoiding fluctuation in temperature and humidity conditions.

Feeding worms with good quality leaves.

Avoiding starvation.
Avoiding over crowding
Avoiding any damage to the skin of worms.
Proper disposal of the dead worms in 2 % bleaching powder + 0.3 % slaked lime solution.
Avoiding borrowing of mountages.

9.2.2. General bed disinfection

Keep the rearing bed thin and dry by applying slacked lime at 30 to 50 g/ m^2.
Apply bed disinfections such as Sakthi or Vijetha or Resham Jyothi or Sanjeevini @ 4 kg/100 DFLs to prevent the secondary transmission of diseases.
Disinfection of rearing bed with bed disinfectants at dose of 4 kgs/100 dfls and are to be applied at 3g/sq. feet for chawki worms and 5g/sqfeet for late age worms.

9.2.2. Viral/ Grasserie disease

Treat the mulberry leaves with aqueous leaf extract of *Psoralea corylifolia or Plectranthus amboinicus* at 0.1 % or 1000 ppm and feed to the worms immediately after second and third moult. Gentamycin 100 ppm is to be administered after fourth moult.

9.2.3 Bacterial/Flacherie disease (*Streptococcus,Staphylococcus Bacillus, Serratia*)

Treat the mulberry leaves with aqueous leaf extract of *Aegle marmelos* or *Thuja orientalis* at 0.1% or 1000 ppm after second and third moult and 500 ppm *Streptomycin* sulphate after fourth moult.

9.2.4 Fungal/Muscadine disease(*Beauveria bassiana, Metarhizium anisopliae, Aspergillus flavus*)

10 g of dithane M 45 mixed with 1 kg of slaked lime is dusted over chawki worms at 3 g/sq feet. In case of late age worms, 20 g of dithane M 45 is applied at 5 g/ sq.feet.

Disinfect rearing rooms and trays with 4% pentachlorophenol to control Aspergillosis.

9.2.5 Pebrine (*Nosema bombycis*)

This disease is taken care off in the grainages and only disease free eggs are supplied to farmers. If the disease is chance encountered in the rearing, the diseased eggs, larvae, pupae, moths, bed refuses and faecal pellets should be disposed after thorough disinfection. Storage of leaves in a separate room.

10. Moulting care

Apply slaked lime @ 30 to 50 g/m^2 when all the worms settle for moult for uniform moulting.

Dust 10 g dithane M 45 mixed with 1 Kg of slaked lime over chawki worms at 3 g/ sq. feet. In case of late age worms, 20 g of dithane M 45 is applied at 5 g/ sq. feet.

11. Mounting

For early and uniform spinning of cocoons, apply Sampoorna @ 20 ml (dissolved in 4 litres of water) / 100 DFLs over the leaves and feed to silkworms.
Spray the mulberry leaves with phytojuvenoid, Illamathi and feed to second day old fifth instar.
Avoid hiring of mountages.
Arrange 800 to 900 worms per m^2 on a mountage.
Mountages should be kept in shade in a well ventilated place in slanting position during spinning.
Rotary mountages can also be used (one set of rotary mountage can accommodate 1560 worms).

12. Harvesting

Harvest the cocoons of crossbreeds and bivoltines on 5th and 7th day after spinning respectively.

Cross breeds	:	Rainfed 20-25 kg/100 DFLs
		Irrigated 50-60 kg/100 DFLs
Bivoltines	:	60-70 kg/100 DFLs

AGROFORESTRY

The present trend of growing trees in the farm lands demands for identification of economically potential tree species suitable to different climatic conditions and soil types. The concept of agroforestry implies sustained, combined management of the same piece of land for silvicultural, agricultural and pastural crops leading to an overall increase of production compared to single crop management. This practice is of immense importance to our country for it is intimately linked with the question of increasing wood and food production to meet the needs of burgeoning population and conservation of soil land moisture resources which is vital for the tropical regions.

Properly distributed tree growth acts as a foster mother to agriculture. This is particularly true in dry inhospitable climatic conditions. Tree growth in such cases conserves soil moisture, increasing atmospheric humidity, improves soil fertility, protects field crops against the scorching and desiccating effects of winds and generally makes the climate more equable and pleasant, thereby stepping up agricultural production.

Important tree species much involved in agroforestry system and their cultivation details have been presented hereunder viz., *Acacia holosericea, Eucalyptus sp., Casuarina equisetifolia, Tamarindus indica, Azadirachta indica, Ceiba pentandraand Ailanlthus excelsa*.

Acacia holosericea

Origin	:	New introduction from Australia
Rotation age (felling age)	:	4-6 years
Spacing	:	2 x 2 m or 1 x 4 m
Seed rate	:	2500 plants/ha; app. 100 gm/ha.
Preparatory cultivation	:	One ploughing with disc is suggested. Pits of 30 x 30 x 30 cm are recommended. Red lateritic soil preferred.
Nursery	:	Seed require hot water treatment for encouraging maximum germination upto 96 per cent. Viability of seed is good for upto 6-7 years. Single seed is dibbled in 10 x 20 cm polythene containers filled with 3:1:1 soil: sand: manure. Seedlings are raised for 4-5 months to reach 50 cm height.
Planting	:	To be taken up with first few rains of September to October (North east monsoon) Basin formation of 50 cm radius is suggested for capturing rain water.
After cultivation	:	No weeding is needed.
Plant protection	:	No serious outbreak of pests or diseases reported so far.
Yield	:	At the end of 4 years, above ground biomass of 60 tonnes/ha is realisable.
Special features	:	High survival (above 99.0 per cent) under rainfed conditions. It is known to form nodules with local *Rhizobium*. Suitable for low rainfall (600-800 mm), alkaline and lateritic soils. Resistant to termite in the field condition. The stem has very low moisture content (25.0 per cent) as compared to *Prosopis*(47.0 per cent) and *Eucalyptus*(49.0 per cent). It is also resistant to browsing. It is thornless. Petioles modified into phyllodes for phytosynthesis.
Use	:	Fuel wood.

Simarouba glauca

Origin	:	New Introduction from El Salvatodr, (Brazil).The tree is commonly found in Brazil at elevations ranging from sea level to 3000 feet, but the more heavily populated natural stands are encountered at medium elevation of 1,500 to 2,500 ft. prefers sub humid climates with annual precipitations of between 800 and 2000 millimetres and temperature from 20 to 26°C.
Rotation age (felling age)	:	60-80 years
Spacing	:	4 m x 4m , 6-8.0 m interval
Preparatory cultivation	:	The preparation of the site is a completed by May-June, and ploughing with disc is initially suggested.
Nursery	:	Simaruba seedlings are raised during April-June in poly bags filled with nursery mixture. Seedlings older than 2 months can be transplantied. The grafts of elite lines or the apomietic seedlings with known sex should preferred for planting to get higher and earlier return.
Planting	:	In rain fed marginal lands / Wastelands transplanting is done in the beginning of monsoon so that the plants can establish well by the end of raining season.
Pit size	:	45 x 45 x 45 cm size half filled with top soil and 3-5 kg compost. The plants grow well with a protective watering of 2-5 l/week during the first summer
After care	:	Regular weeding in the first two years of growth is recommended.
Special feature		For effective pollination and good bearing planting of andromonoecious and female plants in a 1:20 ratio in the right geometry is advocated (or) some selected female plants may be grafted with a few branches, of high yielding andromonoecious grafts.
Plant protection	:	No major pest and diseases; Only some mites and bark feeder found
Yield	:	Simaruba seeds contain 60-65 percent oil; Each well grown tree yields up to 10 kg of seeds (i.e. 5-6 kg of oil and 4-5 kg of oil cake) and a well established tree gives an oil yields alone 600-800 kg/ha/ year after 10 years of planting
Uses	:	Edible oil, soap making, medicinal value, remedy for diarrhoea, lubricants, varnishes, light furniture, match sticks

Eucalyptus spp.

There are about 700 different Eucalyptus species in the world and majority of them are located in Australia. Nearly 170 species are believed to have been tested under Indian conditions and a handful is considered essential for industrial application. *Eucalyptus camaldulensis* and *E. tereticornis* are ideally suited for the plains receiving about 800-1000 mm rainfall and prefer sandy loam to loam soils within a pH range of 6.0-7.5. Its altitudinal range limited to about 0-500 m above sea level.

The preferred espacement is 2 x 2 m or 3 x 1.35 m and seedlings are planted in pits 30 cm^3 size. While preparatory ploughing by disc is desirable to enhance moisture conservation and subsequent survival rate, it is substituted by ploughing with country plough. Seedlings grown in 10 x 20 cm. poly containers for a period of 5-6 months are preferred. Quality of seedlings is guaged by thickness of the stem rather than by height which remains fairly uniform among them

Survival of planted seedlings in the field is influenced by the following:

i) Deeper pits of 30x30x45 cm as against 30x30x30 cm.

ii) Saucer basin formation around the planted saplings

iii) Coir dust/plant mulching around the plant.

iv) Compartment or contour bunding along the slopes.

v) Soil working during January-February to receive maximum benefit of summer rains.

Intercropping with legumes by modifying the espacement from 2 x 2 m to 1x4, 1x5, 1x6 m so that the continued filling of the soil helps to aerate the plant roots and also capture and retain maximum moisture.

vii) Planting during the early phase of the monsoon, especially within a fortnight of commencement of the rains.

Despite the fact that *E. camaldulensis* and *E.tereticornis* are closely related, the former shows better adoption of drought conditions and also show least variation in foliar characteristics. Currently, a shift is noticed from *E.tereticornis* in developing large scale plantations due to the above causes. Once established, the above need no special care in maintenance.

Similar to the above, operational strategies remain the same for *E. grandis* which is slated for altitudes in the range of 1000-1400 metres with an annual rainfall of 1200 to 1500 mm. Hence, this species raised for rayon industries is found largely in Cumbum mettu, Bodi mettu, Hasanur plateau, Perumal malai, Thirumoorthi hills - all in Tamil Nadu and Western Ghat areas of Kerala.

E.globulus, the popular blue gum of the higher hills like Kodaikanal and The Nilgiris, demand an altitude of 1500-2500 metres with a rainfall of 1200-1800 mm and lands free from forests. The planting techniques being the same, the rotation period is fixed as ten years as against seven for the other low land species.

The significant management in this Eucalyptus is the coppice growth. These have high potential to produce hundreds of new shoots from the callus tissue developing on the margin of the cut stem. Felling the trees immediately after the monsoon helps to rapid callus formation and consequently thicker coppice stems.

Care should be taken to fell the trees with a gentle slope at the cut end so that rain water does not stay as a pool and cause decay of the callus tissue. Even though hundreds of coppice shoots may develop by a process of natural competition and thinning, only two or three stems ultimately remain on the stump. There is no separate need to manually reduce this bulk of the growth occurring on the stump. Nature itself does the job. However, the health and number of coppice stumps growing from the stump are related to the diameter of the stump.

The coppice growth are allowed before the stumps loose their regenerating power. The productivity of coppice plantation is generally higher by above 20-25 per cent as against the first seedling plantation. At end of the second coppice growth it is necessary to uproot the roots.

Though fertilization with commercial fertilizers is resorted to in developed countries, no systematic schedule has been drawn for *Eucalyptus* type in India and our expertise in this area is incomplete. The productivity of a rain fed crop in Tamil Nadu plains range from 50-75 tonnes/ha/seven years and in mid-altitudes it is about 100-125 tonnes, while blue gum shows 100-140 tonnes at a high altitude.

Casuarina equisetifolia

Casuarina species are native to the Southern hemisphere from tropical India to Polynesia. Most are native to Australia where they occur in subtropical and tropical coastal regions as well as in the arid central areas. In Tamil Nadu, this tree is mainly grown in coastal districts of Cuddalore, Villupuram, Kancheepuram,Tiruvallur Thanjavur and Ramanathapuram. It could also be seen on sandy soils of inland districts.

The tree is suited to a wide range of temperature from 10^{o}-33^{o}C from sea level upto 1500 m and mean annual rainfall between 700 to 2000 mm. The tree is best suited to light soils. This species tolerates calcareous and slightly saline soils, but it is grown poorly on heavy soils such as clays. It can withstand partial water logging for a long time. Seedlings produced in the nursery are outplanted after 6 months.

Site preparation: Since this tree is a light demander, the area should be cleared of its regrowth before planting.

Spacing: Depending upon the end use this is varied. Poles 1 m x 1 m, Fuel wood 0.5 m x 0.5 m, Pulp 2 m x 2 m, Agri-silviculture 4 m x 1 m.

Pitting and planting: Pits of 30 cm^3 are prepared and seedlings are planted. Planting of naked seedlings is done in coastal areas and container seedlings in inland. Planting of 2 seedlings per pit at an espacement of 2 m x 2 m has given more basal area/unit area.

Cultural practice: Weeding and Soil working: Not necessary in sandy soils. In heavy soils weeding and soil working is essential.

Watering: Particularly in sandy tract watering is essential till the onset of monsoon. In high rainfall area it is not necessary. Early planting and establishment by the end of monsoon makes the plant to survive till next monsoon. Watering once in five to ten days is sufficient from December to next monsoon.

Application of manure: Added fertilizer boosts up growth immediately in sandy tract, fertilizer application produces more survival percentage, farmyard manure serves better. Neem cake application further acts as a pesticide also.

Pruning: At the end of 2nd year or after beginning of third year pruning is essential. Thereafter when the canopy is closed, pruning is not essential as natural pruning occurs.

Thinning: This is done to get large size poles and straight poles.

Harvest: The trees are felled after the required period and the stumps are uprooted.

Intercropping: Pulses can be raised as intercrops in the inter space of tree rows (i.e. 4 m x 1 m; 4 m North-South and 1 m East-west; in row spacing 1 m and inter row spacing 4 m) under protective irrigated condition.

Yield: Coastal area at 2 m x 2 m - 80 to 100 t/ha in 8 years. 1 m x 1 m spacing at Marakkanam yields 25 t/ha in 4 years.

Tamarindus indica

It is an introduced tree in India from tropical Africa. It is not a tree of the forest. But it is cultivated throughout India except the Himalayan region and arid western zone. It is mostly planted as an avenue tree along roads and a shade tree in and around the villages.

Climate: *Tamarindus indica* is a tree of tropical climate. It is grown where the maximum temperature touches about 46^{o}C in South India and minimum temperature rarely drops to 0^{o}C in North India. It is grown in areas where the annual rainfall varies from about 500 to 1500 mm.

Soil: It can be grown in variety of soils ranging from gravelly to deep alluvial soil. It thrives best in deep loamy soil with adequate supply of moisture.

Seed collection and storage: The ripe pods are collected from healthy trees by shaking the branches. The pods should be allowed to ripen on the tree until the outer shell is dry and can be separated from the pulp without adherence. Individual pods contain about 3 to 10 seeds covered with pulp. A good full grown tree produces about 2 quintals of fruits per season. The pods are trod by hand and washed in water to separate the seed which is dried in shade and stored. The seeds constitute about one third the weight of the pods. The pulp is about 55 per cent and shell and fibre about 11 per cent of the pod. About 1800-2000 seeds weigh one kilogram.

Direct sowing: Direct sowing can be done either in lines or in patches. Sowing in lines can be done behind the plough. Depth of sowing should be about 1.5 cm. About 20 kg seed is needed to sow each hectare. For patch sowing, patches of 45 cm^{2} are prepared by digging the soil upto about 30 cm depth and then pulverising it well. About 8-10 seeds are sown per patch.

Planting technique: Planting is done in July-August after the soil is fully soaked by monsoon rains. Pits of 30 cm should preferably be dug up in advance to allow soil weathering. Spacing is normally 5 m x 5m to 10 m x 10 m. The plants are dug out from the nursery with balls of earth and the root portion is wrapped in moist gunny bags. In case the seedlings are more than one year old, pruning of the tap root is necessary. Bushes likely to shade the plant should also be cut at the time of digging of the pits or planting.

Pest and diseases: Larva attack fruits and destroy seeds. Sap rot -*Xylaria euglosaand* white rot *Tramates floccasaare* the principal diseases, It will cause pre and post emergence rot of tamarind seedlings.

Uses: Leaves are regarded as good fodder. Tender leaves are used as vegetables. The analysis of leaves show that it contains 70.5% moisture, protein 5.8%, fat 2.1%, fibre 1.9%, carbo-hydrate 18.2% and minerals 15%. It also contains calcium, magnesium, phosphorus, iron, copper, chlorine, sulphur, thiamine, riboflavin, niacin, vitamin C. Tamarind kernel powder is extensively used as sizing material in textile and jute industry and also used as cattle feed.

Azadirachta indica (Neem)

Distribution: Neem grows throughout the greater part of India more especially in the drier parts of the country. It is a tree with wide climatic adaptability. In its range, the maximum temperature may exceed 40^{0}C and the minimum temperature varies about 2^{0} to 15^{o}C. The annual rainfall varies from about 450 to 1200 mm.

Soil: It grows well on wide variety of soils ranging from sandy to clayey. It can thrive even in stony shallow soils or with calcareous soils. It grows best on well drained soils with subsoil water level fairly high. It can persist under adverse soil condition also.

Flowering and fruiting: Leaf shedding and flowering are controlled by the climatic conditions. The trees become leafless for a short period. The new leaves appear in March-April. It flowers in April to May. The flowers are in panicles and are white in colour. The fruits appear soon after and attain full size in 2-3 months. A fully developed fruit is a smooth ellipsoidal drupe, greenish, yellow and normally one seeded. The fruits ripe generally in June - July.

The yield per tree varies from 30-33 kg of seeds depending upon age and soil characteristics. The oil content ranges from 40 to 45%.

Collection: Fruits fallen down or beaten down are swept together or hand picked. They are depulped with water or by dumping them with soil/ash and then by trampling.

Processing: Processing is done by decorticating and winnowing. Decorticator gives 70% shell and 25% kernels. In a depulped seed 45% is shell and 50% kernel. Maximum oil is obtained only after 2-5 months of collection.

Cultural practices: Nursery technique: Seeds are sown either directly or in polybags. The seeds do not require any pre-sowing treatment. As the seeds loose viability quickly the seeds should be sown as soon as possible. About 3300 – 6000 seeds weigh one kilogram.

Planting technique: One year old seedlings are preferable. Planting is done in July-August in pits dug up in April-May to allow weathering of the soil. The spacing may be 4 x 4 m and after 5 years, alternate trees are felled down. The recommendation is 8 - 10 m spacing.

Economics: After planting, the tree flowers at 6th or 7th year. After 10 year, each tree yields about 50 kg of fruits and 20 kg of seeds. In one acre of land 1000 kg of seeds can be obtained. If the seeds cost Rs.2/kg, the income is Rs.2000.

***Ceiba pentandra* (silk cotton)**

It is a native of South America and now grown in Myanmar (Burma), Jawa, Ceylon and India. It grows to a height of 20 to 25 m under various agro - climatic conditions. It comes up well in heavy rainfall areas. In Tamil Nadu, it is grown in Coimbatore, Salem, Dharmapuri besides Madurai where it is grown in very large areas of about 40,000 hectares.

Based on the branches, colour of the flower, number of fruits besides length and breadth of the fruits, pod breaking and colour of the fibre, *Ceiba pentandra* can be differentiated into three types.

1. *C.pentandra* var. *india*
2. *C.pentandra* var. *caribea*
3. *C.pentandra* var. *afria*

Of the above three types, the first two are mainly for fibre. Moreover caribea is otherwise called as “Singapore Kapok”. Local variety is *indica*.

Difference between *indica* and *caribea* variety:

1. In Indica variety, the branches will start from centre of the trees and grown horizontally whereas in caribea variety the branches will go upright.
2. In Singapore variety, the fruits will be more. After the age of 8 to 10 years, it will yield 800 to 900 fruits in the Singapore variety whereas in the local variety it is only 450 to 500.
3. In Singapore variety, the fruits are long and the length of fruits may vary from 25 to 35 cm whereas in the local variety the length of the fruits is 10 to 15 cm.
4. The pods are not broken even in the fully matured fruits so there is no loss of fibre whereas in the local variety, the fruits burst in the tree itself resulting in loss of fibre.
5. In Singapore kapok, colour of the fibre is pearl white whereas in the local variety it is only dullpale white colour.

6. Number of seeds per fruit is very low in Singapore variety as compared to local variety.

Uses

1. It is used as stuffing material for pillow and bed.
2. It is also used for making tennis ball, boxing gloves, shooting suits
3. Its oil is used for making soap, its cake used as cattle feed.
4. Shell is used for fuel.

Cultural practices

Seeds and sowing: Fresh seeds can be used for sowing. The seeds are sown directly in the polythene bags of size 20 x 10 cm and watered daily. Seeds start germinating at 7th day and it will be over after 15 days. 6 months old seedlings are generally used for planting.

Mainfield

Spacing: 7 x 7 m

Pit size: 30 cm^3

Planting: During rainy season or at any time with irrigation facilities

Weeding: Should be done twice, for first two years.

Irrigation: In areas receiving less than 1,000 mm rainfall, irrigation is a must especially during summer season at 10 days interval.

Intercropping: Pulse crops can be raised as intercrop for initial two years. Bund planting with an espacement of 6 m can be taken up and main field can be utilized for agricultural crops.

Ailanthus excelsa

Common name: The tree of Heaven, Matchsplint tree

Tamil name: ‘Aiyilai’ ‘peemaram’ ‘peenari’

Distribution: Indigenous to India and more common in Bihar; Gujarat, Madhya Pradesh, Orissa and South India.

Soil: Grows in all types of soils, but more suitable to red soil.

Flowering: February-March

Fruiting: April to May

Optimum time of fruit collection: April third week to 1st week of May, when the fruits turn to brown/biscuit colour, before being blown off by wind from the mother tree.

Nursery: Use of presprouted seeds obtained by soaking seeds for 24 hours followed by sprouting in wet gunny bags for 48 hours is advocated for raising nursery seedlings in polythene containers filled with soil mixture. Sow the sprouted seed in polythene bag size 10 x 20 cm. 200 guage filled with nursery mixture of 1:1:1 red soil, sand and farmyard manure and Rosecane watering is advocated; shifting the containers to prevent rooting in the earth once in 20-30 days is necessary.

Planting: Size of the pit 30 x 30 x 30 cm. planting should be done during rainy season and saucer basin should be done to conserve moisture.

Spacing: 5 x 5 m i.e. 160 seedlings/acre under agro-forestry situations, under rainfed conditions. The intercrops are cumbu, sorghum, blackgram, greengram and gingelly. If it is for a grove, the spacing should be 3 x 3 m. i.e. 444 seedlings/acre.

Yield: It depends on site quality; a ten year old tree yield 250-300 kg wood. 35 - 40 tons of wood/acre is expected. The current price is about Rs.5,000/ton. The price is flexible due to the production cost and availability of raw material.

Plant protection measures: *Eligma narsissus*, defoliator and *Atteva fabriciella* are important pests. a) *Eligma narcissus* an be controlled by spraying monocrotophos 35 EC at 0.1% (1 ml. per litre). b) Neem oil 2% (20 ml per litre) and mixed with teepol should be sprayed to control the pest.

Pongamia pinnata

Pongamia pinnata (L.) Pierre, is a nitrogen-fixing, fodder and important tree borne oil seed of the leguminous family.

Origin: It is native to humid and subtropical environments along the coasts and river banks in India and Myanmar, and will thrive in areas having an annual rainfall ranging from 500mm to 2500 mm.

Distribution: India and Burma and this species have been introduced to humid tropical low land in the Philipines, Malaysia, Australia United States and Indonesia.

Rotation: Grown in 30 years rotations for fuel wood

Spacing: 2 x3 m (or) 3x3 m for block planting

6 x 8 m for avenue planting and on field borders.

Nursery: Pungam is easily propagated by seeds and stem cutting. Seed is dibbled in the nursery beds any time after collection preferably in the beginning of hot weather, at a spacing of 7.5 cm x 15 cm. Mulching of sown beds is helpful. Germination commences after about 10 day and completed in about a month. Pricking out improves the growth. Seedlings attain a height of 25-30 cm by the end of first growing season and / or about 60 cm by the beginning of the next rainy season, when they may be planted out entire, with ball of earth, or in the form of stumps. The stem cuttings of 20-30 cm long and 2-4 cm in diameter are prepared in the month of November to February when plants become leafless. Cuttings are planted in the month of November to February at 60 x 30 cm distances.

Planting: Seedlings about 60 cm in height are suitable for planting with ball of earth, or in the form of root and shoot cuttings, in pits 45-60 cm^3.

After Care: Young plants should be provided with sufficient soil moisture by occasional watering for at least two seasons.

Plant Protection: Karanj plants may be attacked by defoliaters, leaf miners and sapsuckers. Beside fungi attack the seedlings and trees are *Ganoderma lucidum* (root rot) and *Fomes merillii*.

Special Features : Nodulation capacity and biodiesel property of the oil.

Tending: Two (or) three weedings are required per year for the first 2-3 years of sowing / planting. For the avenue trees, side branches should be pruned to get proper bole.

Yield and Economics: Trees often reach height in 4 (or) 5 years, bearing at age of 4-7 years. A single tree is said to yield 9-90 kg seed per tree, indicating a yield potential of 900-9000 kg seed/ha, and seed contain oil 25% of which weight be rendered as oil (assuming 100 trees/ha). In general, Indian mills extract 24 -27.5% oil, village crushers, 18-22% oil.

Uses: Timber, Fire wood, Fodder, Oil, Manure, Food, Pest control, Poultry feed, Folk medicine.

Jatropha curcas

Jatropha curcas is multipurpose non-edible oil yielding perennial shrub originated in tropical America.

Family	Euphorbiaceac
Special Features	Hardy and drought tolerant and non-browsable and latex producing plant. The oil from *J. curcas* can be used as biodisel blend upto 20%.
Rotation	Economically maintained upto 30 years
Climate	It grows well under subtropical and tropical climates. It can tolerate extremes of temperature but not the frost.
Soil	It is grown in wide range of soils. It comes up in the margined land and also in problem soil.
Propagation	*Jatropha* is normally propagated through seeds. Well developed plumpy seeds are used for sowing. Germinated seeds are sown in poly bags of 10 x 20 cm size filled with red soil / sand and farmyard manure in the ratio of 1:1:1 respectively.
Planting of *Jatropha*	In one acre 1000 plants can be planted at spacing: 2 m x 2m under rain fed condition. The spacing for irrigated condition is 3 x 3m and wider spacing of 4 x 4 m for agroforestry systems..
Pits	30 cm^3 may be dug and filled with soil and organic (5 kg FYM+ 100 g Neem cake + 100 g super) per pit be fore planting.
Planting time	Monsoon season (June-July, October-November)
Manures and fertilizer	50: 100: 50 N:P:K: / acre in 2nd year onwards applied during September-October
Irrigation	Fortnight interval
After care	Weeding may be attended
Canopy Management	The terminal growing twig is to be pinched to induce secondary branches. Likewise the secondary and tertiary branches are to be pinched or pruned at the end of first and second year to induce a minimum of 25 branches at the end of third year.
Yield	9 months after sowing the seedling produce flowering and 3rd year onwards the economic yield started. We obtain 500 kg – 750 kg / seed per ha under rain fed and 1-1.25 ton/ha under irrigated condition.
Plant protection	Pest (Bark eater) and collar rot disease; Drenching with copper oxychloride controls the collar rot disease.

Tectona grandis

Origin	Indigenous to India and North-East part of Java.
Rotation	In natural forest rotation is 100-120 years, in artificial regeneration it is 20-40 years and in coppice regeneration it is 15-20 years.
Climate and soil	Mostly occurs in monsoon climate, under tropical and sub tropical conditions. Sandy loam soil with 6-7 pH not exceeds 8.5 & well drained.
Rainfall	1000-1500 mm and even less than 750 mm per year.
Spacing	1.8x1.8 m, 2x2 m is generally initially applied. (Then thinned)
Nursery practices	20-30% germination percentage and 3 to 5 kg seeds are required to prepare one mother bed and derived 1000-1500 seedlings. Stumps are prepared out of seedlings that of 2.5 cm long shoot and 22.5 cm of tap root.
Planting	It is done in pre monsoon period which has high success. Square or line planting is done in 45-60 cm^3 size pits for seedlings and for stump planting 2.5 – 3 cm diameter holes and 30 cm depth are prepared.
Plant protection Important pest	Leaf defoliaters (*Hyblaea puera*) and leaf skeletonizer (*Eutectona macheralis*)

Important disease	:	Leaf blight (*Rhizoctonia solani*) and fungal on fruits (*Alternaria* sp)
Special features	:	Presence of "Tectol" phenol in sap gives high resistance to sap wood rot.
Uses	:	Timber value is superior, so called "King of Trees". It can use for all purpose.
Yield	:	It Yields volume 1.58 cum of timber per year per tree (increment).

AGROFORESTRY OPTIONS FOR DIFFERENT AGROCLIMATIC ZONES OF TAMIL NADU

The state of Tamil Nadu has experienced drought almost every fourth or fifth year in the past involving a decline in the annual rainfall. The severity of drought is highly pronounced if it occurs during the major north-east monsoon and especially when the first rains of the monsoon is delayed by three to four weeks from the customary third or fourth week of September. It is also on record that the monsoon rarely extends, itself beyond the second or third week of December. Hence, the precipitation falling within the eight to ten week period between October and November has to be harnessed for maximum exploitation. Since four to six weeks period is essential for the establishment of planted up seedlings, the pace of planting operations that spans for about six to eight weeks from the third week of September has to be abridged to about two to three weeks in October and acceleration of all the connected activities is called for. It is in this backdrop, the present suggestions are put forth for compliance to obtain a reasonably good survival of planted materiel across the different zones of Tamil Nadu.

PRECAUTIONS TO BE FOLLOWED IN PLANTING ACTIVITIES

1. Choice of pit size

The conventional pitting of 30x30x30 cm. for species like Eucalyptus, casuarina etc., needs to be deepened to at las 30x30x45 cm. so that it provides deeper open dug soil for the roots to meander. It is also necessary that the edges of the pit are cut critically at 45° so that it forms a wide mouth leading to a funnel like structure. This allows maximum rain water to accumulate on the tip and percolate deep. This also helps for better harvesting of rain water during summer. Most hardened seedlings of forestry species show a sudden spurt of new root primordia within a duration of five to seven days and elongation of roots is complemented by loosening the soil, both from the sides and the bottom. The degree of drying moisture from ground level to the deeper layer, say about 30 cm. takes about 30-45 days after the cessation of the monsoon. The provision of extra 15 cm depth encourages percolation of moisture for the next 30-45 cm. depth (i.e. about 75-90 cm.from the ground level). In a normal distribution of rainfall, moisture reaches early to a depth of 1.0 to 1.2 m below ground. The rainfall in deficit years does not encourage percolation of moisture to that extent. Hence this simple method of deepening the pit and cutting the edges, though costing a little more than the conventional pitting, justifies towards better survival of the seedlings (Fig.2).

2. Organic amendment for filling the pits

It is generally considered unnecessary to fill the pits with organic materials like FYM or good tank silt in most forestry planting operation, hoping that the hardy seedlings will cope up the deficiency in the soil in the long run. But in agroforestry situation every individual living tree is a monetary advantage to the farmer. Every possible support has to provided for the seedlings to firmly establish through a well established root system. It is a well established fact that there is a direct correlation between the quantum of organic matter in the soil and the rate of growth. Therefore the 2-3 kg of organic input in the form of FYM per pit of 30x30x45 cm. is suggested so that the accelerated root development will get a boost to dichotomise and consequently lead to greater shoot area development. In places where the pit sizes are bigger as in the case of 45x45x45 cm. and 60x60x60 cm. for timber species a proportionate increase in the organic inputs is also indicated.

3. Bio-fertilizer amendments

It has been provided beyond doubt that wherever, biofertilizers like Rhizobium, Azotobacter, phosphobacteria or Arbuscular Mycorrhiza are incorporated, either within the containers or applied inside a pit, they accelerate nutrient absorption and confer a higher root shoot ratio in the first year itself which is a critical period for survival of seedlings. Most leguminous species have responded well to application of Rhizobiuminoculation as evident in Acacia plantations under SIDA aided social forestry programme. Release of unavailable phosphate from the laterite soils is possible with the help of phosphobacteria, both in the plains and in the hills.

The non-leguminous species have responded favourably to the application of Azotobacter and Arbuscular Mycorrhizalcultures in almost all situations. Hence this simple low cost technology could be effectively adopted to overcome the defecits caused by limited availability of moisture.

4. MULCHING

Use of locally available weed species that emerge out during the monsoon period is a rich source to be used as a mulch over the pits soon after the monsoon rains are over. Despite the short duration of monsoon, there is a preponderance of weeds like Croton sparsiflorus, Xanthium Sp. Leucas aspera etc. growing along the open spaces. These weed species can be harvested and covered on the pits. Decomposition of the mulch over a period of time also enriches the top soil of the pit which is beneficial during the following summer rains or earlier monsoon rains for the growth of the plants.

5. SOIL CONSERVATION MEASURES

If is not possible to go far contour bunding within the short span of 2 to 3 months but an option is available to erect square bunding enclosing a reasonably number of seedlings in places where the slope is less than two per cent. Where the slope exceeds from gentle to moderate or even steep slope, semicircular bunds of 1m radius and 15 cm height on the lower side of the gradient is strongly suggested. Within level ground improvement in the form of circular basins is also desirable to encourage better moisture retention (Fig.3 & 4).

6. CHOICE OF SPECIES

A wide range of species is available for planting in the normal course of a well distributed monsoon. But in a situation like this where the imminent drought overrides all other considerations, a restriction in the choice of species quite compatible to drought is warranted. Based on this edict, to species recommended for different agroclimatic zones are mentioned below.

i) North eastern zone

Species that are suitable for block planting adopting the usual espacements are only indicated. Intervention of intercropping is very much restricted because, the restricted rainfall does not satisfy the growth requirements of the locally accepted annual crops. Species like Casuarina equisetifolia, Acacia auriculiformis, A.holesericea, Bassia latifolia, Eucalyptus tereticornis and E.camaldulensis, can survive this situation. In the case of casuarina, which is planted with naked seedlings, instead of planting two seedlings per pit planting three seedlings per pit as in cluster planting is advocated. If by any chance, more than one seedling gets established in the field at the end of one year, the excess seedlings can be eliminated. Considering the relatively very low cost of naked seedlings, adopting this techinique should not cause serious monetary loss to the farmer. In the case of other containerised seedlings, preference should be given to such seedlings having a taller growth and thicker shoot collar.

ii) North western zone

Compared to North Eastern Zone, this zone has lesser rainfall in the order of 700-900 mm and the terrain is also undulating as in the farthest western part. However the prevalence of plateau effect in the major part of the region can be exploited by planting fruit yielding species like mango, tamarind. The Thenkanikottai and Keelamangalam areas show an affinity for establishment of Jack trees.Higher water table in this location can be made use of to grow these horticultural trees. Though silver oak and casuarina are recommended species for this plateau region,it is better to avoid them during this drought period.Pongamia pinnata, an oil yielding tree species is capable of with standing the restricted rainfall and it can be planted in bigger pits of 45X45X45 cm.size.Since all these species demand a wider espacement ranging from 5m x5 m to 10m x 10m the wide interspace can be successfully intercropped with short duration Dolichos lablab,D.biflous,Cicer arietinum and also finger millet, Pongamia pinnata is the preferred species with an intercropping of Dolichos biflorus in the eastern part of NW Zone.

iii) Western zone

This is largely benefited by North east monsoon.Hence it restricts the choice of species to Ailanthus excelsa, Neem, Acacia ferrugenia and Acacia planifrons. Raising of tamarind and silk cotton can be confined to the foot hills along the Western Ghats. Since these species call for wider espacement, intercropping with short duration legumes like vegetable cowpea maturing in less than 75 - 80 days is recommended. These leguminous intercrops will also provide a living mulch for the exposed interspace.

iv) Cauvery delta zone

This is a zone characterised by riverine alluvial soil with a high degree of water holding capacity and offers a relatively greater chance of survival of the planted seedlings of any kind. Though letting in of water from Mettur dam may be delayed by a month, planting of seedlings can progress right from July onwards. Considering the precarious situation, hardly species like Acacia arabicafor planting along the field bunds, Dalbergia sissoo and Tectoina grandis along the canal bunds and Bambusa bambos rhizomatous seedlings of not less than two years at elevated ground will certainly help in the success of the planting. It is generally accepted that quite healthy and sturdy seedlings of not less than 60 cm for sissoo and babul and also teak stumps of not less than 2 cm thickness are the suitable planting materials for this situation. Though it may not be necessary to irrigate them at the end of January or February, it is still prudent to do an occassional watering from the residual water in the canals or ponds.

v) Southern zone

This is an area comprising both vertisols and alfisols.There is a marginally better success in vertisols accommodating species like Acacia nilotica, Azadirachta indica and Ailanthus excelsa. Though tamarind is found in the larger section of this tract, it is not recommended because its viability following the severe summer stretching from March to September is very much doubtful as it is a slow growing species and it may not attain the required root/ shoot growth with very limited rainfall of NE monsoon. However intercropping in vertisol with pulses of local preference is indicated. In the alfisol region, culture of Eucalyptus and Ailanthus excelsa are recommended. The problematic saline and alkaline patches along the coasts are better left unplanted. Planting of Borassus flabellifer (Palmyrah) on all field bunds in this tract is indicated. Though it takes nearly 10-11 months to emerge out, the palmyrah nut remain dormant in the subsoil until the favourable moisutre regime occurs in the following monsoon.

vi) High rainfall zone

Normally these regions have the benefit of two monsoons. In such situations, where south west monsoon, the dominant rain maker fails, the choice is left to take up planting in North East Monsoon. In this situation it is recommended that seedlings of spices and condiments need not be planted but woodlots of Albizia falcatoria, Grevillea robusta, Callophyllum inophyllum and Hevea brasilensis can be grown successfully with the residual rains.

vii) Hilly zone

Considering the limitation imposed by the restricted rainfall, planting of fuel and pulp wood species like Eucalyptus grandis, E.globulus and Acacia mearnsii (Wattle) are recommended.

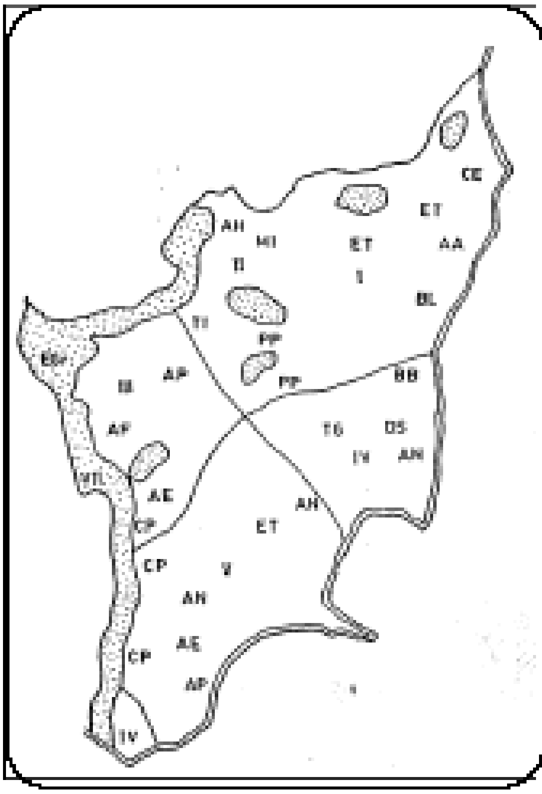

Fig.1 Tree Species for Agro-climatic Zones

<u>LEGEND</u>

AA = *Acacia auriculiformis*
AH = *Artocarpus heterophyllus*
AP = *Acacia planifrons*
CE = *Casuarina equisetifolia*
EGL = *E. globulus*
MI = *Mangifera indica*
AE = *Ailanthus excelsa*
AI = *Azardirachta indica*
BB = *Bambusa bambos*
CP = *Ceiba pentandra*
E.Gr. = *Eucalyptus grandis*
TI = *Tamarindus indica*
AF = *Acacia ferruginea*
AN = *Acacia nilotica*
BL = *Bassia latifolia*
DS = *Dalbergia sissoo*
E.t = *E. tereticornis*
TG = *Tectona grandis*

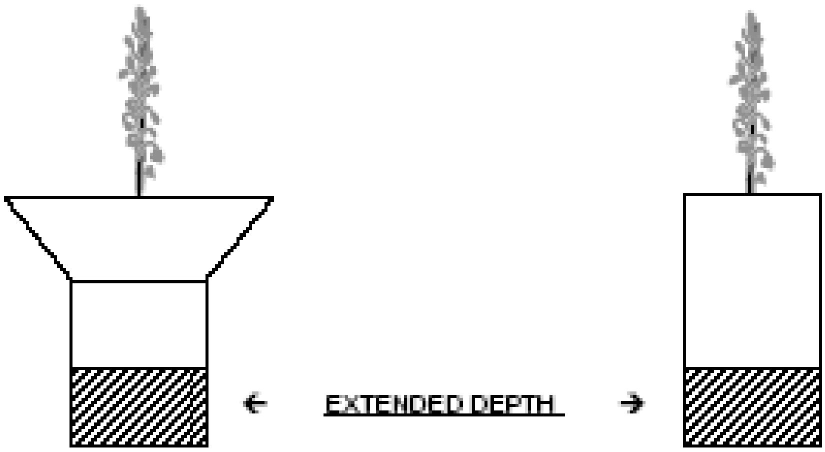

Fig.2 Improved Pits

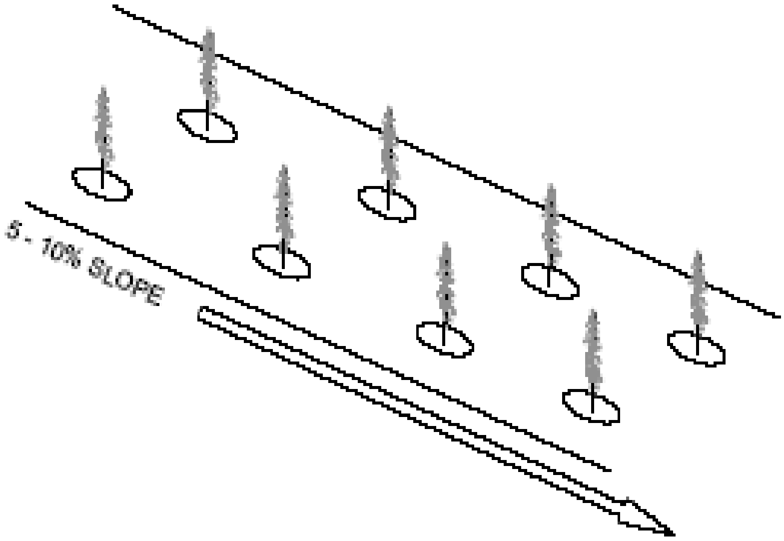

Fig 3. Semilunar Basins

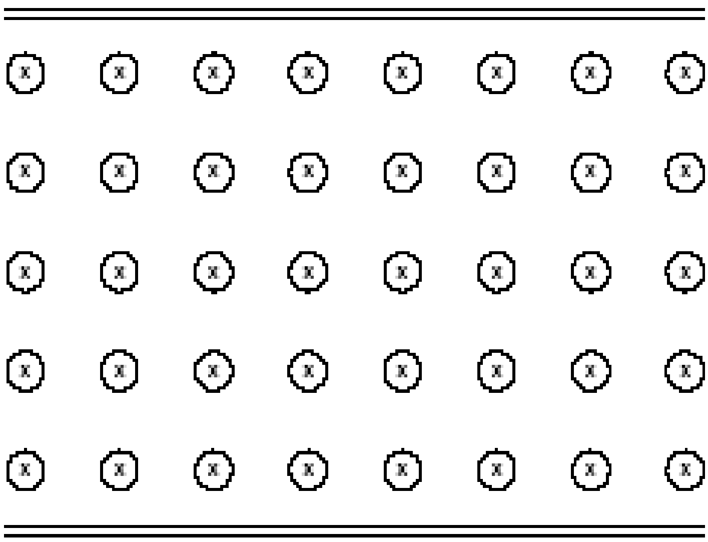

Fig4 Square Bunding and Saucer Basins

INTEGRATED FARMING SYSTEMS RESEARCH IN TAMIL NADU

The marginal and small farmers constitute 78.2 per cent of the farming community in India. The unique Indian situation of small fragmented holdings and lack of capital investments is not suitable for single commodity farming being practiced in developed countries. So, the integrated farming system appears to be a viable solution to the Indian agriculture for increasing productivity and income of the small and marginal farmers with constrained resources. Efforts for a holistic integration of different farming enterprises with cropping were carried out for Western, Cauvery delta, Southern and North western zones out of seven agro climatic zones of Tamil Nadu with the objectives of increasing income and recycling of farm wastes and by-products to sustain the soil productivity since 1985. The approaches were to find out viable components for wetland, irrigated upland and rainfed situations existing in different ecological zones.

INTEGRATED FARMING SYSTEMS

1. WESTERN ZONE

WETLAND

Integrated farming systems experiments were conducted at wetlands from 1987-onwards at Tamil Nadu Agricultural University, Coimbatore involving different components *viz*., poultry, pigeon, goat, fishery and mushroom.

Crop + poultry/ pigeon + fish + mushroom

In this system, the component of integrated farming system involved were crop + fish + mushroom, crop + poultry + fish + mushroom and crop + pigeon + fish + mushroom and was taken from 1993–1995. The efficiency of the component linkages was evaluated predominantly on the basis of productivity, its income and employment generation with the possibility of utilizing recycled organic wastes as nutrient to enrich the soil fertility.

To enhance and sustain the productivity, economic returns, employment generation for the family labour round the year and soil fertility with environmental protection, integration of rice-gingelly-maize and rice- soybean -sunflower cropping each in 0.45 ha with recycled poultry manure as fish pond silt to rice and 75 per cent of the recommended NPK to each crop in the system + poultry (50 layers) + fish (1000 polyculture fingerlings in 0.10 ha of ponded water) comprising catla (20 per cent), silver carp (20 per cent), rohu (20 per cent), mrigal (15 per cent), common carp (15 per cent) and grass carp (10 per cent) fed with poultry dropping + oyster mushroom (5kg/day) for the lowland farmers having one hectare farm.

Cropping + poultry / pigeon / goat + fishery

During 1998-2001, the study involved cropping, poultry, pigeon, goat and fishery enterprises in all possible combinations, with a view to recycle the residue and by- products of one component over the other. In one hectare farm, an area of 0.75 ha was assigned for crop activity, 0.10 ha for growing fodder grass to feed the goat unit (20+1), 0.03 ha allotted to goat shed and the remaining 0.12 ha allotted to 3 fish ponds. Three integrated farming systems *viz.,* crop + fish + poultry (20 Bapkok layer birds), crop + fish + pigeon (40 pairs) and crop + fish + goat (Tellicherry breed of 20 female and 1 male maintained in 0.03 ha deep litter system) were tried for three years. Polyculture fingerlings of 400 numbers (catla, rohu, mirgal/ common carp and grass carp) in the ratio of 40:20:30:10, respectively, reared in 3 ponds of size 0.04 ha (depth of 1.5 m) each.

Integration of crop with fish, poultry, pigeon and goat resulted in higher productivity than cropping alone under lowland. Crop + fish + goat integration recorded higher rice grain equivalent yield of 39610 kg/ha. The highest net return of Rs.131118 and per day return of Rs.511 ha^{-1} were obtained by integrating goat + fish + cropping applied with recycled fishpond silt enriched with goat droppings. Higher net return of Rs.3.36 for every rupee invested was obtained by integration of pigeon + fish + cropping applied with recycled fishpond silt enriched with pigeon droppings. The poultry, pigeon and goat droppings were utilized as feed initially and at the end of a year after the fish harvest, about 4500 kg of settled silt from each pond were collected. The pond silt was utilized as organic sources to supply sufficient quantity of nutrients to the crops.

IRRIGATED UPLAND

Crop + Dairy + Biogas + Mushroom + Fish

Integration of 0.32 ha each of sorghum + red gram - sunflower + coriander, maize + fodder cowpea - cotton + coriander and perennial fodder CO3 grass + legume fodder (Lucerne) with dairy (6 cows + 4 calves), biogas (2 m^3 capacity) and mushroom (2 kg day^{-1}) + spawn production (10 bottles day^{-1}) recorded higher productivity than the cropping alone with sorghum - cotton (0.50 ha) and maize - cotton (0.50 ha) cropping systems. Cropping + dairy + biogas + fish + mushroom integration recorded the highest gross, net and per day returns. It also registered the highest benefit cost ratio of 2.41 during 2000-2001.

On farm study was conducted during 2004-2007. The crop activity in integrated farming system consisted of field crop, vegetable crop and fodder crops. The livestock kept were two cross bred milch cows + one calf, ten female tellicherry does + one buck and twenty guinea fowls. Improved farming system gave the maximum maize grain equivalent yield of 22,754 kg/ac/year which was 47.9 % higher than the traditional farming system. The improved system was able to generate employment of 235 man day's $acre^{-1}$ which was higher than traditional farming system (105 man day's $acre^{-1}$). Through recycling of crop residues and livestock manure about 3.72 tonnes of bio-compost and 1.59 tonnes of vermicompost were obtained. This could able to supply 26.0, 22.3, and 26.0 kg N P K to field and fodder crops through biocompost application and 39.4,10.5 and 18.0 kg NPK to vegetable crops as vermicompost application in an acre land area. The returns per rupee of investment from the ratio of gross value of output to total cost (GVCR) was 3.62 and ratio of net value of the products to total cost (NVCR) was 2.80.

RAINFED LAND

Crop + Tree + Goat

Integrated farming system model involving crop + tree + goat was taken from 1999-2001. Experimental results on integrated farming system revealed that (i) integration of sorghum + cowpea (grain), sorghum + cowpea (fodder) and *C. glaucus* each in 0.33 ha intercropped in *E. officinalis* with Tellichery goat component (5+1) in 0.01 ha resulted in higher productivity, economic returns and provided better employment opportunity and improved soil fertility than raising sole sorghum alone (ii) coir pith mulching and pitcher irrigation increased the tree seedling growth than the control, (iii) tied ridges conserved more moisture and improved the productivity of the crops, (iv) application of 50 per cent N through fertilizer and 50 per cent N through goat manure increased the productivity, enhanced the soil fertility and provided better opportunity for recycling of manure to the crops.

Results of on-farm field experiments conducted during 2009 - 2011, revealed that, integration of *Cenchrus setigerus* + *Stylosanthes hamata* and fodder sorghum + *Pillipesara* with sheep (5+1) and buffalo (2 No.'s) could be the best silvipastoral farming system with the application of recommended dose of 25: 45: 19 kg ha^{-1} NPK for *Cenchrus* based system and 30: 20: 10 kg ha^{-1} NPK for fodder sorghum based system along with FYM (10 t ha^{-1}) for dry land of Western Zone of Tamil Nadu.

2. CAUVERY DELTA ZONE

Cropping + fish + poultry/duck/goat/dairy

An experiment was conducted during 1992-1994 in rice based farming system as a demonstration trial at Aduthurai. The components were cropping, fish culture and poultry. An area of 0.40 ha was selected for the farming system study, considering the small and marginal farmers of the state. Conventional cropping as practised by farmers was taken up in an area of 0.96 hectare. In the fish pond with 400 m^2, fingerlings belonging to the species *viz.,* Catla (*Catla catla*) (200) Rohu (*Labeo rohita*) (100), Mirgal (*Cirrbinus mrigala*) (100) were stocked.

The economics worked out for the system as a whole was Rs.28.983, in which cropping system contributed Rs.23,709, Poultry and Fisheries contributed additional income of Rs.5,274. Poultry droppings added to the fish pond as feed was 3 tonnes year^{-1} (100g/birds). Mean number of egg production was 262 year^{-1} bird^{-1}. In the case of fish pond (0.04) yield recorded was 234 kg. Of the income obtained from the integrated farming system, 78% was from cropping system and poultry cum fisheries generated additional income and employment.

Cropping + duck + fish culture

Integrated farming system with duck-cum-fish culture as a component was tried during the year 1989. Two farm holdings each with the size of one ha were selected for conducting the study. In one holding, conventional cropping as practiced by farmers was followed. In another one hectare, cropping was practiced in an area of 0.973 ha and an area of 0.027 ha was allotted for duck-cum-fish culture. Economics of IFS was compared with existing cropping systems. Net income of Rs.13790/- was obtained from existing cropping system (*Kuruvai-thaladi* rice - pulse) and a net income of Rs.22676/- was obtained from the modified cropping system (*Kuruvai - thaladi* rice - cotton and maize) with an area of 0.973 ha allotted for cropping.

The additional profit from modified cropping alone was Rs.8886/-. From duck-cum-fish culture as a component in mixed farming system, a net profit of Rs.1441/- was obtained from an area of 0.027 ha. Totally an additional income of Rs.10327/- was obtained from the mixed farming system over existing cropping system.

3. SOUTHERN ZONE

WETLANDS OF TAMBIRAPARANI COMMAND AREA

Evaluation of integrated farming system for wetland farms was conducted during 1990-92. The components of the traditional and integrated farming systems are as follows:

Traditional system (1 ha)	:	Rice – Rice – Fallow
Integrated farming system (1 ha)	:	Crop + dairy + fishery
0.4 ha	:	Rice-rice + soybean (bund) – blackgram
0.2 ha	:	Ragi + sunflower (border) – fodder maize + cowpea – cotton + Greengram
0.2 ha	:	Bajra napier hybrid fodder grass
0.1 ha	:	Desmanthus
0.04 ha	:	Fish pond
0.06 ha	:	Cattle shed for 3 jersey cows and 2 work bullocks

The integrated farming system provided a net income of Rs.25,215/- which was 100.7 per cent more than the income from the traditional rice farming (Rs.12,662/-

On-farm studies were also undertaken to assess the economic benefits of integrated farming systems actually practised by wetland farmers of Tirunelveli-Kattabomman district during 1990. The study covered four farms in four villages with a farm size of 1-2 ha, raising rice, banana and pulses. The allied activities includes dairy, goat rearing, poultry and fishery. The average monthly income of the farm family practicing the integrated farming system varied from Rs.1,850 to 2,560.

WETLANDS OF PERIYAR VAIGAI COMMAND AREA

In the Periyar – Vaigai command area, nearly one lakh hectares are raised with a single crop of rice during August – January. The lands are usually left fallow after rice harvest in January. To assess the potential of IFS in such single crop wetlands, experiments were conducted at Agricultural College and Research Institute, Madurai during 1989-91. The results revealed that by crop intensification, diversified cropping and by inclusion of fishery and poultry, the farm income per acre could be increased by Rs.5435 to Rs.6235 per year.

DRY LANDS OF SOUTHERN ZONE

To identify suitable integrated farming for the dry lands, experiments were conducted at Regional Research Station, Aruppukottai and Agricultural Research Station, Kovilpatti.

In the rainfed black soils, the common crops are sorghum, pulses, cotton and sunflower. Introduction of tree legumes like subabul, *Acacia senegal* and *Prosopis cineraria* and perennial fodder grass *Cenchrus ciliaris* and inclusion of goat rearing were evaluated at Regional Research Station, Aruppukottai. Five female and one male goat of Tellicherry breed were raised in deep litter system. The results revealed that the IFS yielded an additional income of Rs.2163 to Rs.2556 per year from a farm area of 1.6 ha. In another study at Aruppukottai proved the IFS system of crop + horticulture + goat proven to be successful in the black soils and increased the profit by Rs.2363 to Rs.4706 per ha over cropping alone.

At Agricultural Research Station, Kovilpatti, studies were taken in farmers' holdings in the dryland red soils. IFS with crop+goat yielded an annual income of Rs.8410 per ha compared to Rs.4654 per ha under traditional cropping alone.

4. NORTH WESTERN ZONE

The studies were made under garden land condition. The results revealed that in both Paiyur and Yercaud Centres dairy linked farming system was more remunerative, with more employment generation. The next successful farming system under rainfed condition at Paiyur was sericulture.

POTENTIAL ALTERNATIVES

Western zone

Wetlands

Crop + poultry/ pigeon + fish + mushroom
Crop + poultry/ pigeon + goat + fishery

Upland with supplemental irrigation

Crop + dairy + biogas + silviculture
Crop + dairy + biogas + mushroom + fish

Rainfed lands

Crop + goat
Crop + goat + tree

Cauvery Delta zone

Crop + poultry + fish
Crop + duck + fish
Crop + milch animals
Crop + goat + dairy

Southern zone

Wetlands of Tambirabarani Command: Crop + dairy + fishery
Wetlands of Periyar Vaigai Command: Crop + fish + poultry
Dry lands: Crop + orchard + goat

North Western zone

Crop + dairy + poultry
Crop + dairy + poultry + sericulture

Adoption of improved farming system models can result in the advantages listed below.

- Higher food production to equate the demand of the exploding population of our nation
- Increased farm income through proper residue recycling and allied components
- Sustainable soil fertility and productivity through organic waste recycling
- Integration of allied activities will result in the availability of nutritious food enriched with protein, carbohydrate, fat, minerals and vitamins
- Integrated farming will help in environmental protection through effective recycling of waste from animal activities like piggery, poultry and pigeon rearing
- Reduced production cost of components through input recycling from the byproducts of allied enterprises
- Regular stable income through the products like egg, milk, mushroom, vegetables, honey and silkworm cocoons from the linked activities in integrated farming
- Inclusion of biogas & agro forestry in integrated farming system will solve the prognosticated energy crisis
- Cultivation of fodder crops as intercropping and as border cropping will result in the availability of adequate nutritious fodder for animal components like milch cow, goat / sheep, pig and rabbit
- Firewood and construction wood requirements could be met from the agroforestry system without affecting the natural forest
- Avoidance of soil loss through erosion by agro-forestry and proper cultivation of each part of land by integrated farming
- Generation of regular employment for the farm family members of small and marginal farmers

WEEDS

MANAGEMENT OF PROBLEM, PERENNIAL AND PARASITIC WEEDS

I. *Cynodon dactylon* (*Arugu*) and *Cyperus rotundus* (*Koarai*)

Management of perennial weeds like *Cynodon dactylon* and *Cyperus rotundus* by the application of Glyphosate 15 ml + Ammonium sulphate 20g + activator 1 ml / lit of water

Approach	:	Post emergence, total, translocative herbicide
Stage of weed	:	Active growing, pre flowering stage
Sprayer	:	Hand operated *Knapsack / Backpack*
Nozzle	:	WFN 24 & ULV 50 with 30 Psi
Spray volume	:	200-250 litre / ha

Application technology

Non-Crop Situation/Crop Fallow Situation - Blanket application
Cropped Situation - Pre-sowing / planting- Stale seed bed (Blanket application).
Established Crops - Directed application using hoods.

Note: Rain free period / waiting period: 48 hours

II. *Solanum elaegnifolium (Kattu kandan kathiri)*

Post-emergence application of Glyphosate 20 ml + Ammonium sulphate 20g/ha+ activator 1ml/litre of water or Glyphosate 10 ml in combination with 2,4-D sodium salt 6 g + activator 1ml / litre

Note: The application should be during the active growth / vegetative phase of weed

III. *Parthenium hysterophorus (Parthenium natchu chedi)*

- Manual removal and destruction of Parthenium plants before flowering using hand glouse / machineries **(or)**
- Pre-emergence application of atrazine 4 g / litre in 500 litres of water / hectare **(or)**
- Uniform spraying of sodium chloride 200g + 2 ml soap oil / litre of water **(or)**
- Spraying of 2,4-D sodium salt 8 g or glyphosate 10 ml + 20g ammonium sulphate + 2 ml soap solution / litre of water before flowering **(or)**
- Post-emergence application of metribuzin 3 g / litre of water under non crop situation.
- Raising competitive plants like *Cassia serecea* and *Abutilon indicum* on fallow lands to replace Parthenium **(or)**
- Biological control by Mexican beetle which is very active during only in monsoon seasons.

Note: Parthenium can be decomposed well before flowering and used as organic manure.

IV. *Ipomoea carnea (Neyveli kattamanakku)*

- Foliar application of 2,4-D sodium salt 8 g + urea 20g + soap oil 2 ml / litre of water and then removal and burning of dried weeds **(or)**
- Manual / mechanical removal of grownup plants in channels during summer.

Note: Composted *Ipomoea carnea* can be used as organic manure preferably in rice fields.

V. *Eichhornia crassipes (Agaya thamarai)*

- Manual / Mechanical removal and drying
- Application of 2,4-D sodium salt 8g + urea 20g or Paraquat 6 ml / litre of water
- Application of Glyphosate 15ml+Ammonium sulphate 20g/ litre of water

Note: Vermi-composting and composting of dried water hyacinth and can be used as organic manure in irrigated upland ecosystems.

VI. *Portulaca quadrifida (Shiru pasari)*

- Post-emergence tank mix directed application of Glyphosate 10 ml / ha + 2, 4-D sodium salt 5g / lit to control *Portulaca quadrifida* in cropped fields.

Note: Not to use above herbicides in broadleaved crops particularly cotton and bhendi or other vegetables and pulses as well as oilseed crops.

VII. *Striga asiatica (Sudu malli)*

- Pre-emergence application of atrazine 1.0 kg/ha on 3rd DAP + hand weeding on 45 DAP with an earthing up on 60 DAP combined with post-emergence spraying of 2,4-D 6 g (0.6%) + urea 20 g (2%) / litre of water on 90 DAP + trash mulching 5 t/ha on 120 DAP

VIII. *Orabanche (Pukaielai kalan)*

- Pre-emergence application of pendimethalin 1.0 kg/ha or oxyfluorfen 0.30 kg/ha on 3 DATP in tobacco, tomato and brinjal and 3 DAP in potato.
- Plant hole application of neem cake 25 g / plant or drenching of copper sulphate 5% provides partial control of *Orabanche* in tobacco.
- Directed application of paraquat 6 ml/litre of water or glyphosate 8 ml/ litre of water or imazethapyr 3 ml/ litre of water on the Orbanche shoots

SOIL RELATED CONSTRAINTS AND THEIR MANAGEMENT

A constraint free soil environment is very important for achieving higher food production. The major soil constraints affecting the crop production in Tamil Nadu are

a) Chemical constraints : salinity, sodicity, acidity and nutrient toxicities
b) Physical constraints : high or low permeability, sub soil hard pan, surface crusting, fluffy paddy soils, sandy soils etc.

1. Saline soils

Saline soils are characterised by higher amount of water soluble salt, due to which the crop growth is affected. For these soils with electrical conductivity of more than 4 $dS\ m^{-1}$, provision of lateral and main drainage channels of 60 cm deep and 45 cm wide and leaching of salts could reclaim the soils. Application of farm yard manure at 5 $t\ ha^{-1}$ at 10 - 15 days before transplanting in the case of paddy crop and before sowing in the case of garden land crops can alleviate the problems of salinity.

2. Sodic soils

Sodic soils are characterised by the predominance of sodium in the complex with the exchangeable sodium percentage exceeding 15 and the pH more than 8.5 .To reclaim the sodic soils, plough the soil at optimum soil moisture regime, apply gypsum at 50% gypsum requirement uniformly, impound water, provide drainage for leaching out the soluble salts and apply green manure at 5 $t\ ha^{-1}$ 10 to 15 days before transplanting in the case of paddy crop.

3. Acid soils

Acid soils are characteristically low in pH (< 6.0). Predominance of H^+ and Al^{3+} cause acidity resulting in deficiency of P, K, Ca, Mg , Mo and B. This soils are prevalent in a) hilly tracts of Ooty, Kodaikkanal and Yercaud b) Laterite soils of Pudukkottai, Kanyakumari etc Application of lime **(**as per the lime requirement test**)** uniformly by broadcast and incorporation is recommended. The alternate amendments like dolomite, basic slag, flue dust, wood ash, pulp mill lime may also be used on lime equivalent basis**.**

4. Iron and Aluminum toxicity

These are characterized by the presence of higher concentration of Fe^{2+} and Al^{3+} more specifically in flooded soils. Prevalent in Kanyakumari and Pudukkottai Districts. (pH 4 – 6) Application of lime as per the lime requirement along with the recommended dose of NPK and organic manure will suppress the toxicity.

For ` Ela ` soils of Kanyakumari district (Alfisols, pH : 4-5) ,. application of lime as per lime requirement with recommended NPK + foliar spray of 0.5 % $ZnSO_4$ + 0.2% $CuSO_4$ +1% DAP + 1% MOP thrice during AT to PI will help to overcome the problem in rice. Based on the screening tests, the rice cultivars of the region have been rated for their tolerance to Fe toxicity

Highly susceptible	:	ADT 36
Mod. susceptible	:	ADT 42, IR 50, CORH 1
Less susceptible	:	TPS 1, ASD 16 & 18, IR 64, JJ 92, TKM 9, CO 37 & CO 41

5. Fluffy paddy soils

The traditional method of preparing the soil for transplanting rice consists of puddling which results in substantial break down of aggregates with uniform structures less mass. Under continuous flooding and submergence of soil in a rice-rice-rice cropping system, the soil particles are always in a state of flux and the mechanical strength is lost leading to the fluffy ness. This is further aggrevated by *insitu* application of rice stubbles and weeds during puddling. They are characterized by low bulk density of the top soil resulting in the sinking of farm animals and labourers as well as poor anchorage to paddy seedlings. For such soils, passing of 400 kg stone roller or oil drum with sand inside eight times at proper moisture level (moisture level at friable condition of soil which is approximately 13 per cent) once in two to three years.

6. Sandy soils

Sandy soils are containing predominant amounts of sand resulting in higher percolation rates and nutrient losses. Campacting the soil with 400 kg stone roller or oil drum with sand / stones inside eight times at proper moisture level (moisture level at friable condition of soil which is approximately 13 per cent) once in two to three years could reduce the percolation losses. Addition of tank silt for coastal sandy soils is recommended for enhancing their productivity.

7. Sub Soil hard pan

Hard pan occurs in red soil areas due to the movement of clay and iron hydroxides and calcium carbonate and settling at shallow depth, which increases the soil bulk density to more than 1.8 g/cc, their by preventing the root proliferation. These soils can be reclaimed by chiselling the soils with chisel plough at 0.5 m interval first in one direction and then in the direction perpendicular to the previous one, once in two to three years. Applications of FYM or composted coir pith at 12.5 t ha-1could bring additional yields of about 30 per cent over control. Deep ploughing of the field during summer season can be followed to open up the sub soil. Cultivation of deep rooted crops like tapioca, cotton and semipereneal crop like mulberry encourage natural breaking of the hardpan.

8. Surface crusted soils

Surface crusting occurs due to the presence of colloidal oxides of iron and aluminium in Alfisols which binds the soil particles under wet regimes. On drying it forms a hard mass on the surface and prevents the emerging seedlings and arrest the free exchange of gases between the soil and atmosphere. The surface crust can be easily broken by harrowing or cultivator ploughing and its formation can be prevented by improving the aggregate stability by the application of lime or gypsum at 2 t ha^{-1} and FYM at 12.5 t ha^{-1}. Sprinkle water at periodic intervals. Bold grain crops like cowpea may be grown

9. Heavy textured clay soils

The clay soils are containing major amounts of clay resulting in the poor permeability and nutrient fixation. Such soils can be reclaimed by the addition of river sand at 100 t ha^{-1} or managed by deep ploughing the field with mould board plough or disc plough during summer or forming contour and compartmental bunds and also adoption of ridges and furrows to enhance the infiltration and percolation.

10. Low permeable black soils

These soils are having infiltration rate less than 6 cm per day due to high clay content. The amount of water entering in to the soil is reduced, resulting in high run off encouraging the erosion of surface soil with nutrients. Heavy clay and high capillary porosity results in impeded drainage and reduced soil conditions. Application of 100 cart loads of red loam soil or river sand and deep ploughing the field with mould board plough or disc plough during summer to enhance the infiltration and percolation. Application of FYM , composted coir pith or pressmud at 25 t ha^{-1} per year will improve the physical properties and internal drainage of the soil

11. High permeable red soils.

These soils are having sand exceeding70 per cent and are not able to retain water and nutrients. These soils are devoid of finer particles and organic matter, thus aggregates are weekly formed; presence of high non capillary pores results in poor soil structure. Compacting the soil with 15 passes after 24 hours of irrigation, application of tank silt or black soil @ 25 t ha^{-1} per year along with FYM, composted coir pith to improve the water holding capacity of the soil. Providing asphalt, polythene sheet etc below the soil surface will reduce infiltration

PACKAGE OF PRACTICES FOR CHISEL TECHNOLOGY

The occurrence of hard pans at shallow depth is the most prevalent soil physical constraint in soils. The agricultural crops are denied of the full benefits of the soil fertility and nutrient use due to this constraint. The sub-soil hard pans are characterized by high bulk density (1.8 g cc.') which in turn lowers infiltration, water storage capacity, available water and movement of air and nutrients, with concomitant adverse effect on the yield of crops. This problem is predominantly present in six districts of Tamil Nadu viz., Coimbatore, Erode, Dharmapuri, Tiruchirappalli, Madurai and Salem particularly under rainfed farming affecting a total of 3.8 lakh hectares of land.

TECHNOLOGY

Plough the field with chisel plough at 50 cm interval in both the directions viz., horizontally and vertically. Chiselling helps to break the hard pan in the sub soil. Besides, it ploughs upto 45cm depth. Chisel plough is a heavy iron plough which goes up to 45 cm depth, thereby shattering the hard pans. It is usually drawn by the tractor. Fabrication of chisel plough has been done by the Department of Farm Machinery, Tamil Nadu Agricultural University, Coimbatore.

- Spread 12.5 t of FYM / pressmud / composted coir pith per hectare evenly on the surface.
- Give two ploughings using a country plough for incorporating the added manures. The broken hard pan and incorporation of manures make the soil to conserve more moisture.

PACKAGE OF PRACTICES FOR CHISEL TECHNOLOGY

The occurrence of hard pans at shallow depth is the most prevalent soil physical constraint in soils. The agricultural crops are denied of the full benefits of the soil fertility and nutrient use due to this constraint. The sub-soil hard pans are characterised by high bulk density (1.8 g cc^{-1}) which in turn lowers infiltration, water storage capacity, available water and movement of air and nutrients, with concomitant adverse effect on the yield of crops. This problem is predominantly present in six districts of Tamil Nadu viz., Coimbatore, Erode, Dharmapuri, Tiruchirappalli, Madurai and Salem particularly under rainfed farming affecting a total of 3.8 lakh hectares of land.

Technology

Plough the field with chisel plough at 1 to 1.2m interval in only one direction of the field. Chiselling helps to break the hard pan in the sub soil by reaching upto 45 cm depth. Chiseling develops cracks in the subsoil facilitating easy infiltration of water. Chisel plough is a heavy iron plough which goes up to 45 cm depth, thereby shatters the hard pans and usually drawn by tractor. The low draft chisel plough was developed by the Department of Farm Machinery, Tamil Nadu Agricultural University, Coimbatore.

Vegetative barriers for soil moisture conservation

For better in-situ moisture conservation in drylands of Vertisols, raise vegetative barriers of vettiver or lemon grass across the slope and along the contours at 0.5 m vertical interval.

SURGE IRRIGATION

Even as advanced pressure irrigation method, such as drip and sprinkler systems are in vogue the traditional gravity surface irrigation methods still remain inevitable due to their simplicity in layouts and low installation and operational expenses. However the short strip furrow and check basin layouts (the primary surface irrigation methods in Tamilnadu) warrant division of the irrigated fields into a number of square or rectangular (2m x 2m to 6m x 6 m) plots encompassed by criss-cross ridges and feeder channels for facilitating irrigation flow from head to tail end of the field. This eventually results in prolonged irrigation application time and reduced irrigation efficiencies of 55 - 65% only due to excessive seepage, deep percolation and runoff losses (35-45%). Besides, the criss-cross layout with cross ridges and feeder channels leads to a land loss of 15 -25%. In view of minimizing the land and water loss and to accomplish high level of irrigation and water use efficiencies a relatively new surface irrigation method called "surge irrigation" was introduced in TNAU campus with extensive experimental trials on it's hydraulic performance evaluation and crop compatibility during 1992-95.

Features of Surge irrigation

The term " Surge irrigation" refers to the delivering irrigation flows into individual long furrows (more than 25m upto 200m) in an intermittent fashion of predetermined ON-OFF time cycles (5 minutes to 10 minute) with the design duration of irrigation. During the ON time water front advances into the furrow over a certain length and during the subsequent OFF time the water applied partially saturates the soil and infiltration rate gets reduced on the advanced length. When water is delivered in the succeeding ON time, the water front advance gets accelerated due to the reduced intake rate and eventually it reaches the tail end of long furrow with in 30 -50% of the design duration of irrigation. This process of ON OFF water supply and cutoff results in highly minimized deep percolation and runoff losses (hardly exceeding 20%). Hence, high uniformity of soil moisture distribution with in the effective root zone is achieved over the entire furrow length resulting in enhanced irrigation efficiencies of more than 85% to 95%. In addition due to the series of long furrows emanating from a single head channel, the criss -cross ridges and feeder channel of division are eliminated thereby limiting the land loss within 5% only.

Contributions of TNAU in surge irrigation research

- Manual semi automated and automated surge irrigation layouts were designed and the irrigation parameters such as the individual furrow discharges (30 lit/min to 120 lit/min), surge cycle ON-OFF times (5 min to 30 min), surge cycle ratio (0.25 to 0.66), furrow gradients (0.1% to 0.6%), furrow size (30-120cm) and furrow length (50-200m) could be optimized through mathematical models.
- A significant contribution from TNAU is the development of an original emprical model (senthilvel, 1995) for the prediction of waterfront advance times and resulting irrigation water distribution efficiencies.

  Soil suitability : sandy clay loam and loamy soils only
  Crops tested : maize sunflower and sorghum
  Water saving : 25-40%
  Land saving : 15-25%
  Labour saving : 40%

Limitations

Surge irrigation systems do not show marked differences in land and water saving in extremely clay or sandy soils. Besides, surge irrigation technology is still in the infant stage in India and requires popularization through extension methods.

MICRO IRRIGATION

Micro irrigation is a modern method of irrigation; by this method water is irrigated through drippers, sprinklers, foggers and by other emitters on surface or subsurface of the land. Major components of a micro irrigation system is as follows.

Water source, pumping devices (motor and pump), ball valves, fertigation equipments, filters, control valves, PVC joining accessories (Main and sub main) and emitters.

In this system water is applied drop by drop nearer the root zone area of the crop. The drippers are fixed based on the spacing of crop. Many different types of emitters are available in the market. They are classified as Inline drippers, on line drippers, Micro tubes, Pressed compensated drippers.

Drip irrigation is most suitable for wider spacing crops. Micro sprinkler irrigation system is mostly followed in sandy or loamy soils. This system is most suitable to horticultural crops and small grasses. In this method water is sprinkled in a lower height at various directions.

Portable micro sprinklers are also available. They distribute slightly more water than drippers and micro sprinklers. They spray water in not more than one meter. It is used for preparing nursery and lawns in soils with low water holding capacity.

Advantages of drip irrigation system

- Water saving and higher yield
- High quality and increased fruit size
- Suitable for all types of soil
- Easy method of fertigation and chemigation
- Saving in labour and field preparation cost

Disadvantage of drip irrigation system

- High initial investment
- Clogging of emitters
- Possible damage of system components due to animals, etc.,

Investment cost mostly differs based on spacing of the crops

- Generally, the reasons for clogging are solid particles (sand, rust), soft dirt (organic matter, algae, micro organism, salt), sediments (salt in the fertilizers).
- Filtration is the main key factor to the success or failure of the system. The main of filtration is to stop dirt particles which damage any components of the system.
- To remove salt encrustation, 30 per cent commercial hydrochloric acid can been used at the rate of one liter per one m^3 area. (One part HCl mixed with 5 parts of water)
- To remove algae and fungal clogging 5 to 500 ppm sodium hydrochloride (10 per cent chlorine) can be used.

Maintenance of drip system

- Back washing and sand filters has to be cleaned
- Frequent cleaning of emitters and drippers
- Flushing at every irrigation
- Cleaning of sub main and main pipes
- Cleaning of PVC pipes and laterals and acid or chlorine may be used to remove clogging.

Water used and yield of crops in micro and conventional irrigation methods

Crop	Methods of irrigation	Water requirement (cm)	% water saving	Yield kg ha^{-1}	% increase in yield	Water use efficiency (kg ha mm^{-1})
Banana	Drip	97.00	45.00	87500	52.00	90.20
	Surface	176.00	-	57500	-	32.67
Sugarcane	Drip	94.00	56.00	170000	33.00	180.85
	Furrow	215.00	-	128000	-	59.53
Grapes	Drip	27.80	48.00	32500	23.00	116.90
	Surface	53.20	-	26400	-	49.62
Aerobic rice	Conventional aerobic rice	74.30	38.10	4747	-	6.39
	Surface drip	61.90	48.40	5940	14.20	9.60
	Sub-surface drip	61.90	48.40	6227	19.80	9.74
	Conventional transplanted	120.00	-	5200	-	4.33
Cotton	Drip	28.00	66.27	3250	25.00	116.10
	Furrow	83.00	-	2600	-	31.33
Beetroot	Drip	17.70	79.34	887	55.34	50.11
	Surface	85.70	-	571	-	6.66
Radish	Drip	10.80	75.72	1186	13.49	109.80
	Surface	46.40	-	1045	-	22.52
Papaya	Drip	73.88	67.89	23490	69.47	0.32
	Surface	225.80	-	13860	-	0.06
Mulberry	Drip	20.00	60.00	71400	3.03	3570
	Surface	50.00	-	69300	-	1386
Tomato	Drip	18.40	39.00	48000	50.00	260.86
	Surface	30.00	-	32000	-	106.66

(WTC Annual Reports 1985-2003)

Affordable micro irrigation systems

Affordable micro irrigation system is mostly suitable to kitchen garden, nursery and ornamental crops.

1. Bucket kit system

Bucket kit system is defined for kitchen garden suitable for women, marginal and small farmers. It consists of a bucket (15 lit.) 10 metre long lateral (12mm) fitted with drippers (4 LPH), which can irrigate about 100 plants in approximately 15 m^2 area. The bucket is placed at a height of 1m (3 feet) and water is filled for 4 to 5 times daily.

2. Drum kit system

This system is ideally suitable to kitchen garden and small commercial vegetable growers. The drum is having 200 liter capacity which would supply water approximately 500 plants by filling the drum twice daily. It consists of lateral (16mm and 12mm). One number of 16mm lateral and five 12mm laterals are used. This system could cover an area of 120 m^2 (3 cents).

3. Micro sprinkler system

Micro sprinkler kit is suitable for farmers with access to pressurised water. It is very useful for groundnut, vegetables, nurseries home gardens, and lawns etc. It can be connected with a tap from an overhead tank or a domestic water pump. It consists of 15 micro sprinklers with pipes irrigating an area of 250 m^2 (6 cents). Fertigation can also be done through this method.

Sl.No.	Item	Selling Cost/Unit	Area covered by the kits
1.	Bucket Kit (Drip system)	Rs.225	20 m^2 (0.5 cent)
2.	Drum Kit (Drip system)	Rs.600 (Excluding Drum Cost)	120 m^2 (3.0 cents)
3.	Micro sprinkler kit	Rs.900	240 m^2 (6.0 cents)

Fertigation

Fertigation is a method of fertilizer application in which fertilizer is incorporated within the irrigation water by the drip system. In this system fertilizer solution is distributed evenly in irrigation. The availability of nutrients is very high therefore the efficiency is more. In this method liquid fertilizer as well as water soluble fertilizers are used. By this method, fertilizer use efficiency is increased from 80 to 90 per cent.

Fertilizer efficiencies of various application methods

Nutrient	Fertilizer use efficiency (%)	
	Soil application	Fertigation
Nitrogen	30-50	95
Phosphorous	20	45
Potassium	50	80

Advantages of fertigation

- Nutrients and water are supplied near the active root zone through fertigation which results in greater absorption by the crops.
- As water and fertilizer are supplied evenly to all the crops through fertigation there is possibility for getting 25-50 per cent higher yield.
- Fertilizer use efficiency through fertigation ranges between 80-90 per cent, which helps to save a minimum of 25 per cent of nutrients.
- By this way, along with less amount of water and saving of fertilizer, time, labour and energy use is also reduced substantially.

Water saving, yield and profit under drip and drip fertigation systems

Crops	Water Saving (%)	Yield (t/ha)			Profit (Rs/ha)		
		Conventional	Drip	Drip+ Fertgn	Conventional	Drip	Drip + Fertgn
Banana	35	26	30	37	81000	98000	120000
Sugarcane	29	120	160	207	30000	47000	68000
Tomato	32	45	56	65	56000	77000	95000
Aerobic rice	48	4.75	5.58	6.23	47470	55760	62270

Fertilizer used in fertigation

- Urea, potash and highly water soluble fertilizers are available for applying through fertigation.
- Application of super phosphorus through fertigation must be avoided as it makes precipitation of phosphate salts. Thus phosphoric acid is more suitable for fertigation as it is available in liquid form.
- Special fertilisers like mono ammonium phosphate (Nitrogen and Phosphorus), poly feed (Nitrogen, Phosphorus and Potassium), Multi K (Nitrogen and Potassium), Potassium sulphate (Potassium and Sulphur) are highly suitable for fertigation0 as they are highly soluble in water. Fe, Mn, Zn, Cu, B, Mo are also supplied along with special fertilisers.

Fertilizers commonly used in fertigation

Name	$N - P_2O_5 - K_2O$ content	Solubility (g/l) at 20 C
Ammonium nitrate	34-0-0	1830
Ammonium sulphate	21-0-0	760
Urea	46-0-0	1100
Monoammonium phosphate	12-61-0	282
Diammonium phosphate	18-46-0	575
Potassium chloride	0-0-60	347
Potassium nitrate	13-0-44	316
Potassium sulphate	0-0-50	110
Monopotassium phosphate	0-52-34	230
Phosphoric acid	0-52-0	457

Specialty water soluble fertilizers

Name	N %	P_2O_5 %	K_2O %
Polyfeed	19	19	19
Polyfeed	20	20	20
Polyfeed	11	42	11
Polyfeed	16	8	24
Polyfeed	19	19	19
Polyfeed	15	15	30
MAP	12	61	0
Multi-K	13	0	46
MKP	0	52	34
SOP	0	0	50

N fertigation

Urea is well suited for injection in micro irrigation system. It is highly soluble and dissolves in non-ionic form, so that it does not react with other substances in the water. Also urea does not cause precipitation problems. Urea, ammonium nitrate, ammonium sulphate, calcium ammonium sulphate, calcium ammonium nitrate are used as nitrogenous fertilizers in drip fertigation.

P fertigation

Application of phosphorus to irrigation water may cause precipitation of phosphate salts. Phosphoric acid and mono ammonium phosphate appears to be more suitable for fertigation.

K fertigation

Application of K fertilizer does not cause any precipitation of salts. Potassium nitrate, Potassium chloride, Potassium sulphate and mono potassium phosphate are used in drip fertigation.

Micro nutrients

Fe, Mn, Zn, Cu, B, Mo could be used as micro nutrients in drip fertigation.

Fertigation equipments

Three main groups of equipments used in drip system are :

- Ventury
- Fertilizer tank
- Fertilizer pump

Ventury

Construction in the main water flow pipe causes a pressure difference (Vaccum) which is sufficient to suck fertilizer solution from an open container into the water flow. It is very easy to handle and it is affordable even by small farmers. This equipment is most suitable for smaller area.

Fertilizer tank

A tank containing fertilizer solution is connected to the irrigation pipe at the supply point. Part of the irrigation water is diverted through the tank diluting the nutrient solution and returning to the main supply pipe. The concentration of fertilizer in the tank thus becomes gradually reduced.

Fertilizer pump

The fertilizer pump is a standard component of the control head. The fertilizer solution is held in non-pressurised tank and it can be injected into the irrigation water at any desired ratio. Therefore the fertilizer availability to each plants is maintained properly.

Cost of fertigation equipments

Sl.No.	Fertigation devices	Cost (Rs.)
1.	Ventury type	1200
2.	Fertilizer Tank	3000
3.	Injectors	12000

Economics of drip irrigation system

The initial investment in drip irrigation system is mainly depends upon the spacing of crops. The initial cost will be almost 20-25 thousand rupees per hectare for wider spacing crops such as coconut, mango, grapes and for orchard crops. The initial cost is approximately 50-70 thousand rupees per hectare for close spacing crops such as sugarcane, banana, papaya, mulberry, turmeric, tapioca, vegetables and flower crops.

Drip fertigation technology for aerobic rice

Surface drip fertigation

Under aerobic rice conditions, provision of surface drip fertigation (with 0.8 m lateral spacing provided with drippers at 0.3 m distance) scheduled at 125 % Pan Evaporation value for clay soil / 150 % open Pan Evaporation value for sandy soil + STCR based NPK fertigation + biofertigation of *Azophosmet* @ 500 mL ha^{-1} during panicle initiation and flag leaf stages is recommended.

Sub Surface drip biogation

Under aerobic rice conditions, provision of sub-surface drip fertigation (10 cm depth with 0.8 m lateral spacing provided with drippers at 0.3 m distance) scheduled at 125 % Pan Evaporation value for clay soil / 150 % open Pan Evaporation value for sandy soil + STCR based NPK fertigation + biofertigation of *Azophosmet* and seaweed extract each @ 500 mL ha^{-1} during panicle initiation and flag leaf stages is recommended.

AGROMETEOROLOGY

CROP PLANNING AND MANAGEMENT

DRYLAND

1. Length of Growing Period

Length of growing period is defined as a period in which the available soil moisture is enough to meet the evapotranspiration requirement of dry land crops and hence the dry land productivity is assured. Based on scientific study (Jeevananda Reddy, 1983), length of growing period for different rain gauge stations of each district of different agroclimatic zones of Tamil Nadu have been computed. The length of growing period is given as 'G' with starting and ending of length of growing period in terms of Meteorological standard weeks. If the G is less than 5 weeks period it means that always crop failures will occur. The G period must be a minimum of 14 weeks (98 days) which permit the dry land crop to attain its potential productivity. If the growing period is 14 weeks, a single dry land crop can be cultivated. If G period is between 14 to 20 weeks, suitable inter cropping system can be recommended. If the G period is more than 20 weeks long duration crop / double crop can be organized.

The following information indicates length of growing period for different district of Tamil Nadu. Based on the G period, suitable dry land crop may be selected.

1. North Eastern Zone

District	Station	G period (Met. Standard week)	No. of G period (No. of weeks)
Thiruvaalur	Athipettu	34-52	19
	Ponneri	33-52	20
	Poonamallee	32-52	21
	Saidapet	32-52	21
	Tirutani	31-50	20
	Tiruvallur	31-51	21
Kanchipuram	Chengalpattu	30-52	23
	Cheyur	33-52,1	21
	Covelong	31-52	22
	Kanchipuram	29-51	23
	Madurantakam	30-52	23
	Sriperumudur	31-51	21
	Uttiramerur	30-51	22
	Vayalur	34-52	19
Vellore	Ambur	33-46	14
	Arakkonam	29-51	13
	Gudiyattam	33-47	15
	Sholingnur	31-49	19
	Tiruppattur	31-45	15
	Vaniyambadi	32-45	14
	Vellore	30-50	21
	Walajapet	30-50	21
Tiruvannamalai	Arani	30-50	21
	Chengam	31-49	19
	Cheyyar	30-50	21
	Polur	30-50	21
	Tiruvannamalai	31-50	20
	Vandavasi	29-51	23

District	Station	G period (Met. Standard week)	No. of G period (No. of weeks)
Viluppuram	Gingee	30-51	22
	Tindivanam	31-52	22
	Tirukkovilur	30-50	21
	Ulundurpettai	32-51	20
	Vanur	32-52,1	22
	Viluppuram	31-51	21
Cuddalore	Cuddalore	32-52,1,2	23
	Kurinjippadi	32-52,1	22
	Marakkanam	32-52	21
	Panruti	31-52	22
	Porto Novo	33-52, 1,2	22
	Srimushnam	33-52	20
	Tittagudi	31-51	21
	Vriddhachalam	31-51	21
Perambalur	Chettikulam	35-48	14
	Jayamkonda cholapuram	35-52	18
	Uppiliyapuram	38-48	11
Chennai	Nungambakkam	32-52	21

2. North Western Zone

District	Station	G period (Met. Standard week)	No. of G period (No. of weeks)
Dharmapuri	Denkanikota	32-46	15
	Dharmapuri	32-46	15
	Harur	33-47	15
	Hosur	33-45	13
	Krishnagiri	33-45	13
	Palacode	32-46	15
	Pennagaram	33-45	13
	Rayakottai	33-46	14
	Thalli	31-44	14
	Uttangarai	31-46	16
Salem	Attur	33-48	16
	Omalur	29-45	17
	Salem	27-45	19
	Sankari Durg	33-45	13
	Tammampatti	34-49	16
	Valapadi	33-46	14
Namakkal	Namakkal	33-46	14
	Paramathi	35-45	11
	Rasipuram	30-45	16
	Sendamangalam	32-45	14
Perambalur	Ariyalur	35-50	16
	Perambalur	35-50	16

3. Western Zone

District	Station	G period (Met. Standard week)	No. of G period (No. of weeks)
Coimbatore	Annur	38-47	10
	Avanashi	38-47	10
	Coimbatore	41-47	7
	Mettupalayam	39-50	12
	Palladam	41-47	7
	Periyanaiakampalayam	38-49	12
	Pollachi	24-31, 41-47	8, 7

	Sulur	41-46	6
	Tiruppur	38-47	10
	Udumalaipettai	41-48	8
Erode	Bhavani	34-47	14
	Dharapuram	40-47	8
	Erode	34-47	14
	Gopichettipalayam	35-47	13
	Kangayam	38-47	10
	Kodumudi	38-44	7
	Perundurai	35-47	13
	Sathyamangalam	35-47	13
	Talavadi	34-45	12
Namakkal	Tiruchengodu	34-45	12
Karur	Aravakkurichi	39-46	8
	Karur	39-45	7
Dindigul	Nilakottai	36-47	12
	Palani	40-49	10
Theni	Periakulam	38-49	12
	Uttamapalayam	40-48	9
Madurai	Usilampatti	36-49	14
Tiruchchirapalli	Manaparai	36-48	13

4. Cauvery Delta Zone

District	Station	G period Met. Standard week)	No. of G period (No. of weeks)
Thanjavur	Atirampattinam	34-52	19
	Kattuumvadi	39-51	13
	Kumbakonam	34-52	19
	Papanasam	35-52	18
	Pattukottai	35-52	18
	Thanjavur	35-51	17
	Tirukkatupalli	35-49	15
	Vallam	33-50	18
Thiruvarur	Kudavasal	35-52,1	19
	Mannargudi	34-52,1	20
	Muttupet	35-52,1,2	20
	Nannilam	35-52,1	19
	Neidavasal	35-52,1,2	20
	Nidamangalam	35-52,1	19
	Thiruvaiyaru	35-50	16
	Thiruvarur	35-52,1,2	20
	Tirutturaippundi	35-52,1,2	20
	Valangiman	35-52	18
Nagapattinam	Mayuram	35-52,1	19
	Nagapattinam	37-52,1,2	18
	Sirkazhi	34-52,1,2	21
	Tarangambadi	35-52,1,2	20
	Tiruppundi	36-52,1,2,3	20
	Vedaranniyam	35-52,1,2,3	21
Tiruchchirapalli	Kulattur	36-48	13
	Kulittalai	38-47	10
	Lalgudi	38-49	12
	Manapparai	36-48	13
	Musiri	38-47	10
	Tattayyangarpettai	36-47	12
	Tiruchchirapalli	36-48	13

Perambalur	Turaiyur	36-47	12
Cuddalore	Chidambaram	33-52,1,2	22
	Kattumannarkovil	33-52,1	21
Pudukkottai	Arantangi	34-50	17

5. Southern Zone

District	Station	G period (Met. Standard week)	No. of G period (No. of weeks)
Ramanathapuram	Kamudi	41-47	7
	Mudukulattur	41-49	9
	Pamban	42-52,1	12
	Paramakudi	40-48	9
	Ramanathapuram	41-52	12
	Theethanathanam	41-51	11
	Tiruvadanai	41-50	10
	Vattaram	41-51	11
Virudunagar	Arupukottai	39-48	10
	Sattur	41-48	8
	Sivakasi	41-48	8
	Srivilliputtur	41-49	9
	Virudunagar	38-48	11
	Watrap	39-50	12
Tuticorin	Arasadi	43-49	7
	Kayattur	41-49	9
	Kovilpatti	41-49	9
	Kulasekarapatnam	42-52	11
	Morekulam	42-51	10
	Ottappidaram	41-48	8
	Sattankulam	42-50	9
	Srivaikuntam	42-50	9
	Tiruchchendur	42-52	11
	Tuticorin	43-50	8
Tirunelveli	Ambasamudram	42-52,1	12
	Ayikudi	42-51	10
	Kadaiyam	42-52,1	12
	Kadaiyanallur	42-51	10
	Kirnurnam	43-51	9
	Nanguneri	42-51	10
	Palayamkottai	42-50	9
	Radhapuram	42-49	8
	Sankarankovil	41-49	9
	Shencottah	41-51	11
	Sivagiri	41-52	12
	Tenkasi	41-52	12
	Tirunelveli	42-51	10
Sivaganga	Manamadurai	39-48	10
	Sivaganga	35-48	14
	Tirupattur	33-48	16
Madurai	Cholavandan	36-48	13
	Madurai	34-48	15
	Melur	33-49	17
	Nattam	33-49	17
	Peraiyur	36-49	14
	Tirumangalam	34-49	16
Pudukkottai	Adanakottai	37-49	13
	Alangudi	36-50	15

	Annavasal	36-47	12
	Ilupur	36-48	13
	Karambakkudi	38-50	13
	Kilanilai	38-49	12
	Marungapuri	35-49	15
	Ponnamaravati	34-48	15
	Pudukkottai	35-49	15
	Tirumayam	36-48	13
	Udyalipatti	37-47	11
	Viralimalai	38-48	11
Dindigul	Chattrapatti	38-50	13
	Dindigul	36-49	14
	Vedasunthur	38-48	11
Theni	Bodinayakanur	39-48	10

6. High Rainfall Zone

District	Station	G period (Met. Standard week)	No. of G period (No. of weeks)
Kanyakumari	Aramboli	41-49	9
	Eranial	19-29, 39-48	11, 10
	Kalial	14-50	37
	Kolachel	21-30, 40-48	10, 9
	Kottaram	42-48	7
	Kulasegraram	12-50	39
	Kuzhitturai	15-48	34
	Meycode adanadi	15-49	35
	Mulakumood	15-31, 40-49	17, 10
	Nagerkoil	20-26, 40-48	7, 9
	P.P. Channel	16-29, 40-50	14, 11
	Pechiaprai	13-50	38
	Puthendam	13-50	38
	Rajakkammangalam	19-27, 40-48	9, 9
	Seetapal	19-26, 40-48	8, 9
	Shorlakode	18-25, 36-47	8, 12
	Thadikarekonam	14-49	36
	Thamaraikulam	42-47	6

7. Hilly and High Altitude Zone

District	Station	G period (Met. Standard week)	No. of G period (No. of weeks)
The Nilgiris	Devala	17-50	34
	Glen Morgan	16-50	35
	Gudalur	17-49	33
	Kallatty	17-51	35
	Ketty	18-52,1	36
	Kodanadu	18-52,1,2	37
	Kotagiri	14-52,1-3	40
	Kundha (Kailkund)	21-52,1	33
	Naduvattam	16-49	34
	Ootacamund	16-51	36
Coimbatore	Anaimalai	32-52,1	22
Dindigul	Kodaikanal	32-52,1	22
Salem	Yercaud	34-50	17

2. Climate of Tamil Nadu

South West Monsoon

Arid	Semi arid	Humid
(MI = (-) 66.7 to (-) 100)	(MI = (-) 66.7 to (-) 33.3)	(MI = 20 to 80)
Coimbatore, Erode, Tiruchirapalli, Karur, Perambalur, Madurai, Theni, Dindugal, Ramanathapuram, Sivagangai,Viruudunagar, Tirunelveli, Tuticorin	Kanchipuram, Thrivallur Cuddalore, Villupuram Dharmapuri , Krishnagiri Salem ,Namakal Pudukottai Thanjavur ,Nagai & Thiruvarur Kanyakumari Velore, Thiruvannamalai	**The Nilgiris**

North East Monsoon

Dry sub humid	Moist sub humid	Per humid
MI= (-) 33 to 0	MI= 0 to 20	MI=100 and above.
Coimbatore, Erode, Dharmapuri, Krishnagiri. Salem, Namakal	Triuchirapalli, Karur, Perambalur, Pudukottai, Madurai, Theni, Dindugal, Sivagangai, Vridunagar, Ramanathapuram, Kanchipuram, Thiruvallur, Vellore, Tiruvannamalai, Cuddalore,Villupuram, Thanjavur, Nagai, Thiruvarur, Kanyakumari, Thirunelveli, Tuticorin	The Nilgiris

3. Rain fall pattern in Tamil Nadu

The rainfall pattern of Tamil Nadu based on the criteria of rainfall quantity and Seasons of precipitation is given below: (NCA, 1976)

A = > 30 cm rainfall per month
B = 30-20 cm rainfall per month
C = 20-10 cm rainfall per month
D = 10-5 cm rainfall per month
E = < 5 cm rainfall per month

Three distinct seasons have been considered

Pre monsoon season	:	February to May
Monsoon season	:	June to September
Post monsoon season	:	October to January

Considering the distribution of rainfall within a season, a standard pattern is developed.

This is explained through the following example

A_2 B_2 (C_1 B_1 A_1 E_1) C_2 D_1 E_1

Where in,

i) Alphabets in bracket denote rainfall in monsoon season months.
ii) Left to bracket denotes rainfall in pre-monsoon months.
iii) Right to bracket denotes rainfall in post monsoon months.
iv) Numerical suffix gives the number of months.

Rainfall pattern in Tamil Nadu

Rainfall	Taluks in which the pattern is seen
$E_4 (E_4) C_2 E_2$	Aruppukottai, Paramakudi, Muthukulathur, Thiruvadanai, Sathur, Srivilliputhur, Kovilpatti, Vilathikulam, Sankarankovil, Thoothukudi, Srivaikuntam, Udumalpet, Coimbatore, Dharapuram, Palladam, Gobichettipalayam, Bhavani, Erode, Avinashi, Uthamapalayam, Palani, Kodaikanal, Vedasandur, Dindugul, Nilakottai, Usilampatti, Thirumangalam, Periakulam, Karur
$E_4 (E_4) B_1 C_2 E_1$	Tiruchendur, Nanguneri, Tirunelveli, Ambasamudram, Ramanathapuram
$E_4 (E_4) A_1 B_2 E_1$	Nagapattinam, Thiruthuraipoondi, Lalgudi, Musiri
$E_4 (C_1 E_3) C_2 E_2$	Thuraiyur, Kulithalai, Tiruchirappalli, Manapparai, Pollachi, Agastheswaram
$E_4 (C_1 E_3) A_1 B_1 C_1 E_1$	Mayavaram, Nannilam
$E_4 (C_2 E_2) C_1 E_3$	Vaniyambadi, Thirupathur, Uthankarai, Thirukoilur, Kallakurichi, Perambalur, Kulathur, Alangudi, Thirumayam, Harur, Athur, Thanjavur, Aranthangi, Arakkonam, Walajapet, Cheyyar, Arani, Polur, Chengam, Thiruvannamalai,,Gudiyatham, Vellore, Thiruthani, Madurai North, Madurai South, Melur, Thirupathur, Sivaganga, Chengam, Wandavasi.
$E_4 (C_2 E_2) B_1 C_2 E_1$	Virudhachalam, Ariyalur, Udayarpalayam, Kumbakonam, Papanasam, Mannargudi, Pattukottai, Orathanadu, Tenkasi, Shencottai, Thiruvallur, Sriperumpudur, Kanchipuram, Chengalpattu, Maduranthagam, Tindivanam, Villupuram.
$E_4 (C_2 E_2) A_1 B_1 C_1 E_1$	Ponneri, Saidapet, Chidambaram, Sirkazhi.
$C_1 E_3 (C_1 E_3) C_1 E_3$	Hosur, Denkanikottai,
$C_1 E_3 (C_2 E_2) C_1 E_3$	Omalur, Krishnagiri, Dharmapuri, Mettur, Salem, Rasipuram, Sangagiri, Thiruchengodu, Namakkal.

4. Pre monsoon sowing

Based on the probability of receiving sowing rains, pre monsoon dry seeding weeks have been identified for the different districts of Tamil Nadu, which is feasible in Vertisols.

Name of the Districts	Sowing STD week	Dates
1. Coimbatore & Erode	37 to 38	Sep 10 to 23
2. Dharmapuri	38 to 39	Sep 17 to 30
3. Vellore	36 to 37	Sep 3 to 16
4. Ramanathapuram	40 to 41	Oct 1 to 14
5. Thoothukudi	39 to 40	Sep 24 to Oct 7
6. Thrinelveli	39 to 40	Sep 24 to Oct 7
7. Virudhunagar	38 to 39	Sep 17 to 30

5. Water balance study

Water balance study was conducted for Tamil Nadu based on the Water Requirement Satisfaction Index (WRSI). It is suggested that sorghum can be sown during 36th Std week against 16th Std week. The data from the Table indicate that if it is sown during 16th Std week, the crop may suffer with soil moisture stress. This result is valid for sorghum crop for Manapparai Taluk sowing by 36th standard week is recommended.

Manapparai - Sorghum crop

Manapparai (16th week sowing)			Manapparai (36th week sowing)		
STD week	Date	WRSI	STD week	Date	WRSI
16	April 16 - 22	100.00	36	Sep 3 - 9	100
17	April 23 - 29	100.00	37	Sep 10 - 16	100
18	April 30-May 6	97.78	38	Sep 17 - 23	100
19	May 7 - 13	95.81	39	Sep 24 - 30	100

20	May 14 - 20	92.11	40	Oct 1 - 7	100
21	May 21 - 27	87.59	41	Oct 8 - 14	100
22	May 28 -Jun 3	81.80	42	Oct 15 - 21	100
23	June 4 - 10	74.58	43	Oct 22 - 28	100
24	June 11 - 17	66.13	44	Oct 29 - Nov 4	100
25	June 18 - 24	54.06	45	Nov 5 - 11	100
26	June 25-July 1	48.29	46	Nov 12 - 18	100
27	July 2 - 8	43.93	47	Nov 19 - 25	100
28	July 9 - 15	43.93	48	Nov 26 - Dec 2	100

Similar study was undertaken for Namakkal Taluk for Groundnut sowing:

The result indicates that, rainfed groundnut sowing can be taken in the order of 28th Std week, 26th Std week, 23rd Std week.

Further studies were made from water balance for rainfed crops of Virudhunagar district and the information are presented in the Table *

District	Location	Crop	Soil	Sowing week (MSW)	Final harvest (MSW)	Moisture stress period(MSW)
Virudhunagar	Aruppukottai	Cotton	Black	36	4	1 to 4
Virudhunagar	Rajapalayam	Cotton	Black	36	4	3 to 4
Virudhunagar	Sattur	Cotton	Black	36	4	1 to 4
Virudhunagar	Srivilliputtur	Cotton	Black	36	4	2 to 4
Virudhunagar	Tiruchuli	Cotton	Black	36	4	1 to 4
Virudhunagar	Virudhunagar	Cotton	Black	36	4	1 to 4
Virudhunagar	Aruppukottai	Cotton	Black	37	5	1 to 5
Virudhunagar	Rajapalayam	Cotton	Black	37	5	2 to 5
Virudhunagar	Sattur	Cotton	Black	37	5	1 to 5
Virudhunagar	Srivilliputtur	Cotton	Black	37	5	2 to 5
Virudhunagar	Tiruchuli	Cotton	Black	37	5	51to 5
Virudhunagar	Virudhunagar	Cotton	Black	37	5	2 to 5
Virudhunagar	Aruppukottai	Cotton	Black	38	6	1 to6
Virudhunagar	Rajapalayam	Cotton	Black	38	6	2 to 6
Virudhunagar	Sattur	Cotton	Black	38	6	1 to 6
Virudhunagar	Srivilliputtur	Cotton	Black	38	6	2 to 6
Virudhunagar	Tiruchuli	Cotton	Black	38	6	51to 6
Virudhunagar	Virudhunagar	Cotton	Black	38	6	1 to 6
Virudhunagar	Aruppukottai	Cotton	Black	39	7	1 to 7
Virudhunagar	Rajapalayam	Cotton	Black	39	7	2 to 7
Virudhunagar	Sattur	Cotton	Black	39	7	1 to 7
Virudhunagar	Srivilliputtur	Cotton	Black	39	7	2 to 7
Virudhunagar	Tiruchuli	Cotton	Black	39	7	1 to 7
Virudhunagar	Virudhunagar	Cotton	Black	39	7	1 to 7
Virudhunagar	Aruppukottai	Cotton	Red	36	4	49 to 4
Virudhunagar	Rajapalayam	Cotton	Red	36	4	51 to 4
Virudhunagar	Sattur	Cotton	Red	36	4	52 to 4
Virudhunagar	Srivilliputtur	Cotton	Red	36	4	50 to 4
Virudhunagar	Tiruchuli	Cotton	Red	36	4	49 to 4
Virudhunagar	Virudhunagar	Cotton	Red	36	4	51 to 4
Virudhunagar	Aruppukottai	Cotton	Red	37	5	50 to 5
Virudhunagar	Rajapalayam	Cotton	Red	37	5	51 to 5
Virudhunagar	Sattur	Cotton	Red	37	5	50 to 5
Virudhunagar	Srivilliputtur	Cotton	Red	37	5	50 to 5

Virudhunagar	Tiruchuli	Cotton	Red	37	5	49 to 5
Virudhunagar	Virudhunagar	Cotton	Red	37	5	51 to 5
Virudhunagar	Aruppukottai	Cotton	Red	38	6	50 to 6
Virudhunagar	Rajapalayam	Cotton	Red	38	6	51 to 6
Virudhunagar	Sattur	Cotton	Red	38	6	50 to 6
Virudhunagar	Srivilliputtur	Cotton	Red	38	6	51 to 6
Virudhunagar	Tiruchuli	Cotton	Red	38	6	49 to 6
Virudhunagar	Virudhunagar	Cotton	Red	38	6	50 to 6
Virudhunagar	Aruppukottai	Cotton	Red	39	7	51 to 7
Virudhunagar	Rajapalayam	Cotton	Red	39	7	51 to 7
Virudhunagar	Sattur	Cotton	Red	39	7	51 to 7
Virudhunagar	Srivilliputtur	Cotton	Red	39	7	51 to 7
Virudhunagar	Tiruchuli	Cotton	Red	39	7	50 to 7
Virudhunagar	Virudhunagar	Cotton	Red	39	7	50 to 7
Virudhunagar	Aruppukottai	Pulses	Black	36	48	-
Virudhunagar	Rajapalayam	Pulses	Black	36	48	-
Virudhunagar	Sattur	Pulses	Black	36	48	-
Virudhunagar	Srivilliputtur	Pulses	Black	36	48	-
Virudhunagar	Tiruchuli	Pulses	Black	36	48	-
Virudhunagar	Virudhunagar	Pulses	Black	36	48	-
Virudhunagar	Aruppukottai	Pulses	Black	37	49	-
Virudhunagar	Rajapalayam	Pulses	Black	37	49	-
Virudhunagar	Sattur	Pulses	Black	37	49	-
Virudhunagar	Srivilliputtur	Pulses	Black	37	49	-
Virudhunagar	Tiruchuli	Pulses	Black	37	49	-
Virudhunagar	Virudhunagar	Pulses	Black	37	49	-
Virudhunagar	Aruppukottai	Pulses	Black	38	50	-
Virudhunagar	Rajapalayam	Pulses	Black	38	50	-
Virudhunagar	Sattur	Pulses	Black	38	50	-
Virudhunagar	Srivilliputtur	Pulses	Black	38	50	-
Virudhunagar	Tiruchuli	Pulses	Black	38	50	-
Virudhunagar	Virudhunagar	Pulses	Black	38	50	-
Virudhunagar	Aruppukottai	Pulses	Black	39	51	-
Virudhunagar	Rajapalayam	Pulses	Black	39	51	-
Virudhunagar	Sattur	Pulses	Black	39	51	-
Virudhunagar	Srivilliputtur	Pulses	Black	39	51	-
Virudhunagar	Tiruchuli	Pulses	Black	39	51	-
Virudhunagar	Virudhunagar	Pulses	Black	39	51	-
Virudhunagar	Aruppukottai	Pulses	Red	36	48	-
Virudhunagar	Rajapalayam	Pulses	Red	36	48	-
Virudhunagar	Sattur	Pulses	Red	36	48	-
Virudhunagar	Srivilliputtur	Pulses	Red	36	48	-
Virudhunagar	Tiruchuli	Pulses	Red	36	48	-
Virudhunagar	Virudhunagar	Pulses	Red	36	48	-
Virudhunagar	Aruppukottai	Pulses	Red	37	49	-
Virudhunagar	Rajapalayam	Pulses	Red	37	49	-
Virudhunagar	Sattur	Pulses	Red	37	49	-
Virudhunagar	Srivilliputtur	Pulses	Red	37	49	-
Virudhunagar	Tiruchuli	Pulses	Red	37	49	-
Virudhunagar	Virudhunagar	Pulses	Red	37	49	-
Virudhunagar	Aruppukottai	Pulses	Red	39	51	-
Virudhunagar	Rajapalayam	Pulses	Red	39	51	-
Virudhunagar	Sattur	Pulses	Red	39	51	-
Virudhunagar	Srivilliputtur	Pulses	Red	39	51	-
Virudhunagar	Tiruchuli	Pulses	Red	39	51	-
Virudhunagar	Virudhunagar	Pulses	Red	39	51	-

Virudhunagar	Aruppukottai	Redgram	Black	36	01	-
Virudhunagar	Rajapalayam	Redgram	Black	36	01	-
Virudhunagar	Sattur	Redgram	Black	36	01	-
Virudhunagar	Srivilliputtur	Redgram	Black	36	01	-
Virudhunagar	Tiruchuli	Redgram	Black	36	01	-
Virudhunagar	Virudhunagar	Redgram	Black	36	01	-
Virudhunagar	Aruppukottai	Redgram	Black	37	02	-
Virudhunagar	Rajapalayam	Redgram	Black	37	02	-
Virudhunagar	Sattur	Redgram	Black	37	02	-
Virudhunagar	Srivilliputtur	Redgram	Black	37	02	-
Virudhunagar	Tiruchuli	Redgram	Black	37	02	-
Virudhunagar	Virudhunagar	Redgram	Black	37	02	-
Virudhunagar	Aruppukottai	Redgram	Black	38	03	-
Virudhunagar	Rajapalayam	Redgram	Black	38	03	-
Virudhunagar	Sattur	Redgram	Black	38	03	03
Virudhunagar	Srivilliputtur	Redgram	Black	38	03	-
Virudhunagar	Tiruchuli	Redgram	Black	38	03	-
Virudhunagar	Virudhunagar	Redgram	Black	38	03	-
Virudhunagar	Aruppukottai	Redgram	Red	36	01	-
Virudhunagar	Rajapalayam	Redgram	Red	36	01	-
Virudhunagar	Sattur	Redgram	Red	36	01	-
Virudhunagar	Srivilliputtur	Redgram	Red	36	01	-
Virudhunagar	Tiruchuli	Redgram	Red	36	01	-
Virudhunagar	Virudhunagar	Redgram	Red	36	01	-
Virudhunagar	Aruppukottai	Redgram	Red	37	02	-
Virudhunagar	Rajapalayam	Redgram	Red	37	02	-
Virudhunagar	Sattur	Redgram	Red	37	02	02
Virudhunagar	Srivilliputtur	Redgram	Red	37	02	-
Virudhunagar	Tiruchuli	Redgram	Red	37	02	02
Virudhunagar	Virudhunagar	Redgram	Red	37	02	01 to 02
Virudhunagar	Aruppukottai	Redgram	Red	38	03	02 to 03
Virudhunagar	Rajapalayam	Redgram	Red	38	03	03
Virudhunagar	Sattur	Redgram	Red	38	03	01 to 03
Virudhunagar	Srivilliputtur	Redgram	Red	38	03	03
Virudhunagar	Tiruchuli	Redgram	Red	38	03	01 to 03
Virudhunagar	Virudhunagar	Redgram	Red	38	03	01 to 03
Virudhunagar	Aruppukottai	Sorghum	Black	36	52	48 to 52
Virudhunagar	Rajapalayam	Sorghum	Black	36	52	-
Virudhunagar	Sattur	Sorghum	Black	36	52	49 to 52
Virudhunagar	Srivilliputtur	Sorghum	Black	36	52	-
Virudhunagar	Tiruchuli	Sorghum	Black	36	52	48 to 52
Virudhunagar	Virudhunagar	Sorghum	Black	36	52	49 to 52
Virudhunagar	Aruppukottai	Sorghum	Black	37	01	49 to 01
Virudhunagar	Rajapalayam	Sorghum	Black	37	01	-
Virudhunagar	Sattur	Sorghum	Black	37	01	50 to 01
Virudhunagar	Srivilliputtur	Sorghum	Black	37	01	-
Virudhunagar	Tiruchuli	Sorghum	Black	37	01	49 to 01
Virudhunagar	Virudhunagar	Sorghum	Black	37	01	50 to 01
Virudhunagar	Aruppukottai	Sorghum	Black	38	02	50 to 02
Virudhunagar	Rajapalayam	Sorghum	Black	38	02	-
Virudhunagar	Sattur	Sorghum	Black	38	02	51 to 02
Virudhunagar	Srivilliputtur	Sorghum	Black	38	02	02
Virudhunagar	Tiruchuli	Sorghum	Black	38	02	49 to 02
Virudhunagar	Virudhunagar	Sorghum	Black	38	02	51 to 02
Virudhunagar	Aruppukottai	Sorghum	Black	39	03	52 to 03
Virudhunagar	Rajapalayam	Sorghum	Black	39	03	01 to 03

Virudhunagar	Sattur	Sorghum	Black	39	03	51 to 03
Virudhunagar	Srivilliputtur	Sorghum	Black	39	03	02 to 03
Virudhunagar	Tiruchuli	Sorghum	Black	39	03	50 to 03
Virudhunagar	Virudhunagar	Sorghum	Black	39	03	51 to 03
Virudhunagar	Aruppukottai	Sorghum	Red	36	52	48 to 52
Virudhunagar	Rajapalayam	Sorghum	Red	36	52	-
Virudhunagar	Sattur	Sorghum	Red	36	52	49 to 52
Virudhunagar	Srivilliputtur	Sorghum	Red	36	52	-
Virudhunagar	Tiruchuli	Sorghum	Red	36	52	48 to 52
Virudhunagar	Virudhunagar	Sorghum	Red	36	52	49 to 52
Virudhunagar	Aruppukottai	Sorghum	Red	37	01	49 to 01
Virudhunagar	Rajapalayam	Sorghum	Red	37	01	51 to 01
Virudhunagar	Sattur	Sorghum	Red	37	01	50 to 01
Virudhunagar	Srivilliputtur	Sorghum	Red	37	01	52 to 01
Virudhunagar	Tiruchuli	Sorghum	Red	37	01	49 to 01
Virudhunagar	Virudhunagar	Sorghum	Red	37	01	49 to 01
Virudhunagar	Aruppukottai	Sorghum	Red	38	02	49 to 02
Virudhunagar	Rajapalayam	Sorghum	Red	38	02	51 to 02
Virudhunagar	Sattur	Sorghum	Red	38	02	50 to 02
Virudhunagar	Srivilliputtur	Sorghum	Red	38	02	51 to 02
Virudhunagar	Tiruchuli	Sorghum	Red	38	02	49 to 02
Virudhunagar	Virudhunagar	Sorghum	Red	38	02	49 to02
Virudhunagar	Aruppukottai	Sorghum	Red	39	03	50 to 03
Virudhunagar	Rajapalayam	Sorghum	Red	39	03	51 to 03
Virudhunagar	Sattur	Sorghum	Red	39	03	50 to 03
Virudhunagar	Srivilliputtur	Sorghum	Red	39	03	51 to 03
Virudhunagar	Tiruchuli	Sorghum	Red	39	03	49 to 03
Virudhunagar	Virudhunagar	Sorghum	Red	39	03	49 to 03
Virudhunagar	Aruppukottai	Sunflower	Black	43	03	-
Virudhunagar	Rajapalayam	Sunflower	Black	43	03	-
Virudhunagar	Sattur	Sunflower	Black	43	03	02 to 03
Virudhunagar	Srivilliputtur	Sunflower	Black	43	03	-
Virudhunagar	Tiruchuli	Sunflower	Black	43	03	02 to 03
Virudhunagar	Virudhunagar	Sunflower	Black	43	03	02 to 03
Virudhunagar	Aruppukottai	Sunflower	Black	44	04	02 to 04
Virudhunagar	Rajapalayam	Sunflower	Black	44	04	04
Virudhunagar	Sattur	Sunflower	Black	44	04	02 to 04
Virudhunagar	Srivilliputtur	Sunflower	Black	44	04	04
Virudhunagar	Tiruchuli	Sunflower	Black	44	04	01 to 04
Virudhunagar	Virudhunagar	Sunflower	Black	44	04	02 to 04
Virudhunagar	Aruppukottai	Sunflower	Red	43	03	52 to 03
Virudhunagar	Rajapalayam	Sunflower	Red	43	03	01 to 03
Virudhunagar	Sattur	Sunflower	Red	43	03	52 to 03
Virudhunagar	Srivilliputtur	Sunflower	Red	43	03	01 to 03
Virudhunagar	Tiruchuli	Sunflower	Red	43	03	51 to 03
Virudhunagar	Virudhunagar	Sunflower	Red	43	03	52 to 03
Virudhunagar	Aruppukottai	Sunflower	Red	44	04	01 to 04
Virudhunagar	Rajapalayam	Sunflower	Red	44	04	01 to 04
Virudhunagar	Sattur	Sunflower	Red	44	04	52 to 04
Virudhunagar	Srivilliputtur	Sunflower	Red	44	04	01 to 04
Virudhunagar	Tiruchuli	Sunflower	Red	44	04	51 to 04
Virudhunagar	Virudhunagar	Sunflower	Red	44	04	52 to 04
Virudhunagar	Aruppukottai	Groundnut	Red	26	41	33 to 41
Virudhunagar	Rajapalayam	Groundnut	Red	26	41	31 to 41
Virudhunagar	Sattur	Groundnut	Red	26	41	30 to 41
Virudhunagar	Srivilliputtur	Groundnut	Red	26	41	29 to 41

Virudhunagar	Tiruchuli	Groundnut	Red	26	41	32 to 41
Virudhunagar	Virudhunagar	Groundnut	Red	26	41	30 to 41
Virudhunagar	Aruppukottai	Groundnut	Red	27	42	33 to 42
Virudhunagar	Rajapalayam	Groundnut	Red	27	42	31 to 42
Virudhunagar	Sattur	Groundnut	Red	27	42	31 to 42
Virudhunagar	Srivilliputtur	Groundnut	Red	27	42	31 to 42
Virudhunagar	Tiruchuli	Groundnut	Red	27	42	32 to 42
Virudhunagar	Virudhunagar	Groundnut	Red	27	42	32 to 42
Virudhunagar	Aruppukottai	Groundnut	Red	28	43	33 to 43
Virudhunagar	Rajapalayam	Groundnut	Red	28	43	31 to 43
Virudhunagar	Sattur	Groundnut	Red	28	43	32 to 43
Virudhunagar	Srivilliputtur	Groundnut	Red	28	43	32 to 43
Virudhunagar	Tiruchuli	Groundnut	Red	28	43	33 to 43
Virudhunagar	Virudhunagar	Groundnut	Red	28	43	33 to 43

* Note: During moisture stress period suitable agro- techniques may be adopted. If moisture stress period is long concerned sowing week may not be viable.

6. Weather Based Management Technologies

i) Nutrient management for *thaladi* season rice

Application of 200:75:75kg NPK/ha for November 15th transplanted crop (Co45 or Co43) under split application of N at 40, 20, 20 and 20% respectively during basal, active tillering, panicle initiation and flowering while 75 percent P and K as basal and 12.5 percent P and K as foliar spray twice at panicle initiation and flowering stages.

ii) Acceptable *insitu* moisture conservation practice for rainfed groundnut –sunflower and maize

During South West monsoon season groundnut sowing along the contour and ridging to be done three weeks after sowing. During NEM, especially for sunflower, the same technology of contour sowing followed by ridging three weeks latter can be adopted. In respect of maize, sowing and tieing alternate furrows with mulching of locally available material can be practiced.

iii) Sustainable dryland management for hybrid maize (UMH 28)

Sowing of dry land hybrid maize at 38th meteorological standard week (17th – 23 Sept.) with modified crop production recommendation based on medium range weather forecast is suggested.

iv) Time of sowing and nutrient level for sorghum under different rainfall situations in dryland (black soil) of western agro climate zone of Tamil Nadu

Sowing of sorghum variety CSV15 before the receipt of monsoon rainfall (Premonsoon sowing) is recommended with 60:30:0 kg NPK / ha during above average rainfall year and 40:20:0 Kg NPK / ha during below average rainfall year. The result is applicable when seasonal climate forecast information is available in advance.

v) Technical feasibility of introducing new irrigated cropping system of Greengram – Maize – Sunflower against the outdated cropping system of Cotton – Sorghum – Finger millet of western agro climatic zone of Tamil Nadu

Sowing of crops at normal sowing of concerned crops viz.; 33 Meteorological Standard Week (MSW) for (Aug 13-19) greengram, 48th MSW (Nov 26-Dec2) for maize and 15th MSW (April 9-15) for sunflower with 100 percent inorganic source of recommended nutrients for green gram (12.5:50:0 kg NPK / ha) and sunflower (40:20:20 kg NPK/ ha) and 25% organic N alone and 75 percent inorganic source of nutrient recommended to maize (135:62.5: 50 kg NPK/ ha) for the new tailored cropping system of Greengram –Maize – Sunflower.

vi) Potential season and sowing window for CoH3 Hybrid Maize under irrigated condition

Sowing of irrigated Maize hybrid CoH3 in the second fortnight of August during *Kharif* season with integrated application of both organics and inorganic at 50:50 either as blanket (135:625:50 kg NPK/ha) or as soil test based recommendation.

vii) Potential transplanting window for hybrid rice

Planting hybrid rice CORH2 either on 26th September or at 3rd October as compared to planting in normal date of planting of 19th September which is recommended for planting rice variety especially for the variety ADT39.

viii) Polyethylene film mulch for irrigated groundnut

Spreading of seven micron thickness black polyethylene film as mulch to irrigated groundnut along with pre-plant incorporation of fluchloralin @ 1.0 kg ai/ha under flat bed system.

ix) Forewarning disease incidence in groundnut

Forewarning model was developed against late leaf spot and rust diseases in groundnut. The model was validated and the deviation is around 10 percent. The model was developed for both for Aliyarnagar (mountain climate) and Vridhachalam (Marine climate) domain.

Late leaf spot disease

i. Aliyarnagar domain	
Y = -755.72 + 18.54 Z11	Y = Percent disease incidence
ii. Vridhachalam domain	Z11 = Weighted maximum temperature
Y = 671.21 + 12.44 Z11	

Rust disease

i. Aliyarnagar domain	
Y= - 699.58 + 21.05 Z11	Y = Percent disease incidence
ii. Vridhachalam domain	Z11 = Weighted maximum temperature
Y = 599.23 + 9.16 Z11	

7. Basic information

i. Crop – weather studies

Rice grain yield of *Kuruvai* and *Thaladi* seasons over 30 years (1961 – 1990) were correlated with concerned weather data. Reproductive stage was very critical to prevalence weather parameters both for *Kuruvai* and *Thaladi* seasons. In addition maturity stage of *Kuruvai* and Vegetative stage of *thaladi* season were also critical to weather.

During *Thaladi* season, correlation study indicated the positive relationship for maximum temperature at vegetative and reproductive stages.

ii. Management response to seasonal climate forecast in cropping system

Two locations viz. Avinashi and Thiruchengodu were considered for the study. Model to simulate the yield of crops (Groundnut, Cotton) was done.

The chance of achieving (65%) at least 1000 kg/ha of peanut occur, when the Southern Oscillation Index (SOI) phase is positive for April / May. Conversely there is only 32% chance of achieving such a yield in years when the SOI is falling. Similar analysis was conducted for cotton and economic performance of both systems was compared on gross margin basis. Results indicate that in positive SOI years, peanuts out performed in cotton in 70 percent of years, but income difference can still range from Rs.(-)15,000 to (+) 15,000 / ha. However under falling SOI conditions peanut only had minor advantage in 40% of years (up to Rs.3,800/ ha).

iii. Seasonal rainfall Vs El-Nino

Analyses of long term average of Southwest monsoon rainfall during El-Nino years revealed that during El-Nino years, the amount of rainfall found decreased in all the locations of Tamil Nadu as compared to normal rainfall of this season, except Northeastern parts of Tamil Nadu. Analyses of long term Northeast monsoon rainfall indicate that during El-Nino years there was increase in amount of rainfall than normal in all the locations of Tamil Nadu.

iv. Tamil years Vs annual rainfall forecast

The annual rainfall of a particular Tamil year in a cycle of 60 years was not the same for the corresponding Tamil years on the forth coming cycle and one can expect an opposite event.

v. Stars Vs Seasonal rainfall forecast

The star Revathi had greater influence on rainfall during hot weather period (March- May) while during Southwest monsoon (June – Sept) and Northeast monsoon seasons (Oct – Dec), stars Maham and Uthiram respectively did influence seasonal rainfall.

In the monthly analysis at 30% probability, the star Uthiram had influenced in getting rainfall of > 20mm during July and November months. While during other months the stars viz. Maham, Pooradam, Kettai, Swathi and Moolam showed their influence to get < 20mm of rainfall.

vi. Pest and weather relationship study in cotton

When maximum and minimum temperature got increased, the infestation from American bollworm also got decreased. In contrast, positive relationship existed for pink bollworm for the above weather parameters. In the case of aphid, maximum temperature, diurnal variation, Relative Temperature Disparity, bright sunshine hours, and wind speed, had negative relationship, while positive correlation was observed for minimum temperature.

vii. Study on the weather relationship of *eriophyid* mite in coconut

The maximum temperature had negative correlation with nuts affected in all the varieties (Tall (east coast), Dwarf (yellow), Tall X Dwarf, Orange, and Dwarf X Tall) at three months after spathe emergence; where as positive correlation was obtained for maximum temperature one to two months before spathe emergence in respect of Tall (east coast) and Dwarf x Tall varieties. In general *eriophyid* mite affected nuts were either positively and negatively influenced by minimum temperature and relative humidity respectively (0722 IST and 1422 IST). From the stepwise regression analysis made, one to two months earlier or one to two months after spathe emergence, wind speed had higher influence on the nuts affected with mite irrespective of varieties except Tall x Dwarf .

viii. Probing the association of lunar phases "*Thithies*" with rainfall at Coimbatore

Based on the interaction between earth and moon in relation to sun, each month is governed by both new moon and full moon. In between these two, there are fourteen *thithies* covering the 14 days interval. A study was undertaken to find out the association between rainfall and the different *thithies*. Results revealed that the first eight *thithies* succeeding new moon, and eight *thithies* preceding the new moon did relate to annual rainfall events. Higher rainfall occurred normally during the eight *thithies* preceding the new moon as compared to *thithies* succeeding the new moon. Almost similar results could be noticed for both Southwest and Northeast monsoon seasons. Analysis also indicated that towards full moon phase, the *thithi* Shasthi (sixth phase) is associated with high rainfall while such effect was noticed at Ekadasi (eleventh phase) *thithi* towards new moon. High intensity events occurred frequently during new moon phase as compared to full moon phase.

8. Medium range weather forecast

In Tamil Nadu, about 55.4 per cent of the arable land depends entirely on rainfall for its crop productions. Since rainfall varies in space and time, there is risk in farming for dry land crop production. Proper understanding of the climate and issuing weather forecast based on the dynamic nature of atmosphere would help in multiple ways. Four different weather forecasts are presently made. They are now casting, short range, medium range and long range.

Among the forecasts, the weather forecast given under medium range seems to serve the purpose of the farmers, since it provides enough time to the farmers to change the agricultural operations based on anticipated weather change under dry land environment.

In this context, a project on the establishment of National Centre for Medium Range Weather Forecast (NCMRWF) and Development of Agro-meteorological service was approved by the Government of India and implemented by the Department of Science and Technology (DST) in mission mode. Currently local weather forecast based on Direct Model output of General Circulation Model (GCM) is prepared by NCMRWF and given to Agromet Advisory Service units located at different State Agricultural Universities (SAU) including seven in Tamil Nadu, four under TNAU (Coimbatore, Pechiparai, Kovilpatti and Aduthurai) and two under Tamil Nadu Veterinary and Animal Sciences University (Chennai and Namakkal) and one at Kannivadi (MSSRF). In turn the SAU prepares weather based agro advisory bulletin and communicate to the farmers for making decisions on agricultural activities based on anticipated weather change. The forecast covers, cloud cover, rainfall, wind speed, wind direction, maximum temperature, and minimum temperature. This forecast is given for four days from Tuesday to Friday and again from Friday to Monday and thus it covers a whole week.

Presently TNAU installs Automatic Weather Station at block level and once completed, block level weather forecast with agro advisories will be given.

9. Seasonal climate forecast

Seasonal climate forecast is being given to all districts of Tamil Nadu through TNAU Research Stations both for South-west and North-east monsoon seasons with a lead time of 15 days. This forecast contains the seasonal rainfall both in temporal and spatial dimensions. This forecast is based on probability analysis made through Australian Rainman Software. The inputs are location specific past rainfall data more than twenty one years and real time southern oscillation index and sea surface temperature. This type of forecast is being given from 1999 onwards and presently institutionalized by the TNAU. Based on the verification of the forecast, the accuracy goes up to 70 per cent. Since the forecast is given with a lead time the information is highly useful for farm planning and hence it becomes response farming in nature.

10. Climate change and crop production

a) Model result on Temperature and Rainfall

The results of the projected climate change over Cauvery basin of Tamil Nadu for A1B scenario using PRECIS and RegCM3 regional climate models showed an increasing trend for maximum temperature, minimum temperature and rainfall. Decadal means of maximum and minimum temperatures were generated to understand the variation more clearly and the results revealed that the increase in maximum temperature in PRECIS was 3.7^{o}C and in RegCM3, it was 3.1^{o}C. The increase in minimum temperature in PRECIS model was 4.2^{o}C and in RegCM3, it was 3.7^{o}C during the same period. The increase in minimum temperatures is higher than maximum temperatures in both models.

b) Model result on rice productivity

The study on the yield of ADT 43 rice over Cauvery Delta Zone as simulated by Decision support System for Agricultural technology Transfer (DSSAT) under CO2 fertilization, the result had shown that a reduction of 135 Kg ha^{-1} decade^{-1} for PRECIS (Providing Regional Climates for Impact Studies) model, while there was an increase in yield of24 Kg ha^{-1} decade^{-1} for RegCM3 (Regional Climate Model System 3) model, thus indicating the possibility of change in rice yield under climate change scenario.

c) Impact of Climate change on crops

Analysis on the maize crop yield indicated reduction in yield by 3.0, 9.3 and 18.3 per cent respectively during 2020, 2050 and 2080 from the current yield levels in the major maize growing districts of Tamil Nadu with increase in minimum temperature.

Sorghum crop yield is expected to decline by 4.5, 11.2 and 18.7 per cent during 2020, 2050 and 2080 from the current yield levels if no management intervention is made in the major sorghum growing districts of Tamil Nadu. This is due to nighttime temperature increase.

d) Adaptation strategies developed under ClimaRice project for sustaining rice productivity in Cauvery Delta Zone (CDZ) against climate change

- Introduction of System of Rice Intensification (SRI) under non-rainy season
- Introduction of temperature tolerant rice varieties
- Seed treatment with bio-fertilizer (Azospirillum), application of blue green alage (BGA) and growing azolla as dual crop in rice. This reduces methane emission from the rice field

Table of Meteorological Standard Week

Std. Week. No.	Month	Dates	Std. Week. No.	Month	Dates
1	January	1-7	27	July	2-8
2		8-14	28		9-15
3		15-21	29		16-22
4		22-28	30		23-29
5		29-4	31		30-5
6	February	5-11	32	August	6-12
7		12-18	33		13-19
8		19-25	34		20-26
9		26-4*	35		27-2
10	March	5-11	36	September	3-9
11		12-18	37		10-16
12		19-25	38		17-23
13		26-1	39		24-30
14	April	2-8	40	October	1-7
15		9-15	41		8-14
16		16-22	42		15-21
17		23-29	43		22-28
18		30-6	44		29-4
19	May	7-13	45	November	5-11
20		14-20	46		12-18
21		21-27	47		19-25
22		28-3	48		26-2
23	June	4-10	49	December	3-9
24		11-17	50		10-16
25		18-24	51		17-23
26		25-1	52		24-31**

* In leap year the week No.9 will be 26 February to 4 March, i.e. 8 days instead of 7.
**Last week will have 8 days, 24 to 31 December.

FARM IMPLEMENTS AND MACHINERY

I. LAND PREPARATION IMPLEMENTS

TWO ROW FINGER TYPE PADDY ROTARY WEEDER

Purpose	:	For weeding in paddy row crop
Power source	:	Manual
Capacity	:	0.35 ha/day.
Cost of operation	:	Rs. 250/ha
Cost of unit	:	Rs. 900/-

TWO ROW FINGER TYPE PADDY ROTARY WEEDER

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Cost of unit	:	Rs. 900/-

SEED CUM FERTILIZER DRILL FOR PADDY

Purpose	:	For direct sowing of paddy and simultaneous application of fertilizer
Power source	:	35 hp tractor
Capacity	:	3 ha/day
Cost of Operation	:	Rs. 800/ha
Cost of unit	:	Rs. 35,000/-

TRACTOR OPERATED PIT DIGGER FOR SUGAR CANE PLANTING

Purpose	:	PitDigger for Sugarcane Planting
Power source	:	35 HP tractor Cost of
operation	:	Rs.300/- per hour
Capacity	:	250 to 300 holes per hour
Cost of operation	:	Rs. 300/ hour
Cost	:	Rs. 65,000/-

HORTICULTURE

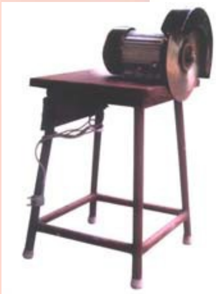
COCONUT TREE CLIMBER

Purpose	:	To climb coconut trees for harvesting nuts cleaning and other operations
Power source	:	Manual Time
required climbing one Tree	:	1.5 minutes
Cost of operation	:	Rs. 1.50/tree
Cost of unit	:	Rs. 2000/-

HAND OPERATED ANOLA SEED REMOVER

Capacity	:	20 Kg/hr (or) 530 fruits / hr
Efficiency of pulping	:	90 Percent
Percent juice wastage	:	2 Percent
Cost of the equipment	:	Rs. 1000/-
Cost of operation	:	Rs. 10/hr

SUGARANE SETT CUTTER



Purpose	:	Cutting sugarcane sett with single bud
Capacity	:	One sugarcane sett per second
Power source	:	½ Hp Single phase Motor
Cost of operation	:	Rs.240/- per hectare
Cost of the equipment	:	Rs. 2750/-

MINI COMBINE HARVESTER FOR PADDY

Purpose	:	Harvesting, threshing, winnowing operations are carried out simultaneously
Capacity	:	1 ha. per day
Power source	:	
Cost of operation	:	Rs.1300 per ha.
Cost of the equipment	:	Rs.2,00,000/-

POWER TILLER OPERATED SLASHER CUM INSITU SHREDDER

- Suitable for shredding vegetable residues of brinjal, chillies, bhendi, etc. left after harvest and parthenium, etc.
- 0.8 hectare can be shredded per day
- Suitable for any make of power tiller with 10-15 HP
- Saving in time - 73 %
- Saving in cost - 75%
- Cost of the unit - Rs. 9500 (attachment)

SUGARCANE DETRASHER

- Labour requirement is less
- Easy for handling
- Reduced cost of de-trashing
- Used for all varieties of cane
- Also removed the sprouted buds
- Easy collection of de-trashed leaves

A SUBSOILER ATTACHMENT FOR STUMP REMOVAL

Purpose	: Removes stumps in dryland
Saving in cost	: Rs. 1.50 per stump
Saving in time	: 10 – 12 minutes per stump
Cost of operation	: Rs. 2.00 per stump
Cost of unit	: Rs. 10,500 (including subsoiler)
Cost of attachment	: Rs. 5000

BATTERY OPERATED PORTABLE WETLAND WEEDER

- Coverage - 0.2 – 0.3 ha/day
- Weeding Efficiency – 95 %
- Cost Of Operation - Rs. 625/ha
- Cost Of Weeder - Rs. 8000/-

TRACTOR OPERATED FRUIT-SHAKE HARVESTER

- Can be used for Harvesting Tamarind, Citrus and in Forestry

- Cost of the Unit Rs.2600/-
- Cost of Operation Rs.8/100 kg
- Harvesting Efficiency 85 %
- Saving in time 95 %

TRACTOR OPERATED ROTARY SPADING MACHINE

Field capacity	-1.5 ha per day
Saving in cost	-26.2 to 38.50 Per cent
Saving in time	-96 Per cent
Cost of Machine	-Rs. 1,00,000

TRACTOR OPERATED SUBSOIL COIRPITH APPLICATOR

- The sub soil coir pith mulch applied at 15-30 cm deep ensured higher moisture retention ,crop growth and yield
- Cost of the subsoil coir pith applicator is Rs. 20,000/-
- Field capacity - 0.60 ha/day

IMPROVED TNAU DHALL MILL

Special features

- Suitable for splitting, cleaning and grading of pulses into dhal at the rate of 30 Kg/hour
- Capable of dry milling of cereals into powder (by changing into cast iron rolls)
- The unit has pitting unit for enhancing the preconditioning process

Coverage	: Reduced conditioning time of 4-6 hrs compared to 12 hrs
Power capacity	: One H.P single phase motor
Efficiency	: Milling and grading efficiencies are more than 90%
Cost of operation	: Re.1/- per kg
Cost of Unit	: Rs. 25,000/-

TWIN ROW PRECISION ORGANIC MANURE CUM FERTILIZER APPLICATOR

Special features

- Suitable for accurate and controlled application of organic manure/mulch directly below the root zone of crop
- Helps in improving the soil nutrient use efficiency, crop yield and soil quality.
- Adjustable spacing between furrows enables the use at different row spacing
- Simultaneous precise placements of organic manure and inorganic fertilizer
- The cost of the unit is
- The unit can cover one ha per day
  Coverage : 1 ha / day
  Cost of Unit : Rs. 50,000/-

WORKER FRIENDLY ARECANUT STRIPPER

Special features

- Suitable for stripping both green and riped arecanut.
- Damage caused to the stripped arecanut is eliminated.
- Result in 66 and 77 per cent saving in cost and time when compared to conventional arecanut stripping Coverage

Coverage	:	Can strip 650-950 Kg of arecanut per hour
Efficiency	:	Stripping efficiency of 99.5 per cent is achieved
Cost of operation	:	Rs. 0.16 per Kilogram
Cost of Unit	:	Rs. 15,000/-

MULTI ROW POWER WEEDER FOR SRI

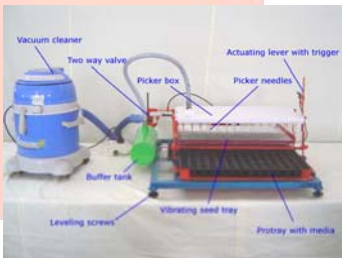
Special features

- Weeder for SRI rice at row spacing of 22 to 26cm.
- Light weight weeder (17 Kg) on sled suitable for all soils
- Two or three rows can be weeded in a single pass.
- Self propelled weeder – no need to push or pull.
- Can be operated and lifted by one person easily to change rows.
- Complete cutting of weeds at a depth of 3 to 4 cm with less than 1% plant damage.

Coverage	:	Can weed 0.75 to 1.0 ha per day
Power capacity	:	Weeding done by two rotary weeding units powered by 1.5 HP engine
Cost of Unit	:	Rs. 35,000/-

NEEDLE TYPE TRAY SEEDER FOR VEGETABLE NURSERY

Salient features



- Vegetable growers prefer pro-tray grown seedlings
- To mechanize placement of seeds in the pro-tray cells
- Singulated raw/ pelleted seeds placed in all the cells in a single stroke
- Cost of operation is Rs. 280 for sowing 750 trays /day
- Saving in time is 300% and saving in labour is 60 %
- Cost of equipment is Rs.10,000 including the vaccum source

TRAILER MOUNTED STEERING FOR POWER TILLER – TRAILER SYSTEM

Salient features

- Avoids the operator getting down and turn the power tiller trailer system.
- All the controls are well within the reach of the operator.
- Shorter turning radius, enabling the operator to take turns even in very narrow space
- Operator feels comfortable while taking a turn.
- Reduced discomfort to the operator through elimination of lateral and vertical swing of the handle.
- Cost of the steering system is Rs.1,000/= only.


SORGHUM COMPOSITE BISCUITS
Salient features

- Sorghum contains more energy, protein, fat, high fiber, when compared to rice.
- Sorghum in general are rich sources of B-complex vitamins, 2 to 9% fiber and antioxidants.
- Sorghum has a Low glycemic index which helps to reduce the glucose level of diabetics.
- Sorghum Lowers the incidence of cardiovascular diseases and reduce gastro-intestinal complications.
- Level of incorporation of sorghum flour upto 50% and 5% defatted soy flour.
- Keeping quality of the product is 15 days.
- Cost of the sorghum composite biscuit Rs 10.50 per 100 gm


Management technology

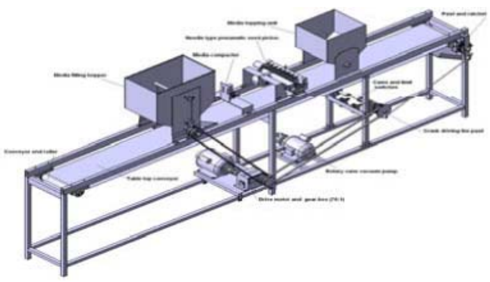
Title of the technology	:	**SORGHUM COMPOSITE BISCUITS**
Details of technology	:	Level of incorporation of sorghum flour upto 50% and 5% defatted soy flour
Advantages of the technology	:	• Sorghum contains more energy, protein, fat, high fiber, when compared to rice. • Sorghum in general are rich sources of B-complex vitamins, 2 to 9% fiber and antioxidants. • Sorghum has a Low glycemic index which helps to reduce the glucose level of diabetics
Economics	:	Cost of the sorghum composite biscuit Rs 10.50 per 100 gm

PALMYRAH TREE CLIMBING DEVICE

- Even unskilled workers can use it to climb the tree with increased stability and comfort.
- Seating arrangement provides added comfort and safety.
- The grippers are so positioned that while ascending/descending up/down, the upper frame accommodating the operator is always horizontal to the ground, irrespective of the girth variations in the tree.
- The operator, after reaching the top, can also use the device to move around the tree, to reach all the parts of the canopy to do tapping, harvesting and cleaning of dry fronds.
- It eliminates the severe bruises caused in traditional method of climbing due to use of climbing ropes.
- The device weighs about 17 kg. The device along with the ladder costs Rs. 6000.
- Eliminates the high work stress, severe neck and back pain disorders caused in traditional method of climbing.

AUTOMATIC PROTRAY SOWING MACHINE FOR VEGETABLE NURSERY PRODUCTION

- The automated protray sowing machine provides for automating all the steps involved in the sowing of seeds in protrays.
- The machine is able to provide above 100 per cent saving in cost over the cumbersome method of manual sowing.
- Cost of the Unit is Rs. 30,000/-



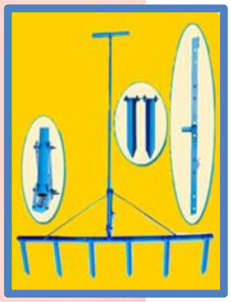
ARECANUT HARVETSER

Special features

- Unskilled workers can also use to climb
- Light weight aluminium pole with improved configuration of cutting edge of the knife for easy harvesting
- Seating arrangement (adjustable and pivotable) with back rest for safe and secure operations
- Rotatable unit to facilitate harvesting of bunches form surrounding trees.

Weight	:	12 kg
Cost of the device along with the knife	:	Rs.7000/-

MANUALLY OPERATED LINE MARKER



Special features

- Easy to operate
- Reduced seed rate
- Suitable for small and marginal farmers
- Reduction in cost of cultivation
- Maintenance of optimum plant population
- Easy for inter cultural operation (Weeding, Spraying)

Total Weight	:	6 Kg
Bottom Rod “L” Angle	:	1.5 m
Spacing	:	15 cm to 150 cm
Marking Tyne Length	:	22.5 cm
Handle Rod Length	:	1.5 m (Similar to Cono weeder)
Cost of the implement	:	Rs. 650/-

TRACTOR OPERATED MULTI-PURPOSE HOIST

Special features

- Amenable for fruit plucking, coconut harvesting, training, pruning, lopping and spraying tree crops.
- The equipment is attached to the back of a 45 hp agricultural tractor.
- Two labourers can stand on the platform and do operations
- Platform can reach a maximum height of 8.1 m
- Can also be used for maintenance works on street lights, white washing and painting of buildings.

Cost of the machine	:	Rs.45,000/- (only the attachment)

IMPROVED COCONUT TREE CLIMBER

Special features

- Lesser weight of the lower unit (3.0 kg) then existing model (6.0 kg)
- Lower unit is lifted simultaneously by leg and hand force for continuous operation
- Comfortably designed upper frame makes
- Harvesting capacity 45 trees/day (38 trees/day for existing model)
- Cost of harvesting - Rs. 3.50/tree (Rs. 4.50/tree for existing model)

Cost of the machine : Rs.2,300/-

AERIAL ACCESS HOIST FOR COCONUT HARVESTING

Special features

- First machine of its kind in tractor mounted form
- A full length chassis from front to rear of the tractor provides support
- The entire weight of the hoist and moments transmitted through the chassis to the stabilizers with out transferring to the tractor chassis.
- Four trees can be accessed from a single position.
- The time required for locating unit and operating stabilizers - 1 min.
- The time required for positioning against a tree of 10 m height was 2 min.
- The positioning of the operator platform can be done by the operator himself

Lifting capacity	:	120 kg
Platform size	:	1000 x 700 x 1000 mm
Working height	:	16 m
Platform access height from the ground	:	15 m
Platform outreach	:	6 m
Rotation/slewing angle	:	360 degrees
Stabilizer	:	Hydraulically operated 4 nos. to provide absolute stability
Power	:	PTO of tractor, with exclusive hydraulic system and controls
Cost of unit	:	Rs.7.60 lakhs

HOME SCIENCE

FOOD PROCESSING TECHNOLOGIES

Utilization of rice bran in traditional breakfast foods

- Rice bran is a byproduct of rice, obtained on polishing. The bran is a rich source of protein, essential fats, B and E vitamins, minerals, fiber and antioxidants.
- Rice bran extracts in water can be used as a fiber free nutrient that has a lot of health giving properties.
- The rice oil is high in mono- and polyunsaturated fatty acids.
- Rice bran extracts can be used in a variety of preparations like bakery products and beverages.
- The Home Science College has standardised the preparation of flavored milk with the incorporation of rice bran extract.
- This beverage has antioxidant properties besides the soluble vitamins and proteins of bran.
- The heat stabilized bran can be incorporated in putt mix, ready to cook idiappam mix and spagetti, thus increasing the nutritive value of these products.

Sorghum Flakes

- Nutritionally superior to rice flakes.
- Ideal breakfast and snack food.
- Simple and low cost processing technique.
- Quick to cook and easily digestible.
- Good source of minerals and fibre.
- Sorghum flakes (100 g) contains 8.6 g protein, 3.7 g fat, 1.5 g fibre, 69 mg calcium and 16 mg iron.

Samai Biscuits

- Little millet (samai) is a good source of minerals, B vitamins and fibre.
- Fat, iron and niacin content are higher in little millet, than in other cereals.
- Calcium, phosphorus and iron content of samai biscuits are 25.8, 150 and 4.21 mg/100g respectively.
- High in fibre (1.40 %), and is important as health food.
- Has a shelf life of upto nine months.

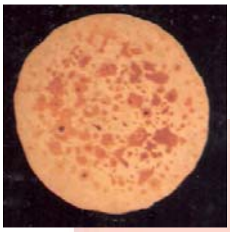
Health Mix for Geriatrics

- The health mix designed for the aged was formulated from cereals, millets, pulses, and vegetables.
- In combination with milk powder and jaggery improved nutritional status of selected elderly subjects.
- Significant increase in haemoglobin level.
- The health mix (100 g) furnished 12 g protein, 2 g fat and 482µg β carotene.

Millet based health food mix

- ❖ Can be used for preparing nutritious balls and beverages.
- ❖ Easily digestible and good for children and aged persons.
- ❖ Health mix (100g) contains 9.75% moisture, 16.61% protein, 3.69% crude fibre, 6.19 % reducing sugar 9.67 % total sugar, 20.68mg calcium, 244.00 mg phosphorous, 5.35 mg, potassium, 7.57 mg iron and 5.32 mg zinc.
- ❖ Has good storage stability.

Khakra



- ❖ Khakra is Indian flat bread.
- ❖ Traditional food of Gujarat, simulating chapathi in terms of product formulation and is further toasted to a moisture content of 5-6%.
- ❖ Incorporated with defatted soya flour (25%), the product is a rich source of protein.
- ❖ Addition of defatted soya flour increases protein (70%), iron (50%) and calcium (36%)

The product has a shelf life upto 90 days at room temperature.

Puffed Soya

- ❖ Puffing of soya reduces antinutrients and improves bioavailability of nutrients.
- ❖ Rich source of protein.
- ❖ Easily digestible and ideal protein source for vulnerable groups.
- ❖ Provides 32%protein.
- ❖ Low moisture content (6%).
- ❖ Has storage stability upto two months.

Okara Mix

- ❖ Okara is a by-product obtained during the processing of soy milk.
- ❖ Cheap source of protein and can be used to enrich traditional food products.
- ❖ Fresh okara contains 80% moisture, 13.7% protein, 1.5% fat, 4 % carbohydrate and 2% fibre.
- ❖ The processed okara in the ready to use form finds application in the preparation of traditional foods, bakery and confectionery products.
- ❖ Okara mix has a shelf life of 4 months.

Soya milk Fruit Juice

- ❖ Blending fruit juice and soya milk improves nutritive value and sensory quality.
- ❖ Rose and mango flavoured soya milk is highly acceptable.
- ❖ Contains 4 g protein, 2 g fat, 78 mg calcium, 21 mg phosphorous and 1.5 mg iron per 100 g of the fruit blended soya milk.
- ❖ Has a shelf life of 15 days under refrigerated condition.

Best used in nutrition intervention programmes for the vulnerable groups.

Extruded products from texturised soya protein

- ❖ Extruded products (noodles) incorporated with texturised soya protein are richin protein.
- ❖ Addition of tomato juice further improved the quality of the noodles.
- ❖ Has good sensory appeal
- ❖ Texturised vegetable protein incorporated noodles is suitable for children.

Texturised soya noodles contains 20.3 g protein and 72 mg calcium

Millet based value added products

- ❖ Millets are miles ahead of rice and wheat in terms of their nutritional content. Millets are good source of minerals and dietary fibre.
- ❖ The nutrients present in the millets have the capacity for reducing the risk of life style diseases.
- ❖ Due to urbanization, climatic changes, erratic rainfall etc, the farmers are forced to seek alternative crops for rice.
- ❖ Forecasting the future need of our country millet based products like multigrain adai mix, multipurpose snack mix, health mix, samosa mix, karasev mix, pongal mix, priyani mix, flakes etc., were developed.
- ❖ The processed millet based products has six months shelf life and it suits the convenience seeking farmers.

Sugarcane Syrup

- ❖ Concentrated sugar cane juice.
- ❖ Alternative natural sweetener in the place of refined sugar.
- ❖ Convenient and ready to use, has wide application in the preparation of traditional, bakery and confectionary products.
- ❖ Sugarcane syrup (100 g) contains 43 mg calcium, 42 mg phosphorus and 2 mg iron.
- ❖ Has a shelf life of twelve months at room temperature.

At Home Science College and Research Institute, a Food Processing Training Center was established by installing the processing equipments namely Murukku machine, Sieving machine, Mixture machine, Steaming machine, Tray wrapping machine, Handy induction sealing machine, Continuous sealing machine, Nitrogen flush vaccum packaging machine, Pulveriser, Extruder, Milk Extraction unit, Cabiner drier and other processing accessories to train the entreprenuers, farmers, SHGs on processing of millets based value added products. The equipments are available to the budding entrepreneurs on rental basis to utilize the facilities.