Practical Manual on

Crop Production

AgriMoon.Com

All About Agriculture...

Practical Crop Production

ICAR e-Course

For

B.Sc (Agriculture) and B.Tech (Agriculture)

AGRO202, 203 Practical Crop Production- I & II

(0+2)

Crop Choice is according to season

The crops are:

Irrigated puddled lowland rice / any irrigated dry crop (maize / sorghum / pearl millet / finger millet / cotton / groundnut / sunflower / sesame

The student him/herself is doing the cultivation practices.

If transplanted crop:

Selection of nursery area - Preparation of nursery - Application of manures to nursery - seed treatment with fungicide and bio-fertilizers - seed soaking and incubation - forming nursery beds and sowing seeds - weed control and plant protection to nursery - preparation of main field - application of organic manures - basal application of fertilizers and bio-fertilizers - pulling out seedlings and transplanting - application of herbicides - after cultivation practices - top dressing of fertilizers, plant protection measures - harvesting, threshing, drying and cleaning the produce - working out cost of cultivation and economics.

If direct sown crop:

Selection of main field - Preparation of main field - land configuration for sowing - application of manures and fertilizers - seed treatment with fungicide and bio-fertilizers - sowing and irrigation - application of herbicides - after cultivation practices - top dressing of fertilizers, plant protection measures - harvesting, threshing, drying and cleaning the produce - working out cost of cultivation and economics

Crop Production Guide

RICE (*Oryza sativa* L.)

I. SEASON AND VARIETIES

District/Season	Month	Varieties
1. Kanchipuram/Tiruvallur		
Sornavari	(April -May)	ADT 36, IR 36, IR 50, ADT 37, ASD 16, ASD 17, IR 64, ASD 18, ADT 42, MDU 5, ASD 20, ADT43, CO 47, TRY (R)2*, ADT (R) 45, ADTRH 1, ADT (R) 47
Samba	(Aug)	IR 20, White Ponni, CO 43, ADT 40, PY 4, ADT 39, TRY 1, ASD 19, ADT(R) 44, CORH 2
Late Samba	(Sep - Oct)	IR 20, White Ponni, ADT 39, CO 43, TRY 1, ADT (R)46, CORH 2
Navarai	(Dec -Jan)	ADT 36, ADT 37, ASD 16, IR 64, ASD 18, ADT 42, ADT 43 MDU 5, ASD 20
Dry	(July - Aug)	PMK 2, MDU 5, TKM 11, PMK (R) 3, TKM (R) 12
Semi-dry	(July - Aug)	IR 20, TKM 10, PMK 2, MDU 5, TKM 11, TKM (R) 12, PMK (R) 3
2. Vellore/Tiruvannamalai		
Sornavari	(April-May)	IR 64, ADT 36, IR 50, ADT 37, ASD 16, ASD 17, ASD 18, ADT 42, MDU 5, ASD 20, ADT 43, CO 47, ADT (R) 45, ADT RH1, ADT (R) 47
Samba	(Aug)	Ponmani, ADT 40, Bhavani, IR 20, White Ponni, CO 43, Paiyur 1, PY 4, CO 45, TRY 1, ASD 19, CORH 2
Navarai	(Dec -Jan)	ADT 36, IR 20, ADT 39, CO 43, IR 64, ASD 16, ASD 18, ADT 42, MDU 5, CO 47, ASD 20, TRY (R)2*
3. Cuddalore/ Villupuram		
Sornavari	(April -May)	ADT 36, IR 50, ASD 16, IR 64, ASD 18, ADT 42, MDU 5, ASD 20, ADT 43, CO 47, ADT (R) 45, TRY (R)2*, ADTRH 1, ADT (R) 47
Samba	(Aug)	IR 20, White Ponni, CO 43, Ponmani, PY 4, ADT 38, TRY 1, ASD 19, ADT (R) 44, CORH 2
Navarai	(Dec-Jan)	ADT 36, IR 20, IR 36, IR 64, ADT 39, ASD 16, ASD 18, ADT 42, MDU 5, ASD 20, TRY (R)2*
4. Tiruchirappalli/Karur/Perambalur		
Kuruvai	(Jun -Jul)	ADT 36, IR 50, IR 64, ASD 16, ADT 37, ASD 18, ADT 42, MDU 5, ADT 43, CO 47, ADT (R) 45 (except Karur), TRY (R)2*, ADTRH 1, ADT (R) 47
Samba	(Aug)	IR 20, White Ponni, CO 43, ADT 40, Ponmani, TRY 1, ASD 19, ADT (R) 44
Late Samba / Thaladi	(Sep -Oct)	IR20, WhitePonni, ADT39, CO43, TRY1, ASD19, ADT(R)46,
Navarai	(Dec -Jan)	ADT 36, IR 64, ASD 16, ASD 18, ADT 42, MDU 5, ASD 20, TRY (R)2*
5. Thanjavur/Nagapattinam/Tiruvarur		
Kuruvai	(Jun -Jul)	ADT 36, IR 50, IR 64, ADT 37, ASD 16, ASD 18, ADT 42, MDU 5, ADT 43, ADT (R) 45, TRY (R) 2*, ADTRH 1, ADT (R) 47, ,ADT (R) 48
Samba	(Aug)	IR 20, White Ponni, CO 43, Ponmani, ADT 38, TRY 1, ASD 19, ADT (R) 44, CORH 2
Late Samba / Thaladi	(Sep -Oct)	ADT 38, IR 20, CO 43, Ponmani, ADT 39, TRY 1, ASD 19, ADT (R)46,
Navarai (Kullankar)	(Dec -Jan)	ADT 36, ADT 37, IR 64, ASD 16, ASD 18, ADT 42, MDU 5, ASD 20, TRY (R)2*

6. Pudukottai		
Kuruvai	(Jun -Jul)	ADT 36, IR 50, IR 64, ASD 16, ADT 42, MDU 5, ASD 20, ADT 43, ADT (R) 45, TRY (R) 2*, ADTRH 1, ADT (R) 47
Samba	(Aug)	IR 20, White Ponni, CO 43, Ponmani, TRY 1, ASD 19, ADT (R) 44, CORH 2
Late Samba/Thaladi	(Sep - Oct)	IR 20, ADT 38, ADT 39, TRY 1, ASD 19, CO 43, ADT (R)46
Dry	(Jul -Aug)	ADT 36, PMK 2, TKM 10, TKM (R) 12, PMK (R) 3
Semi-dry	(Jul -Aug)	ADT 36, PMK 2, TKM 10, TKM (R) 12, PMK (R) 3
7. Madurai/Dindigul/Theni		
Kar	(May - Jun)	ADT 36, IR 50, IR 36, IR 64, ADT 37, ASD 16, ASD 18, ADT 42, MDU 5, ASD 20, ADT 43, CO 47, ADT (R) 45 (Dindigul only), TRY (R) 2*, ADTRH 1, ADT (R) 47
Samba	(Aug)	IR 20, White Ponni, CO 42, CO 43, ADT 38, ADT 40, MDU 4, TRY 1, ASD 19, ADT (R) 44, CORH 2
Late Samba/Thaladi	(Sep - Oct)	IR 20, White Ponni, MDU 3, ADT 39, MDU 4, CO 43, ASD 19, TRY 1, ADT (R)46
Navarai	(Dec -Jan)	IR 64, ADT 36, ADT 37, ASD 16, ASD 18, ADT 42, MDU 5, ASD 20, TRY (R) 2*
Semi-dry	(Jul -Aug)	PMK 2, TKM 10, MDU 5, TKM (R) 12, PMK (R) 3
8. Ramanathapuram		
Samba	(Aug)	IR 20, White Ponni, CO 43, MDU 3, ASD 19, TRY 1, ADT (R) 44, CORH 2
Rainfed & Semidry	(Jul -Aug)	ASD 17, ADT 36, PMK 2, MDU 5, TKM (R) 12, PMK (R) 3
9. Virudhunagar		
Samba	(Sep-Oct)	CO 43, TRY 1, IR 20, ADT (R)46, ADT 39, CORH 2
Dry	(Jul -Aug)	ADT 36, PMK 2, MDU 5, TKM (R) 12, PMK (R) 3
10. Sivaganga		
Semi-dry	(Jul –Aug)	ADT 36, IR 36, ADT 39, PMK 2, MDU 5, TKM (R) 12, PMK (R) 3
11. Tirunelveli, Thoothukudi		
Early Kar	(Apr - May)	IR 50, ADT 36, IR 64, ADT 42, ADT 43, ADT 45, CO 47, ADT (R) 47
Kar	(May -Jun)	ASD 16, ASD 17, ASD 18, ADT 42, ADT 43, CO 47, ADT (R) 45, TRY (R) 2*, ADTRH 1, ADT (R) 47
Late Samba/Thaladi	(Sep - Oct)	White Ponni, IR 20, ADT 39, ASD 19, TRY 1, ADT (R)46, CORH 2
Pishanam/Late Pishanam	(Sep-Oct.)	ASD 18, ASD 16, ASD 19, CO 43, TRY 1, ADT (R)46
Semi Dry	(July- Aug)	MDU 5, ADT 36, TKM (R) 12, PMK (R) 3
12. Kanyakumari		
Kar	(May –Jun)	ADT 36, IR 50, IR 64, ASD 16, ASD 17, ASD 18, ADT 42, MDU 5, ASD 20, ADT 43, ADT 45, CO 47, ADTRH 1, ADT (R) 47
Pishanam / Late Samba / Thaladi	(Sep – Oct)	White Ponni, IR 20, Ponmani, CO 43, TRY 1, TPS 2, TPS 3, ADT (R) 44, ADT 39, ASD 18, ASD 19, MDU 5, ADT (R) 46
Semi-dry	(Jul – Aug)	ADT 36, ASD 17, PMK 2, TKM (R) 12, PMK (R) 3
13. Salem, Namakkal		
Kar	(May - Jun)	IR 50, ADT 36,IR 64, ADT 37, ASD 16, ASD18, ADT 42, MDU 5, ASD 20, ADT 43, CO 47, ADT (R) 45, TRY (R)2*, ADTRH 1, ADT (R) 47
Samba	(Aug)	IR 20, White Ponni, Bhavani, CO 43, MDU 4, TRY 1, ASD 19, ADT (R) 44
Navarai	(Dec - Jan)	IR 20, ADT 36, IR 64, ASD 18, ASD 19, ADT 42, MDU 5, ASD 20, TRY (R)2*
14. Dharmapuri/ Krishnagiri		
Kar	(May -Jun)	IR 50, IR 64, ASD 16, Bhavani, IR 20, White Ponni, CO 43, ASD 18, MDU 4, ASD 19, PAIYUR 1, ADT 42, TRY 1,

		MDU 5, ASD 20, ADT 43, CO 47, ADTRH 1, TRY (R)2*, ADT (R) 47
Navarai	(Dec- Jan)	IR 64, ADT 37, ASD 16, ADT 36, ASD 18, ADT 42, MDU 5, ASD 20, TRY (R)2*
Samba/Late Samba	(Aug - Oct)	TRY 1, Bhavani, IR 20, White Ponni, CO 43, MDU 4, ASD 19, ADT (R) 44, ADT (R) 46
15. Coimbatore		
Kar	(May - Jun)	IR 50, ADT 36, ASD 16, IR 64, ASD 18, ADT 42, MDU 5, ASD 20, ADT 43, CO 47, ADT (R) 45, TRY (R)2*, ADTRH 1, ADT (R) 47
Samba	(Aug)	IR 20, CO 43, White Ponni, ADT 39, MDU 4, TRY 1, ASD 19, Bhavani, ADT(R) 44, CORH 2
Late Samba/Thaladi	(Sep - Oct)	IR 20, ADT 39, ADT(R) 46, CORH 2
Navarai	(Dec -Jan)	IR 20, ADT 36, IR 64, ASD 16, ASD 18, TRY1, MDU 5, ASD 20, TRY (R) 2*
16. Erode		
Kar	(May - Jun)	IR 50, ASD 16, IR 64, ADT 36, ASD 18, ADT 42, MDU 5, ASD 20, ADT 43, CO, 47, ADT (R) 45, TRY (R)2*, ADTRH 1, ADT (R) 47
Samba	(Aug)	IR 20, Bhavani, CO 43, White Ponni, ADT 39, TRY 1, CO 46, ADT (R) 44
Late Samba	(Sep - Oct)	IR 20, White Ponni, ADT 39, CO 43, TRY 1, CO 46, ADT (R) 46, CORH 2
Navarai	(Dec – Jan)	IR 20, ADT 36, IR 64, ASD 16, ASD 18, ADT 42, MDU 5, ASD 20
17. The Nilgiris		
Samba	(Jul -Aug)	IR 20, CO 43, TRY 1, ADT (R) 44

* 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. ASD19 and White Ponni are also susceptible to blast and care should be taken on plant protection measures.

II. PARTICULARS OF RICE VARIETIES

PARTICULARS	PY 4 (JAWAHAR)	IR 20	BHAVANI
Parentage	IR 8 X H 4	IR 262 X TKM 6	Peta x BPI 76
Duration (Days)	145 - 150	130 -135	130 - 135
Average Yield (kg/ha)	5330	5000	5000
1000 grain wt (g)	24.8	19	21.5
Grain L/B ratio	3.1	3	4.72
Grain type	Long bold	Medium slender	Long Slender
Morphological Characters			
Habit	Semi dwarf, erect	Semi-dwarf	Medium tall
Leaf sheath	Green	Green	Green
Septum	Green	Cream	Cream
Ligule	Colourless	White	Colourless
Auricle	Colourless	White	Colourless
Panicle	Long drooping	Medium compact	Long compact
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Absent	Absent	Absent
Grain size (mm)			
Length	9.3	8.2	9.6
Breadth	3	2.7	2.03

Thickness	1.8	2	1.5

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

PARTICULARS	ADT 36	IR 50	IR 64
Parentage	Triveni x IR 20	IR 2153-14 X IR 28 X IR 36	IR 5657-33-2-1/ IR 2061-465-1-5-3
Duration (Days)	110	105(Summer) 130 (Winter)	115 – 120
Average Yield (kg/ha)	4000	6000	6146
1000 grain wt (g)	20.6	20.35	23.1
Grain L/B ratio	3.1	3.9	3.25
Grain type	Medium	Long Slender	Long slender
Morphological Characters			
Habit	Erect	Erect	Semi dwarf
Leaf sheath	Green	Green	Green
Septum	Green	Green	White
Ligule	Colourless	Colourless	Light green
Auricle	Colourless	Colourless	Light green
Panicle	Long compact	Long & drooping	Intermediate, well exerted
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Absent	Absent	Absent
Grain size (mm)			
Length	7.8	8.9	10.1
Breadth	2.5	2.3	2.9
Thickness	2	1.8	2.2

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

PARTICULARS	CO 43	Ponmani	White Ponni
Parentage	Dasal x IR 20	Pankaj x Jagannath	Taichung 65/2 Mayang Ebos-80
Duration (Days)	135 - 140	155 - 160	135 - 140
Average Yield (kg/ha)	5200	5300	4500
1000 grain wt (g)	20	23.5	16.4
Grain L/B ratio	3.5	2.2	3.22
Grain type	Medium slender	Short bold	Medium slender
Morphological Characters			
Habit	Erect	Erect	Medium tall
Leaf sheath	Green	Green	Green
Septum	Green	Green	Green
Ligule	White, longer	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	8.1	6.9	8

Breadth	2.3	3.1	3
Thickness	1.8	2.1	2

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

PARTICULARS	IR 36	MDU 3	CO 47
Parentage	IR 1561-228/1 IR 244/O.nivara./ CR 94-13	IR 8/W 1263	IR 50 / CO 43
Duration (Days)	120	120 - 125	110-115
Average Yield (kg/ha)	5000	4970	5832
1000 grain wt (g)	21	23.1	20.6
Grain L/B ratio	2.88	3.92	2.7
Grain type	Medium	Long Slender	Medium slender
Morphological Characters			
Habit	Dwarf Erect	Semi dwarf	Erect
Leaf sheath	Green	Green	Green
Septum	Cream	Cream	Yellow
Ligule	Colourless	White	Acute to acuminate, white
Auricle	Colourless	White, 2-Clefted	Colourless
Panicle	Compact	Medium Compact	Compact
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Absent	Absent	Absent
Grain size (mm)			
Length	8.85	9.4	7.7
Breadth	3.07	2.4	2.3
Thickness	2.18	1.6	1.7

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

PARTICULARS	ASD 16	ASD 17	ADT 37
Parentage	ADT 31/CO 39	ADT 31/RATNA/ / ASD 8/IR 8	BG 280-1 2/ PTB 33
Duration (Days)	110 - 115	101	105
Average Yield (kg/ha)	5600	5422	6200
1000 grain wt (g)	24.2	23.8	23.4
Grain L/B ratio	2.6	2.24	1.79
Grain type	Short Bold	Short bold	Short bold
Morphological Characters			
Habit	Semi dwarf erect	Semi dwarf slightly open	Semi dwarf semi erect
Leaf sheath	Green	Green	Green
Septum	Cream	Cream	White
Ligule	White	White, 2-clefted	White
Auricle	Colourless	Pale green	White
Panicle	Long Compact	Long, Intermediate densely drooping, just exerted	Compact
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Present	Present	Present
Grain size (mm)			
Length	7.86	7.9	5
Breadth	3.02	2.8	2.8
Thickness	1.96	1.88	1.88

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

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 dense	Medium	Medium, Modera tely 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	2	1.9

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

PARTICULARS	ASD 18	MDU 4	PMK 2
Parentage	ADT 31/IR 50	AC 2836/Jagannath	IR13564-149-3/ASD 4
Duration (Days)	105 - 110	120 - 125	110-115
Average Yield (kg/ha)	5900	5900	3200
1000 grain wt (g)	21.8	22.9	22.1
Grain L/B ratio	3.2	4	2.53
Grain type	Medium slender	Long slender	Medium bold
Morphological Characters			
Habit	Semi dwarf(90cm)	Erect, tall	Erect
Leaf sheath	Pale Green	Green	Green
Septum	Light green	Green	Cream
Ligule	White clefted	Colourless	Palegreen
Auricle	Pale green	Colourless	Palegreen
Panicle	Medium, compact exerted	Compact, Medium	Medium, compact
Husk colour	Straw	Yellow	straw
Rice colour	White	White	Dull white
Abdominal white	Slightly present	Absent	Present
Grain size (mm)			
Length	8.64	9.12	7.8
Breadth	2.7	2.26	3
Thickness	2.2	—	2

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

PARTICULARS	TKM 10	TPS 3	ADT 42
Parentage	CO 31/C22	RP 31-492/LMN	AD9246/ ADT29
Duration (Days)	135	135 -140	115
Average Yield (kg/ha)	2563	5253	5537
1000 grain wt (g)	23.2	23.2	24.8
Grain L/B ratio	3.6	2.06	3.6
Grain type	Medium slender	Short Bold	Long, slender
Morphological Characters			
Habit	Semi tall	Semi dwarf/erect	Semi-dwarf
Leaf sheath	Green	Green	Green
Septum	Green	Cream	Cream
Ligule	Colourless	—	White
Auricle	Colourless	—	Palegreen
Panicle	Compact	Long	Intermediate
Husk colour	Light brown	Straw	straw
Rice colour	White	White	White
Abdominal white	Present	Present	Occasionally present
Grain size (mm)			
Length	9	7.96	9.32
Breadth	2.53	3	2.58
Thickness	1.75	2	1.89

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

PARTICULARS	ASD 19	TRY 1	MDU 5
Parentage	Lalnakanda/ IR 30	IR578-172-2-2/ BR-1-2-B-1	*O.glaberrima* x Pokkali
Duration(Days)	127 (120-132)	135-140	95 - 100
Average Yield (kg/ha)	5800	5255	4500
1000 grain wt(g)	18.39	24	21.1
Grain/L/B ratio	3.06	2.6	3.12
Grain type	Short, slender	Medium	Medium slender
Morphological characters			
Habit	Semi-dwarf, erect	Erect	Erect
Leaf sheath	Light green	Green	Green
Septum	Cream	White	-
Ligule	White	White	Colourless
Auricle	Palegreen	White	Colourless
Panicle	Compact, dense drooping & well exerted	Long, moderately compact	Intermediate
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Absent	Absent	-
Grain size(mm)			
Length	8.28	6.2	8.45
Breadth	2.32	2.4	2.7
Thickness	1.72	1.8	-

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

PARTICULARS	ASD 20	CO 46	ADT 43
Parentage	IR 18348/IR25863/ IR 58	T7/IR 20	IR 50/White ponni
Duration(Days)	110	125	110
Average Yield (kg/ha)	6000	6000	5900
1000 grain wt(g)	22.08	23.5	15.5
Grain/L/B ratio	3.12	3.14	2.81
Grain type	Long Slender	Long Slender	Medium slender
Morphological characters			
Habit	Erect	Tall erect	Semi dwarf
Leaf sheath	Pale green	Green	Light green
Septum	Cream	-	Cream
Ligule	Pale white	-	White
Auricle	Pale green	Colourless	-
Panicle	Medium compact	Long, heavy & Compact	Moderately long, Intermediate type, drooping
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Absent	Absent	Very occasionally present
Grain size(mm)			
Length	9.38	6.6	5.46
Breadth	2.18	2.1	1.94
Thickness	1.46	1.7	1.63

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

PARTICULARS	TKM 11	ADTRH 1	CORH 2
Parentage	C22/BJ1	IR 58025 A/IR 66 R	IR 58025 A/C 20R
Duration(Days)	110 - 120	115	125
Average Yield (kg/ha)	3000	6400	6100
1000 grain wt(g)	21.4	23.8	23.77
Grain/L/B ratio	3.2	3.46	2.62
Grain type	Long slender	Long slender	Medium
Morphological characters			
Habit	Erect	Semi dwarf, erect	Semi dwarf
Leaf sheath	Green	Green	Green
Septum	Cream	Cream	Cream
Ligule	Colourless	White	White
Auricle	Light green	-	Absent
Panicle	Long, compact drooping	Long	Compact
Husk colour	-	-	Straw
Rice colour	White	White milky, scented	White
Abdominal white	-	Very occasionally present	Occasionally present
Grain size(mm)			
Length	9.3	6.96	6.11
Breadth	2.3	2.01	2.33
Thickness	1.6	1.72	1.86

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

PARTICULARS	ADT (R) 44	ADT (R) 45	ADT (R) 46
Parentage	IET 14099-IR56/ OR142-99	IR50 / ADT 37	ADT38 / CO 45
Duration(Days)	148	110	135
Average Yield (Kg / ha)	6214	5400	6656
1000 grain wt(g)	23.9	17.5	23.8
Grain/L/B ratio	2.21	2.98	3.12
Grain type	Short Bold	Medium slender	Long Slender
Morphological characters			
Habit	Medium Tall	Semi dwarf, erect	Erect, semi-dwarf
Leaf sheath	Light Green	Green	Green
Septum	Cream	Cream	Cream
Ligule	White	White	Long white
Auricle	-	-	Pale green
Panicle	Long Compact	Compact	Intermediate
Husk colour	Straw	Straw	Straw
Rice colour	White	White	White
Abdominal white	Present	Absent	Absent
Grain size(mm)			
Length	8.07	8.00	9.58
Breadth	2.95	2.16	2.46
Thickness	2.06	1.97	1.95

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

PARTICULARS	TKM (R)12	TRY (R)2	PMK (R)3
Parentage	TKM 9/ TKM 11	IET 6238 / IR 36	UPLRi 7/ CO 43
Duration(Days)	115-120	115-120	110-115
Average Yield (Kg/ ha)	3043	5362	3025
1000 grain wt(g)	18.3	22.8	26.10
Grain/L/B ratio	2.42	3.5	2.84
Grain type	Medium slender	Long slender	Long Bold
Morphological characters			
Habit	Erect	Semi-dwarf erect	Erect
Leaf sheath	Green	Green	Green
Septum	Cream	Light green	-
Ligule	White	distinct	Pale green
Auricle	Dull white	Hairy light brown	-
Panicle	Medium compact	Compact	Intermediate
Husk colour	Straw	Straw	Golden yellow with brown streaks
Rice colour	White	White	White
Abdominal white	Present	Absent	-
Grain size(mm)			
Length	7.5	9.1	6.75
Breadth	3.1	2.6	2.38
Thickness	2.3	1.7	2.08

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

PARTICULARS	ADT (R) 47	ADT (R) 48
Parentage	ADT 43/ Jeeragasamba	IET 11412/ IR 64
Duration(Days)	118	94-99
Average Yield (Kg/ ha)	6200	4800
1000 grain wt(g)	13.5	22.0
Grain/L/B ratio	2.72	3.25
Grain type	Medium slender	Long slender
Morphological characters		
Habit	Semidwarf erect	Semidwarf erect
Leaf sheath	Green	Green
Septum	-	Cream
Ligule	-	Acute, prominent
Auricle	Light green	-
Panicle	Long com droopy	Intermediate
Husk colour	straw	straw
Rice colour	White	white
Abdominal white	Occassionally present	Occassionally present
Grain size(mm)		
Length	7.20	9.15
Breadth	2.20	2.54
Thickness	1.80	1.90

III RICE SEASONS OF TAMIL NADU

Month of sowing	Season	Duration (Days)	Districts
Dec - Jan	Navarai	< 120	Tiruvallur, Vellore, Tiruvannamalai, Cuddalore, Villupuram, Tiruchirapalli, Perambalur, Karur, Nagapattinam, Madurai, Theni, Salem, Namakkal, Dindigul, Dharmapuri, Coimbatore,Erode and Pudukkottai.
Apr - May	Sornavari	<120	Tiruvallur, Vellore, Tiruvannamalai, Cuddalore, Villupuram, Namakkal, Dharmapuri
Apr - May May - June	Early Kar Kar	<120	Tirunelveli, Kanyakumari, Thoothukudi, Erode, Coimbatore, Madurai, Theni, Dindigul, Salem, Namakkal, Dharmapuri.
June - July	Kuruvai	<120	Tiruchirapalli, Perambalur, Karur, Thanjavur, Nagapattinam, Tiruvarur, Pudukottai, Erode
July - Aug.	Early Samba	130 to 135	Tiruvallur, Vellore, Tiruvannamalai, Salem, Namakkal, Cuddalore, Villupuram, Madurai, Theni, Ramanathapuram, Dharmapuri, Coimbatore, Erode, Pudukkottai, The Nilgiris
August	Samba	130 - 135 and >150	All districts
Sep - Oct	Late Samba Thaladi/Pishanam	130 - 135	Tiruvallur, Madurai, Theni, Coimbatore, Erode
Sep -Oct	Late Pishanam	130 - 135	Madurai, Theni, Dindigul, Kanyakumari Tirunelveli , Thoothukudi
Oct - Nov	Late Thaladi	115 -120	Thanjavur, Nagapattinam, Tiruvarur, Tiruchirapalli, Perambalur, Karur,

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 sloping 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 Dharmapuri district in Tamil Nadu.
4. **Deep water rice** cultivation exits in certain pockets of Nagapattinam and Tiruvarur idstricts. These areas are not always seen with deep water situation. Varieties suitable for that situation can yield better grain yield.

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 *Azospirillum***: Three packets (600 g/ha) of Azospirillum and 3 packets (600g/ha) of Phosphobacteria or 6 packets (1200g/ha)of Azophos. In bioinoculants 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 nursery.

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.

Nutrient management

- Apply 1tonne of fully decomposed FYM or compost to 20cents 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 40kg of DAP and if not readily available, apply straight fertilizers 16kg of urea and 120kg 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, 4kg of gypsum and 1kg 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 20cents.
- 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 2days 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 37.5kg of Zinc sulphate per ha with sand to make a total quantity of 75kg 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 2.5t/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 (1000 g)/ha of Azospirillum and 5 packets (1000g/ha) of Phosphobacteria or 10 packets of (2000g/ha) of 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 7th and 10th 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 one or two 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 @ 20 kg /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 22 kg urea / ha 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 (2000 g)/ha of Azospirillum and 10 packets (2000g/ha)of Phosphobacteria or 20 packets (4000g/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 soil test recommendations
- N dose may be through Leaf Color Chart (**LCC**)
- P & K may be through Site Specific Nutrition Management by Omission plot technique (Ref. Appendix II)
- If the above recommendation are not able to be followed, adopt blanket recommendation as follows:

Nutrients	N	P_2O_5 (kg/ha)	K_2O
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

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 as given below

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 @ 35kg N/ha in dry season and 30kg N/ha in wet season per application per ha.

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 mixed with 50 kg dry sand 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, 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 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.
- **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.
- **Zinc deficiency:** Lower leaves have chlorotic particularly towards the base. Deficient plants give a brown rusty appearance.

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.

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.

Post - emergence herbicides

- 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.

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

1.8.3. Nursery

1.8.3.1. Seed rate

- 7- 8 kg for single seedling per hill
- 12 -15 kg 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 nurseries 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 in the soil mixture 1.5 kg of powdered di -ammonium phosphate or 2 kg 17-17-17 NPK fertilizer.
- *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.
- *Pre-germinating the seeds 2 days before sowing:* Soak the seeds for 24 h, drain and incubate the soaked seeds for 24 h, sow when the seeds sprout and radical (seed root) grows to 2-3 mm long.
- *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 sulfate 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.

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 15 days old
- Square planting of 22.5 x 22.5 cm (9 x 9 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 2.5cm after development of hairline cracks in the soil until panicle initiation
- Increasing irrigation depth to 5.0cm after PI one day after disappearance of ponded water

1.8.7. Weed management

- Using rotary weeder / Cono weeder
- Moving the weeder with forward and backward motion to bury the weeds and as well to aerate the soil at 7-10 days interval from 10-15 days after planting on either direction of the rows 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.

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 (15cm 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
Co 43, IR20, ADT 38 ADT 39, Ponni, Improved White Ponni	125 to135	1st to 30th September
ADT 36, ADT 37	105 to 110	1st to 10th October

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 40cm 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 3 for broadcasted and 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 0.75kg/ha on 8 DAS or pretilachlor + safener (Sofit) at 0.45kg/ha on 3-4 DAS followed by one hand weeding on 40 DAS.

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* 2000g or Azospirillum *and Phosphobacteria* @ 600g 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

- Azospirillum inoculants 10 packets (2000g/ha) and Phosphobacteria 10 packets (2000g/ha) or 20 packets (4000g/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.
- 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 1.0kg/ha on 5 days after sowing or Pretilachlor + safener (Sofit) 0.45kg/ha on the day of receipt of soaking rain followed by one hand weeding on 30 to 35 days after sowing.

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: 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* 2000g or Azospirillum *and Phosphobacteria* @ 600g 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

- Azospirillum inoculants 10 packets (2000g/ha) and Phosphobacteria 10 packets (2000g/ha) or 20 packets (4000g/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.
- Biofertilizers as recommended to transplanted rice may be followed wherever feasible and moisture available.
- 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 1.0kg/ha on 5 days after sowing or Pretilachlor + safener (Sofit) 0.45kg/ha on the day of receipt of soaking rain followed by one hand weeding on 30 to 35 days after sowing.

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 -5.0cm 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* 2000g or Azospirillum *and Phosphobacteria* @ 600g 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

- Azospirillum inoculants 10 packets (2000g/ha) and Phosphobacteria 10 packets (2000g/ha) or 20 packets (4000g/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.
- 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 25kg/ha and $FeSO_4$ at 50 kg/ha is desirable wherever Zinc and iron deficiency were noted.
- Biofertilizers as recommended to transplanted rice may be followed wherever feasible and moisture available.
- 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 1.0kg/ha on 5 days after sowing or Pretilachlor + safener (Sofit) 0.45kg/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.
- The 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 up on the growth.
- LCC based N application is more suitable for this tract.

Intercropping

- Blackgram for every four rows of rice.

Grain Yield

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

Appendix – I

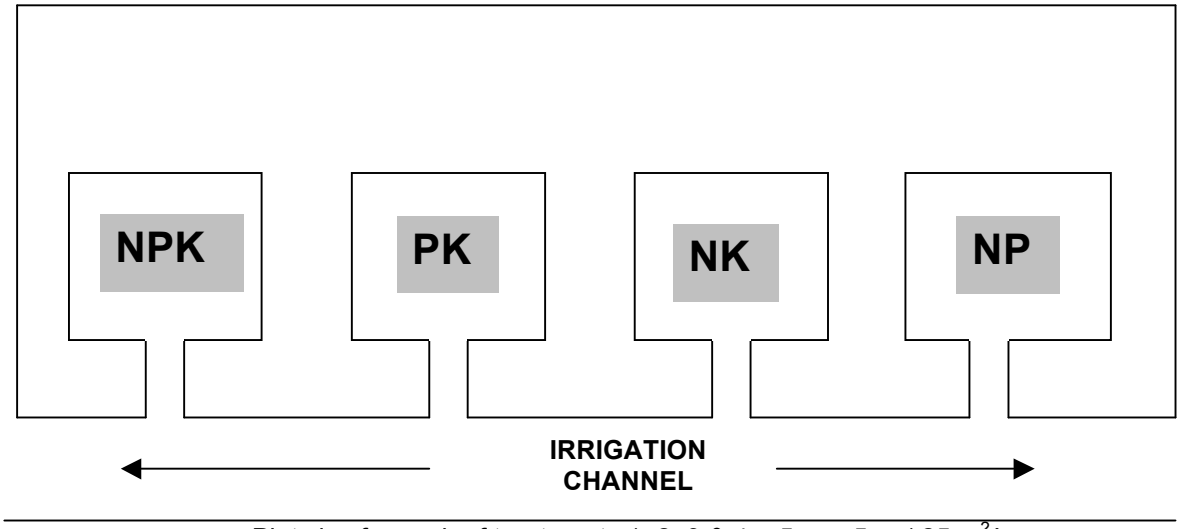
Site Specific Nutrient Management through Omission Plot Techniques

An omission plot receives all nutrients except the omitted nutrient (0 P or 0 K). The objective of P and K omission plots is to develop a site-specific P and K fertilizer recommendation. The difference in grain yields between a fully fertilized plot and a P or K omission plot illustrates the deficit between the crop demand for P or K and indigenous supply of P or K, from soil, rain water etc., the deficit has to be met by fertilizer application.

Guidelines for establishing and managing omission plots

- Establish omission plots both in dry season as well as wet season (high yielding season of any region is more preferable)
- Measure four plots of 5 m × 5 m size each within a farmer's field. Do not place the plots in a corner of the field. Separate each plot by about 3 m distance from the next plot to minimize risk of fertilizer movement between the plots.
- Construct bunds of sufficient height surrounding each plot to prevent water flow between the plots and the adjacent field. Maintain the bunds nicely throughout the crop season to avoid fertilizer and water contamination from one plot to another or from outside the plot. Provide guard channel all around the plot.
- All the crop management practices including pest management should be under optimal conditions and uniform in the treatment plots.
- Apply fertilizers to the plots strictly as per the treatment with the involvement of the farmers.

Fig. 1. Field layout of omission plot trial



Plot size for each of treatments 1, 2, 3 & 4 = 5 m × 5 m (25 m^2 **)**

a. For heavy textured soil

T_1 = + NPK - 193 g Urea, 940 g SP, 350 g MOP
T_2 = + PK - 940 g SP and 350 g MOP
T_3 = + NK - 193 g Urea and 350 g MOP
T_4 = + NP - 193 g Urea and 940 g SP

b. For light textured soil

T_1 = + NPK - 193 g Urea, 940 g SP, 400 g MOP
T_2 = + PK - 940 g SP and 400 g MOP
T_3 = + NK - 193 g Urea and 400 g MOP
T_4 = + NP - 193 g Urea and 940 g SP

SP – Super phosphate full basal,
MOP – Muriate of Potash in two splits 50 % basal and 50 % at PI
Urea - Applied in 4 splits at basal, AT, PI and FF stages each time 193 g
As the Omission Plot technique is only an experimentation for fertilizer calibration we should apply N on blanket basis without using LCC in order to avoid risk in N supply based on color combination
Apply Zinc Sulphate @ 65 g/25 m^2 uniformly to all the plots

Determination of grain yield

- Harvest all the hills of a central 5-m^2 area of each treatment plot separately and properly label each harvested sample.
- Thresh and clean the harvested grain. Record the grain yield at 14% moisture level.
- Convert the sample weight to yield in t $ha^{-1.}$
- Determine the P and K response
- P response = Yield in NPK plot – Yield in P omission plot
- K response = Yield in NPK plot – Yield in K omission plot
- From the P and K response, P & K requirement of the field will be calculated based on the ready reckonar table as suggested by Fairthurst and Witt (2002), as in the table below.

Note: The N omission plot yield (0 N Plot) is only to understand the indigenous N supplying capacity of the soil and to decide on the need for basal N application. If the N omission plot yield is < 3.0 t/ha, apply 20-30 kg N/ha basally within 14 DAT, or if the yield is > 3.0 t, there is no need to give basal N application.

Recommended P_2O_5 rates according to target yield and P limited plot

Target yield (t/ha)	4	5	6	7	8
Yield in '0' P plot	Fertilizer P_2O_5 (kg/ha)				
3	20	40	60		
4	15	25	40	60	
5	0	20	30	40	60
6	0	0	25	35	45
7	0	0	0	30	40
8	0	0	0	0	35

Example:

Experiment	Yield (t/ka)
P_2O_5 fertilized	6
P omitted	5
Calculated P_2O_5 (kg/ha) to get an yield of 6 t/ha	30

Recommended K_2O rates according to target yield and K limited plot

Target yield (t/ha)	4	5	6	7	8
Yield in '0' K plot	Fertilizer K_2O (kg/ha)				
3	30	60	90		
4	0	35	65	95	
5	0	20	50	80	110
6	0	0	35	65	95
7	0	0	0	50	80
8	0	0	0	0	65

Example:

Experiment	Yield (t/ka)
K_2O fertilized	6
K omitted	5
Calculated K_2O (kg/ha) to get an yield of 6 t/ha	50

Appendix II

STCR based fertilizer recommendation for transplanted rice
Coimbatore STL Jurisdiction

Soil type	:	Alfisol (Noyyal series)	**Season**	:	Kharif	**Yield target**	:	6.0 t ha^{-1}

Basic data for Fertiliser Prescription Equations

	Basic Data				Fertiliser Prescription Equations
	NR (kg/q)	CS (%)	CF (%)	CO (%)	
N	1.76	20.76	40.12	32.10	FN = 4.39 T - 0.52 SN - 0.80 ON
P	0.41	29.35	18.50	18.13	FP_2O_5 = 2.22 T - 3.63 SP - 0.98 OP
K	1.50	19.83	61.50	44.65	FK_2O = 2.44 T - 0.39 SK - 0.72 OK

Ready reckoner of fertiliser doses at varying soil test values for specific yield target

S. No.	Initial soil tests (kg ha^{-1})			Nutrients required (kg ha^{-1}) - target of 6.0 t ha^{-1}		
	N	P	K	N	P_2O_5	K_2O
1	180	16	180	170	75	76
2	190	18	190	165	68	72
3	200	20	200	159	61	68
4	210	22	210	154	53	64
5	220	24	220	149	46	60
6	230	26	230	143	39	56

7	240	28	240	138	32	52
8	250	30	250	133	24	49
9	260	32	260	128	17	45
10	270	34	270	123	10	41
11	280	36	280	118	3	37

Soil type	:	Alfisol (Noyyal series)	**Season**	:	Rabi	**Yield target**	:	6.0 t ha^{-1}

Basic data for Fertiliser Prescription Equations

	Basic Data				Fertiliser Prescription Equations
	NR (kg/q)	CS (%)	CF (%)	CO (%)	
N	1.71	20.69	36.95	33.20	FN = 4.63 T - 0.56 SN - 0.90 ON
P	0.47	32.87	23.67	10.20	FP_2O_5 = 1.98 T - 3.18 SP - 0.99 OP
K	1.94	26.18	75.42	50.17	FK_2O = 2.57 T - 0.42 SK - 0.67 OK

Ready reckoner of fertiliser doses at varying soil test values for specific yield target

S. No.	Initial soil tests (kg ha^{-1})			Nutrients required (kg ha^{-1}) for an yield target of 6.0 t ha^{-1}		
	N	P	K	N	P_2O_5	K_2O
1	180	16	180	177	68	78
2	190	18	190	172	62	74
3	200	20	200	166	55	70
4	210	22	210	160	49	66
5	220	24	220	155	43	62
6	230	26	230	149	36	57
7	240	28	240	144	30	53
8	250	30	250	138	24	49
9	260	32	260	132	17	45
10	270	34	270	127	11	41

Erode, Coimbatore, Salem & Trichy STL Jurisdiction

Soil type	:	Inceptisol (Irugur series)	**Season**	:	Kharif	**Yield target**	:	6.0 t ha^{-1}

Basic data for Fertiliser Prescription Equations

	Basic Data				Fertiliser Prescription Equations
	NR (kg/q)	CS (%)	CF (%)	CO (%)	
N	1.82	31.27	35.13	34.43	FN = 5.19 T - 0.89 SN - 0.98 ON
P	0.84	72.92	37.11	17.81	FP_2O_5 = 2.27 T - 4.50 SP - 1.09 OP
K	2.14	33.55	68.81	58.00	FK_2O = 3.11 T - 0.59 SK - 1.02 OK

Ready reckoner of fertiliser doses at varying soil test values for specific yield target

S.No.	Initial soil tests (kg ha^{-1})			Nutrients required (kg ha^{-1})- target of 6.0 t ha^{-1}		
	N	P	K	N	P_2O_5	K_2O
1	150	8	150	178	100	98
2	160	10	160	169	91	93
3	170	12	170	160	82	87
4	180	14	180	151	73	81
5	190	16	190	142	64	75
6	200	18	200	133	55	69
7	210	20	210	124	46	63
8	220	22	220	115	37	57
9	230	24	230	106	28	51
10	240	26	240	97	19	45

Soil type	:	Inceptisol (Irugur series)	**Season**	:	Rabi	**Yield target**	:	6.0 t ha^{-1}

Basic data for Fertiliser Prescription Equations

	Basic Data				Fertiliser Prescription Equations
	NR kg/ q)	CS (%)	CF (%)	CO (%)	
N	1.75	24.31	35.75	25.74	FN = 4.88 T - 0.68 SN - 0.72 ON
P	0.92	56.98	44.87	44.42	FP_2O_5 = 2.06 T - 2.91 SP - 2.27 OP
K	1.92	26.12	66.42	32.55	FK_2O = 2.89 T - 0.47 SK - 0.59 OK

Ready reckoner of fertiliser doses at varying soil test values for specific yield target

S.No.	Initial soil tests (kg ha^{-1})			Nutrients required (kg ha^{-1})- target of 6.0 t ha^{-1}		
	N	P	K	N	P_2O_5	K_2O
1	150	8	150	191	100	103
2	160	10	160	184	94	98
3	170	12	170	177	89	94
4	180	14	180	171	83	89
5	190	16	190	164	77	84
6	200	18	200	157	71	79
7	210	20	210	150	65	75
8	220	22	220	143	56	70
9	230	24	230	137	54	65
10	240	26	240	130	48	61

Kovilpatti STL Jurisdiction

Soil type	:	**Inceptisol** (Manakkarai series)	**Season**	:	Kharif	**Yield target**	:	6.0 t ha^{-1}

Basic data for Fertiliser Prescription Equations

	Basic Data				Fertiliser Prescription Equations
	NR (kg/q)	CS (%)	CF (%)	CO (%)	
N	1.54	21.90	36.20	28.5	FN = 4.25 T - 0.60 SN - 0.79 ON
P	0.53	37.60	19.60	7.6	FP_2O_5 = 2.71 T - 4.39 SP - 0.89 OP
K	1.94	25.04	50.90	34.5	FK_2O = 3.83 T - 0.60 SK - 0.82 OK

Ready reckoner of fertiliser doses at varying soil test values for specific yield target

S.No	Initial soil tests (kg ha^{-1})			Nutrients required (kg ha^{-1}) - target of 6.0 t ha^{-1}		
	N	P	K	N	P_2O_5	K_2O
1	180	12	180	147	110	122
2	190	14	190	141	102	116
3	200	16	200	135	93	110
4	210	18	210	129	84	104
5	220	20	220	123	75	98
6	230	22	230	117	66	92
7	240	24	240	111	58	86
8	250	26	250	105	49	80
9	260	28	260	99	40	74
10	270	30	270	93	31	68
11	280	32	280	87	23	62

Soil type	:	**Inceptisol** (Manakkarai series)	**Season**	:	Rabi	**Yield target**	:	6.0 t ha^{-1}

Basic data for Fertiliser Prescription Equations

	Basic Data				Fertiliser Prescription Equations
	NR (kg/q)	CS (%)	CF (%)	CO (%)	
N	1.62	21.02	36.24	28.63	FN = 4.47 T - 0.58 SN - 0.79 ON
P	0.46	27.84	17.29	6.74	FP_2O_5 = 2.66 T - 3.68 SP - 0.89 OP
K	2.06	27.26	50.49	34.22	FK_2O = 4.08 T - 0.65 SK - 0.82 OK

Ready reckoner of fertiliser doses at varying soil test values for specific yield target

S.No	Initial soil tests (kg ha^{-1})			Nutrients required (kg ha^{-1})- target of 6.0 t ha^{-1}		
	N	P	K	N	P_2O_5	K_2O
1	180	12	180	164	115	128
2	190	14	190	158	108	121
3	200	16	200	152	101	115
4	210	18	210	146	93	108
5	220	20	220	140	86	102
6	230	22	230	135	79	95
7	240	24	240	129	71	89
8	250	26	250	123	64	82
9	260	28	260	117	57	76
10	270	30	270	111	50	69
11	280	32	280	106	42	63

Aduthurai STL Jurisdiction

Soil type	:	**Vertisol (Kalathur series)**	**Season**	:	Kharif	**Yield target**	:	6.0 t ha^{-1}

Basic data for Fertiliser Prescription Equations

	Basic Data				Fertiliser Prescription Equations
	NR (kg/ q)	CS (%)	CF (%)	CO (%)	
N	1.68	23.80	31.75	28.26	FN = 5.29 T - 0.75 SN - 0.89 ON
P	0.87	40.40	52.70	17.92	FP_2O_5 = 1.65 T - 1.76 SP - 0.78 OP
K	1.65	18.70	60.50	41.14	FK_2O = 2.73 T - 0.37 SK - 0.82 OK

Ready reckoner of fertiliser doses at varying soil test values for specific yield target

S.No	Initial soil tests (kg ha^{-1})			Nutrients required (kg ha^{-1})- target of 6.0 t ha^{-1}		
	N	P	K	N	P_2O_5	K_2O
1	180	16	180	182	71	97
2	190	18	190	174	67	93
3	200	20	200	167	64	90
4	210	22	210	159	60	86
5	220	24	220	152	57	82
6	230	26	230	144	53	79
7	240	28	240	137	50	75
8	250	30	250	129	46	71
9	260	32	260	122	43	68
10	270	34	270	114	39	64
11	280	36	280	107	36	60

Soil type	:	**Vertisol (Kalathur series)**	**Season**	:	Rabi	**Yield target**	:	6.0 t ha^{-1}

Basic data for Fertiliser Prescription Equations

	Basic Data				Fertiliser Prescription Equations
	NR (Kg/ q)	CS (%)	CF (%)	CO (%)	
N	1.72	21.42	32.18	23.49	FN = 5.34 T - 0.67 SN - 0.73 ON
P	0.92	39.10	48.20	14.73	FP_2O_5 = 1.90 T - 1.86 SP - 0.70 OP
K	1.84	17.80	65.42	43.25	FK_2O = 2.81 T - 0.33 SK - 0.80 OK

Ready reckoner of fertiliser doses at varying soil test values for specific yield target

S.No	Initial soil tests (kg ha^{-1})			Nutrients required (kg ha^{-1}) - target of 6.0 t ha^{-1}		
	N	P	K	N	P_2O_5	K_2O
1	180	16	180	199	84	110
2	190	18	190	193	81	106
3	200	20	200	186	77	103
4	210	22	210	179	73	100
5	220	24	220	173	69	96
6	230	26	230	166	66	93
7	240	28	240	159	62	90
8	250	30	250	152	58	86
9	260	32	260	146	55	83
10	270	34	270	139	51	80
11	280	36	280	132	47	77

Aduthurai STL Juristiction

Soil type	:	**Vertisol (Adanur series)**	**Season**	:	Kharif	**Yield target**	:	7.0 t ha^{-1}

Basic data for Fertiliser Prescription Equations

	Basic Data				Fertiliser Prescription Equations
	NR (kg/ q)	CS (%)	CF (%)	CO (%)	
N	1.56	16.3	56.0	49.84	FN = 2.80 T - 0.29 SN - 0.89 ON
P	0.68	28.2	50.4	39.30	FP_2O_5 = 1.35 T - 1.28 SP - 1.78 OP
K	1.64	22.6	65.6	61.99	FK_2O = 2.50 T - 0.42 SK - 1.14 OK

Ready reckoner of fertiliser doses at varying soil test values for specific yield target

S.No	Initial soil tests (kg ha^{-1})			Nutrients required (kg ha^{-1})- target of 7.0 t ha^{-1}		
	N	P	K	N	P_2O_5	K_2O
1	180	16	180	144	74	99
2	190	18	190	141	72	95
3	200	20	200	138	69	91
4	210	22	210	135	66	87
5	220	24	220	132	64	83
6	230	26	230	129	61	78
7	240	28	240	126	59	74
8	250	30	250	123	56	70
9	260	32	260	121	54	66
10	270	34	270	118	51	62
11	280	36	280	115	48	57

Note: Wherever GLM is applied @ 6.25 t ha^{-1} 38, 13 and 33 kg of N, P_2O_5 and K_2O and for the addition of azospirillum & phosphobacteria each @ 2 kg ha^{-1} 15 and 10 kg of N & P_2O_5 respectively could be reduced from the recommended fertiliser nutrient doses.

References:

Selvakumari , G., Santhi,R., Natesan,R and Mathan, K. K. 2000. Compendium of research on soil test crop response studies and rationalized fertilizer recommendations for crops in Tamil Nadu. Dept of SS&AC, TNAU, Coimbatore-3: pp 93

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:** Chlorpyriphos 20 EC 80 ml Endosulfan 35 EC 80 ml during late evening
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:** Phosphamidon 40 SL 50 ml Monocrotophos 36 SL 40 ml Endosulfan 35 EC 80 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:** Fenitrothion 50 EC 80 ml Phosphamidon 40 SL 50 ml Fenthion 100 EC 40 ml Quinalphos 25 EC 80 ml Phosalone 35 EC 120 ml Endosulfan 35 EC 80 ml Monocrotophos 36 SL 40 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 Quinalphos 5 G 2.0 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:** 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/m^2 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 :** Fenthion 100 EC 500 ml/ha Monocrotophos 36 SL 1000 ml/ha Endosulfan 35 EC 1000 ml/ha Fenitrothion 50 EC 1000 ml/ha Phosalone 35 EC 1500 ml/ha Quinalphos 25 EC 1000 ml/ha Phosphamidon 40 SL 600 ml/ha Profenophos 50 EC 1000 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. ▪ **Spray any one of the following:** Fenitrothion 50 EC 1000 ml/ha Monocrotophos 36 SL 1000 ml/ha Phosalone 35 EC 1500 ml/ha Quinalphos 25 EC 1000 ml/ha Dichlorvos 76 WSC 250 ml/ha Phosphamidon 40 SL 600 ml/ha Chlorpyriphos 20 EC 1250 ml/ha Carbaryl 50 WP 1.0 kg/ha Fenthion 100 EC 500 ml/ha Profenophos 50 EC 1000 ml/ha Neem seed kernel extract 5% 25 kg/ha
Gall midge *Orseolia oryzae*	▪ Release *Platygaster oryzae* parasitised galls at 1 per 10 m^2 on 10 days after transplanting (DAT) ▪ **Spray any one of the following :** Fenthion 100 EC 500 ml/ha Endosulfan 35 EC 1000 ml/ha Fenitrothion 50 EC 1000 ml/ha

	Phosalone 35 EC 1500 ml/ha Quinalphos 25 EC 1000 ml/ha Phosphamidon 40 SL 600 ml/ha
Thrips *Stenchaetothrips biformis*	▪ **Spray any one of the following :** Phosphamidon 40 SL 600 ml /ha Monocrotophos 36 SL 500 ml /ha Endosulfan 35 EC 1000 ml / 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 :** Phosphamidon 40 SL 1000 ml/ha Monocrotophos 36 SL 1250 ml/ha Phosalone 35 EC 1500 ml/ha Carbaryl 10 D 25 kg/ha Methyl demeton 25 EC 1000 ml/ha Acephate 75 SP 625 gm/ha Chlorpyriphos 20 EC 1250 ml/ha Carbofuran 3 G 17.5 kg/ha Dichlorvos 76 WSC 350 ml/ ha Neem oil 3% 15 lit/ha Iluppai oil 6% 30 lit/ha . Neem seed kernel extract 5% 25 kg/ha
White backed planthopper *Sogatella furcifera*	▪ Phosphamidon 40 SL 1000 ml/ha.
Green leafhopper *Nephotettix nigropictus* *N. cincticeps* *N. virescens*	▪ Apply insecticides twice, 15 and 30 days after transplanting. Monocrotophos 36 SL 1000 ml/ha Phosphamidon 40 SL 1000 ml /ha Fenthion 100 EC 500 ml/ha Profenophos 50 EC 1000 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:** Phosphamidon 40 SL 600 ml/ha Fenitrothion 50 EC 1000 ml/ha Phosalone 35 EC 1500 ml/ha Dimethoate 30 EC 500 ml/ha
Black bug *Scotinophora lurida*	▪ **Spray any one of the following :** Monocrotophos 36 SL 1000 ml/ha Acephate 75 SP 625 g/ha 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 Fenitrothion 2 D Carbaryl 10 D Malathion 5 D 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** Monocrotophos 36 SL 500 ml/ha Fenitrothion 50 EC 1000 ml/ha Fenthion 100 EC 500 ml/ha 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
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

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), fenthion 100 EC (500 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.

B) 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 2h ▪ 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 for over night. 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 stratergies**
Blast *Pyricularia grisea* ***(Magnaporthe grisea)***	➢ **Spray any one of the following: (for 20 cents)** ▪ Edifenphos 50 EC 25 ml ▪ Carbendazim 50 W 25g
Brown spot *Drechslera oryzae* **(*Cochliobolus miyabeanus*)**	➢ **Spray any one of the following: (for 20 cents)** ▪ Edifenphos 50 EC 40 ml ▪ Mancozeb WP 80 g
Tungro ***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** ▪ Monocrophos 36 WSC 40ml ▪ Phosphomidan 85 WSC 40ml ▪ Fenthion 100 EC 40 ml
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. ❖ **Biological** ▪ Spray *P. fluorescens* (Pf1) formulations @ 0.2% (1 kg) dissolved in 500 litres of water for one hectare, commencing from 45 days after transplanting at 10 days interval for 3 times depending on the disease severity. ❖ **Chemical** ▪ Spray after observing initial infection of the disease, ▪ Edifenphos 50 EC 500 ml or Carbendazim WP 250 g or Tricyclozole 75 WP 500 g or Iprobenphos (IBP) 500ml/ha.
Brown spot *Drechslera oryzae* **(Cochliobolus miyabeanus)**	➢ **Spray any one of the following:** ▪ Edifenphos 50 EC 500 ml ▪ Mancozeb 1000 g/ha when grade reaches 3. If necessary, repeat 15 days later.

Sheath rot ***Saroclodium oryzae***	❖ **Cultural** ▪ Apply Gypsum @ 500 kg/ha at two equal splits once basally and another at active tillering stage. ❖ **Botanicals** ▪ NSKE (5%) ▪ 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 250 g /ha ▪ Edifenphos 500 ml /ha ▪ Mancozeb 1000g/ha

Sheath blight *Rhizoctonia solani* ***(Thanatophorus cucumaris)***	❖ **Cutlural** ▪ Apply Neem cake at 150 kg/ha ❖ **Botanical** ▪ Foliar spray with Neem oil at 3% (15 lit /ha) starting from disease appearance. ❖ **Biological Control** ▪ Soil application of *P. fluorescens* talc based formulation at 30 DAT @ 2.5 Kg/ha and foliar spray (0.2%) at boot leaf and 10 days later @ 1 Kg/ha. ❖ **Chemcial** ▪ Carbendazim 250 g /ha ▪ Iprobenphos (IBP) 500 ml/ha ▪ Edifenphos 500 ml / ha
Rice grain discoloration 1. *Helminthosporium oryzae* 2. *Alternaria tenuis* 3. *Fusarium moniliforme* 4. *Sarocladium oryzae* *	❖ ***Chemcial*** ➢ ***Spray any one of the following*** ▪ Carbendazim + Thiram + Mancozeb (1:1:1) 0.2% at the time of 50% flowering stage.

** In addition to the above the following are also found to be associated with the grain discoloration viz.,Cladosporium herbarum,Curvularia lunata,C. pallescens,Cephalosporium oryzae,F. 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 neem oil 3% or NSKE 5% ▪ Spray fresh cowdung extract 20% twice (starting from initial appearance of the disease and another at fortnightly interval) ❖ **Chemical / antibiotics** ▪ Spray Streptomycin sulphate + Tetracycline combination 300 g + Copper oxychloride 1250 g/ha. If necessary repeat 15 days later.
Bacterial leaf streak ***Xanthomonas oryzae* pv. *oryzicola***	❖ **Botanical / others** ▪ Spray fresh cowdung water extract at 20%
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** ▪ Monocrotophos 36 WSC (1000 ml/ha) ▪ Fenthion 100 EC (500 ml/ha) may be sprayed 15 and 30 days after transplanting. The vegetation on the bunds should also be sprayed with the insecticides. ❖ Special detection technique ▪ Collect leaf samples at 6 a.m. ▪ The top 10 cm portion of the leaf is immersed in a solution containing 2 g of iodine and 6 g of potassium iodide in 100 ml of water for 15 minutes or 10 ml of tincture of iodine + 140 ml of water for one hour. ▪ Washed in water and when examined. Tungro infected leaves develop dark blue streaks.

Rice yellow dwarf ***Phytoplasma*** Vector *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.

C) Nematode management

Sl.No	Nematode pest	Control measures
1	**Rice root nematode,** *Hirschmanniella oryzae*	Treat *Pseudomonas fluorescens* at 10 g/kg seed 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 or Phosphamidon 85 WSC 300 ml/ha or Monocrotophos 36 WSC at 1 l/ha 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, if same variety it should be passed production of certified procedure.

Isolation

- Adopt 3m all around the field

Pre-sowing seed management

- For rainfed rice or direct sowing harden the seeds by soaking the seeds in equal volume of 1% KCl solution for 20 h and dry back the seeds to original moisture content.
- 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 -16h. The seeds are to be dried to original moisture content.
- Grade the seeds using specific gravity adopting salt water (egg flotation grading) to remove ill filled and immatured seed.

Blanket 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 $ZnSO_4$ @ 30 kg ha^{-1}

Roguing space

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

Foliar application

- DAP 2% at panicle emergence stage.

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 harvest the crop as once over harvest.

Threshing

- Thresh the ear-heads at 16-17% moisture content either manually or using mechanical threshers.

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 / Thiram @ 2g kg^{-1} of seed using 5 ml of water kg^{-1} of seed.

Storage

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

Mid storage correction

- Adopt hydration – dehydration treatment with disodium hydrogen phosphate (3.59g dissolved in 100 liters of water) to improve the viability and vigour when the germination of seed reduce to 5-10% lesser than MSCS level (Minimum Seed Certification Standard).

Other management practices

- As in crop production technique

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

Staggered sowing

Sowing Time (Western zone)

Dec – Jan

CORH 2

- Restorer (R) line, the male parent should be sown 3, 6 and 9 days later than sowing of male sterile (A) line, the female parent

ADTRH 1

- 'R' line should be sown 14,17and20 days after the sowing of'A' line

June – July

CORH 2

- Sowing of R line 0,3 and 6 days after 'A' line sowing

ADTRH – 1

- 'R' line should be sown 12, 15 and 18 days after 'A' line sowing

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 seedling / 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

- 2% DAP at panicle differentiation stage.

Panicle exertion

- Spray GA_3 @ 45 – 60g/ha.
- Spray 40% of GA_3 at 5-10% panicle emergence stage (based on tillers)
- Spray the remaining 60% of GA_3 at 24 h after first spray

Note: GA_3 should be dissolved in 70% alcohol

Supplementary pollination

- Rope pulling or shaking the pollen parent with the help of two bamboo sticks at 30-40% of spikelets opening stage. The 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 removed from the field

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

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.
- Sun dry the seeds to reduce the moisture content to 12-13% with adequate stirring

Storage

- As that of varieties

MILLETS

SORGHUM (*Sorghum bicolor*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

DISTRICTS/SEASON	VARIETIES/HYBRIDS
Kanchipuram, Tiruvallur	
1. Thaipattam	CO 26, CO (S) 28, BSR 1, COH 4
2. Chithiraipattam	CO 26, CO (S) 28, BSR 1, COH 4
3. Adipattam	K Tall, CO 26, CO (S) 28, BSR 1, COH 4,
4. Puratasipattam	K Tall, CO 26, CO (S) 28, BSR 1
Vellore, Tiruvannamalai	
1. Thaipattam	CO 26, CO (S) 28, COH 4, BSR 1
2. Chithiraipattam	CO 26, CO (S) 28, COH 4, BSR 1
3. Adipattam	K Tall, CO 26, CO (S) 28, BSR 1, COH 4, Paiyur 1
4. Puratasipattam	K Tall, CO 26, CO (S) 28, BSR 1, Paiyur 2
Cuddalore, Villupuram	
1. Thaipattam	CO 26, CO (S) 28, COH 4, BSR 1
2. Chithiraipattam	CO 26, CO (S) 28, COH 4, BSR 1
3. Adipattam	K Tall, CO 26, CO (S) 28, BSR 1, COH 4
4. Puratasipattam	K Tall, CO 26, CO(S) 28, BSR 1
Tiruchirapalli, Karur, Perambalur	
1. Thaipattam	COH 4, BSR 1
2. Chithiraipattam	BSR 1, COH 4
3. Adipattam	K Tall, CO 26, CO (S) 28, BSR 1
4. Puratasipattam	K Tall, CO 26, CO (S) 28, BSR 1
Kanyakumari	
1. Thaipattam	CO (S) 28
2. Chithiraipattam	CO (S) 28
Salem, Namakkal	
1. Thaipattam	CO 26, CO (S) 28, BSR 1
2. Chithiraipattam	CO 26, CO (S) 28, BSR 1
3. Adipattam	CO (S) 28, Paiyur 1, Paiyur 2, BSR 1
4. Puratasipattam	CO 26, CO (S) 28, Paiyur 2, BSR 1
Dharmapuri	
1. Thaipattam	CO 26, CO (S) 28, BSR 1
2. Chithiraipattam	CO 26, CO (S) 28, BSR 1
3. Adipattam	CO 26, CO (S) 28, Paiyur 1, Paiyur 2
4. Puratasipattam	CO 26, CO (S) 28, Paiyur 2
Coimbatore	
1. Thaipattam	CO 26, CO (S) 28, COH 4, BSR 1
2. Chithiraipattam	CO 26, CO (S) 28, BSR 1, COH 4
3. Adipattam	CO 26, CO (S) 28, BSR 1
4. Puratasipattam	CO 26, CO (S) 28
Erode	
1. Thaipattam	CO 26, CO (S) 28, COH 4, BSR 1
2. Chithiraipattam	CO 26, CO (S) 28, BSR 1, COH 4
3. Adipattam	CO 26, CO (S) 28, BSR 1, Paiyur 2
4. Puratasipattam	CO 26, CO (S) 28, BSR 1, Paiyur 2
Pudukottai	
1. Thaipattam	BSR 1, COH 4
2. Chithiraipattam	BSR 1, COH 4
3. Adipattam	CO 26, CO (S) 28, K Tall, BSR 1, COH 4
4. Puratasipattam	CO 26, CO (S) 28, K Tall, BSR 1

Madurai, Dindigul, Theni

1. Thaipattam	CO 26, CO (S) 28, COH 4, BSR 1
2. Chithiraipattam	CO 26, CO (S) 28, BSR 1, COH 4
3. Adipattam	CO 26, CO(S) 28, COH 4, K 11, BSR 1, COH 4, APK 1
4. Puratasipattam	CO 26, CO(S) 28, K Tall, K 11, BSR 1, APK 1

Ramanathapuram, Sivaganga, Virudhunagar

1. Thaipattam	CO 26, CO (S) 28, COH 4
2. Chithiraipattam	CO 26, CO (S) 28, BSR 1, COH 4
3. Adipattam	BSR 1, COH 4, APK 1
4. Puratasipattam	CO 26, K 11, K Tall, BSR 1, APK 1

Tirunelveli, Thoothukudi

1. Thaipattam	CO 26, CO (S) 28, COH 4, BSR 1
2. Chithiraipattam	CO 26, CO (S) 28, COH 4, BSR 1
3. Adipattam	K Tall, K 11, CO 26, CO(S) 28, BSR 1, APK 1
4. Puratasipattam	K Tall, CO 26, CO (S) 28, K 11, BSR 1, APK 1

Note: Thaipattam: January - February; Chithiraipattam: April - May; Adipattam: June - July; Puratasipattam: September - October.

II. PARTICULARS OF SORGHUM VARIETIES

PARTICULARS	CO 26	CO (S) 28	COH 4
Parentage	Derivative of MS 8271x IS 3691	Derivative of CO 25 x SPV 942	296A X TNS30
Duration (days)	105 - 110	100-105	105 - 110
Area (Districts)	All districts	All districts	All districts
Season (Pattam)			
Rainfed	Adi, Puratasi	Adi, Puratasi	…
Irrigated	Thai, Chithirai	Thai, Chithirai	Thai, Chithirai
Grain yield kg/ha			
Rainfed	4500	2493	...
Irrigated	6000	4568	6500
Fodder yield kg/ha			
Rainfed	14000	12600	...
Irrigated	19000	17700	20000
Stalk	Juicy, Sweet	Juice	Juicy
Height (cm)	160 - 190	220-240	200 - 215
Sheath colour	Green	Tan	Green
Node	Green	Green	Green
Midrib	Dull white	Dull white	White
Earhead shape	Long cylindrical	Cylindrical	Elliptic
Compactness	Semi compact	Semi compact	Semi Compact
Grain colour	Pearly white	White	Pearly white
Special features	--	--	Less incidence of leaf diseases, grain mould and sugary diseases

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	Southern districts and	Southern districts

	western districts	other districts	
Season (Pattam)			
Rainfed	Adi, Puratasi	Adi, Puratasi	Puratasi
Irrigated	...	Thai, Chithirai	…
Grain yield kg/ha			
Rainfed	1000	3750	1560
Irrigated	...	4250	--
Straw 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, moderate resistance to earhead bug, shoot fly and stem borer.	Dual purpose red grain sorghum suited to rainfed tract of Salem Namakkal districts. Tolerant to downy mildew and charcoal rot diseases.	Non-lodging

CROP MANAGEMENT

I. SELECTION OF SEEDS

Good quality seeds are 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 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 blackgram also. This was true with Sorghum followed by Groundnut also.

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 (2000g/ha) and 10 packets (2000 g/ha) of phosphobacteria or 20 packets of Azophos (4000g/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 using a ridger at 6 m long 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

i. Apply NPK fertilizers as per soil test recommendations. 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 basally before planting
iii. 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.
iv. 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 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.
viii. Soil test based fertilizer recommendation may be adopted in Western and North Western Zone *viz.,* Alfisol, Inceptisol and Vertisol for prescribing fertilizer doses for specified yield targets.

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 for the 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

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.
vii. Maintain a spacing of 15 cm between plants in the row which are 45 cm apart ($15/m^2$).

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 inter-cropped in sorghum at two rows of fodder cowpea in between paired rows of sorghum.

3. WEED MANAGEMENT

i. Apply the pre-emergence herbicide Atrazine 50 WP - 500 g/ha on 3 days after sowing as spray on the soil surface, using Backpack / Knapsack / Rocker sprayer fitted with a flat fan nozzle using 900 l of water/ha.
ii. Sorghum is slow growing in early stages and is adversely affected by weed competition. Therefore keep the field free of weeds upto 45 days. For this, after pre-emergence herbicide application, one hand weeding on 30 - 35 days after sowing may be given
iii. If pulse crop is to be raised as an inter-crop in sorghum do not use Atrazine.
iv. Hoe and hand weed on the 10th day of transplanting if herbicides are not used. Hoe and weed between 30 - 35 days after transplanting and between 35 - 40 days for a direct sown crop, if necessary.

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 on the 23rd day of sowing. 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 straw 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 straw.

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

Test the soil and apply fertilizers based on soil test recommendations.

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 volum and then dried back to its original moisture content is shade and are used for sowing.

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) Soak the seeds in 2% (20 g in one litre of water) potassium dihydrogen phosphate or 500 ppm of CCC (500 mg in one litre of water) for six hours and shade dry the seeds for 5 hours. Use 350 ml of solution for soaking one kg of seed.
iv) 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.

7. SOWING

Sow the seeds well before the onset of monsoon at 5 cm depth (by seed drill or by country plough). The seed is pelletised with 15 g of Chloropyriphos in 150 ml of gum and shade dried.

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 5^{th} week. If sufficient moisture is available spray Atrazine @ 500 g/ha as pre-emergence application within 3 days after the receipt of the soaking rainfall for sole sorghum while for sorghum based intercropping system with pulses, use Pendimethalin at 3.0 l/ha.

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 Coimbatore.
- Intercropping of soyabean 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 monocrotophos 36 WSC 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 :** Endosulfan 35 EC 18 ml/ha 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 :** Endosulfan 35 EC 500 ml/ha Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha Neem Seed Kernal extract 5% Azadirachtin 1%

	▪ Soil application of phorate 10 G 10 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
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 :** Quinalphos 5 G 15 kg/ha Endosulfan 4 G 15 kg/ha Phorate 10 G 8 kg/ha Carbofuron 3 G 17 kg/ha Carbaryl 4 G 20 kg/ha Endosulfan 4 D 10 kg/ha Phosalone 4 D 10 kg/ha Phenthoate 2 D 5 kg/ha ▪ **Spray any one of the following insecticides :** Endosulfan 35 EC 750 ml/ha 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% Azadirachtin 1% ▪ 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 Phosalone 4 D 25 kg/ha Neem seed kernel extract 5% Azadirachtin 1% ▪ For the earhead bug and sugary disease predominance, spray twice with Malathion 50 EC 500 ml/ha. plus ziram 1.25 kg/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 Monocrotophos 36 WSC 4 ml/kg of seed. 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

- Since the ratoon crop invites pests and diseases in early stages, plant protection measures have to be resorted to. Spray chemicals immediately after application of fertiliser before irrigation.
- Fallow the plant protection measures as recommended for the control of stemborer, earhead midge and earhead bug for the main crop.

B. Disease Management

Nursery practices	
Seed treatment	Treat the seeds 24h prior to sowing with Carbendazim or Captan or Thiram 2g/kg of seed or Metalaxyl+Mancozeb 4g/ kg of seed
Main field	
Name of the Disease	**Management** (Dosage / ha)
Rust Puccinia purpurea	Spray Mancozeb at 1kg/ha. Repeat fungicidal application after 10 days
Ergot or Sugary disease *Sphacelia sorghi* *Claviceps purpurea*	❖ Cultural method ▪ Sowing period to be adjusted so as to prevent heading during rainy season and severe winter. ▪ Chemcial ➢ 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
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*	➢ Cultural method ▪ Rogue infected plants upto 45 days after sowing ▪ Spray any one of the fungicides like Metalaxyl 500 g or Mancozeb 1000g/ha afternoticing the symptoms of foliar diseases, for both transplanted and direct sown crops.
Charcoal Rot *Macrophomina phaseolina*	▪ Treat the seeds with *Trichoderma viride* @ 4g/Kg of seed.

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

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Districts/Season	Varieties/Hybrid
1. IRRIGATED	
i. Chithiraipattam (March-April)	
All pearl millet growing districts except Nilgiris	CO 7, CO (Cu) 9, X 7, ICMV 221
ii. Masipattam (January-February)	
All pearl millet growing districts except the Nilgiris,	CO 7, CO (Cu) 9, X 7, ICMV 221
2. RAINFED	
i. Adipattam (June-July)	
	CO 7, CO (Cu) 9, X 7, ICMV 221
ii. Purattasipattam (September -October)	CO 7, CO (Cu) 9, X 7, ICMV 221

II. PARTICULARS OF CUMBU HYBRIDS AND VARIETIES

PARTICULARS	CO 7	X 7	CO (Cu) 9	ICMV 221
Parentage	(CO 6 x PK 560) PT 1921	L111 A x PT 1890	Selection from ICMV 93752	ICRISAT Composite
Season-irrigated/ rainfed	Both	Both	Both	Both
Duration (Days)	90 - 100	90	80-85	75-80
Grain yield (kg/ha)				
Rainfed	2500 - 2800	2513	2354	13% >ICTP 8203
Irrigated	3000 - 3500	3295	2865	--
Plant height (cm)	130 - 145	155 - 180	186-222	140-200
Tillers (No.)	6 - 10	4 - 7	3-6	More tillering
Pigmentation	Green	Non- pigmented	--	--
Hairiness	Glabrous	Glabrous	Glabrous	Absent
Days to 50% bloom	65 - 70	50 - 55	50-55	50-55
Shape of earhead	Conical/ cylindrical/ spindle	Candle	Candle to cylindrical	Semicompact to compact lanceolate to oblanceolate
Bristles	Nil	—	Absent	Usually non bristled
Length of earhead	22 - 26	25 - 35	33-39	--
(cm)				
Breadth of earhead	3 - 4	—	8-10	Wide in girth
(cm)				
Grain colour	Slate colour	Slate	Grey seed with yellow base	Dark grey
1000 grains weight (gm)	6.8 - 7.2	8.0 - 9.0	9-11	10-15
Special features	Resistant to downy mildew	Resistant to downy mildew	Resistant to downy mildew	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 7^{th} and 14^{th} 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.
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. 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 Atrazine 50 WP 500 g/ha on the 3rd day. Then, one hand weeding on 30 - 35 days after transplanting may be given. If herbicide is not used hand weed on 15th day and again between 30 and 35 days after transplanting.

Direct Sown crop

i. Apply the pre-emergence herbicide Atrazine 50 WP at 500 g/ha, 3 days after sowing as spray on the soil surface using Back-pack/Knapsack/Rocker sprayer fitted with flat type nozzle using 900 l of water/ha.
ii. Apply herbicide when there is sufficient moisture in the soil.
iii. Hand weed on 30 - 35 days after sowing if pre-emergence herbicide is applied.
iv. If pre-emergence herbicide is not applied hand weed twice on 15 and 30 days after sowing.

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

STAGES	Days after transplantation/sowing 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

A. PEST MANAGEMENT

Pest management strategies

Pest	Management strategies
Shoot fly *Atherigona approximate*	▪ 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 :** Endosulfan 35 EC 500 ml/ha Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha Neem seed kernel extract 5% Neem Azal 1% ▪ Soil application of phorate 10 G 40 kg/ha at the time of sowing
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 Endosulfan 35 EC 750 ml/ha (500 l of spray fluid/ ha).

B. DISEASE MANAGEMENT

Nursery	
Seed treatment	❖ **Cultural method** **<u>Removal of ergot / sclerotia to prevent primary infection</u>** ▪ 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. ❖ **Chemical** ▪ Thiram 75%WDP @ 2g + 5ml of water/kg of seed or Metalaxyl 6 g/kg for the control of downy mildew in the endemic area
Main field	
Name of the Disease	**Management**
Sugary or Ergot disease *Claviceps fusiformis*	▪ Spray any one of the fungicides like Carbendazim 500g or Mancozeb 1000g when 5 - 10% flowers have opened and again at 50% flowering stage.
Rust *Puccinia penniseti*	❖ Cultural method ▪ 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. ❖ Chemcial ➢ 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*	❖ **Cultural method** ▪ Grow downy mildew resistant varieties CO7, WCC 75 ▪ 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 after sowing as and when the symptoms are noticed. ➢ Spray any one of the fungicides ▪ Metalaxyl 500 g or ▪ Mancozeb 1000g/ha

RAGI (*Eleusine coracana*)
IRRIGATED

CROP IMPROVEMENT

1. SEASONS AND VARIETIES

DISTRICTS/SEASON	VARIETIES
Irrigated	
i. Marghazipattam (Dec - Jan)	
All districts except Kanyakumari & Nilgiris	CO 9, CO 13, CO (Ra) 14 , TRY 1
ii. Chithiraipattam (April - May)	
All districts except Kanyakumari & Nilgiris	CO 9, CO 13, CO (Ra) 14
Rainfed	
i. Adipattam (June - July)	
All districts except Kanyakumari & Nilgiris	Paiyur 1, CO 13, CO (Ra) 14
ii. Puratasipattam (September - October)	
All districts except Kanyakumari & Nilgiris	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

Contd..

Contd..

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

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 seeds evenly on the beds.
iii. Cover the seeds by levelling out 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	12^{th} day after sowing	16th day after sowing
5th	17^{th} 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

i. Soil test based fertilizer recommendations may be adopted in Western and North Western Zones in soils of Vertisols, Alfisols, Inceptisols and Entisols for prescribing the fertilizer doses for specified yield targets. In soils having high intensive cropping system viz., Ragi-Maize-Cowpea, having high soil available K (310 kg/ha) potassium need not be applied. Apply NPK fertilizers as per soil test recommendation as far as possible. 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.

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 Butachlor 2.5 l/ha or Fluchloralin 2 l/ha or Pendimethalin 2.5 l/ha, using Backpack Knapsack/Rocker sprayer fitted with flat fan type of nozzle with 900 litre of water/ha.
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 day after transplanting.
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 10th day after sowing 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 is 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% 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 of 15-20 kg per hectare will contain about 4 million seeds. 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

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 around 20-25 days after sowing effectively controls weeds. Isoproturon @ 0.5 a.i/ha as pre-emergence spray is also effective in control of weeds. In broadcast crop two effective hand weedings will minimize weeds as inter cultivations is not possible.

Cropping systems

Crop rotation

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

Intercropping

Finger millet + Pigeon pea combinations in 8 : 2 or 6 : 2 proportion brings higher returns in Tamil Nadu. Finger millet + field bean in 8 : 1 proportion or finger millet + blackgram or green gram in 8 : 2 proportion are the other profitable crop combinations.

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 : Endosulfan 35 EC 1000 ml/ha Carbaryl 50 WP 1 kg/ha (500 l spray fluid/ha).
Root aphid *Tetraneura nigriabdominalis*	▪ Spray any one of the following : Endosulfan 35 EC 1000 ml/ha 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

B. DISEASE MANAGEMENT

i)Nursery	
Seed treatment	▪ Thiram 4 g or Captan 4 g or Carbendazim 2 g/kg of seed. ▪ Treat the seeds 24 hr prior to sowing.
ii)Main field	
Name of the Disease	**Management**
Blast *Pyricularia grisea*	➢ Spray any one of the fungicides ▪ Edifenphos 500 ml or Carbendazim 250 g or 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. ▪ Treat the seeds with *P. fluorescens* 10 g/kg and spray the extracts of *Prosopis juliflora* leaf extract (10%), *Ipomoea cornea* leaf extract (10%). ▪ Foliar spray with Aureofungin sol 100 ppm at 50% earhead emergence followed by a second spray with Mancozeb 1000g/ha 10 days later.
Mosaic (*Potyvirus*) *Vector* *Aphis* sp. **Ragi mottle streak** *(Nucleo rhabdovirus)* Vector *Cicadulina bipunctella* *C. chinai*	❖ **Cultural method** ▪ Rogue out the affected plants. ▪ Spray any one of the insecticide like Monocrotophos 36 WSC 700 ml/ha or Methyl demeton 25EC 500 ml/ha on noticing symptoms and repeat twice if necessary at 20 days intervals.

MAIZE (*Zea mays* L.)

I. SEASON AND VARIETIES

SEASON	STRAIN
1. Adipattam (July - August)	CO 1, COH (M) 4, COBC 1
2. Purattasipattam (September -October)	CO 1, COH (M) 4, COBC 1
3. Thaipattam (January -February)	CO 1, COH (M) 4, COBC 1

MAIZE - MORPHOLOGICAL DESCRIPTION

PARTICULARS	CO 1	COH(M) 4	COBC 1
Parentage	Unit Selection from Indonesian popu lation Suwan 1	(UMI 90 x xUMI 285) x UMI 112	Composite involving UMI 836 and UMI 836-1-2
Duration (days)	105 - 110	94 (90 – 95 days)	55 - 65 (fresh cobs harvest)
Area of Adoption	Coimbatore, Erode, Tirunelveli, Tanjore and Pudukottai	Coimbatore, Dindugul, Erode, Salem, Virudhunagar, Perambalur, Tuticorin, Madurai and Theni districts	All maize growing areas
Rainfed/Irrigated	Both	Both	Both
Grain yield (kg/ha) Irrigated	5200	5694	6.7 tonnes of tender cobs & 32.3 tonnes of green fodder / ha
Rainfed	3300	4521	3 tonnes of tender cobs per ha.
Special features	Resistant to downy mildew Orange flint grains	Shorter duration, suitable for rainfed areas Moderate resistance to downy mildew and stemborer	2 to 3 cobs / plant, possessing delightful sweet taste and flavour Suitable for inland and export market Green fodder has good forage value
Sheath colour	Green	Green	Green
Node colour	Green	Green	Green
Mid rib	White	White	White
Cob size	Big	Big	Small
Husk coverage	Full	Full	Nil
Grain colour	Deep orange	Yellow	Yellow
Nature of kernels	Flint	Flint	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. Apply NPK fertilizers as per soil test recommendation as far as possible. If soil test recommendation is not available adopt a blanket recommendation of 135:62.5:50 NPK kg/ha.
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.
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 the mixture over the furrows and two thirds in the top of ridges, if ridge planting is followed.
iii. If bed system of sowing is followed, apply the micronutrient mixture over the furrows.
iv. 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 COH(M) 4 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 the pre-emergence herbicide, Atrazine 50 WP at 500 g/ha (900 lit of water) at 3 days after sowing as spray on the soil surface followed by one hand weeding on 40-45 days after sowing.
ii. Apply herbicide when there is sufficient moisture in the soil.
iii. Do not disturb the soil after herbicide application.
iv. Hoe and hand weed on the 17th or 18th day of sowing, if herbicide is not applied. NOTE: If pulse crop is to be raised as intercrop, do not use Atrazine.

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 -4th,12th day
Vegetative	2	25th, 36th day
Flowering(Irrigate copiously)	2	48^{th,} 60th day
Maturity phase (Control irrigation)	2	72nd, 85th day

Light soils		
Germination & establishment	3	After sowing, Life irrigation -4th ,12thday
Vegetative Phase	3	22nd ,32nd & 40th day
Flowering phase (Irrigate copiously)	3	50th ,60th & 72nd day
Maturity phase (Controlled irrigation)	2	85th , 95th day

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.

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 PROTECTION

A. PEST MANAGEMENT

Pests	Management strategies
Shoot fly *Atherigona orientalis*	▪ 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 : Endosulfan 35 EC 500 ml/ha Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha Neem seed kernel extract 5% Neem azal 1% ▪ Soil application of phorate 10 G 40 kg/ha at the time of sowing
Stem borer *Chilo partellus* **Ash weevil** *Myllocerus* spp **Aphids** *Rhopalosiphum maidis*	▪ 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 : Quinalphos 5 G 15 kg/ha Carbaryl 4 G 20 kg/ha. ▪ If granular insecticides are not used, spray any one of the following : Quinalphos 25 EC 1 lit/ha Carbaryl 50 WP 1 kg/ha on the 20th day of sowing (500 l of spray fluid/ha).
Cob borer *Helicoverpa armigera*	▪ Apply any one of the following insecticides at silk drying stage : Carbaryl 10 % D 25 kg/ha Carbaryl 50 WP 1.0 kg/ha. ▪ Repeat the insecticidal application 15 days later (500 l spray fluid/ha).

B. DISEASE MANAGEMENT

Seed treatment	Metalaxyl or Carbendazim or Thiram @ 2 g/kg of seed.
Name of the Disease	**Management**
Downy mildew or Crazy top ***Peronosclerospora sorghi***	▪ Use resistant hybrids / varieties ▪ Rogue out affected plants. ▪ Spray Metalaxyl 72 WP @ 1000g, Mancozeb 1000g/ha 20 days after sowing.
Leaf spot *Helminthosporium turcicum*	▪ Spray Mancozeb or Captan 1000g/ha when the disease intensity reaches grade 3

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.

District/Season	Variety
1. TENAI	
Rainfed	
a) June-July (Hill slopes of Coimbatore and Erode Districts)	CO 6, CO (Te) 7
b) September-October (Coimbatore and Southerndistricts)	CO 6, CO (Te) 7
Irrigated	
a) February-March	
b) September-October	CO 6, CO (Te) 7
2. SAMAI	
a) June-July (Hill slopes of Coimbatore and Erode districts)	CO 3
b) July-August (Dharmapuri)	Paiyur 1, Paiyur 2, CO 3
c) September-October	CO 3
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
Irrigated	
a) February-March	K 2 , CO 4
5. KUDIRAIVALI	
Rainfed	
a) September-October	CO 1
Irrigated	
a) February-March	CO 1

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
Parentage	Pureline selection from Santhur local	Pure line selection from PM 295	Selection from germplasm bank
Duration (days)	105 -110	85	80 - 85
Pigmentation	Dark green	Green	Green
Tillering ability	Moderate	Moderate	High
Panicles	Semi compact long	long, loose panicle	long, loose panicle
Grain Character	Brown	Brown	Brown
Grain Yield (kg/ha) Rainfed	870	850	1066
Special features	Long duration	Short duration, suitable for little millet – Horse gram cropping sequence	Bold grain, Non-lodging suits for early & late sowing

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
Parentage	Selection from PV1685	Pureline selection from Sengathur local
Duration (days)	75	75
Pigmentation	Green	Green
Tillering ability	High	High
Panicles	Loose	Loose density subscent

Grain character	Grey	Golden yellow
Grain yield (kg/ha) Rainfed	3184	1500
Special features	Non-lodging drought tolerant Non-shattering and responsive to fertilizers	High tillering,wider adaptability

KUDIRAIVALI

PARTICULARS	**CO 1**
Parentage	Pureline selection from Coimbatore local
Duration (days)	75
Pigmentation	Green
Tillering ability	High
Panicles	Loose
Grain Character	Yellow
Grain Yield (kg/ha) Rainfed	1750
Special features	No major diseases noted

CROP MANAGEMENT

Package of practices for Tenai

Seeds and sowing :

For line planting	:	10kg/ha
For sowing	:	12.5kg/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 x 10 cm, for sowing 10 cm in between plants
Weeding	:	First weeding on 15 th 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 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 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 for sowing 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 for sowing 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

2. Morphological Description of COW(W) 1

Particulars		
Parentage	:	HD2646/HW2002A/CPAN3057
Duration (days)	:	85-90
Grain yield (Kg /ha)	:	2364
Stem	:	Erect
Height (cm)	:	73 – 78
Tillers	:	5-6
Days to 50% flowering	:	50 days
Ear size and shape	:	Fusiform ears
Grain colour	:	Amber
1000 grains weight (g)	:	37
Special features	:	Non lodging, non shattering; tolerance to stem and leaf rust ; suitable for chappathi and bread making.

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.

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

5. APPLICATION OF FERTILIZERS

i. Apply NPK fertilizer as per soil test recommendation as far as possible. 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 and K_2O_5 basally before sowing and incorporate in the sowing line.

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 spraying 3 days after sowing followed by one hand weeding on 35th day after sowing.
ii. If herbicide is not applied, give two hand weedings on 20th and 35th day after sowing.

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 voided 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. Trash 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
Vitavax @ 2 g/kg of seed

PULSES

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

CROP IMPROVEMENT

I. SEASON AND VARIETIES

District/season	Varieties
Adipattam (June - August)	
Kanchipuram, Tiruvallur, Dharmapuri, Erode	SA 1, CO 6, CO(RG) 7, COPH 2, Vamban 2, VBN (RG) 3
Coimbatore, Vellore, Tiruvannamalai,	
Cuddalore, Villupuram, Salem, Namakkal, Pudukottai	CO 6*, COPH 2, CO(RG) 7, Vamban 1, VBN (RG) 3
* For all districts	
Thanjavur, Tiruvarur, Nagapattinam, Tiruchirapalli, Perambalur, Karur, Pudukottai, Madurai, Dindigul, Theni, Ramanathapuram, Virudhunagar, Tirunelveli, Thoothukudi, Sivagangai	CO(RG) 7
Purattasipattam (September – November)	
Kanchipuram, Tiruvallur, Vellore, Tiruvannamalai, Dharmapuri, Salem, Namakkal, Erode, Coimbatore, Madurai, Dindigul, Theni	COPH 2, CO(RG) 7, APK 1, VBN (RG) 3
Summer (February - March)	
All districts except The Nilgiris and Kanyakumari	COPH 2, CO(RG) 7, VBN (RG) 3
Pudukottai	Vamban 1, VBN (RG) 3
Wetland bunds	BSR 1 , Vamban 2

II DESCRIPTION OF REDGRAM VARIETIES

PARTICULARS	BSR 1	CO 6	VBN 1
Parentage	Pureline selection from Mayiladumparai	Mutant of SA 1 (25 Kr gamma rays)	(Prabhat x HY 3A) x (T 21 x 102)
Year of release	1986	1991	1992
50% flowering (days)	100-110	120 - 130	70
Duration days)	Perennial	170 - 180	95 – 100
Grain Yield (kg/ha)			
Rainfed	0.75 - 1.0 kg of green pods/plant	893	840
Irrigated	..	..	1200
Height (cm)	150 - 200	166	92 – 100
Branches	7-10	8-12	4-6
Plant spread	Semi spreading	Semi spreading	Erect
Colour of standard petal	Red at dorsal side	Yellow with light purple streaks at the base	Yellow with faint Red veins at the base
Colour of pod	Red with diagnal	Green with purple streaks	Green with purple

	constriction		streaks
Colour of grain	Reddish brown	Reddish brown	Brown
100 seed weight (g)	12 .0	8.8	6.8-7.5
Pattern of growth	NDT	NDT	DT

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

PARTICULARS	**COPH 2**	**APK 1**	**VBN 2**
Parentage	ms CO 5 x ICPL 83027	Pure line selection from ICPL 87101	ICPL 341 x Bhavani-sagar local
Year of release	1997	1999	1999
50% flowering (days)	60 - 75	70	70
Duration days)	120 - 130	95 – 105	172 – 180
Grain Yield (kg/ha)			
Rainfed	-	900	1050
Irrigated	1050	1250	-
Height (cm)	100 - 120	91 – 128.2	200 - 250
Branches	4 - 6	4 – 5	8-12
Plant spread	Erect	Erect	Semi spreading
Colour of standard petal	Yellow with faint Red veins at the base	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	Green with purple streaks
Colour of grain	Tan brown	Reddish brown	Reddish brown
100 seed weight (g)	9.0 to 9.4	10.9 – 11.0	7.52 8-0
Pattern of growth	NDT	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
Grain Yield (kg/ha)		
Rainfed	950	885
Irrigated	1168	-
Height (cm)	120 – 130	100 - 120
Branches	7 – 9	3 - 10
Plant spread	Semi spreading	Erect, 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	DT

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

CROP MANAGEMENT

III. SEED RATE

Quantity of seed required kg/ha

Varieties	CO 6	CO(Rg) 7	Vamban 1	APK 1	Vamban 2	COPH 2	VBN (Rg) 3
Sole Crop	10	25	25	25	10	25	25
Mixed Crop	5	10	10	10	5	--	10

[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

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 treated seeds should be again treated with a bacterial culture. Treat with Rhizobial culture CRR6. There should be an interval of atleast 24 hours after fungicidal treatment for giving the bacterial culture treatment. For red lateritic soil Rhizobial culture VPR 1 is effective.

b) Treat the seeds with 3 packets (600 g/ha) of Rhizobial culture CRR6 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.

4. APPLICATION OF FERTILIZERS

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

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

5. SOWING THE SEEDS

Dibble the seeds adopting the following spacing.

Variety	Pure crop	Mixed crop
CO(Rg) 7	45 cm x 30 cm	120 cm x 30 cm
COPH 2	45 cm x 15 cm	……..
Vamban 1, APK 1, Vamban (Rg) 3	45 cm x 20 cm	120 cm x 30 cm
CO 6, Vamban 2	90 cm x 30 cm	240 cm x 30 cm
Bund Crop	60 cm for BSR 1 and 30 cm for others.	

6. WEED MANAGEMENT

i) Pre emergence application of Pendimethalin 2 litres /ha 3 days after sowing mixed with 500 l of water using Backpack/Knapsack/Rocker sprayer using flat fan type of nozzle. Then irrigate the field. Following this, one hand weeding may be given on 30-35days after sowing.

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

7. WATER MANAGEMENT

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

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

a) Foliar Spray of NAA 40 mg/l and Salycylic acid 100 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 thereafter

9. HARVESTING THE CROP

1) Picking the matured pods and drying and processing
2) Harvesting the whole plants heaping ,drying and processing.

10. INTER-CROPPING

a) Raising one row of long duration redgram varieties as inter crop for every six rows of groundnut (6:1) is recommended for rainfed crops.

b) Raising one row of short and medium duration redgram as inter crop for every four rows of groundnut (4:1) is recommended for rainfed as well as for irrigated crops.

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. For both systems, apply 40 kg N and 20 kg P_2O_5/ha. (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).

11. 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 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
Plume moth	5/plant
Spotted pod borer	3/plant

Pests	Management strategies
Aphids *Aphis cracivora* **Red spider mite** *Schizotetranychus cajani*	▪ **Spray any one of the following :** Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha Phosphamidon 40 SL 500 ml/ha (250 l spray fluid/ha).
Blister beetle *Mylabris* spp.	▪ **Spray any one of the following :** Dichlorvos 76 EC 500 ml/ha Carbaryl 50 WP 500 g/ha
Pod borers Spotted pod borer *Maruca testulalis* **Plume moth** *Exelastis atomosa* **Grampod borer** *Helicoverpa armigera* **Pod fly** *Melanagromyza obtuse* **Pod bug** *Clavigralla gibbesa*	▪ Pheromone traps for *Helicoverpa armigera* 12/ha ▪ 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 :** Dichlorvos 0.07% Endosulfan 4% D 25 kg/ha Quinalphos 4% D 25 kg/ha Carbaryl 5% D 25 kg/ha Endosulfan 35 EC 1.25 lit./ha Monocrotophos 36 WSC 625 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)

B. Disease Management

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

Name of the Disease	Management
Wilt *Fusarium oxysporum f.sp.udum*	▪ Spot drench Carbendazim – 1 gm/ litre (or) ▪ *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 drench Carbendazim – 1 gm/ litre (or) ▪ *P. fluorescens* or *T. viride*– 2.5 Kg / ha + 50 Kg of well decomposed FYM or sand at 30 days after sowing.
Sterility Mosaic *Pigeonpea sterility mosaic virus* *Vector : Aceria cajani*	▪ Rogue out the infected plants in the early stages of growth. ▪ Spray monocrotophos 500 ml/ha on noticing the initial symptoms and repeat after a fortnight.

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.

SEED PRODUCTION

Variety Seed Production

Land requirement
- Land should be free of volunteer plants.

Isolation
- Adopt 100 m of certified seed production

Pre-sowing seed treatment
- Soak the seeds before sowing for 3 hrs in aqueous solution of $ZnSO_4$, 100 ppm (10g/100 lit of water) at 1/3 volume of seeds and quickly air dry in shade to their original moisture content.
- Slurry treat the seeds with Thiram 75% WP @ 2 g dissolved in 5 ml of water per kg of seeds. After air-drying, treat the seeds with the Rhizobial culture before sowing, following the recommended procedures.

Foliar Application
- Spray 2% DAP at the time of first appearance of flowering and give a second spray 15 days after first spray.
- Spray NAA 40 ppm first round at 1st flowering and a second round after fortnight.
- NAA can be mixed with fungicide and pesticide

Pre-harvesting sanitation spray
- Apply of Endosulfan 35 EC @ 0.07% or malathion 50 EC @ 0.05% before harvesting (3 - 5 days before) to minimise bruchid infestation in seed crop.

Harvesting
- Pods should be harvested 40 days after 50% flowering stage for production of quality seed.

Processing
- Dry the pods immediately to about 12 to 13 per cent moisture content.
- Dry the seeds to 10 % moisture content.
- Size grade using wire mesh sieve B.S.S. 5 x 5 (width of square aperture 3.35 mm) for large seeded varieties and 6 x 6 (2.8 mm) for small seeded varieties and rejected discoloured and broken seeds.

Pre-storage Seed treatment
- Dry the seed to 7 - 8 % moisture content
- Treat the seed with Carbendazim @ 2g dissolved in 5 ml of water kg^{-1} of seed.
- Dry dressing of seeds with halogen mixture (Pure $CaOCl_2$ + $CaCO_3$ + arappu leaf powder at (5:4:1) ratio @ 3g/kg of seed
- For grain cum seed storage, treat the seed with activated clay, neem oil, groundnut oil and leaf powder of tobacco, nochi, neem, *Albizzia amara* (arappu) and fruit rind powder of *Sapindus laurifolius* (Poochi kottai) and *Acacia concinna* (Soapnut powder).

Storage
- Use gunny or cloth bags for short term storage with seed moisture content of 8 - 9%
- Use polylined gunny bag for medium term storage with seed moisture content of 8 - 9%
- Use 700 gauge polythene bag for long term storage with seed moisture content of less than 8%.

Other management techniques
- As in crop management technique

HYBRID SEED PRODUCTION (COPH 2)

Isolation

- Adopt 200 m for parental line seed production (foundation) and 100 m for hybrid (Certified) seed production

Planting ratio

- Adopt 4:2 ratio of female : male

Border rows

- Plant 2 rows of male all around the field

Spacing

- Adopt 45 x 15 cm

Fertilizer

- Apply NPK @ 25:50:25 kg ha^{-1}

Roguing

- Pull out all fertile plants in female rows

Seed Treatment

- Treat the seed with halogen mixture @ 3g/kg of seed.
- Treat with turmeric rhizome powder (or) Neem leaf powder @ 1:50 powder to seed ratio for ecofriendly seed treatment with nil bruchid infestation

Other management practices

- As in varietal seed production

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)	
Kanchipuram, Tiruvallur, Trichirapalli, Perambalur, Karur	T 9, VBN 1, VBN 2, VBN 3, VBN(Bg) 4
Vellore, Tiruvannamalai, Dharmapuri, Pudukottai Cuddalore, Villupuram, Salem and Namakkal	T 9, VBN 1, VBN 2, VBN 3, VBN(BG) 4
Ramanathapuram, Virudhunagar, Sivagangai Tirunelveli and Thoothukudi	CO 5, T 9, VBN 2, VBN 3, VBN(BG) 4
Madurai, Dindigul, Theni	CO 5, VBN 1, VBN 2, VBN 3, VBN(BG) 4
Erode, Coimbatore	CO 5, VBN 1, VBN 2, VBN 3, VBN (BG) 4
Puratasipattam (September-November)	
Kanchipuram, Tiruvallur, Vellore, Tiruvannamalai Cuddalore, Villupuram, Dharmapuri, Salem, Namakkal	VBN 1, K 1*, VBN 2, VBN 3, VBN(Bg) 4
Pudukottai, Madurai, Dindigul, Theni, Ramanathapuram, Sivagangai, Virudhunagar, Thoothukudi, Tirunelveli.	VBN 1, VBN 2, VBN 3, VBN(BG) 4
Erode,Coimbatore,Tiruchirapalli,Perambalur,Karur	
Rice fallows (January)	
Cuddalore, Villupuram, Thanjavur, Tiruvarur, Nagapattinam, Trichirapalli, Perambalur, Karur	ADT 3
Tirunelveli, Thoothukudi	ADT 3
Summer (February-March)	
Kanchipuram, Tiruvallur, Vellore, Tiruvannamalai, Cuddalore, Villupuram, Dharmapuri Thanjavur, Tiruvarur, Nagapattinam, Tiruchirapalli, Perambalur, Karur,	ADT 5
Pudukottai, Madurai, Dindigul, Theni, Ramanathapuram, Sivagangai, Virudhunagar	T 9, VBN 3, VBN(Bg) 4
Tirunelveli, Thothukudi, Salem, Namakkal	VBN 3, VBN(Bg) 4
Erode, Coimbatore	VBN 3, VBN(BG) 4

*** suitable for intercropping in cotton.**

II. DESCRIPTION OF BLACKGRAM VARIETIES

Particulars	T 9	CO 5	ADT 3	VBN 1
Parentage	Selection from Bareilly, U.P	Pureline selec tion from Musiri -	Pureline selection from Tirunelveli local	KM 1xH 76-1
Year of release	1972	1981	1981	1987
50% flowering (days)	30 - 35	35 - 40	30 - 35	30 - 35
Maturity duration (days)	65 - 70	70 - 75	70 - 75	60 - 65
Grain yield (kg/ha)				
Rainfed	-	740	..	700
Irrigated	1000	1270	-	850
Rice fallows			720	
Height (cm)	35 - 40	30 - 35	50	30 - 35
Clusters	10 - 12	10 to 12	10 - 15	12 – 13
Hairiness of pods	Glabrous	Hairy	Hairy	Hairy
Colour of grain	Black & Dull	Black & Dull	Black & dull	Black
100 grain wt (g)	4.0	5.7	3.6	5.1

Particulars	ADT 5	K 1	VBN 2	VBN 3	VBN(Bg) 4
Parentage	Selection from Kanpur variety	CO 3 x US 131	Spontaneous mutant	LBG 402 x LBG 17	CO 4 x PDU 102
Year of release	1988	1994	1996	2000	2003
50% flowering (days)	32	40 - 45	33 - 40	35 -40	35 – 40
Maturity duration (days)	62	70 - 75	60 - 70	65 – 70	75 – 80
Grain yield (kg/ha)					
Rainfed	-	707	750	775	780
Irrigated	1323	-	1000	825	900
Rice fallows		-	-		
Height (cm)	20 - 25	30 - 35	25 - 35	25 – 35	40 – 45
Clusters	13 - 15	10 - 13	4 - 18	5 - 10	8 – 10
Hairiness of pods	Hairy	Hairy	Glabrous	Hairy pods	Glabrous
Colour of grain	Black	Dull black	Black with green tinge	Dull black	Black
100 grain wt (g)	3.6	5.3	3.83	4.4	4.8

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	20	10
ADT 5, TMV 1 (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 3 packets (600 g/ha) of Rhizobial culture CRU-7 + 3 packets (600 g/ha) of PGPR 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 10packets of Rhizobium (2000 g/ha) + 10 packets of PGPR (2000 g/ha) and 10 packets (2000 g) of Phosphobacteria with 25 kg of FYM and 25 kg of soil 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 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 and Salicylic acid 100 mg/lt once at pre-flowering and another at 15 days thereafter
b. i) For rice fallow crops foliar spray of DAP 20 g/lt once at flowering and another at 15 days thereafter
   ii) For irrigated and rainfed crops, foliar spray of 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 2 litres/ha 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 30 days after sowing gives weed free environment throughout the crop period.

ii) If herbicides are 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 growth habit and continue to produce new flashes the top dressing will be done on 40-45 days after sowing. The crop 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 ▪ **Spray any one of the following** (Spray fluid 250 l /ha) Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha
Aphids *Aphis craccivora*	
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 Wettable sulphur 1.5 kg/ha
Mite *Tetranychus urticae*	
Tobacco cut worm *Spodoptera litura*	▪ Use of light trap to monitor and kill the attracted adult moths. 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 Phenthoate 50 EC 2.0 l/ha

	Chlorpyriphos 20 EC 1.25 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* **Apids** *Aphis craccivora* **Spotted pod borer** *Maruca vitrata*	▪ **Apply any one of the following :** Endosulfan 4 D 25 kg/ha Quinalphos 1.5 D 25 kg/ha Phosalone 4 D 25 kg/ha Carbaryl 5 D 25 kg/ha ▪ **Spray any one of the following** (Spray fluid 500 l/ha) Endosulfan 35 EC 1.0 l/ha Monocrotophos 36 SL 500 ml/ha Note : When the activity of coccinellid predator (both grubs and adults) is seen, insecticide application should be avoided.
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 :** Activated kaolin 1 kg Malathion 5 D 1 kg TNAU Neem oil 60 EC (C) 1 lit Pungam oil 1 lit. Monocrotophos 36 SL 400 ml ▪ 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 or Thiram @ 2 g/kg

Name of the Disease	Management
Powdery Mildew *Erysiphe polygoni*	▪ Spray NSKE 5% or Neem oil 3% twice at 10 days interval from initial disease appearance. ▪ Spray Carbendazim 250 g or Wettable sulphur 2500g/ha. **Botanical** ▪ Spray Eucalyptus leaf extract 10% at initiation of the disease and 10 days later.
Rust *Uromyces appendiculatus*	▪ Spray Mancozeb – 1000g or Wettable sulphur–2500g
Leaf spot *Cercospora canescens*	▪ Spray Carbendazim – 250 g

Root rot *Macrophomina phaseolina (Rhizoctonia bataticola)*	▪ 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 drench Carbendazim – 1 gm/ litre ▪ Basal application of zinc sulphate 25 kg/ha
Yellow mosaic (*Geminivirus*) and **Leaf Crinkle** Vector: *Bemisia tabaci* **Leaf Curl** (*Tospovirus*) Vector: *Frankliniella schultzii* *Thrips tabaci* *Scirtothrips dorsalis*	▪ Rogue out the infected plants up to 30 days ▪ Spray Monocrotophos 500 ml or Methyl demeton 500 ml/ha and repeat after 15 days, if necessary. ▪ For seed crop, the plants affected by leaf crinkle should be periodically removed upto 45 days after sowing since the leaf crinkle virus is seed borne.

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 and Salicylic acid 100 mg/lt once at pre-flowering and another at 15 days thereafter
b. Foliar spray of DAP 20 g/lt once at flowering and another at 15 days thereafter

4. HARVESTING

i) Picking the matured pods, drying and processing
ii) Uprooting or cutting the whole plants ,heaping ,drying and processing

SEED PRODUCTION

Variety Seed Production

Land Requirement

- Land should be free of volunteer plants.

Isolation

- Adopt 5 m certified seed production

Presowing seed treatment

- Remove all discoloured seeds and use only normal coloured seeds (black coloured in blackgram and olive green in greengram).
- Avoid seeds with bruchid infestation for sowing.
- If the hard seed percentage exceeds more than 10 per cent scarify with commercial H_2SO_4 for 2 min.
- For rainfed sowing harden the greengram seeds for 3 h in aqueous solution of manganese sulphate @ 100 ppm / (0.1 g/lit) at 1/3 volume of seeds and quickly air-dry in shade to their original moisture content. For blackgram, zinc sulphate @ 100 ppm may be used for hardening.
- Fortify the blackgram seed 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.

Foliar application

- Spray 2% DAP at the time of first appearance of flowers.
- Give a second spray 15 days after first spraying
- Spray NAA 40 PPM at first flowering and a second spray after a fortnight.
- NAA can be mixed with pesticides and fungicides.

Preharvest sanitation spray

- Three to 5 days before harvesting spray endosulphan 35 EC @ 0.07% or malathion 50 EC @ 0.05% for seed crop to minimise the bruchid infestation in storage.

Harvesting

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

Threshing

- Thresh the seed with pliable bamboo stick or pulses thresher.

Drying

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

Processing

- Grade the seeds using B.S.S.7 x 7 wire mesh sieve for large seeded varieties
- Reject the discoloured and broken seeds.

Seed treatment

- Treat the seed with Carbendazim 75% WDP at 2g dissolved in 5 ml of water kg^{-1} of seed (or)
- Dry dress the seeds with halogen mixture (Pure $CaOCl_2$ + $CaCO_3$ + arappu leaf powder at (5:4:1) ratio @ 3g/kg of seed

- For grain cum seed storage, treat the seed with activated clay, neem oil, groundnut oil and leaf powder of tobacco, nochi, neem, *Albizzia amara* (arappu) and fruit rind powder of *Sapindus laurifolius* (Poochi kottai) and *Acacia concinna* (Soapnut powder).

Storage

- Use gunny or cloth bags for short term storage with seed moisture content of 8 - 9%
- Use polylined gunny bag for medium term storage with seed moisture content of 8 - 9%
- Use 700 gauge polythene bag for long term storage with seed moisture content of Less than 8%.

Others management practices

- As in crop management

GREENGRAM (*Vigna radiata* L.)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

District/Season	Varieties
Adipattam (June - July)	
Kanchipuram, Tiruvallur, Vellore, Tiruvannamalai, Cuddalore, Villupuram, Pudukkottai, Madurai, Dindigul, Theni	KM 2, CO 4, CO 6, VBN 1, VBN(Gg) 2, VRM(Gg) 1
Thanjavur, Tiruvarur, Nagapattinam, Tiruchirapalli, Perambalur, Karur	CO 4, CO 6, KM 2, Paiyur 1, VBN 1, VBN(Gg) 2
Salem, Namakkal	CO 4, CO 6, KM 2, Paiyur 1
Dharmapuri	CO 4, CO 6, KM 2, Paiyur 1, VBN 1, VBN(Gg) 2
Erode, Coimbatore, Kanyakumari	CO 4, CO 6, VBN 1, VBN(Gg) 2
Ramanathapuram, Sivagangai Virudhunagar, Tirunelveli, Thoothukudi	CO 4, CO 6, KM 2, VBN 1, VBN(Gg) 2
Puratasipattam (September - October)	
Kanchipuram, Tiruvallur, Vellore, Tiruvannamalai, Cuddalore, Villupuram, Pudukottai	CO 4, CO 6, KM 2, VBN 1, VBN(Gg) 2
Dharmapuri, Salem, Namakkal, Tirunelveli, Thoothukudi	CO 4, CO 6, Paiyur 1, VBN 1, VBN(Gg) 2, K1
Erode, Coimbatore	CO 4, CO 6, VBN 1, VBN(Gg) 2
Ramanathapuram, Virudhunagar, Sivagangai	CO 4, CO 6, KM 2, Paiyur 1, K1
Madurai, Dindigul, Theni	CO 4, CO 6, Paiyur 1
Tiruchirapalli, Perambalur, Karur	Paiyur 1, CO 6, VBN 1, VBN (Gg) 2
Rice fallows (January - February)	
Thanjavur, Tiruvarur, Nagapattinam, Tiruchirapalli, Perambalur, Karur, Pudukottai, Tirunelveli, Thoothukudi	ADT 3
Summer (February - March)	
Kanchipuram, Tiruvallore, Vellore, Tiruvannamalai, Cuddalore, Villupuram, Pudukkottai	CO 4, CO 6, KM 2
Salem, Namakkal,Dharmapuri,Tiruchirapalli, Perambalur, Karur, Tirunelveli, Thoothuku	CO 4, CO 6, Paiyur 1
Erode, Coimbatore, Thanjavur, Tiruvarur, Nagapattinam	CO 4, CO 6, Paiyur 1
Madurai, Dindigul, Theni, Ramanathapuram, Virudhunagar, Sivagangai	CO 4, CO 6, KM 2, Paiyur 1

II. DESCRIPTION OF GREENGRAM VARIETIES

Particulars	KM 2	CO 4	ADT 3	Paiyur 1	VBN 1	K 1
Parentage	Hybrid derivative of No.127xS.9	Mutant of CO 1	Hybrid derivative of H70-16/ Rajendran/ G65	PS from DPT 703	Hybrid derivative of S.8xPIMS 3	Co 4 x ML 65
Year of release	1978	1981	1988	1988	1989	1998
50% flowering (days)	35 - 40	40 – 45	36	45 - 50	30 - 35	70 - 75
Duration (days)	65 - 70	85	66	85 – 90	65	-
Grain yield (kg/ha)					770	670
Rainfed	767	910	500	742		
Irrigated	..	1550	500 (Rice fallows)	-	..	
Plant height (cm)	35 - 45	60 - 70	35 – 45	5 5- 60	55 - 60	70 - 75
Stem, branches etc.	Green stem	Green stem	Green stem	Green	Green sparsely hairy	Green, slightly Pubescent
Branches	-	3 – 4	2 – 3	3 – 4	2 – 3	3 - 4
Leaves	Medium	Broad tripartate and hairy	Medium broad, Petiole long	Broad	Medium, foliate, ovate	Broad
Pod characters	Dark brown and tip covered	Green when tender & black on drying	Dark brown	Dull green	Sparsely hairy , light black pods	Long and slightly pubescent, brown
Colour of grain	Shiny green	Dull green	Green	Dull Green	Green	Dull green
100 grain wt (g)	3.0	4.1	2 - 3	3 - 5	3.6	3.5

Particulars	CO 6	VRM(Gg) 1	VBN(Gg) 2
Parentage	WGG 37 x CO 5	Pure line selection from K 851	Cross derivative of VGG 4 x MH 309
Year of release	1999	2001	2001
50% flowering (days)	26 – 30	31 – 35	30 – 35
Duration (days)	62 – 67	56 – 67	65 – 70
Grain yield (kg/ha)			
Rainfed	900	1100	750
Irrigated	1050	-	900
Plant height (cm)	35 - 55	45 – 55	50 – 60
Leaves	Broad	Broad	Trifoliate with lobes
Colour of pod	Pubescent	Pubescent	Sparsly hairy pods
Colour of grain	Green with smooth surface	Shiny green bold and smooth surface	Shiny green
100 grain wt (g)	3 .4	3.5	3.6 – 3.9

CROP MANAGEMENT

III. SEED RATE

Particulars	Quantity of seed required kg/ha	
	Pure crop	Mixed crop
All strains	20	10
Rice fallows - ADT 3	25	--

Optimum plant population 3,25,000/ha.

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 3 packets (600 g/ha) of Rhizobial culture CRM 6 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 (2000g/ha) and 10 packets (2000 g) of Phosphobacteria with 25 kg of FYM and 25 kg of soil 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 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 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/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 DAP 20 g/litre once at flowering and another at 15 days thereafter

ii) For irrigated and rainfed crops foliar spray of DAP 20 g/litre or urea 20 g/litres once at flowering and another at 15 days thereafter.

8. WEED MANAGEMENT

i) Pre emergence application of Pendimethalin 2 litres on 3 days after sowing using Backpack/ Knapsack/Rocker sprayer fitted with flat fan nozzle using 500 litre of water for spraying one ha. After this, one hand weeding on 30 days after sowing gives weed free environment throughout the crop period.

ii) If herbicides are 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 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* **Aphid** *Aphis craccivora*	▪ Seed treatment with dimethoate 30 EC 5 ml/kg of seed ▪ **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* **Mite** *Tetranychus urticae*	▪ **Spray any one of the following** (Spray fluid 250 l /ha) Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha Wettable sulphur 1.5 kg/ha
Apid *Aphis craccivora* **Spotted pod borer** *Maruca vitrata* **Pod bug** *Nezara viridula* *Riptortus pedestris*	▪ **Apply any one of the following :** Endosulfan 4 D 25 kg/ha Quinalphos 1.5 D 25 kg/ha Phosalone 4 D 25 kg/ha Carbaryl 5 D 25 kg/ha ▪ **Spray any one of the following** (Spray fluid 500 l/ha) Endosulfan 35 EC 1.0 l/ha Monocrotophos 36 SL 500 ml/ha ▪ Neem seed kernel extract 5% twice, starting from 50% flowering stage followed by one round of endosulfan 0.07%.
Gram caterpillar *Helicoverpa armigera*	▪ Pheromone traps for *Helicoverpa armigera* 12/ha ▪ Bird perches 50/ha ▪ Hand picking of larvae ▪ Ha NPV 1.5 x10^{12} POB/ha with teepol (1 ml/lit.) ▪ **Apply any one of the following** (Spray fluid 625 l/ha) Dichlorvos 76 WSC 625 ml/ha Endosulfan 4 D 25 kg/ha Quinalphos 4 D 25 kg/ha Carbaryl 5 D 25 kg/ha Endosulfan 35 EC 1.25 lit./ha Monocrotophos 36 SL 625 ml/ha. Neem seed kernel extract 5% twice followed by triazophos 40 EC 780 ml/ha Neem oil 12.5 l/ha Phosalone 35 EC 1.25 l/ha (Note : Insecticide / Ha NPV spray should be applied when the larvae are in early stage)
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** : Activated kaolin 1 kg Malathion 5 D 1 kg

	TNAU Neem oil 60 EC (C) 1 lit. Pungam oil 1 lit. Monocrotophos 36 SL 400 ml ▪ 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 or Thiram @ 2 g/kg
Name of the Disease	**Management**
Powdery Mildew *Erysiphe polygoni*	▪ Spray NSKE 5% or Neem oil 3% twice at 10 days interval from initial disease appearance. ▪ Spray Carbendazim 250 g or Wettable sulphur 2500g/ha. **Botanical** ▪ Spray Eucalyptus leaf extract 10% at initiation of the disease and 10 days later.
Rust *Uromyces appendiculatus*	**Spray any one of the following:** Mancozeb 1000g /ha Wettable sulphur 2500g/ha
Leaf spot *Cercospora canescens*	**Spray any one of the following:** ▪ Carbendazim 250 g ▪ Mancozeb 1000g/ha
Root rot *Macrophomina phaseolina (Rhizoctonia bataticola)*	▪ Basal application of zinc sulphate – 25kg/ha. ▪ 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 drench Carbendazim – 1 gm/ litre ▪ Basal application of zinc sulphate 25 kg/ha
Yellow mosaic (*Geminivirus*) and Leaf **Crinkle** Vector: *Bemisia tabaci* **Leaf Curl** (*Tospovirus*) Vector: *Franklinielle schultzii* *Thrips tabaci* *Scirtothrips dorsalis*	▪ Rogue out the infected plants up to 30 days **Spray any one of the following:** Monocrotophos 500 ml Methyl demeton 500 ml/ha and repeat after 15 days, if necessary. ▪ For seed crop, the plants affected by leaf crinkle should be periodically removed upto 45 days after sowing since the leaf crinkle virus is seed borne.

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

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
All varieties	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 and Salicylic acid 100 mg/litre once at pre-flowering and another at 15 days thereafter

b. Foliar spray of DAP 20 g/lt once at flowering and another at 15 days thereafter

4. HARVESTING

i) Picking the matured pods, drying and processing

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

COWPEA (*Vigna unguiculata* (L.) Walp.aggreg.)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

DISTRICT/SEASON	VARIETIES
Adipattam (June-August)	
For all districts	CO 6, VBN 1, VBN 2, CO(CP) 7
Kanchipuram, Tiruvallur,	CO 6 , CO(CP) 7
Vellore, Tiruvannamalai, Dharmapuri	Paiyur 1
Cuddalore, Villupuram	CO 6 , CO(CP) 7
Salem, Namakkal	Paiyur 1, CO 6 , CO(CP) 7
Tiruchirapalli, Perambalur, Karur	CO 6 , CO(CP) 7
Pudukottai	CO 2, CO 6 , CO(CP) 7
Erode	Paiyur 1, CO 6 , CO(CP) 7
Coimbatore, Madurai, Dindigul, Theni, Ramanathapuram, Sivagangai, Virudhunagar	CO 2, CO 6 , CO(CP) 7
Tirunelveli, Thoothukudi , Kanyakumari, Thanjavur, Tiruvarur, Nagapattinam	CO 6 , CO(CP) 7
Purattasipattam (September - November)	
For all districts	CO 6, VBN 1, VBN 2, CO(CP) 7
Kanchipuram, Tiruvallur	CO(CP) 7
Dharmapuri	Paiyur 1
Cuddalore, Villupuram	Paiyur 1, CO (CP) 7
Salem, Namakkal	CO 2, Paiyur 1, CO (CP) 7
Pudukottai	CO 2, VBN 2
Erode	CO 2, CO(CP) 7
Coimbatore	CO 2, Paiyur 1, CO 6 , CO(CP) 7
Madurai, Dindigul, Theni, Ramanathapuram, Virudhunagar	CO, 2, VBN 2, CO(CP) 7
Sivagangai, Tirunelveli, Thoothukudi ,	CO 2, VBN 2, CO(CP) 7
Kanyakumari, Vellore, Tiruvannamalai,	Paiyur 1, CO(CP) 7
Summer irrigated	
Salem, Namakkal, Coimbatore, Erode,	CO 2, CO 6, CO (CP) 7, VBN 2
Madurai, Dindigul, Theni, Tiruchirapalli, Perambalur, Karur and Tirunelveli, Thoothukudi	

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	75	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	671	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	Ovote, 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 squire shape
100 grain wt (g)	12.5	9.9	9.9	12 - 15	13 - 15	12 - 14

III. SEED RATE

STRAIN	Quantity of seed required (kg/ha)	
	Pure crop	Mixed crop
Paiyur 1, VBN 1, VBN 2, CO 6, CO(CP) 7	25	12.5

Optimum plant population 3,50,000/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 3 packets (600 g/ha) of Rhizobial culture COC 10 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 10packets 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 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

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

5. SOWING

Dibble the seeds adopting the following spacing.

Varieties	Sole crop	Mixed crop
CO 6, VBN 1	30 cm X 15 cm	200 cm X 15 cm
CO (CP) 7, VBN 2	45 cm x 15 cm	..
Paiyur 1	30 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 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/litre and Salicylic acid 100 mg/litre once at pre-flowering and another at 15 days thereafter
b. Foliar spray of 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 2 litres 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 30 days after sowing gives weed free environment throughout the crop period.
ii) If herbicides are not applied give two hand weedings 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

Pests	Management strategies
Stem fly *Ophiomyia phaseoli*	▪ Soil application of carbofuran 3 G (15 kg/ha) at the time of sowing ▪ Spray endosulfan 35 EC 500 ml/ha a week after germination and second round 10 days after first round.
Aphid *Aphis craccivora*	
Spotted pod borer *Maruca vitrata*	▪ Apply any one of the following : Endosulfan 4 D 25 kg/ha Quinalphos 1.5 D 25 kg/ha Phosalone 4 D 25 kg/ha Carbaryl 5 D 25 kg/ha ▪ Spray any one of the following (Spray fluid 500 l/ha) Endosulfan 35 EC 1.0 l/ha Monocrotophos 36 SL 500 ml/ha
Blue butterflies *Lampides boeticus* *Euchrysops cnejus*	
Pod bug *Nezara viridula* *Riptortus pedestris* *Clavigralla gibbosa*	
Blister beetle *Mylabris pustulata*	
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 : Activated kaolin 1 kg Malathion 5 D 1 kg TNAU Neem oil 60 EC (C) 1 lit. Pungam oil 1 lit. Monocrotophos 36 SL 400 ml ▪ 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 or Thiram @ 2 g/kg

Name of the Disease	Management
Rust *Uromyces appendiculatus*	▪ Two sprays of chlorothalanil 0.1% or one spray with 0.1% chlorothalanil followed by 3% Neem oil after the appearance of rust disease, effectively controls the 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 at 30 days after sowing. ▪ Spot drench Carbendazim – 1 gm/ litre
Aphid borne Mosaic Virus (*Potyvirus*) Vector: *Aphis craccivora* *A. fabae* *A. gossypii* *Myzus persicae*	▪ Roguing out of cowpea mosaic virus diseased plants in the early stage of growth upto 30 days and spraying twice at fortnightly intervals with monocrotophos 500 ml/ ha (or) methyldemeton 25 EC500 ml/ha.

SEED PRODUCTION

Variety Seed Production

Land requirement

- Land should be free of volunteer plants.

Isolation

- Adopt 5 m for certified seed production

Season

- September to October

Sowing seed treatment

- Remove all discoloured seeds and use highly germinable (>75%) seeds.

Intercultural operation

- Pinching the tendrils and application of NAA 40 ppm (940 mg/l) may be followed at flower initiation and at peak flowering stage to promote pod setting.
- Pull out and destroy plants exhibiting severe symptoms of mosaic in the early stages of growth.

Harvesting

- Seeds attain physiological maturity 27-30 days after anthesis
- Harvest the pods as they turn light straw in colour and the seeds turn brown or mottled in colour.
- At this stage the moisture content of seeds will be about 18 per cent.
- Harvest the pods as picking (2 –3 no) at 10 days interval
- Air dry pods at first for 1-2 days and sun dry until they become brittle
- Beat with pliable bamboo stick or pulse thresher by adjusting the cylinder to avoid splitting and cracking of seeds.
- The seed should be dried to 8-10% moisture content.

Processing

- Grade the seeds at 10% moisture content using 12/64" diameter (Aperture width 4.60 mm) round perforated sieve for CO 2 and 10/64" diameter (aperture width 3.96 mm) for small seeded varieties.

Drying

- Remove of the broken and immature seeds

- Dry seed to 7 to 8 % moisture content.

Seed Treatment

- Treat with thiram / Carbendazim @ 2g kg^{-1} of seed
- Treat with halogen mixture @ 3g kg^{-1} of seed
- Treat with activated clay @ 1 kg/100 kg of seeds. May be dry dressed for grain cum seed storage use.

Storage

- Use gunny or cloth bags for short term storage with seed moisture content of 8 - 9%
- Use polylined gunny bag for medium term storage with seed moisture content of 8 - 9%
- Use 700 gauge polythene bag for long term storage with seed moisture content of less than 8%.

Other management practices

As in crop management technique.

HORSEGRAM (*Macrotyloma uniflorum*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

DISTRICT/SEASON	VARIETIES
November (Winter season) (Rainfed)	
All districts except The Nilgiris and Kanyakumari	CO 1, Paiyur 1, Paiyur 2

II. DESCRIPTION OF VARIETIES

Variety	CO 1	Paiyur 1	Paiyur 2
Parentage	PurelineSelection from Mudukulathur	PurelineSelection from Mettur local	Gamma irradiation of CO 1
Year of release	1953	1988	1998
50% flowering (days)	55 - 60	45 - 50	45 - 50
Maturity duration(days)	110	110	100 - 105
Grain yield (Kg/ha)			
Rainfed	560	650	870
Height (cm)	30-40	35 - 40	40 - 45
Branches	2-3	2-3	4 - 5
Colour of grain	Buff mottled	Light brown	Pale brown
100 grain weight (g)	4.6	3.4	3.56

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 a 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 3 packets (600 g/ha) of Rhizobial culture 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 10packets 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 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 the pods and extract seeds

SEED PRODUCTION

Variety Seed Production

Land Requirement

- Should be free from volunteer plants

Isolation

- Adopt a isolation of 10mt

Season

- October - November

Pre sowing Seed Treatment

- Treat the seed with Captan 75% WP at 2 g/kg of seed.

Harvesting

- Seeds attain physiological maturity when the pods turn yellowish brown in colour. Harvest pods when 75 - 80% of the pods have matured.

Processing

- Grade the seed with a sieve having 8/64" round perforation.

Storage

- Store in cloth upto two years
- For long term storage (more than three years) store in 700 gauge polythene bag

Note

- Magnesium chloride is to be sprayed against any chlorotic symptom at 6 g/litre with a power sprayer 2 - 3 times at 5-day interval.
- 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.
- The discoloured seeds loose viability much faster than the normal seeds in storage.
- The hard seededness of 50 - 55% noticed immediately after harvest declined to 4 to 6% over a period of 2 months.

Others

As in management practices

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.

As a pure crop to have an optimum plant population 325000 / 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 3 packets (600 g/ha) of Rhizobial culture 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 10packets of Rhizobium (2000g/ha) and 10 packets(2000 g) 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
b) Soil application of 25 kg $ZnSo_4$/ha under irrigated condition

5. SOWING

Dibble the seeds by adopting the spacing of 30 cm x 10 cm.

6. WEED MANAGEMENT

i) Pre emergence application of Pendimethalin 2 litres on 3rd day after sowing using Backpack/ Knapsack/Rocker sprayer fitted with flat fan nozzle using 500 l 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) Endosulfan 4 D 25 kg/ha Quinalphos 4 D 25 kg/ha Carbaryl 5 D 25 kg/ha Dichlorvos 76 WSC 625 ml/ha Endosulfan 35 EC 1.25 lit./ha Monocrotophos 36 SL 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** : Activated kaolin 1 kg Malathion 5 D 1 kg TNAU Neem oil 60 EC (C) 1 lit. Pungam oil 1 lit. Monocrotophos 36 SL 400 ml ▪ 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 or Thiram @ 2 g/kg

Name of the Disease	Management
Wilt *Fusarium oxysporum* f.sp. *ciceri*	▪ Soil application with P. *fluorescens* @ 2.5 kg/ha.
Root rot *Macrophomina phaseolina (Rhizoctonia bataticola)*	**Biological control** ▪ Soil application *P. fluorescens* or *T. viride*– 2.5 Kg / ha + 50 Kg of well decomposed FYM or sand at 30 days after sowing. **Chemical** ▪ Spot drench Carbendazim – 1 gm/ litre

SEED PRODUCTION

Variety Seed Production

Land Requirements

- Land to be used for seed production of Bengal gram shall be free of volunteer plants.

Isolation

- Adopt 5 m for certified seed production

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 quickly air dry in shade.
- Avoid using of bruchid infected seed for sowing

Harvesting

- Seeds attain physiological maturity @ 35 – 40 days after anthesis
- Harvest when 70 – 80% of pods are creamy in colour.

Processing

- Grade the seeds using 13/64” or 18/64" round perforated metal sieve depending on the variety.
- Dry the seed to 8-10% moisture content

Seed treatment

- Slurry treat the seeds with Carbendazim (or) Thiram 75% WP @ 2 g kg^{-1} of seed (or).
- Treat the seed with halogen mixture @ 3g + Carbendazim @ 2g kg^{-1} of seed
- For grain cum seed storage treat the seed with activated clay @ 1:100 (W/W).

Storage

- Use gunny or cloth bags for short term storage with seed moisture content of 8 - 9%
- Use polylined gunny bag for medium term storage with seed moisture content of 8 - 9%
- Use 700 gauge polythene bag for long term storage 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
Thanjavur, Tiruvarur, Nagapattinam, Tiruchirapalli, Perambalur, Karur, Pudukottai, Kanyakumari, Erode	CO 12, CO 13
Purattasipattam (Sept - Nov)	
Kanchipuram, Tiruvallur, Tiruchirapalli, Perambalur, Karur, Vellore, Tiruvannamalai, Cuddalore, Villupuram.	CO 13
Dharmapuri, Salem, Namakkal	CO 13
Pudukottai, Erode, Coimbatore, Madurai, Dindigul, Theni, Ramanathapuram, Sivagangai, Virudhunagar, Tirunelveli, Thoothukudi , Thanjavur, Tiruvarur, Nagapattinam.	CO 12, CO 13
Summer (April)	
Kanchipuram, Tiruvallur, Vellore, Tiruvannamalai, Cuddalore, Villupuram.	CO 12, CO 13
Dharmapuri, Salem, Namakkal, Thanjavur, Tiruvarur, Nagapattinam.	CO 12, CO 13
Kanyakumari, Pudukottai, Erode, Coimbatore, Madurai, Dindigul, Theni, Ramanathapuram, Virudhunagar, Tirunelveli, Thoothukudi, Sivagangai	CO 12, CO 13

II.DESCRIPTION OF AVARAI VARIETIES

Particulars	CO 12	CO 13
Parentage	Pedigree selection from CO 9 x CO 4	Derivative of CO 9 x Florikifield
Year of release	1991	1997
1st flowering (days)	40	40
Duration	100 - 110	110 - 120
Grain yield (kg/ha)		
Irrigated	9700	10000
Habit	Erect, bushy	Dwarf, bushy and tendency to form tendrils
Height (cm)	60 - 70	50 - 75
Colour of flowers	Purple	White
Colour of pod	Deep purple	Whitish green
Shape of pod	Broad, flat	Flat and long
Colour of grain	Black	Brown
100 seed wt(g)	38.4	35.2

III. SEED RATE

Particulars	Quantity of seed required kg/ha	
	Sole crop	Mixed crop
CO 12	20	10.0
CO 13	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	: 45 cm X 30 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 and 45days 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. 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* **Gram caterpillar** *Helicoverpa armigera* **Blue butterflies** *Lampides boeticus* *Euchrysops cnejus* **Pod bug** *Nezara viridula* *Riptortus pedestris* *Clavigralla gibbosa* **Aphid** *Aphis craccivora* **Blister beetle** *Mylabris pustulata*	▪ **Apply any one of the following :** Endosulfan 4 D 25 kg/ha Quinalphos 1.5 D 25 kg/ha Phosalone 4 D 25 kg/ha Carbaryl 5 D 25 kg/ha ▪ **Spray any one of the following** (Spray fluid 500 l/ha) Endosulfan 35 EC 1.0 l/ha Monocrotophos 36 SL 500 ml/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** : Activated kaolin 1 kg Malathion 5 D 1 kg TNAU Neem oil 60 EC (C) 1 lit. Pungam oil 1 lit. Monocrotophos 36 SL 400 ml ▪ 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 or Thiram @ 2 g/kg

Name of the Disease	Management
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

Variety Seed Production

Land requirement

- Land should be free of volunteer plants.

Isolation

- Adopt 5 m for certified seed production

Preharvest sanitation spray

- Spray with 0.07% Malathion or Endosulfan @ 0.07 % before harvesting the pods for seed crop.

Harvesting

- Harvest the pods as they turn straw coloured.
- Discard the terminal pods, 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 pods to 15-18% moisture content.

Drying

- Dry the seeds to 8 -10% moisture content.

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 to 7 to 8 per cent moisture content.

Seed Treatment

- Treat with Carbendazim @ 2 g + Carbaryl 50% WP at 200 mg/kg^{-1} of seed
- Activated clay @ 1:100 kg^{-1} of seed

Storage

- Use gunny or cloth bags for short term storage with seed moisture content of 8 - 9%
- Use polylined gunny bag for medium term storage with seed moisture content of 8 - 9%
- Use 700 gauge polythene bag for long term storage 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	
June - July	CO 1
All through the year	CO 2

II. DESCRIPTION OF MOCHAI VARIETIES

Particulars	CO 1	CO 2
Parentage	Pureline selection	Derivative of CO 8 X CO 1
Year of release	1980	1984
50% flowering (days)	75 - 90	35 - 45
Duration (days)	140	105
Grain yield (Kg/ha)		
Rainfed	1600	900
Irrigated	..	1400
Habit	Medium Erect and bushy (indeterminate) photo sensitive	Erect and bushy determinate photo insensitive
Height (cms)	60 - 70	60
Colour of flowers	Purple	Purple
Colour of pod	Green	Green
Shape of pod	Flat	Flat
Colour of grain	Black	Black
100 seed weight (g)	24.4	20.0

III. SEED RATE

Particulars	Quantity of seed required kg/ha	
	Sole crop	Mixed crop
CO 1	20	10.O
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 25th and 45th 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

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 practices
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* **Field bean pod borer** *Adisura atkinsoni* **Pod bug** *Nezara viridula* *Riptortus pedestris*	▪ **Apply any one of the following :** Endosulfan 4 D 25 kg/ha Quinalphos 1.5 D 25 kg/ha Phosalone 4 D 25 kg/ha Carbaryl 5 D 25 kg/ha ▪ **Spray any one of the following** (Spray fluid 500 l/ha) Endosulfan 35 EC 1.0 l/ha Monocrotophos 36 SL 500 ml/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** : Activated kaolin 1 kg Malathion 5 D 1 kg TNAU Neem oil 60 EC (C) 1 lit. Pungam oil 1 lit. Monocrotophos 36 SL 400 ml ▪ 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 or Thiram @ 2 g/kg

Name of the Disease	Management
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)
Purattasipattam (Sep. - Oct.) ——— CO 1 (Irrigated), CO 2
Masipattam (February - March)
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)	85	75 - 80	85 – 90
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 ZnSO4 @ 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.

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 at Bhavanisagar.
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. Soyabean varieties UGM21, UGM 37 and ADT 1 are recommended for sowing in rice fallows of Thanjavur, Tiruvarur, Nagapattinam district.
5. 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

1. VARIETIES

CO 1, ADT 1

2. 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.

CROP PROTECTION

A. Pest management

Pests	Management strategies
Whitefly *Bemisia tabaci*	▪ **Spray any one of the following** (Spray fluid 500 l/ha) Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha
Tobacco caterpillar *Spodoptera litura*	▪ **Spray Endosulfan 35 EC 1000 ml/ha**
Leaf miner *Aproaerema modicella*	▪ Quinalphos 1.5 D 25 kg/ha or Neem seed kernel extract (25 kg/ha) spray on 15th and 25th day after sowing
Galerucid beetle *Madurasia obscurella*	▪ Methyl demeton 25 EC 500 ml/ha

B. Disease management

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

Name of the Disease	Management
Rust *Phakopspora pachyrhizi*	**Spray any one of the following:** ▪ Triadimefon - 0.1 % or Propiconazole – 0.1% or ▪ Hexaconazole - 0.1% at flowering stage or at the onset of disease.
Yellow Mosaic (*Geminivirus*) Vector -*Bemisia tabaci* **Bud blight (*Ilarvirus*)** Vector- *Thrips palmi*	**Cultural Method** ▪ Rogue out infected plants up to 30 days. **Spray twice on 15 and 30 days after sowing with any one of the following:** ▪ Monocrotophos 36 WSC 500 ml ▪ Methyldemeton 25EC500 ml/ ha.

SEED PRODUCTION

Variety Seed Production

Land requirement

- Land to be used for seed production of soyabean shall be free of volunteer plants.

Isolation

- Adopt 3 m for certified seed production

Presowing seed treatment

Mid storage 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.
- Moist conditioning of seeds in 5% sand for 16h and drying back to original moisture content (or)
- Moisture equilibration treatment with water for 24 h followed by dry dressing with thiram @ 2.5 g kg^{-1} of seed resulted in better crop establishment.

Harvesting

- Seeds attain physiological maturity 27 –30 days after flowering
- Harvest the plants as such on yellowing of pods

Threshing

- Dry the plant and thresh with pliable bamboo stick

Processing

- Grade the seeds using 14/64” to 12/64” round perforated metal sieve based on varieties.

Drying

- Dry the seeds to 7- 8% moisture content

Seed Treatment

- Treat the seeds with Thiram @ 2 g kg^{-1} of seed.

Storage

- Use gunny or cloth bags for short term storage with seed moisture content of 10 - 12%
- Use polylined gunny bag for medium term storage with seed moisture content of 8 - 10%
- Use 700 gauge polythene bag for long term storage 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 endosulfan @1.25 l/ha or 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

DISTRICT / SEASON VARIETIES

A. Rainfed

1. Chithiraipattam (Apr - May)

Pollachi, Theni and Tenkasi — TMV 7, ALR 3

2. Early Adipattam (Jun - Jul)

All districts — Bunch : TMV 7, CO 2, VRI 2, VRIGn 5, Semispreading : TMV 10, COGn 5

3. Late Adipattam (Jul - Aug)

All districts — TMV 7, VRI 2, CO 2

B. Irrigated

1. Margazhipattam (Dec - Jan)

All districts — TMV 7, CO 2, CO 3, COGn 4, VRI 2, VRI 3, ALR 3, VRIGn 5

2. Masipattam (Feb - Mar)

(New Delta areas of Thanjavur, Tiruvarur, Nagapattinam) — TMV 7, CO 2, VRI 2, VRI 3,

3. Chithiraipattam (Apr – May)) — TMV 7, CO 2, CO 3, COGn 4, VRI 2, VRI 3

II. PARTICULARS OF GROUNDNUT VARIETIES

Particulars	TMV 7	TMV 10	CO 3	COGn 4	COGn 5
Parentage	Pureline selection from Tennessee white	Spontaneous mutant from Argentina	Derivative of VG 55 x JL 24	Derivative of TMV 10 x ICGV 82	Multiple cross derivative
Duration (days)	100 - 105	120 - 130	115-120	115-120	125-130
Average yield of pods kg/ha	1400	1650	1950	2150	1850
Shelling %	74	77	70	70	70
100 seed wt (g)	36	43	65	60	47
Oil content %	49.6	54.4	49.2	52.7	51
Special features	Seed dormancy for 10 days	Yield, oil, shelling high	Bold 1-2 seeded, HPS kernels. Low bud necrosis incidence	Bold pods; 1-2 seeded; high oil content.	Dark green foliage; Tolerant to foliar diseases
Growth habit	Bunch	Semi-spreading	Bunch	Bunch	Semispreading
Leaf colour	Green	Dark green	Green	Dark green	Dark green
Seed colour	Light rose	Red blotched with white	Rose	Rose	Red testa

Particulars	ALR 3	VRI 2	VRI 3	VRIGn 5
Parentage	Derivative of (R33-1 x ICGV 68) x (NCAC 17090 x ALR 1)	JL24 x CO2	J11 x R 33-1	Derivative of CG 26 x ICGS 44
Duration(days)	110-115	100 - 105	90	105 -110
Average yield of pods (kg/ha)	2095	2060	1882	2133
Shelling %	69	74.8	73	75
100 Seed wt. (g)	46	49.9	35	46
Oil content %	50	48	48	51
Special features	Suitable for rainfed, rust resistant, tolerant to late leaf spot.	suitable for irrigated	Suitable for intercropping	High reproductive efficiency. Dormancy 45 days.
Growth habit	Bunch	Bunch	Bunch	Bunch
Leaf colour	Dark green	Ashy green	Light green	Dark green
Seed colour	Rose	Light rose	Light rose	Red testa.

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

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.

4. APPLICATION OF MICRONUTRIENTS

Mix 12.5 kg/ha of micronutrient mixture developed by Department of Agriculture with enough dry sand to make a total quantity of 50 kg/ha. 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. 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 400 kg/ha at 45th day after sowing.

6. SEED RATE

Use 120 kg/ha of kernels. Increase the seed rate by 15% in the case of 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 at 2.0 l/ha soil applied and incorporated.
ii) **Pre-emergence**: Fluchloralin 2.0 l/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 20^{th} and 40^{th} 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 45^{th} 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.

II. 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 nutrient

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	Sulphur sludge
17	34	54 kg/ha	60 kg/ha

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.

4. POLYTHENE FILM MULCHING

Spread black polythene sheet over the soil surface. Seven micron polythene film sheet @50 kg/ha is required. Holes can be made at required spacing before spreading of the sheets.

5. APPLICATION OF MICRONUTRIENTS

Mix 12.5 kg/ha of micronutrient mixture developed by Department of Agriculture with enough dry sand to make a total quantity of 50 kg/ha. Broadcast evenly on the soil surface immediately after sowing. Do not incorporate the micronutrient mixture to the soil.

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. 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.

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 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 hoeing and weeding 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 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.

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 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 *Amsacta albistriga*	▪ Dig out and destroy the pupae from the field bunds and shady 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) :** Quinalphos 1.5 D Phosalone 4 D Endosulfan 4 D Carbaryl 10 D ▪ **Spray any one of the following insecticides :** Endosulfan 35 EC 750 ml/ha Fenitrothion 50 EC 750 ml/ha Quinalphos 25 EC 750 ml/ha Dichlorvos 76 WSC 625 ml/ha Chlorpyriphos 20 EC 1250 ml/ha Ethion 50 EC 500 ml/ha Phosalone 35 EC 750 ml/ha in 375 l of water. ▪ Use Nuclear Polyhedrosis Virus (NPV) at 1.5 x 10^{12} POBs per ha as detailed below. ▪ **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 10 D 25 kg/ha Fenitrothion 50 EC 750 ml/ha Carbaryl 50 WP 2.0 kg/ha Quinalphos 25 EC 750 ml/ha Fenthion 100 EC 500 ml/ha Phenthoate 50EC 1250 ml/ha Dichlorvos 76 WSC 750 ml/ha Endosulfan 35 EC 1.0 l/ha ▪ **Spray any one of the following insecticides to control the 4th to 6th instar larvae :** Chlorpyriphos 20 EC 2.0 l/ha Dichlorvos 76 WSC 1.0 l/ha Phenthoate 50 EC 2.0 l/ha Profenophos 2.0 l/ha 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 10^{12} 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. Use castor leaves for larvae
Leaf hopper *Empoasca kerri*	▪ Intercrop lab lab with groundnut 1:4 ratio ▪ Spray Imidacloprid 200 SL at 100 ml/ha twice, at 30 and 51 days after sowing
Leaf miner *Aproaerema modicella*	▪ Set up light traps between 8 and 11 p.m at ground level ▪ **Apply anyone of the following insecticides at 25 kg/ha :** Phosalone 4 D Endosulfan 4 D Carbaryl 10 D Fenitrothion 2 D

	▪ **Spray any one of the following :** Endosulfan 35 EC 750 ml/ha Dichlorvos 76 WSC 625 ml/ha Monocrotophos 36 WSC 750 ml/ha Phosphamidon 40 SL 750 ml/ha Chlorpyriphos 20 EC 1250 ml/ha Phosalone 35 EC 750 ml/ha Quinalphos 25 EC 750 ml/ha Phenthoate 50 EC 750 ml/ha Imidacloprid 200 SL 150 ml/ha (in 375 l of water)
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 Endosulfan 4 D 25 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.
Millipede *Spirostreptus* spp.	▪ Apply methyl parathion 2D 25 kg/ha during gypsum application and earthing up

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 :** ❖ **Botanical /others** ▪ Spray 10% *Calotropis* leaf extract ❖ **Chemical** ▪ 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*	❖ **Biological control** ▪ Soil application of *P. fluorescens* @ 2.5g /ha mixed with 50 kg of well decomposed FYM / sand at 30 DAS ❖ **Chemical** ▪ Spot drench with Carbendazim 1 g / l
Groundnut Bud Necrosis (*Peanut Bud Nercrosis Virus*)	❖ **Cultural Method** ▪ Adopt a close spacing of 15 x 15 cm.

vector: *Thrips tabaci* *Frankliniella schultzeii*	▪ 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. **Botanical/others** ▪ 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

Variety Seed Production

Land Requirements

- A seed crop of groundnut shall not be eligible for certification if planted on land on which the crops grown within previous two seasons were of the same kind unless the crops grown within the previous two seasons were of the same variety and of an equivalent or higher class of certified seed and were certified.
- Boron deficient soil should be avoided as it produces single compartment seeds.
- Calcium deficient soils should be avoided as it causes production of darkened plumules.

Isolation

- Adopt 3 m for certified seed production all around the field against other varieties

Season

- June – July and December – January.

Spacing

- Adopt spacing of 25 x 15 cm

Pre-sowing seed treatment

- Obtain seed from healthy pods.
- Shrivelled and disfigured seeds should be discarded.
- Others as in crop management techniques for crop production.

Pre-sowing seed hardening

- The graded seeds can be hardened by soaking in 0.5% $CaCl_2$ (50% seed volume) for 6 hrs. After 6 hrs soaking, seeds should be incubated in between moist gunny bags for 12–18 h. The sprouting of radicle should be observed periodically at 2 hr intervel after 12 h of incubation. The seeds with sprouted radicle (just visible expression of radicle) should be separated and dried under shade. All the viable seeds with the expression of radicle emergence should be separated and dried under shade.

Fertilizers

- NPK @ 40:40:60 kg ha^{-1} as basal
- Apply borax @ 10 kg ha^{-1} as basal
- Apply gypsum @ 200 kg ha^{-1} at peg formation stage

Harvesting

- Harvest the pods as and when the color of the inner side of the shell turns black.
- The pod moisture will be 35 – 40% at harvest.
- Strip the pods and dry to 10 – 12 per cent moisture.
- Mechanically injured pods should be rejected.
- Remove all discolored pods.
- Pods sorting should be practiced to remove genetically impure seed.

Drying

- Stake the plants as the pods are exposed to outside for easy drying of pod.
- Dry the pod to 15 – 20 % moisture content under sun.

Decortication

- Pods dried to 16 per cent moisture content could be decorticated either manually or using hand operated decorticator with proper adjustment
- The kernels should be dried to 7 to 8 per cent moisture.

Seed Treatment

- Treat the pods with Thiram 75% WP @ 2 g kg^{-1} of seed at pods with 6 -7 per cent kernel moisture.

Seed Storage

- Store the pods in closed plastic container or gunny bags with Calcium chloride at 250g/30 kg of pods.
- Use gunny or cloth bags for short term storage with seed moisture content of 8 - 9%
- Use polylined gunny bag for medium term storage with seed moisture content of 6- 8%
- Use 700 gauge polythene bag for long term storage with seed moisture content of less than 5%.

Other management practices

- As in crop management technique

SESAME (*Sesamum indicum*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

DISTRICT/SEASON	VARIETIES
A) Rainfed	
1. Adipattam (Jun - Jul)	
All districts	CO 1, TMV 3
2. Karthigaipattam (Oct - Nov)	
All districts	CO 1, TMV 3, TMV 5, SVPR 1, VRI(SV) 2
B) Irrigated - Masipattam (Feb - Mar)	
Coimbatore, Erode, Tiruchirapalli, Perambalur, Karur, Madurai, Dindigul, Theni, Thanjavur, Tiruvarur,Nagapattinam	TMV 3, TMV 4, TMV 6, CO 1, VRI(SV) 1, SVPR 1, VRI(SV) 2
C) Rice fallows	
Coastal situations	VRI(SV)1

II. PARTICULARS OF SESAME VARIETIES

Particulars	CO 1	TMV 3	TMV 4	TMV 5
Parentage	(TMV3 x SI 1878) x SI 1878	South Arcot local x Malabar	Pureline from Sattur local variety	Pureline from Srivaikuntam variety
Duration (Days)	85 - 90	80 - 85	85 - 90	80 - 85
Oil content(%)	51	51	50	51
Yield kg/ha				
Irrigated	750 - 790	625 - 750	700 - 850	..
Rainfed	450 - 650	400 - 650	..	450 - 650
Habit	Erect with branching and short internodes on the main stem	Bushy with profuse branching	Bushy with profuse branching	Erect with moderate branching
Capsules	4 loculed	4 loculed	4 loculed	4 loculed
Seeds	Intense dark brown almost black	Darkbrown	Brown	Brown

Particulars	TMV 6	SVPR 1	VRI (SV)1
Parentage	Pureline selection from Andhra Pradesh variety	Selection from Western Ghat White	Pureline seletion from Tirukattupalli local
Duration (Days)	85 - 90	75 - 80	70 - 75
Yield kg/ha			
Irrigated	700 - 950	800	650 - 900
Rainfed	..	600	450 - 650
Oil content(%)	54	53.8	51
Habit	Erect with moderate branching	Erect and moderate branching	Moderate branching
Capsules	4 loculed	4 loculed	4 loculed
Seeds	Brown	White	Brown

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) Apply NPK fertilizers as per soil test recommendation. 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.

v) 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.

vi) If furrow application is not done, broadcast the fertilizer mixture evenly on the beds before sowing.

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.

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

Weed and hoe on 15^{th} and 35^{th} day of sowing. Apply Alachlor @ 20 kg/ha on 20^{th} day after sowing and irrigate the crop immediately.

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 10^{th} 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/m^2 during the reproductive stage

Pest management strategies

Pests	Management strategies
Shoot and Leaf webber *Antigastra catalaunalis* **Pod borer** *Elasmolomus (= Aphanus) sordidus* **Gall fly** *Asphondylia ricini*	▪ Two sprayings with neem formulation 0.03% ▪ **Apply any one of the following insecticides 25 kg/ha on the 25th, 35th and 50th day of sowing :** Endosulfan 4 D Phosalone 4 D Quinalphos 1.5 D Malathion 5 D ▪ **Spray any one of the following :** Phosalone 35 EC 1000 ml/ha Quinalphos 25 EC 1000 ml/ha Dichlorvos 6W SC 500 ml/ha Monocrotophos 36 WSC 625 ml/ha Endosulfan 35 EC 1000 ml/ha Carbaryl 50 WP 1000 g/ha in 500 litre of water Neem seed kernel extract (5%). Neem oil 2% (two rounds) ▪ Use alternate insecticides each time and avoid the usage of same insecticide every time.
Leaf webber *Antigastra catalaunalis*	
Storage pests *Triboilum castaneum* *Corcyra cephalonica*	▪ **Dust any one of the following on gunny :** Malathion 5 D Phosalone 4 D Carbaryl 10 D ▪ Mix one kg of activated clay with 100 kg of seeds after adequate drying of seeds

B. 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.
Name of the Disease	***Management***
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)*	**Biological control** ▪ 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. **Chemical** ▪ Spot drench Carbendazim – 1 gm/ litre
Phyllody Phytoplasma Vector: *Orosius albicinctus*	❖ **Cultural Method** ▪ Remove and destroy infected plants. ❖ **Chemical** ▪ To control vector, spray Monocrotophos 36 or Dimethoate 30 EC 500 ml/ha combined with Intercropping of Sesamum + Redgram (6 : 1)

SEED PRODUCTION

Variety Seed Production

Land requirement
- Land should be free of volunteer plants.

Isolation
- Adopt 50 m for certified seed production

Fertilizer
- NPK @ 50:25:25 kg ha^{-1} as basal
- Apply manganese sulphate @ 5 kg ha^{-1} as basal

Foliar application
- Spray 1% DAP at the time of first flowering and again 10 days after first spray.

Harvest
- Harvest when 75–80% of the pods start 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%.
- Seeds would have attained chocolate brown colour.
- Stack the plants in inverted position and allow them to dry for 3 – 4 days.

Threshing
- Remove the staked plants and beat with pliable bamboo stick

Processing
- Use 4/64" (1.6 mm) round perforated metal sieve for grading.

Drying
- Dry the seeds to 7- 8% moisture content and treat the seeds with Carbendazim or Thiram @ 2 g kg^{-1} of seed.

Storage
- Use gunny or cloth bags for short term storage with seed moisture content of 8 - 9%
- Use polylined gunny bag for medium term storage with seed moisture content of 7 - 8%
- Use 700 gauge polythene bag for long term storage with seed moisture content of less than 5%.

Mid-storage correction
- Soak the seeds for two hours in double the volume of Disodium phosphate solution (3.60 g/100 lit of water).
- Remove the floaters
- Dry back the seeds to original moisture content 6 – 7%.

Other management practices
- As in crop management technique

CASTOR (*Ricinus communis*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

SEASON

i) Rainfed
Adipattam (June - July)
ii) Gardenland (border)

VARIETIES : TMV 5, TMV 6
HYBRID : TMVCH 1
CO 1 (Perennial)

II. DESCRIPTION OF CASTOR VARIETIES

Particulars	CO 1
Parentage	Pureline selection from Anamalai
Duration (months)	Perennial
Average yield (kg/ha)	
Pure crop	2.5 kg/tree/yr
Mixed crop	..
Oil percentage	57
Special features	
Stem colour	Pinkish green
Bloom (Waxy coat)	No bloom
Receme/ capsule	Bold, sparse settings, non dehiscent
Suitability	Bund crop and fit for raising in vacant areas

Particulars	TMV 5	TMV 6	TMVCH1
Parentage	SA 2 X S248/2	VP 1 x RC 962	LRES 17 x TMV 5
Duration (months)	4	160	160 - 170
Average yield(kg/ha)			
Pure crop	850	950	1300
Mixed crop	...	500	600
Oil percentage	50	51.9	51.7
Special features			
Stem colour	Rose	Red	Red
Bloom (Waxy coat)	Trible	Double	Trible
Receme/ capsule	Spiny, non-dehiscent, resistant to leafhopper	Medium length, spiny capsules	Semi compact, spiny capsules
Suitability	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.

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 for short and long duration strains.

	Spacing		**Spacing**
Long duration	90 x 90 cm	**Short duration**	60 x 45 cm
TMV 6,	90 x 60 cm	TMV 5	60 x 30 cm
TMVCH 1	90 x 60 cm		

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 of 30:15:15 kg/ha NPK.

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.

7. SOWING

a) Sow the seeds adopting the recommended spacing. b) Place the seeds at depth 4 - 6 cm. c) Put one seed in each hole.

8. GAP FILLING

Gap fill on the 10th day of sowing.

9. WEED MANAGEMENT

Hoe and hand weed on 20th day of sowing to remove the weeds and repeat the operation on 40th day of sowing, if necessary.

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.

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 Fenthion 100 EC 1.0 l /ha Carbaryl 50 WP 2.0 kg / ha in 1000 l of water ▪ Apply endosulfan 4 D 25 kg/ha
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 Fenthion 100 EC 1.0 l / ha Carbaryl 50 WP 2.0 kg / ha in 1000 l of water ▪ Apply endosulfan 4 D 25 kg/ha

	▪ Apply neem seed kernel extract 5% + Neem oil 2%

B. Disease management

Name of the Disease	*Management*
Botrytis *Botrytis ricini*	▪ Removal and destroyal 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 seconds pray after a fortnight.

C. Nematode management

Nematode pest	Control measure
Reniform nematode, *Rotylenchulus reniformis*	Seed treatment with *Pseudomonas fluorescens* @ 20 g/kg seed.

SEED PRODUCTION

Variety Seed Production

Land requirement

- Land to be used for seed production shall be free from volunteer plants.

Isolation

- Adopt 200 m all around the field

Spacing

- Adopt 60 x 20 m

Fertilizer

- Apply NPK @ 60 : 60 : 20 kg NPK ha-1 as basal

Physiological maturity

- Seeds attain physiological maturity 35 days after anthesis

Processing

- Grade the seeds using BSS 6 x 6 wire mesh sieve

Seed Treatment

- Treat the seed with mixture of halogen mixture @ 3g kg^{-1} of seed along with carbendazim @ 2 g kg^{-1} of seed

Storage

- Use gunny or cloth bags for short term storage with seed moisture content of 8 - 9%
- Use polylined gunny bag for medium term storage with seed moisture content of 7 - 8%
- Use 700 gauge polythene bag for long term storage with seed moisture content of less than 5%.

Other management practices

- As in crop management technique

Hybrid Seed Production

LAND REQUIREMENT
- Free from volunteer plants

Isolation
- Adopt 100 m distance for Certified seed production around the plot for other varieties and hybrids of castor

Planting ratio
- Adopt a ratio of 3:1 between female and male

Season
- First fortnight of September for production of more pistillate inflorescence in female line

Fertilizer
- Apply NPK @ 90:70:70 kg ha $^{-1}$

Spacing
- Adopt 90 X 30 cm

Physiological Maturation
- Forty five days after 50% flowering
- Seed coat will be mottled
- Well developed caruncle
- Slight Splitting of capsule

Harvesting
- Once over harvest after drying of capsules (browning) in 80% of plants
- The seeds from secondary raceme are better than primary and others

Threshing
- Use power oprerated thresher for shelling
- Avoid hand operated thresher to avoid mechanical damage

Grading
- Grade with two screen cleaner cum grader with top screen of 7.2mm for obtaining higher recovery of quality seeds

Drying
- Thin layer drying at 60^0C for one hour reduce the moisture content to safe level (8- 10%) with high seed quality characters

Storage
- Slurry treat the seed with carbendazim @ 2g kg^{-1} of seed or dry dress with *Achorus calamus* rhizome powder at the ratio of 1:100 for preservation of seed quality.
- Use 700 gauge polythene bag for long term storage
- The seeds of female parent are poor storer than male and hybrid

SAFFLOWER (*Carthamus tinctorius*)

CROP IMPROVEMENT

I. Season	**Varieties**
Rainfed crop (November)	K1, CO 1

Particularas of varieties

	K1	**CO 1**
Duration (days)	120	125
Yield (kg/ha) Rainfed	700	800
Percentage of oil	31	33
Plant character	Spiny	Non-spiny

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

Hoe and weed on 25th and 40th 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.

SUNFLOWER (*Helianthus annuus*)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

SEASON/DISTRICT	VARIETIES
A. Rainfed :	
1. Adipattam (June-July)	
Coimbatore, Erode, Salem, Namakkal, Tirunelveli, Dindigul, Dharmapuri, Tiruchirapalli, Perambalur, Karur	Variety : Morden, CO 4 Hybrid : TCSH 1, KBSH 1, KBSH 44, PAC 1091, MSFH 17
2. Karthigaipattam (Oct - Nov)	
Cuddalore, Villupuram, Virudhunagar, Sivagangai , Ramanathapuram, Madurai, Dindigul, Theni, Tiruchirapalli, Perambalur, Karur, Tirunelveli	Variety : Morden, CO 4 Hybrid : TCSH 1, KBSH 1, KBSH 44, PAC 1091, MSFH 17
B. Irrigated :	
1. Margazhipattam (December - January)	
Salem, Namakkal, Dharmapuri, Erode Coimbatore, Madurai, Dindigul, Theni, Tirunelveli, Thoothukudi	Variety : Morden , CO 4 Hybrid : TCSH 1, KBSH 1, KBSH 44, PAC 1091, MSFH 17
2. Chithiraipattam (April - May)	
Coimbatore, Erode, Dharmapuri, Salem, Namakkal, Tiruchirapalli, Perambalur, Karur	Variety : Morden, CO 4 Hybrid : TCSH 1, KBSH 1, KBSH 44, PAC 1091, MSFH 17

II. DESCRIPTION OF SUNFLOWER VARIETIES

Particulars	MORDEN	CO 4	TCSH 1
Parentage	Selection from Cernianka 66	Extract from the cross Dwarf x Surya	234A x R 272
Duration (days)	75	80 - 85	85
Yield (kg/ha)			
Rainfed	900	1500	1800
Irrigated	1000	1750	2500
Oil percentage	36	39.7	41

Ray floret	Light yellow	Light yellow	Light yellow
Height (cm)	90	145 - 175	160
Seed size & Seed Colour	Medium, black	Black	Black Very few seeds may have strips
1000 seed weight (g)	44	56	60

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.

ii) Apply NPK fertilizers basally as per soil test recommendations. 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**	50	60	40
	RF	*40*	*50*	*40*

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.
b) Apply the mixture over the furrows and top two thirds of the ridges before sowing.
c) 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 at 2.0 l/ha before sowing and incorporate or apply as pre-emergence spray on 5 day after sowing followed by irrigation or apply Pendimethalin 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 l 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.

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 :** Endosulfan 35 EC 1000 ml/ha Fenthion 100 EC 500 ml/ha Phosalone 35 EC 1000 ml/ha Phenthoate 50 EC 500 ml/ha
Tobacco cut worm *Spodoptera litura*	▪ **Dust any one of the following :** Endosulfan 4 D 25 kg/ha Phosalone 4 D 25 kg/ha
Gram pod borer *Helicoverpa armigera*	▪ 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
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 200 SL at 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.
Name of the Disease	***Management***
Alternaria leaf spot *Alternaria helianthi*	▪ Spray Mancozeb 1000g/ha
Rust *Puccinia helianthi*	▪ Spray Mancozeb 1000g/ha

Charcoal rot *Macrophomina phaseolina (Rhizoctonia bataticola)*	❖ **Biological control** ▪ Soil application *P. fluorescens* or *T. viride* – 2.5 Kg / ha + 50 Kg of well decomposed FYM or sand at 30 days after sowing. ❖ **Chemical** ▪ Spot drench 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 virus (Ilarvirus)* Vector Thrips	❖ **Cultural Method** ▪ Raise sorghum as border crop (One month prior to sunflower sowing) ❖ **Chemical** ▪ Imidacloprid seed treatment 2g/kg ▪ 0.01 % Imidacloprid foliar spray at 30 & 45 DAS.

SEED PRODUCTION

Variety Seed Production

Land requirement

- Same kind of crop should not be grown in the previous year
- It can be same variety if it is certified.

Isolation

- Adopt 200 m for certified seed production

Spacing

- Adopt a spacing of 45 x 30 cm

Presowing seed treatment

- Soaking in water @ 1:1 volume for 16h enhanced the germination and field establishment.

Fertilizer

- Apply NPK @ 60:45:45 kg ha^{-1}.

Foliar application

- Spray 0.5% borax at the stage of button opening for increased seed set.

Supplementary pollination

- During flowering rub the heads with muslin cloth between 8–11 AM at alternate days till the completion of flowering.

Harvesting

- Harvest when the drooping peduncular receptacle 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.
- Cut and dry the heads immediately until the seeds contain 15–16 per cent moisture.
- Separate the seeds with a mechanical thresher or manual labour and pre-clean.

Processing

- Use sieve 9/64" (3.6 mm) round perforated metal sieve or BSS 7x7 wire mesh sieve.
- Remove broken and dehulled seed

Seed Treatments

- Treat with Thiram 75% WP @ 2 g in 5 ml of water kg^{-1} of seed.

Storage

- Use gunny or cloth bags for short term storage with seed moisture content of 8-9%
- Use polylined gunny bag for medium term storage with seed moisture content of 8-9%
- Use 700 gauge polythene bag for long term storage with seed moisture content of less than 8%.

Mid storage seed treatment

- Soak sunflower achenes in dilute solution of sodium dihydrogen phosphate (10^{-4} M) for 2 h followed by dry back to original moisture content (8%), when the germination of seeds falls 5-10% lesser than MSCS level (70%)

Hybrid Seed Production

Land requirement

- Same kind of crop should not be grown in the previous year
- It can be same variety if it is certified.

Isolation

- Adopt 400 m for certified seed production

Planting ratio :

- Adopt a planting ratio of 4 : 1 / 3:1 (female : male)

Border rows

- Four number of male rows all around the field

Harvesting

- Harvest the male line first and remove the produce from the field then harvest the hybrid seed

Other management practices

As that of varieties / crop management techniques

NIGER (Guizotia abyssinica)

CROP IMPROVEMENT

I. SEASON AND VARIETIES

Season	:	
1. Adipattam	:	June - July
2. Purattasipattam	:	Sept.-Oct.
Areas of adoption	:	Hosur and Denkanikotta taluks of Dharmapuri district and hilly regions of Shevroy, Kolli hills, Jawad hills and Thalavadi hills

II. DESCRIPTION OF VARIETIES

Variety	:	Paiyur 1
Parentage	:	Mass selection from composite II
Duration (days)	:	80
Yield (kg/ha)	:	260
Oil content (%)	:	44.6
Plant height (cm)	:	80-85
Branches	:	Profuse
Seed	:	Bold
Colour of seed	:	Brown
50% flowering (days)	:	50

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 20^{th} and 35^{th} 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.

SEED PRODUCTION

Variety seed production

Land requirement

- Same kind of crop should not be grown in the previous season.

Isolation

- Adopt 200 m all around the plot for certified seed production

Spacing

- Adopt 30 x 30 cm

Fertilizer

- Apply 40 : 40 : 20 kg of NPK ha^{-1} as basal application

Physiological maturation

- Harvest when seeds attain physiological maturation ie 85 days after sowing.

Processing

- Grade the seeds using BSS 16 x 16 wire mesh sieve

Seed Treatment

- Treat the seed with halogen mixture @ 3g kg^{-1} of seed

Storage

- Use gunny or cloth bags for short term storage with seed moisture content of 8 - 9%
- Use polylined gunny bag for medium term storage with seed moisture content of 7 - 8%
- Use 700 gauge polythene bag for long term storage with seed moisture content of less than 5%.

Mid storage correction

- Soak the seed in double the volume of disodium phosphate (10^{-4} M) solution for 3 h and dry back to original moisture content.

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, Sumangala, Sruthi*
Dharmapuri	:	MCU 5, TCHB 213*, MCU 12, MCU 13, Suvin
Salem, Namakkal	:	MCU 5, Suvin, TCHB 213*, MCU 12, MCU 13, Sumangala
Cuddalore, Villupuram	:	MCU 5, MCU 12, MCU 13, LRA 5166, TCHB 213*, SVPR 2, Surabhi,
Summer – Irrigated (Feb – Mar)		
Erode	:	MCU 5, MCU 5 VT, SVPR 2 , Supriya, MCU 12, MCU 13, TCHB 213
Madurai, Dindigul, Theni	:	MCU 5, MCU 5 VT, MCU 12,MCU 13, SVPR 2, Supriya,
Ramanathapuram, Virudhunagar, Sivagangai, Tirunelveli, Thoothukudi	:	MCU 5, MCU 5 VT, SVPR 2, MCU 12, MCU 13
Rainfed (Sep – Oct)		
Madurai, Dindigul, Theni	:	LRA 5166, K11, KC 2, SVPR 2
Ramanathapuram, Virudhunagar, Sivagangai	:	LRA 5166, K 11, KC 2, SVPR 2
Tirunelveli, Thoothukudi, Dharmapuri	:	LRA 5166, K 11, KC 2, SVPR 2
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 EECH) x (TCH 92-7 x EECH)	Aug- Oct Jan-Feb	Irrigated	2200	Early duration Can spun upto 50s
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
Supriya	MCU 5 x C 1998	Aug-Oct Jan-Feb	Irrigated	2000	White fly 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
Sumangala	CW 134 x Reba B 50 x Khandwa 2	Sept-Oct Jan –Feb	Irrigated Rainfed	2000 1200	Suitable for rainfed tract
Sruthi	70 E x RSP 4	Sept-Oct Jan –Feb	Irrigated	2500	Early duration
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

II. PARTICULARS OF COTTON VARIETIES/HYBRIDS (CONTD...)

Varieties/ Hybrids	Parentage	Season	Irrigated/ Rainfed	Mean yield of seed (kg/ha)	Special features
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 and tankfed rice fallow tracts of Tamil Nadu.

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.

CROP MANAGEMENT

I. PREPARATION OF FIELD FOR IRRIGATED COTTON CROP

1. PREPARATION 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.

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.

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.

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.

5. APPLICATION OF INORGANIC FERTILIZERS

i) Apply NPK fertilizers as per soil test recommendations.
ii) 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.

v) Foliar application of 2% DAP + 1% KCl will improve kapas yield.

vi) Apply the fertilizers in a band, two-thirds of the distance from the top of the ridge, and incorporate.

6. APPLICATION OF MICRONUTRIENT MIXTURE

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.

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 5% $MgSO_4$ Urea (1.0%) and $ZnSO_4$ (0.10%) as foliar spray on 50th and 80th day to correct this malady. In Mg deficient areas apply $MgSo_4$ @ 20 kg/ha basally.

II. MANAGEMENT OF MAIN FIELD OPERATIONS

I. 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	..

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.

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.

NOTE: Acid delinting has the following advantages:

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.

4A. 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.

4B. 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.

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

6. WEED MANAGEMENT

i) Apply Pendimethalin @ 3.3 l/ha three days after sowing, using a hand operated sprayer fitted with deflecting or fan type nozzle. 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.

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.

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.

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.

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.

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.

12. MANAGEMENT STRATEGIES FOR DELAYED UMMER IRRIGATED COTTON SOWING

KCI 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.

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

MANAGEMENT OF FIELD OPERATIONS

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. 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.

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

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

5. THINNING SEEDLINGS

i) Thin out seedlings on the 20th day of sowing
ii) Leave only one healthy and vigorous seedling per hill.

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.

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.

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.

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

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.

11. TOPPING

Arrest terminal growth by nipping the terminal 15th node for controlling excessive vegetative growth. (70-75 DAS)

12. WATER MANAGEMENT

Regulate irrigation according to the growth phases of the crops.

Stages	No. of Irrigations	Days after dibbling seeds	
		Old delta	New delta
1. Vegetative Phase			
Regulate irrigation during the germination phase	1	One wetting on the 30th to 35th day of sowing after the application of fertilisers	One irrigation on the 20th day after 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 application of 2nd dose of N	45th day
	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.

13. Harvesting |
14. Post harvest operation | As that of the irrigated cotton.
15. Pest and disease management |

RAINFED COTTON

Follow water harvesting techniques and raise a successful crop of cotton.

I. 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.

In places where rains are received during October or November, Select K 11 for Ramanathapuram, Virudhunagar, Tirunelveli and Thoothukudi districts.

II. PREPARATION OF LAND FOR RAINFED COTTON

1. PREPARATION OF THE FIELD

i) Start preparation of the land immediately after harvest of the previous crop.
ii) Adopt permanent broad ridges system.

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.

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_20
K 11	20	0	0
SVPR 2	40	20	40
KC 2	40	20	40

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.
ii) Apply uniformly over the furrows after sowing and cover the seeds.
iii) Do not incorporate in the soil.

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

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.

7. ACID DELINTING

Adopt procedure for acid delinting as for an irrigated crop.

8. PRETREATMENT OF ACID DELINTED SEEDS WITH FUNGICIDES

Same as for the irrigated crop.

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.

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.

11. GAP FILLING

Dibble 3 to 4 seeds in each gap if sufficient moisture is available.

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.

13. FOLIAR FERTILIZATION

Spray 0.5% urea and 1% KCl on the 45th and 65th day of sowing if fufficient moisture is available.

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.

COTTON

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/cm^2 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 fertilisers which will not favour the 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 14th 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, endosulfan, 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 endosulfan 35 EC 2 l/ha. ▪ **During bolling and maturation stage, apply any one of the following insecticides (1000 l of spray fluid/ha):** Phosalone 35 EC 2.5 l/ha Quinalphos 25 EC 2.0 l/ha Carbaryl 50 WP 2.5 kg/ha Pyraclofos 50 EC 1.5 l/ha

Pink bollworm *Pectinophora gossypiella*	▪ Use pheromone trap to monitor the adult moth activity ▪ Spray triazophos 40 EC 2.5l/ha and endosulfan 35 EC 2.0 l/ha in alternation even after 100 DAS.
Tobacco cutworm *Spodoptera litura*	▪ Use of light trap to monitor and kill the attracted adult moths. Set up the sex pheromone trap Pherodin S.L. 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 Dichlorvos 76 WSC 1.0 l Phenthoate 50 EC 2.0 l Chlorpyriphos 20 EC 1.25 l Fenitrothion 50 EC 625 ml ▪ Spraying nuclear polyhedrosis virus at 1.5 x 10^{12} POB per ha. ▪ 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.
Stem weevil *Pempherulus affinis*	▪ Soil application of carbofuran 3 G 30 kg/ha on 20 days after sowing and earthing up on 45^{th} day. ▪ Basal application of FYM 25 t/ha and 250 kg/ha of neem cake.
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 :** **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) Methyl demeton 25 EC 500 ml Phosphamidon 40 SL 600 ml/ha ▪ **Spray any one of the following in mid and late stages** (1000 l spray liquid/ha) Phosalone 35 EC at 2.5 l/ha Quinalphos 25 EC at 2.0 l/ha Ethion 50 EC 1.0 l/ha Monocrotophos 36 SL 1.25 l/ha Triazophos 40 EC 2.0 l/ha Acephate 75 SP 1.30 kg/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.
Thrips *Thrips tabaci*	▪ Seed treatment with imidacloprid 70 WS at 7 g/kg protect the crop from aphids, leafhoppers and thrips upto 8 weeks.

Aphids *Aphis gossypii*	**Spray any one of the following insecticides** (500 l spray fluid/ha)
Leafhopper *Amrasca devastans*	Imidacloprid 200 SL at 100 ml/ha Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha Phosphamidon 40 SL 600 ml/ha Monocrotophos 36 SL 1000 ml/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
Red spider mite *Tetranychus cinnabarinus*	▪ **Apply any one of the following:** Wettable sulphur 1.25 kg/ha Dicofol 1.10 l/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. Endosulfan 10 µg/µl
5. Quinalphos 0.75 µg/µl
6. 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. Endosulfan topical 2.0 µg
2. Profenofos topical 3.0 µg
3. Chlorpyriphos topical 0.15 µg
4. 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 : C*arbaryl, cypermethrin, deltamethrin, endosulfan, fenpropathrin, fenvaerate, flucythrinate, fluvalinate, monocrotophos, permethrin, phorate
- *Amrasca devastans : D*eltamethrin, dimethoate, disulfoton, methylparathion, phorate
- *Bemisia tabaci : C*ypermethrin, deltamethrin, dimethoate, endosulfan, fenvalerate, monocrotophos, phosalone
- *Ferrisia virgata : C*ypermethrin, deltamethrin, fenvalerate, permethrin
- *Tetranychus cinnabarinus : A*cephate, 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 :**
  Endosulfan 4 D
  Carbaryl 5 D
  Phosalone 4 D

B. 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***
Grey Mildew ***Ramularia areola***	▪ *Spray Carbendazim 250 g/ha*
Boll rot *Fusarium moniliforme, Colletotrichum capsici, Aspergillus flavus, A. niger, Rhizopus nigricans, Nematospora, Botryodiplodia*	➢ ***Spray any one of the following:*** ▪ *Spray 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* @ 4 g/kg followed by basal application of zinc sulphate @ 50 kg/ha ❖ **Chemical** ▪ Spot drench Carbendazim @ 1 g/lit at the base of affected plants as well as surrounding healthy plants.

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)		Spacing (cm)	No. of Plants/
	Line Sowing	Broad Casting		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.