

PACKAGE OF PRACTICES
FOR
***KHARIF* CROPS OF ASSAM**
(2015)

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IMPORTANT ABBREVIATIONS USED IN THIS HAND BOOK

Agroclimatic Zones

N= North Bank Plains Zone

U=Upper Brahmaputra Valley Zone

L=Lower Brahmaputra Valley Zone

C=Central Brahmaputra Valley Zone

H=Hill Zone

B=Barak Valley Zone

Reaction to pests & diseases

R=Resistant

MR=Moderately Resistant

S=Susceptible

MS= Moderately Susceptible

T=Tolerant

Others

FYM= Farm Yard Manure

HYV= High Yielding Variety

a.i. = Active ingredient

RHSDRB=Rice Husk Saw Dust Rice Bran

CEREALS
Rice (*Oryza sativa*)
Normal *Ahu* (Autumn rice)
(Direct seeded)

Varieties:

Varieties	*Agro-climatic zone	Duration (days)	Av. Plant height (cm)
A. **Semidwarf			
Govind	U,C,L,B,H	105-100	95
***IR-50	U,C,L,B,H	105-110	85
Rasi	N,U,L,H	110-115	90
IR-36	N,C,L,H	110-120	85
B. Tall			
Banglami	N,L	115-120	100-140
Rangadoria	N,C,L	115-120	-do-
Ahu joha	N,U,L	110-120	-do-
Maibee	H	90-100	-do-
Dimroo	H	90-100	-do-

*Refer to page iii for full forms of agro-climatic zones

** Durations of semi-dwarf varieties are based on experiments conducted at Titabar.

Durations of tall varieties are collected from the Field Trial Stations of respective zones.

*** Not recommended for blast endemic areas.

Varieties recommended (for direct seeded, rainfed upland/*Jhum* land situations of Hills Zone only):

Variety	Sowing time	Duration (days)	Fertilizer (N:P:K) dose (kg/ha)	Grain Yield (t/ha)	Reaction to insect pests & diseases
Maizu Biron	April-May	115	20:10:10	2.7	Moderately resistant to blast and BLB and durable field resistance to stem borer, leaf folder, case worm and rice bug
Inglongkiri	-do-	110	-do-	3.4	Resistant to blast and moderately resistant to stem borer, case worm and leaf folder
Dehangi	-do-	115	-do-	3.3	-do-
Rongkhang	-do-	115	-do-	3.3	-do-
Haccha	-do-	115	-do-	3.5	Moderately resistant to Leaf blast, Neck blast, Brown spot, Sheath rot, Stem borer, Leaf folder, Plant hopper under natural condition

Land selection:

Areas having surface soil with medium to sandy texture overlying a silty clayey sub-soil should preferably be selected.

Seed Selection:

Put the seeds in plain water and stir well. Select the sunken seeds rejecting the floating ones.

Sowing Time:

Seeds should be sown in March and April.

Dry Seed Treatment:

Put seeds in a container and add any of the following fungicides according to the recommendation. Mix the fungicide thoroughly with seeds by agitating them for five minutes.

Fungicide	Dose (g/kg seed)	Cost of fungicide to treat seeds required for one ha.
Mancozeb	2.5	Rs. 57.00 (line sowing)
		Rs. 83.00 (broadcasting)
Captan	2.5	Rs. 66.00 (line sowing)
		Rs. 97.00 (broadcasting)

Field Preparation:

Prepare the land by 3 to 4 ploughings followed by laddering. Laddering is to be done properly to retain water uniformly in the field. FYM should be applied during initial field preparation.

Manures and fertilizers:

Compost or FYM @ 10 t/ha or 15 q/bigha should be applied.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
A. Semi-dwarf varieties :				
N	40	Urea	88	12
P ₂ O ₅	20	SSP	125	17
K ₂ O	20	MOP	32	4
B. Tall varieties :				
N	20	Urea	44	6
P ₂ O ₅	10	SSP	62	9
K ₂ O	10	MOP	17	3

Nutrient recommendation for semi-dwarf varieties is 30:30:20 kg/ha N, P₂O₅, K₂O in North Bank Plain Zone. Granulated mixed fertilizer at appropriate doses can also be applied.

Diammonium phosphate (DAP) in combination with rock phosphate or alone at the recommended level of nutrients (40:20:20) can be applied as substitute for SSP and MRP or their combinations as an economic source of phosphate. For Hill Zone reduction of 50% chemical fertilizer by incorporating 10 t of FYM/ha is recommended.

Time of Application of Fertilizers:

1. Apply full dose of phosphatic fertilizer at the time of final ploughing.
2. Apply half of nitrogenous and half of potassic fertilizer 15-25 days after germination or after first weeding.
3. The second top dressing with the remaining N and K₂O is to be done 40-50 days after germination or after second weeding.

Seed Rate:

Line Sowing: Sow seeds in lines with inter-row spacing of 20 cm @ 75 kg/ha (10-12 kg/bigha)

Broadcasting: Sow seeds @ 105-110 kg/ha (14 kg/bigha).

Interculture:

1. For weeding, use preferably wheel hoe or dry land weeder or *bindha* for laddering after 2 to 3 weeks from sowing. The second weeding should be done with wheel hoe or dry land weeder at 4-5 weeks from sowing. If wheel hoe or dry land weeder is not available give manual weeding. Weeding should precede fertilizer application.
2. As chemical weed control measures apply Pretilachlor @ 750 g/ha at 3 DAS followed by grubber at 30 DAS. For Hills Zone, application of Pretilachlor -*as pre-emergence weedicide @ 1.5 kg a.i./ha one day after sowing followed by two hand weedings at 35 and 50 days after sowing is recommended for rainfed upland rice.

Plant Protection Measures:

A. Insect Pests :

Plant protection measures should be adopted against insect pests at their economic threshold as given in Table 1.

To control rice pests, erect 50 'T'-perches per ha 2 ft (60 cm) above crop canopy as roosting site for insectivorous birds, which are to be removed before flowering in order to prevent activity of granivorous birds

B. Root-knot Nematodes :

Apply carbofuran 3 G @ 3g/m² at the time of sowing.

Alternatively, apply *Pseudomonas fluorescens* @ 20 g/m² at the time of sowing.

C. Diseases:

i) Blast:

- a) Grow tolerant varieties, such as Govind, Cauvery, IR 36.
- b) Treat the seeds as mentioned under seed treatment.
- c) Monitoring of blast is important to schedule spraying. Observe the top five leaves and if 5% leaf area is damaged, resort to spraying. Normally three sprays can control the disease. Spray carbendazim or thiophenate methyl @ 1g/lit of water at tillering stage (40-55 days after sowing) and subsequently give two more sprays of ediphenphos @ 1 ml/lit of water, one at panicle initiation stage and the other when the tip of the panicle just comes out.

ii) Sheath blight disease:

- a) For control of sheath blight disease – spraying of two commercial plant-derived cymbopogon products *viz.* cymbopogon product 20EC @ 5 ml/litre and neem product @ 3 ml/litre is recommended for management of sheath blight disease of rice. The first spraying should be given as soon as symptom of the disease is observed in the field followed by a second spraying at 10 days interval.

iii) Bacterial leaf blight (BLB):

- a) Grow tolerant varieties, such as Govind and IR 36.
- b) Avoid top dressing with nitrogen at panicle initiation stage if BLB has already appeared. Instead top dress with 10 kg of K₂O /ha or apply 5 kg of K₂O/ha in the form of foliar spray of 3% solution.

iv) Brown spot disease:

- a) Dry (1g/kg of seed) or wet (1g/kg of seed/lit of water) seed treatment with carbendazim followed by one spraying of mancozeb @ 2.5 g/litre or ediphenphos @ 1 ml/litre or carbendazim @ 1g/litre at initial symptom development stage.

v) Bakanae Disease:

- a) Soak seeds for 24 hours with thiophenate-methyl or carbendazim @ 1g/kg seed/lit of water.
- b) Rogue out the infected tillers (elongated, from the infected hills in the main field).

Pre-harvest Treatment on Standing Crop for Better Grain Quality:

Harvest of ahu crop usually coincides with rainy weather. Discolouration as well as sprouting of seeds in the panicle itself or after harvest is due to high moisture content of the seeds. To overcome such problem spraying of diquat 0.05% or paraquat 0.1% or common salt (NaCl) 10% should be done on the earhead @ 1000 lit/ha in terms of chemical solution at 20-25 days after 50% flowering. These chemicals enhance the maturity by 5-7 days.

Table 1. Damage identification and Economic Threshold Levels (ETLs) for different insect pests of rice and their chemical control

Crop stage and damage identification	Key pest	ETL	Insecticide (Technical Name)	Concentration (%)	Dose
A. Nursery					
Curling of leaves, leaf blade rolls, yellowish to reddish Discolouration	Thrips	Moderate to severe	Chlorpyriphos 20EC	0.02	
			Quinalphos 25EC	0.025	
			Fenitrothion 50 EC	0.05	
			Monocrotophos 40EC	0.04	
			Dimethoate 30EC	0.03	
Yellowing and withering of plants	Leaf and plant hoppers	Moderate to severe	Monocrotophos 40EC	0.04	
			Chlorpyriphos 20EC	0.02	
Presence of dead heart	Stem borer	Moderate to severe	Chlorpyriphos 20EC	0.02	
			Monocrotophos 40EC	0.04	
			Carbofuran 3G	-	3 gm/sq.m
			Phorate 10G	-	1 gm/sq.m
B. Main field (After transplantation)					
Upon unfolding, the edge of the central leaf shows discoloured (yellowish to whitish) Patches	Whorl maggot	More than 20% damaged hills upto 30 days after transplanting	Chlorpyriphos 20 EC Carbofuran 3G	0.02 -	30 kg/ha
Leaf tissues scrapped in white parallel lines	Hispa	1 adult or 1 damaged leaf/hill	Chlorpyriphos 20EC Quinalphos 25EC Monocrotophos 40EC	0.02 0.025 0.04	

Presence of dead heart	Stem borer	1 egg	Phosphamidon 100 EC	0.025	30 kg/ha
			Phosalone 35EC	0.035	
		mass/sq.m or 5% dead hearts	Dichlorvos 100 EC	0.05	
			Carbofuran 3G	-	
			Chlorpyriphos 20EC	0.02	
				Quinalphos 25EC	
			Fenitrothion 50 EC	0.05	30 kg/ha
				Monocrotophos 40EC	
			Phosphamidon 100 EC	0.025	10 kg/ha
				Carbofuran 3G	
Yellowing and withering of plants	Leaf and plant hoppers	10 insects/hill or 2 insects/hill in tungro endemic areas	Phorate 1G	-	
			Chlorpyriphos 20EC	0.02	
			Monocrotophos 40EC	0.04	
				Phosphamidon 100 EC	
Presence of silver shoots (galls)	Gall midge	1 silver shoot/sq.m in endemic areas or 5% silver shoots in non endemic areas	Carbofuran 3G	-	30 kg/ha
			Phorate 10G	-	10 kg/ha

C. Active tillering stage

Presence of tubular case by cutting the tips of the leaves, leaf tissues scrapped in white patches	Case worm	1-2 cases/hill	Quinalphos 25EC	0.025	
			Monocrotophos 40EC	0.04	
Leaves are folded along margins by webbing them together	Leaf folder	More than 1 damaged leaf per hill	Chlorpyriphos 20EC	0.02	
			Quinalphos 25EC	0.025	
			Fenitrothion 50 EC	0.05	
			Monocrotophos 40EC	0.04	
			Phosalone 35EC	0.035	
			Phosphamidon 100 EC	0.025	
Presence of silver shoots (galls)	Gall midge	1 silver shoot/sq.m. in endemic areas or 5% silver short in non-endemic areas	Chlorpyriphos 20EC	0.02	30 kg/ha
			Phosphamidon 100 EC	0.025	
			Carbofuran 3G	-	10 kg/ha
				Phorate 10G	
Leaf tissues scrapped in white parallel lines	Hispa	1 adult or 1-2 damaged leaves per hill	Chlorpyriphos 20EC	0.02	
			Quinalphos 25EC	0.025	
			Monocrotophos 40EC	0.04	
			Phosphamidon 100 EC	0.025	
			Phosalone 35EC	0.035	30 kg/ha
			Dichlorvos 100 EC	0.05	
			Carbofuran 3G	-	
Presence of dead heart	Stem borer	More than 5%	Chlorpyriphos 20EC	0.02	

dead heart	Quinalphos 25EC	0.025	
	Fenitrothion 50 EC	0.05	
	Monocrotophos 40EC	0.04	
	Phosphamidon 100 EC	0.025	
	Carbofuran 3G	-	30 kg/ha
	Phorate 10G	-	10 kg/ha

D. Boot leaf to heading stage

Presence of partially or completely chaffy grains in the panicle	Rice bug	1-2 bugs/sq.m	Malathion 5% dust	20 kg/ha
Presence of white Earhead	Stem borer	1 moth/sq.m.	Chlorpyriphos 20EC	0.02
			Quinalphos 25EC	0.025
			Monocrotophos 40EC	0.04
			Fenitrothion 50 EC	0.05
			Phosphamidon 100 EC	0.025
Larvae climb and cut the earhead	Ear cutting caterpillar	1 larva/hill	Chlorpyriphos 20EC	0.02
			Quinalphos 25EC	0.025
Presence of shed grains or panicles at the base of the plant	Climbing cutworm	1 larva/hill	Chlorpyriphos 20EC	0.02
			Quinalphos 25EC	0.025
			Monocrotophos 40EC	0.04
			Dichlorovos 100 EC	0.05

Rice (*Oryza Sativa*)
Transplanted Normal *Ahu* Rice
(Autumn Rice)

Varieties

Varieties	*Agro-climatic Zone	Duration (days)	Av. Plant height (cm)
Semidwarf:			
Govind	N,C,B,H	110-115	95
***IR-50	N,U,C,B,H	110-115	85
Rasi	U,C,L,B,H	120-125	90
IR-36	N,U,L,B,H	130-140	105
Lachit	U	125-130	95
Chilarai	U, B	125-130	95
Sonamukhi	B	100-110	85
Luit	B	100-110	-
Gopinath	U	115-120	-
Haccha	H	115-120	-

* Refer to page iii for full forms of the agro-climatic zones

** Durations are based on experiments conducted at Titabar.

*** Not recommended for blast endemic areas.

Land Selection:

Areas with assured irrigation facilities only should be selected. Heavy to medium textured soils are preferred.

Seed Selection:

Seeds are put in plain water, stirred well, the sunk seeds are selected and the floated ones are rejected.

Sowing in Nursery Bed:

Seed should be sown in nursery bed during March-April.

Seed Treatment:

Wet Method:

After seed selection, the seeds should be soaked directly in any of the following fungicidal suspensions for 24 hrs. One litre of fungicidal solution is required to treat 1 kg of seed.

Fungicide	Dose (g/kg seed/lit of water)	Cost (Rs./ha)
Mancozeb	2.5	Rs. 34.00
Captan	2.5	Rs. 40.00
Carbendazim	2.5	Rs. 56.00

Raising of Seedlings:

a) **Preparation of seed bed:** Land is thoroughly paddled and seed bed of 10m length and 1.25m breadth is prepared with 30 cm gap in between beds.

b) **Manures and fertilizers:** In each seed bed 20-30 kg cow dung/compost, 80 g urea, 80 g SSP and 40 g MOP are to be applied.

- c) **Seed rate:** Well germinated seeds are to be sown @ 650g to 1kg per bed. Seed requirement for transplanting one hectare of main field is 40 to 45 kg. In BPH endemic areas a lower seed rate is advocated.
- d) **Water Management:** Irrigation water is to be supplied in furrows to maintain saturated condition in the surface soil of the nursery bed. However, standing water to a depth of 2-3 cm should be maintained at least 2-3 days before uprooting.
- e) **Plant protection in seed bed:**
- As soon as one or two blast spots are seen, carbendazim @ 1g/lit or ediphenphos @ 1 ml/lit of water is to be sprayed.
 - Against root-knot nematode, apply carbofuran 3 G @ 3g/sq.m. at the time of sowing.
 - For control of nursery insect pests any one of the following insecticides is to be sprayed as and when necessary. Generally an insecticidal spray at 5-7 days after sowing is effective against most pests.

Insecticide	Dosage (ml/m ²)
Chloropyriphos	0.1
Quinalphos	0.15
Monocrotophos	0.12
Phosphamidon	0.07
Endosulfan	0.14

High volume spray : 40 ml of water/sq. m

Low volume spray : 13 ml of water/sq. m

- f) **Preparation of seedlings for initial protection of main field:** The uprooted seedlings are washed and then the root portion is dipped in 0.02% solution of chloropyriphos (1 ml/lit of water) along with 1% urea (10g/lit of water) for 3 hours as a protective measure against stem borer, gall midge, leaf hoppers and plant hoppers.

Alternatively, carbofuran @ 3g/sq.m is to be applied in the seed bed 5-7 days before uprooting of seedlings or spray chloropyriphos @ 0.02% in nursery 5 days before uprooting.

Field Preparation:

- One ploughing should be given at least 21 days prior to transplanting. An irrigation for land soaking should be applied before preparatory tillage.
- Secondary irrigation should be applied at 10-12 days prior to transplanting followed by ploughing, laddering and puddling, accompanied by repairing and mud plastering of bunds. Thereafter another irrigation should be applied for land submergence.
- The final puddling should be done 4-5 days prior to transplanting. One irrigation should be applied before final puddling (depth of each irrigation: 5-7 cm).
- The final puddling should be done 4-5 days prior to transplanting. One irrigation should be applied before final puddling (depth of each irrigation: 5-7 cm).

Manures and Fertilizers: Well rotten FYM or compost has to be applied @ 10t/ha in addition to the fertilizers at rates given below in areas with moderate fertility level.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/bigha	kg/ha
Semi dwarf varieties:				
N	40	Urea	88	12
P ₂ O ₅	20	SSP	125	17
K ₂ O	20	MOP	32	4

Above rates of nutrients will be valid for most of the rice growing areas of Assam. In case of poor soil, the rates of nutrients may be raised to the extent of 60:30:30 kg/ha N, P₂O₅ and K₂O respectively. Granulated mixed fertilizers at appropriate doses can also be applied. Di-ammonium phosphate (DAP) in combination with rock phosphate or alone at the recommended level of nutrients (40:20:20) can be applied as substitute for SSP and MRP or their combinations as an economic source of phosphate.

Time of application of fertilizers:

- i) Only 1/3rd of the total urea, full doses of super phosphate and potash at the time of final puddling should be applied.
- ii) The second 1/3rd and third 1/3rd doses of urea should be applied at tillering and panicle initiation stages respectively. Top dressing of urea should be preceded by weeding.
- iii) Super phosphate can also be incorporated into the soil at active tillering stage (25-35 days after transplanting) along with the second dose of nitrogenous fertilizer.

Use of Azolla to supplement nitrogenous fertilizers:

Azolla can be used as supplement to nitrogenous fertilizers. About 300 kg fresh Azolla/ha is to be inoculated in the field, pounded with 5-10 cm depth of water for about 2-3 weeks prior to final puddling. At the time of inoculation, super phosphate @ 8-10 kg/ha is to be applied in the field. Thereby corresponding quantities of phosphatic fertilizer should be reduced at the time of transplanting. Fresh Azolla @ 500 kg may also be applied in the standing water in a transplanted crop after establishment of the seedling. There is no need for application of additional phosphatic fertilizer in the field at the time of inoculation with fresh Azolla after transplanting. Thereafter Azolla will multiply to cover the field. Care should be taken to keep 5-10 cm depth of water for rapid multiplication. Normally sufficient quantities of biomass will be produced for two weeks.

Before inoculation of fresh Azolla, it should be treated with carbofuran 3G @ 1g/kg of Azolla and covered with polythene sheet for 2 hours to avoid pest damage in the field. Such practice will encourage early establishment of Azolla in the field. Further, it is suggested to broadcast granular insecticide preferably carbofuran 3G @ 3g/sq.m on affected patches when damage is noticed.

Natural depression and ponds or tanks may be used for Azolla multiplication outside the main field and may be incorporated at the time of land preparation @ 6t/ha of fresh Azolla.

Nitrogen dose can even be reduced up to 50% when Azolla is applied and incorporated in the field.

Use of Biofertilizer:

Application of organic manure @ 1 t/ha (on dry weight basis) along with mixed inoculum of *Azospirillum amazonense* A-10 and *Bacillus megaterium* P-5 @ 4 kg/ha (0.4-0.5 kg/bigha), rock phosphate @ 10 kg P₂O₅ per ha (rock phosphate 56 kg/ha) or 7.5 kg/bigha) and muriate of potash @ 40 kg K₂O per ha (muriate of potash 67 kg/ha or 9 kg/bigha) is recommended for rice in rice-rice, rice-legume-rice and sole rice sequences.

Method of application of Biofertilizer:

A. Technique of application of the components if the INM package for transplanted rice:

Application of the organic manure and fertilizer component: The required quantity of compost (approx. 1.5 q or 2 bullock cart load per bigha) should be applied at least a week before transplanting or at the time of final ploughing. Required quantity of potassium (40 kg K₂O per ha or 5.5 kg per bigha) should be applied prior to transplanting. Rock phosphate component is used along with the biofertilizer as slurry to treat the seedling roots.

B. Treatment of rice seedling roots with the biofertilizer component and rock phosphate by slurry method: Prepare a pit in the corner of a plot in the morning of the transplanting day by simply raising a bund that touches the two already existing bunds to obtain a triangular shape. The size of the pit should be proportionate to place the quantity of seedlings required for a bigha of land. Excess water from the pit should be removed so that only mud remains. Now add 10 kg of dried compost to the required quantity of rock phosphate, and mix with mud and then add the biofertilizer. The mixture of the mud, compost, rock phosphate and biofertilizer should form uniform slurry. The rice seedling roots in the bundles should be free of adhered soil and dipped in the slurry mixture and kept for two hours. During the two hours time, the biofertilizer and rock phosphate adhere well to the seedling roots. Then remove the seedling bundles from the pit and keep on the raised bund. Care should be taken so that the seedlings are not swept in water of the plot as the Assamese farm women are habituated in occasional sweeping of the seedlings during transplanting. The biofertilizer on the root surface keep multiplying as the root grows bigger and by 20/30 days time they start supplying N, hormone and also soluble P to the roots in adequate quantity.

Time of transplanting:

Transplanting should be done during April-May.

Transplanting:

Transplanting should be done with 3 seedlings per hill. Spacings should be 20 × 15 cm (33 hills/sq.m) for semi-dwarf and 20 × 20 cm (25 hills/sq.m) for tall traditional varieties. The wooden line marker of required spacing may be used for the same purpose. The depth of planting should be 4-5 cm.

Gap-filling: Replanting of dead hills should be done within 7-10 days of transplanting with seedlings of same age.

Water management: Application of 5 cm irrigation water 3 days after disappearance of ponded water is recommended in medium and heavy soils.

Interculture: Preferably two weedings at 20 and 40 days after transplanting should be done. Alternatively weeder can be used at the time of top dressing of nitrogenous fertilizer. For chemical control of weeds, post emergence herbicide 2,4-D @ 0.5 to 0.75 a.i./ha should be applied at 2-3 leaf stage of dicot weeds and sedges.

Plant protection Measures in the field:

A. Insect Pests:

Plant protection measures should be adopted against insect pests at their economic threshold level as given in Table-1.

To control rice pests, erect 50 'T'-perches per ha 2 ft (60 cm) above crop canopy as roosting site for insectivorous birds, which are to be removed before flowering in order to prevent activity of granivorous birds.

B. Root-knot nematode:

Same as direct seeded ahu.

C. Diseases:

Same as in direct seeded ahu.

Pre-harvest treatment should be undertaken on standing crop for better grain quality (Same as in direct seeded normal ahu).

Rice (*Oryza sativa*)
Sali rice
(Winter rice)

Varieties

Varieties	*Agro-climatic zone	Duration (days)	Sowing time	Avg. plant height (cm)
A. Transplanted normal Sali :				
i) Semi dwarf				
IR-36	U,C	110-125	July	85
Jaya	N,U,C,L	125-130	do	105
Pankaj	N,U,C,L,B,H	145-150	do	110
Lakhimi	N,U,C,L,B	140-150	do	135
Bahadur	N,U,C,L,B,H	150-155	June	114
Piolee	N,U,C,L,B,H	150-155	do	102
Kushal	N,U,C,L,B,H	150-155	do	116
Moniram	N,U,C,L,B,H	150-155	do	105
Ranjit	N,U,C,L,B,H	150-155	do	102
Kmj 10-2-2	B	150-155	do	102
TTB 101-15	B	150-155	do	102
ii) Glutinous :				
Rangalee	N,U,C,B	160-165	June	135
Bhogalee	N,U,C,B	155-160	June	99
Kmj 3-144	B	155-160	June	105
Aghoni	N,U,C,B	160-165	June	105
iii) Multiple cropping :				
Satya	N,U,L,B	130-135	do	113
Basundhara	N,U,C,L	130-133	do	107
iv) Tall :				
Monoharsali	N,U,C,L,B,H	155-160	do	130-140
Mahsuri	N,U,C,L,B,H	140-145	Mid June	130
Swarnaprova	U,B	115-120	July	135
v) Scented Rice				
Keteki jaha	N,U,C,B	155-165	June	100-140
B. Post flood transplanted (late Sali) :				
Manohar Sali	N,U,C,L,B	-	Mid Jul to 1 st week of Aug.	130
Biraj	U	-	do	120
Andrewasali	U,B	-	do	130
Solpona	N	-	do	130-140
Prasad bhog	N	-	do	do
Govindabahog	N	-	do	do
Kmj-1-19-1	L	-	July	do
C. Direct Seeded late Sali :				

Sonamukhi	H	85-95	Mid July to 1 st week of August	do
Luit	N,U,C,L,B	90-95	do	do
Kapilee	N,U,C,L,B	90-95	do	do
Dishang	N,U,C,L,B	90-95	do	do

*Refer to page iii for full forms of agro-climatic zones

N.B.

- i) IR 50 is recommended for double cropped medium land rice areas where Jaya is grown as *ahu* in Barak Valley Zone.
- ii) Varieties with plant height more than 130cm are considered as tall varieties

Rice varieties suitable for staggered planting in *sali* season with aged seedlings

Variety	Plant height (cm)	Duration (days)	Sowing time	Transplanting time	Age of seedlings	Yield (t/ha)	Agro-climatic zone	Disease reaction
Prafulla	134	150-160	June	July-Sep	30-75	4.5-5.0	All except Hills zone	R to Sheath rot, MR to blast & BLB, S to sheath blight
Gitesh	130	150-160	June	July-Aug	30-60	5-5.5	All except Hills zone	R to Sheath rot, MR to blast, T to BLB, S to sheath blight

Varieties with plant height more than 130cm are considered as tall varieties

Submergence tolerant rice varieties for rainfed, lowland flash flood situation

Variety	Plant height (cm)	Duration (days)	Sowing Time	Transplanting time	Age of seedlings	Yield (t/ha)	Agro-climatic zone	Disease reaction
Jalashree	133	150-155	June	July	30-35	4.0	All except L& H	T to BLB & sheath blight MR to blast
Jalkunwari	138	150-155	June	July	30-35	4.0	All except L & H	-do-

Varieties with plant height more than 130cm are considered as tall varieties

*Refer to page iii for full forms of agro-climatic zones

Rice varieties for low input situation:

Variety	Sowing Time	Duration (days)	Fertilizer (N:P:K) dose (kg/ha)	Grain Yield (t/ha)	*Agro-climatic diseases zone	Reaction to insect pests &
Gandhari (JR 1)	June 15-30	125	20:10:10	4.2	C	R to blast, BLB, stem borer & rice bug;; MR to sheath blight; MS to leaf folder
Mohan (JR 5)	-do-	126	-do-	4.1	C	R to blast, stem borer & rice bug; MR to sheath blight; MS to leaf folder
Srimanta (JR 2)	-do-	138	20:10:10 40:20:20	4.4 5.1	U,C,H	R to blast, stem borer; MR to BLB & sheath blight; MS to leaf folder
Bharati (JR 7)	-do-	138	20:10:10 40:20:20	4.1 4.8	U,C,H	R to blast, BLB & rice bug; MR to sheath blight & stem borer; MS to leaf folder

New rice varieties recommended for different situations

Variety	Duration (days)	Yield (t/ha)	Adaptation	Disease & pest reaction	Zone for which recommended
Shraboni (TTB 404)	135	5.00	Sali	Moderately resistant to sheath rot, neck blast & RTD and moderately resistant to GLH, PH & stem borer.	All Zones
Mulagabhoru (TTB103-21-1)	135	4.60	Sali in multiple cropping situation	Tolerant to blast, brown spot & sheath blight	All Zones
TTB 303-18-3 (Chakra lahi)	138	4.76	Sali with waterlogged situation up to 50 cm	Resistant to brown spot; MR to blast & BLB; tolerant to sheath blight & stem borer	UBVZ, NBPZ, LBVZ & BVZ
TTB 303-2-23 (Diphalu)	137	5.11	Sali with waterlogged situation up to 50 cm	MR to blast, brown spot, BLB & Sheath blight; tolerant to stem borer	UBVZ, NBPZ, LBVZ & BVZ
TTB 303-1-42 (Dhansiri)	139	4.84	Sali with waterlogged situation (up to 50 cm)	MR to brown spot & sheath blight; tolerant to blast, BLB & stem borer.	UBVZ, NBPZ, LBVZ & BVZ
TTB 303-1-26 (Manah)	138	4.66	Sali with waterlogged situation (up to 50 cm)	-	UBVZ, NBPZ, LBVZ & BVZ
Swarna Sub1 (IR 82809-237)		4.5-5.0	Survives up to 12 days of complete submergence	-	All Zones
BR 11 Sub1	150	4.5-5.0	Submergence tolerance for 10-12 days (Flash flood situation)	-	All Zones

Rice hybrids recommended

	Adaptation	Zone for which recommended	Grain yield (t/ha)	Disease & pest reaction
NK 5251	Kharif	UBVZ, NBPZ & LBVZ	5.19	Resistant to blast, GM; moderately resistant to SB
DRRH 2	Kharif	UBVZ, NBPZ & LBVZ	5.00	Resistant to BL; moderately resistant to BS & SB
CRHR 5	Kharif	UBVZ, NBPZ & LBVZ	6.10	Moderately resistant to BL, BLB & SB
PAC 835	Kharif	UBVZ, NBPZ & LBVZ	5.83	Moderately resistant to BL, BLB & SB
US 312	Kharif	UBVZ, NBPZ & LBVZ	5.90	Resistance to blast, GM; moderately resistant to SB
PA 6444 Gold	Kharif	UBVZ, NBPZ & LBVZ	5.80	Resistance to GM and BLB; moderately resistance to

*Refer to page iii for full forms of agro-climatic zones

Seed Selection:

Seeds are put in plain water, stirred well, sunk seeds are selected and the floated ones are rejected.

Seed Treatment:

A. Wet Method:

After selection, the seeds should be soaked directly in one of the following fungicidal suspensions for 24 hours. One litre of fungicide solution is required to treat one kg of seed.

Fungicide	Dose (g/kg seed/lit of water)	Cost (Rs./ha)
Mancozeb	2.5	34.00
Captan	2.5	40.00
Carbendazim	2.5	56.00

Treated seeds should be kept for incubation for 48hrs.

B. Dry method for dry sowing:

As mentioned in case of Direct seeded normal *ahu* rice.

RAISING OF SEEDLINGS:

A. Normal practice:

- Preparation of seed bed:** Land is thoroughly puddle and seed beds of 10m length and 1.25m breadth are prepared with 30 cm gap in between the beds. The length of the bed may vary according to convenience.
- Manures and Fertilizers:** In each seed bed 20-30 kg cowdung/compost, 80g urea, 80g SSP and 40g MOP are to be applied and mixed well with the soil.
- Seed rate:** Well germinated seeds are to be sown @ 650g to 1kg per bed depending on grain size. Requirement of seed for transplanting one hectare of main field is 40 to 45 kg.
- Water Management:** Irrigation water should be applied in furrows to maintain saturated condition in the surface soil of the nursery bed. However, standing water to a depth of 2-3 cm should be maintained at least 2-3 days before uprooting.
- Plant protection in seed bed :**
 - As soon as one or two blast spots are seen, Carbendazim @ 1g/lit or Ediphenphos @ 1 ml/lit of water is to be sprayed.
 - Root knot nematode: Same as in case of normal *ahu*.

iii) Root dip treatment of seedlings: The uprooted seedlings are washed and then the root portion is dipped in 0.02% solution of chlorpyrifos (1 ml/lit of water) along with 1% urea (10g/lit of water) for 3 hours as protective measure against stem borer, gall midge and hoppers.

Alternatively, carbofuran @ 3g/sq.m or phorate or diazinon 1g/sq.m is to be applied in the seed bed 5 to 7 days before uprooting of seedlings or spray Chlorpyrifos 20 EC @ 0.02% in the seed bed 5-7 days before uprooting.

B. Mat nursery for mechanical transplanting: The success of mechanical transplanting (i.e. using self-propelled rice transplanter or manually operated mechanical transplanter) depends upon the quality of seedling. Therefore, all care should be taken to prepare good quality mat nursery. Preparation of mat nursery is described below:

a. Materials required: Polythene sheet, wooden or iron frame, well pulverized & well-sieved soil, FYM, sprouted and treated paddy seed.

b. Preparation seed: Seeds are treated as per recommendation and kept immersed in water for one night in a jute bag. Seed bags are taken out of water and kept in open air for sufficient period till the length of sprouting becomes 1-2 mm. Lumps if any are broken gently to ensure uniform distribution.

c. Dimension of plot to accommodate seedling: A levelled plot of land free from any undulation and grass, etc. should be selected to accommodate seedling bed. Three numbers of beds, with effective length of 16 m and effective width of 1 m, each are needed to prepare seedlings for 1 ha of cropped area. The dimension of the plot should be selected as per the seedling requirement.

d. Frame: Removable frame is used to ensure uniform mat size. The dimension of the mat frame should be equal to the dimension of the tray of the machine. Wooden bar or mild steel bar (2.5 cm × 0.3 cm) may be used as the boundary of the frame.

e. Preparation of soil cow dung mixture: The soil crushed and sieved (particle size less than 4 to 5 mm) is mixed with FYM in the ratio of 2:1. The FYM is also crushed to ensure homogenous mixture. The mixture should be free from stone or any other foreign objects.

f. Preparation of seedling bed: Polythene sheets (130 cm × 1650 cm) are placed on the selected plot of land. The frames are placed over the polythene sheet such that clear width remains 100 cm. Pulverized soil-FYM mixture is used to fill up the frame over the sheet to have a bed dimension 100 cm × 1600 cm × 1.5 cm. Wooden mallet may be used to level as well as to provide mild compaction to the soil-FYM mixture.

g. Sowing of sprouted seeds: Sprouted seeds are uniformly sown in the soil bed at the rate of about 1 kg/sq.m. Beds are sprinkled with water after sowing.

h. Water management: Beds are covered with light jute bag or straw and water should be sprinkled on the bed for 4 days under covered condition so that soil never dries. The covers are removed after four days. The sprinkling of water may need to be continued up to one week. After about one week seedling would attain some height and water may be applied by flooding. The depth of water should be half of the seedling height.

i. Uprooting of seedlings: Seedlings become ready for transplanting when its height becomes 15 cm with 3 to 4 leaves. The seedling mats are then cut into pieces to be used for transplanter.

Field preparation:

Field should be prepared thoroughly by ploughing 4 to 5 times followed by harrowing and laddering. Ploughing should be started at least 21 days ahead of transplanting so that weeds are dried up/decayed.

Land preparation by bullock drawn modified helical blade puddler: Modified helical blade puddler is an improved bullock drawn implement of puddling operation. The weight of the implement is about 26 kg and it covers about 50 cm in one pass. It can be operated by all

types of bullocks available in Assam. One or two passes of puddler operation followed by one pass of mould board plough are sufficient for obtaining good quality puddle soil. The puddler can cover 2 to 2.5 bigha of land per day.

Considerations for efficient use of the modified helical blade puddler: The well ploughed field should be covered with water at the time of puddler operation. To protect the sharpness of the blade the implement should never be operated over stones or hard ground. At the end of its operation the puddler should be properly cleaned and stored dry. Painting is advisable to avoid rusting.

Manures and Fertilizers:

Well rotten FYM or compost @ 10t/ha has to be applied during field preparation. In addition, the following nutrients are to be applied at rates given below in areas with moderate fertility level.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
A. Semidwarf varieties				
N	60	Urea	132	18
P ₂ O ₅	20	SSP	125	17
K ₂ O	40	MOP	66	9
B. Tall varieties:				
N	20	Urea	44	6
P ₂ O ₅	10	SSP	62	8
K ₂ O	10	MOP	16	2

In case of poor soil, the rates of fertilizers may be required to increase to the extent of 60:30:30 kg/ha N, P₂O₅ and K₂O respectively.

Diammonium phosphate (DAP) in combination with rock phosphate or alone at the recommended nutrient level (40:20:20) can be applied.

In monocrop *sali* areas of Barak Valley Zone, sowing of *dhaincha* is recommended as green manuring crop before *sali* rice.

The optimum doses for NPK for HYV of *sali* rice is 60:20:40 and 60:20:20 for low and medium fertility classes of soil respectively in Hills zone.

Time of Application of Fertilizers:

a) For short duration varieties (100-120 days).

- i) Half of urea and whole of super phosphate and muriate of potash should be applied at the time of final puddling. In standing water, urea along with super phosphate and muriate of potash can be applied in pallet form.
- ii) Second dose (half) of urea should be applied at the time of panicle initiation stage.

b) For medium and long duration varieties (120-150 days).

- i) Half of urea and entire quantity of super phosphate and muriate of potash should be applied at the time of final puddling.
- ii) Of the remaining part of urea, half at tillering stage i.e. 20-30 days after transplanting and other half at panicle initiation stage should be applied.
- iii) For long duration varieties under rainfed low land situation with water depth between 30-50 cm, basal incorporation of prilled urea at 30 kg N/ha is recommended.

iv) Split application of potassic fertilizer half as basal and half at maximum tillering stage is recommended for North Bank Plain Zone.

N.B.

- i) Urea should be applied by mixing with moist soil in 1:10 proportion i.e. 1 part of urea with 10 parts of moist soil and incubate for 48 hours.
- ii) In case single super phosphate is not available diammonium phosphate (DAP) may be used with appropriate adjustment with urea.
- iii) In the case of non-availability of single super phosphate in time, application can be delayed up to 30 days of transplanting.
- iv) Standing water, as far as practicable, should be drained out before application of fertilizer.
- v) In case bacterial leaf blight symptoms appear, stop top dressing of urea.

Mixed Fertilizers:

Granular mixed fertilizer of 15:15:15 grade can also be used to meet the NPK requirement of rice crop. 133 kg/ha (19 kg/bigha) of 15:15:15 grade mixed fertilizers will be equivalent to 20:20:20 kg/NPK/ha (3:3:3 kg/bigha) which is to be supplemented by top dressing of 45 kg/ha urea to give 40:20:20 kg/ha (6:3:3 kg/bigha) of NPK. Half the dose will give 20:10:10 kg/ha (3:1.5:1.5 kg/bigha) of NPK.

Recommendation for use of Rock Phosphate (If super phosphate is not used):

1. For raising two successive rice crops i.e. *ahu* followed by *sali* 60 kg P₂O₅/ha (300 kg/ha MRP as rock phosphate) should be applied at least 20 days ahead of *ahu* transplanting
2. For monocrop rice apply 30 kg P₂O₅/ha (150 kg as rock phosphate) at least 20 days ahead of *ahu* transplanting.

Application of FYM as per recommendation helps in rapid release of phosphorus from this source.

Use of Azolla to Supplement Nitrogenous Fertilizer:

Inoculate 500 kg of fresh Azolla/ha in the field after transplanting. Allow it to grow for 2-3 weeks to cover the water surface. After coverage, either incorporate to the soil or allow it for self-decomposition. Since Azolla is affected by insects (which are not rice pests) it is suggested to broadcast granular pesticide preferably carbofuran 3 G @ 3g/sq.m in affected patches of Azolla.

To obtain 500 kg fresh Azolla, add 16 kg inoculum to an area of 400 cm water surface and allow it to grow for 3-4 weeks. Depending on the growth of Azolla, top dressing of nitrogen could be avoided.

Integrated nutrient management : Integrated nutrient management (INM) package of organic manure @ 1 t/ha (on dry weight basis) mixed inocula of *Azospirillum amazonense* A-10 and *Bacillus megaterium* P-5 @ 4 kg/ha (0.4 to 0.5 kg/bigha), rock phosphate @ 10 kg P₂O₅ (56 kg/ha or 7.5 kg/bigha), MOP @ 40 kg K₂O/ha (67 kg Potash/ha or 9 kg/bigha) is recommended for rice in rice-rice, rice-legume-rice and sole rice sequence.

In low land *kharif* rice(*Sali*), incorporation of 45 days old dhaincha can substitute 50% of recommended NPK in Hills Zone.

Method of application of bio-fertilizer: Same as Normal *ahu*.

Age of seedlings and spacing for Normal *sali*

Varieties	Age of seedlings (days)	Spacing (cm)
1. Short and medium duration varieties (upto 120 days duration)	25	20 × 15

2. Medium long duration varieties (beyond 120-130 days)	30-35	20 × 15
3. Long duration varieties (beyond 130 days)-		
*Pankaj	30-40	20 × 20
Mashuri	35-40	25 × 20
Manohar Sali and other tall varieties	35-45	25 × 25
Ranjit		
Bahadur		
Kushal		

* Transplanting of Pankaj seedlings can be delayed upto 60 days from the date of sowing (i.e. transplanting around 20th Aug.) in BVZ.

Age of seedlings and spacing for late *sali* (transplanted):

Varieties	Age of seedlings (days)	Spacing (cm)
1. Short and medium duration varieties (upto 110 days duration)	20-25	10 × 15/ 15×15
2. Medium long duration varieties (beyond 120-130 days)	30-35	20 × 15
3. Long duration varieties (beyond 130 days)-		
*Pankaj	30-40	20 × 20
Mashuri	35-40	25 × 20
Manohar Sali and other tall varieties	35-45	25 × 25
Prafulla	30-80	20×15/
Gitesh	30-60	15×15/20×15

N.B.:For late transplanted crop fertilizers @ 40:20:20 kg/ha of N, P₂O₅ and K₂O respectively should be applied as basal

Number of Seedlings per Hill:

- i) 2-3 seedlings for normal planting (July – August)
- ii) 4-6 seedlings for late planting (September).

Depth of Planting:

4-5 cm depth of planting should be maintained for all varieties.

Interculture:

- i) Two weedings should be given with paddy weeder or hoe at 20 and 40 days after transplanting.
- ii) For weed control: Pretilachlor @ 0.75 kg/ha or Anilofos is to be applied @ 0.4 kg/ha at 3 days after transplanting.

Water Management:

In *sali* rice, application of 5 cm irrigation water 3 days after disappearance of ponding water is recommended in medium and heavy soils.

Plant Protection Measures in the Field:

The most common pests are thrips (in the seed bed) stem borer, hispa (in endemic areas of Sivasagar, Cachar, Karimganj and Kamrup districts), swarming caterpillar and gall midge. Amongst the diseases, blast, sheath blight and bacterial leaf blight are most common. Close surveillance is necessary for timely control of the pests.

A. Insect pests :

- i) Plant protection measures should be adopted against insect pests at their economic threshold levels as given in Table 1.
- ii) Bio-control measures against stem borer and leaf folder: 6-8 releases of *Trichogramma japonicum* and *T. chilonis* @ 50,000/ha/week starting from 30 days after transplanting gives significantly good control (30-60% parasitization) of rice stem borer and leaf folder. The performance of *Trichogramma* is at par with the chemical control in respect of control efficiency as well as economic benefits.

Since *Trichogramma* is an egg parasitoid, its releases should be coincided with the egg laying activity of the pest. Timely releases are crucial. Releases should be made over the entire infested area throughout the egg laying period of the pests, which results in uniform and effective control.

Method of application: Each 'Trichocard' is to be cut in to 6-12 pieces and distributed over the entire field by fixing them to the plants by using a stapler or adhesive. The parasitoids emerging from these disperse themselves.

To control rice pests, erect 50 'T'-perches per ha 2 ft (60 cm) above crop canopy as roosting site for insectivorous birds, which are to be removed before flowering in order to prevent activity of granivorous birds

B. Diseases:

i) Blast:

- a) Grow tolerant varieties, viz. Monohar Sali, Prasad, IR 36, Pankaj.
- b) Treat the seed as explained under seed treatment.
- c) Monitoring of blast is most important to schedule spraying. Observe the top five leaves and if 5% leaf area is damaged take resort spraying. Normally three sprays can control the disease. Spray carbendazim or thiophenate methyl @ 1g/lit of water at tillering stage (30 days after sowing) and subsequently give two sprays of edifenphos @ 1 ml/lit of water at panicle initiation stage and when the tip of panicle just comes out.

ii) Bacterial leaf blight: Grow tolerant varieties, viz. Lakhimi and Mahsuri

iii) Sheath blight:

- i) Two sprays of carbendazim (1g/lit) should be given, first at appearance of symptoms and the other at 10 days after the first spraying. Mancozeb (2.5g/l) or hexaconazole 5EC (2 ml/l) can also be sprayed for controlling this disease.
 - ii) Spraying of two commercial plant-derived Cymbopogon products @ 5 ml/litre and Neem based fungicide @ 3 ml/litre is recommended for management of sheath blight disease of rice. The first spraying should be given as soon as symptom of the disease is observed in the field followed by a second spraying at 10-12 days interval.
- iv) Brown spot disease :** Dry or wet seed treatment with carbendazim @ 1 gm/kg of seed followed by one spraying of mancozeb @ 2.5 g/litre or ediphenphos @ 1 ml/lit or carbendazim @ 1g/lit at initial symptom development stage is recommended for managing brown spot disease.
- v) Bakanae disease:** Soak the seeds for 24 hrs. in a suspension of carbendazim @ 1g/lit of water or thiophenate methyl @ 1g/lit of water.

Rogue out the infected tillers (elongated) from infected hills.

Management of Direct Seeded Late Sali:

- a. Field should be prepared just after recession of flood by ploughing, cross ploughing and laddering to bring it to a puddle condition.
- b. Sprouted seeds should be sown in lines 20 cm apart.
- c. A seed rate of 75 kg/ha should be maintained.
- d. Need based fertilizer application is advocated.
- e. Pre-emergence herbicide butachlor @ 2 kg a.i./ha should be applied 2-3 days after sowing.
- f. Wherever water management is possible, two irrigations at PI and flowering stages are recommended.

CONTINGENCY PACKAGE OF PRACTICES ON RICE FOR CHRONICALLY FLOOD AFFECTED AREAS

A. Raising Community Nurseries: Community nursery may be raised to meet the seedling requirement of flood affected areas. Community nursery may either be raised by the farmers of flood affected areas in non-flood prone or high lands or by other farmers from flood free areas to help distressed farmers.

1. Varietal Selection: Select recommended varieties for late planting having wide flexibility in respect of seedling age and transplanting time under the following situations.

- a) In occasionally flood affected areas if flood recedes early and rice can be transplanted by mid August, use varieties Kushal, IET-6666, Pankaj, Biraj, Anderw Sali, Solpona, Gitesh and Prasadbhog.
- b) In chronically flood affected areas where flood is expected to recede by the last part of August, varieties like Andrew Sali, Biraj, Monohar Sali, Kmj-1-19-1, Luit, Kapilee, Dum Sali, Gitesh and Prafulla should be selected. In absence of these varieties any traditional photo period sensitive coarse grain *sali* variety can be used.
- c) In areas where transplanting is not possible before mid September, extra early varieties such as Luit, Kapilee, Culture-1, Heera and Disang should be selected.

2. Seed bed preparation: Seed bed should be initially ploughed with addition of adequate FYM/compost. The Flat beds may be selected and a gap of 30 cm (1 ft.) may be left at an interval of every 1.25 m (4 ft.) as passage between the beds. Beds within the strip should be well levelled Chemical fertilizers @ 500 g urea, 500 g SSP and 250 g MOP for the area used to transplant one bigha of land should be applied at the time of final puddling. Strip beds to be made after levelling the field.

3. Seed Rate: About 10 kg seeds are needed to transplant 1 bigha of land i.e. ten strips of 10m × 1.25m size @ 1 kg seed/bed.

4. After care: The gap of 30 cm may be converted into channels one week after sowing for draining out excess water during heavy showers and to supply water to the channels to keep the raised beds moist in the event of drought.

5. Transplanting: Transplanting may be done at a convenient time particularly soon after flood recession. It is to be noted that moisture stress is a common feature after flood recession in flood affected areas.

6. Plant population: Closer planting is essential in case of late planting since tiller development is checked due to emergence of non-effective tillers. In case of modern varieties 36 hills/sq.m (20 cm × 15 cm) and in case of tall varieties 25 hills/sq.m (20 cm × 20 cm) are to be maintained.

7. Seedlings/hill: In late planting situations, the only option to have maximum panicles per unit area is from that of the main culm and primary tillers. Therefore, 6-8 seedlings per hill may only yield 18 panicles per hill, as the growth phase of the rice plant almost expires in the seed bed.

8. Fertilizer: In chronically flood affected areas where high silt deposition occurs; there may not be any need for fertilizer application. However in occasionally flood affected areas irrespective of varieties, a basal application of fertilizer should be done. The fertilizer doses are 40:20:20 or 20:20:40 N, P₂O₅, K₂O as the case may be.

B. Double Transplanting: Double transplanting is a method for seedlings multiplication under seedling scarcity condition. Traditional or improved varieties may be transplanted during July with closer spacing of 20 × 10 cm (50 hills/sq.m) and each tiller developed may be separated and planted once again, which fulfills the seedling requirement by 5-7 times.

- 1. Varietal Selection:** Traditional or improved varieties with long duration (150 days or more) having photoperiod sensitivity, should be selected.
- 2. Sowing:** Sowing should be done during early part of June in well prepared seed beds as indicated earlier.
- 3. First transplanting:** Transplanting should be done in early part of July with 25-30 days old seedlings. About 50 hills/sq.m (20 cm × 10 cm) is to be maintained during first planting. Fertilizers @ 20:10:10 kg/ha is to be applied for rapid and healthy tiller development.
- 4. Second transplanting:** Uprooting should be done at 25-30 days after the first planting and each tiller may be separated and re-transplanted with a single tiller/hill. In case of further delay however, 3-4 tiller/hill may be planted with closer spacing. In flood affected areas, there is no need of any fertilizer application in second transplanting if planting is delayed beyond August and fertilizer is added only in first planting.

C. Direct Seeding (Wet Sowing): This is an effective and remunerative method of rice cultivation in flood affected areas after recession of flood. In general very short duration or extra-early (less than 100 days), such as Luit, Kapilee, Culture-1 and any traditional photo period sensitive coarse grain varieties are suitable for wet sowing in the main field.

Seeds @ 75 kg/ha are to be soaked for 24 hours and incubated for 24-48 hours for sprouting. In the meantime the field has to be puddle with minimum tillage and levelled properly by laddering to ensure uniform moisture retention. Sprouted seeds are then broadcast uniformly on to the puddled and levelled field after application of basal dose of fertilizer @ 40:20:20 kg/ha. Nitrogen should be applied in 2 splits, viz., top dressing at 20 days after sowing and at 45-50 days after sowing. Only P and K are to be applied as basal dose.

Direct seeding of sprouted seeds on puddled soil can be done at any convenient time after flood recession upto September 10. The main drawbacks of this system are :

Water management as moisture stress is a common problem after flood recession.

Late sowing may result in spikelet sterility if temperature falls early.

SPECIAL PACKAGE FOR LOW AND DELAYED RAINFALL AREAS OF UPPER BRAHMAPUTRA VALLEY ZONE

I. PRE SOWING OPERATION: Follow ploughing after harvest of rice in light soil either with tractor or M.B. plough for moisture conservation.

II. VARIETAL SELECTION:

A. Direct Seeded *Ahu*:

- Traditional variety for early *ahu*.
- Lachit, Chilarai, Luit, Kapilee, Govind, Rasi and other recommended varieties for regular *ahu*.

B. Direct Seeded Rice (*Kharif*):

Use modern recommended varieties.

C. Transplanted *Sali* Rice:

- As per recommendation for normal situation.

- ii) Varieties that can be grown up to August 15 with 45-50 days old seedlings:
Pankaj, Kushal, Lakhimi
- iii) Varieties that can be grown upto the end of August with 60 days old seedlings:
Andrew Sali, Biraj, Kmj 1-19-1, Hira, Luit, Kapilee and traditional varieties.

III. SEEDLING RAISING:

- i. treat the seeds with 4% MOP (KCl) (600 ml/kg of seed) for 24 hours, dry in shade for 24 hours and sow.
- ii. Prepare dry, well bunded, flat seedbed with adequate FYM (30 kg), 80 g urea, 80 g SSP and 80 g MOP per bed of 10 m × 1.25 m bed.
- iii. Under zero tillage condition, mulch with dry FYM powder upto 2 cm thickness and keep the beds moist.

IV. APPLICATION OF FERTILIZERS:

- 1. If drought situation appears, top dress additional quantities of MOP @ 5 kg/bigha and incorporate it.
- 2. Spray 2% muriate of potash solution on leaves if and when drought appears.
- 3. Top dressing of urea may be delayed upto heading if drought prevails at the stage of top-dressing. Other recommendations will be as per Package of Practices.

PEST MANAGEMENT PRACTICES IN ENDEMIC AREAS WITH SPECIAL REFERENCE TO RICE HISPA

- a) Destruction of initial population.
- b) Destruction of alternate hosts (*Dol*, *Uridol* etc.)
- c) Burning of stubbles after harvesting.
- d) Deep ploughing during Feb- April.
- e) Monitoring at regular intervals.
- f) Avoidance of staggered planting.
- g) Seed bed treatment or root dip treatment.
- h) Clipping of leaf tips before planting
- i) Use recommended insecticides at proper dosage and spray volume. Add 1% urea and 2% potash to spray fluid.
- j) Planting of moderately resistant varieties.
- k) Spray 1% neem seed oil using sticker (23 g/litre).

For more details of pest management practices against rice hispa, refer to page132.

Rice (*Oryza sativa*)
Bao Rice (Deep Water Rice)

Varieties:

Varieties	*Agro-climatic zones
Maguri	N,U,C
Panikekua	N,U
**Padmapani	N
(PJNB) Panindra	N
(PJNB) Padmanath	N
Rayada 16-06	N
Amona	U
Negheri	U,C,L
Kakua	C,L
Salibadal	B
Dholabadal	B

New deepwater rice varieties recommended

Variety	Duration	Yield (t/ha)	Adaptation
LPR 106 (Panchanan)	186 (T), 240 (DS)	3.0	Deepwater (50-100 cm water depth)
KDML 105 [Padumani]	180 (T), 230 (DS)	2.6	Deepwater (50-100 cm water depth)

*Refer to page iii for full forms of agro-climatic zones

** This variety is early maturing (185 days) and escapes ufra disease.

Land Selection:

Areas having higher land submergence- unsuitable for normal rice are selected for growing of *bao* rice. Such areas are broadly classified into two types, viz.,

- 1) Water level upto 1 meter (deep water rice areas)
- 2) Water level beyond 1 meter (very deep water rice areas).

Land preparation:

- i) Stubbles of the previous crop should be burnt thoroughly to minimize nematode and pest infestation.
- ii) Adequate ploughing and cross ploughing should be given.

Seed Selection:

Plain water is used to select the seeds.

Seed Treatment:

A. Wet method:

After selection, the seeds should be soaked directly in any one of the following fungicidal suspensions for 24 hours.

Fungicides	Dose (g/kg seed/lit of water)	Cost of fungicide to treat the seed required for one ha
Mancozeb	2.5	Rs. 57.00
Captan	2.5	Rs. 66.00
Carbendazim	2.5	Rs. 94.00

One litre of fungicidal solution is required to treat one kg of seed.

B. Dry method:

Seeds and any one of the following fungicides are put in a closed container and then agitated for five minutes for thorough mixing.

Fungicides	Dose (g/kg seed)	Cost of fungicide to treat the seed required for one ha
Mancozeb	2.5	Rs. 57.00
Captan	2.5	Rs. 66.00

Sowing Time:

Sowing should be done during March – April.

Method of Sowing:

- i) For *ahu* areas: *ahu* + *bao* mixtures in the ratio of 4:1 recommended (8 kg *ahu* + 2 kg *bao* seed/bigha).
- ii) For *bao* areas: monocrop *bao* is recommended.

Seed Rate:

Seed rate for both the situations (mixture and monoculture) is 75 kg/ha.

Fertilizers:

Application of neem coated urea @ 30 kg N/ha in two equal splits as basal and at maximum tillering stage is recommended.

Preparation of neem coated urea:

Neem coated urea can be prepared by mixing 50 kg urea with 500 ml *neem* oil over a polythene sheet till uniform yellow colour is obtained.

As an alternative to neem coated urea, application of 4% urea solution as foliar spray at maximum tillering stage (150 DAS) @ 30 kg N/ha is recommended..

- i) Wherever feasible “*bindha*” (rake) may be used.
- ii) In the case of mixture, *bao* crop should be pruned along with harvesting of *ahu* crop.
- iii) The field should be kept free from weeds like water hyacinth etc.

Plant Protection:

Field rats:

Apply dry poison baits in bait stations (broken earthen pot, coconut shell, bamboo cylinder etc.). Prebait prepared out of 1kg cereal +20g vegetable oil+ 10g dried fish may be applied @ 10g/live burrow for 3 days. This treatment should be followed by addition of Zinc phosphide @ 25g/kg bait on the 4th day.

Bait formula:

1.	<i>Atta</i> or wheat bran or maize crush	80g
2.	<i>Gur</i>	10 g
3.	Fried fish (or dry fish)	5g
4.	Zinc phosphide	5 g

Nematode:

For control of plant parasitic nematodes in endemic areas, carbofuran @ 3g/sq. m (30 kg/ha) should be applied 5-7 days after sowing.

N.B. Sowing of *asra* (shallow water rice) under puddle condition is recommended for Barak Valley Zone.

Ufra disease control:

1. Burning of the stubbles and straw followed by several ploughings just after harvest.

2. Delay sowing upto mid April.
3. Apply carbofuran granules @ 30 kg/ha at the time of sowing to reduce the active initial inoculum.
4. Use early maturing bao variety like 'Padmapani'

Maize (*Zea mays*)

Varieties:

Varieties	Duration (days)	Special features	Potential yield (q/ha)
Hybrid:			
Ganga 5	110-120	-	48
Hi-starch	130-140	High starch content	45-50
Vivek Maize Hybrid 47	80-90	Cob yellow with white cap, Semi flint and moderately resistant to MLB and C. rust	69
Vivek Maize Hybrid 53	70-80	Yellow , semi flint	69
Bio 9544	90-110	Orange yellow , semi dent	73
Composite:			
NLD	110-120	-	45-50
Dhawal	110-120	-	48
Naviot	90-100	-	48
Diara	85-90	Suitable for flood prone areas	25-30

Note:

- i) Seed from hybrid maize should not be kept as the crop deteriorates due to segregation. The seeds from composite can be used for three to four years without much deterioration in yield.
- ii) All the above varieties are drought tolerant and resistant to most of the diseases to a fair degree.
- iii) Excepting Diara, all other varieties/hybrids are suitable for all the zones except Barak Valley Zone.

Selection of Site and Land Preparation:

Any well drained soil is suitable for maize. Sandy and sandy loam fertile soils are preferable. It requires a deep fine and firm tilth.

Manures and Fertilizers:

A combination of organic and inorganic fertilizer gives better results than inorganic fertilizer alone.

Compost or FYM @ 5t/ha should be applied

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	60	Urea	134	18
P ₂ O ₅	40	SSP	250	33
K ₂ O	40	MOP	67	9

For Hills Zone, a dose of 90:40:40 kg/NPK per hectare is recommended under rainfed condition.

Method of Fertilizer Application:

FYM or compost should be applied during land preparation. The entire quantity of SSP and MOP and half of the total urea is to be applied in furrows (8-10 cm deep) and covered with 4-5 cm of soil. Sowing of seed should be done at least 2 days after fertilizer application.

The remaining half of urea should be top dressed in two equal doses followed by earthing up; in each case. The first ¼ at 35 days after germination or when the plants are at knee high stage and the second ¼ at the tassel initiation stage of the crop i.e. 45-60 days after germination or at the time of elongation of the flag leaf whichever is earlier. The fertilizer

should be applied on both sides of row and weeds should also be removed from the field during this operation. However, before application of the fertilizer a light hoeing is to be given between the lines 2-3 days ahead.

Seed Rate:

Depending upon the seed size about 18-22.5 kg of seeds/ha (2.5-3 kg/bigha) are required.

Seed Treatment:

Seeds should be dressed with carbendazim @ 2g/kg of seed or captan @ 2.5-3 g/kg of seed.

Sowing Time:

*Agro-climatic zone	L	U	C	N	B	H
Sowing time	Feb-Apr	Mar-Apr	Mar-May	Feb-Apr	Mar-May	**Apr-May

* Refer to page iii for full forms of agro-climatic zones

**July and August for late plantation in hills.

Method of Sowing:

Seeds should be dibbled at a depth of 3-4 cm in rows 65-75 cm apart and at a distance of 20-25 cm from seed to seed within the rows. Two seeds per hill are to be sown followed by thinning 10 days after germination retaining one seedling/hill. Depending upon the fertility status of the soil, a wider spacing can be used. Varieties like Diara can be sown at closer spacing because of their short stature and shorter duration.

Weeding and Interculture:

Light hoeing and earthing up should be done as and when necessary. For further and adequate control of weed, atrazine should be applied @ 0.5 – 1.0 kg a.i/ha in 1000 litres of water as pre-emergence spray.

Irrigation and Drainage:

Maize is primarily grown as rainfed crop; but application of irrigation at the time of soil moisture deficit ensures optimum yield. Silking stages and grain filling period are the two critical stage of the maize crop.

Excess rain water can be drained out through surface drainage channel of 25 cm width, 15 cm deep spaced at 6 m distance.

Plant Protection:

When infestation of stem borer is noticed, fenitrothion 50 EC @ 1.0 lit/ha in 200-250 litres of water should be sprayed with power sprayer or in 700-800 litres of water with hand sprayer. Alternatively, endosulfan 1.5 lit/ha should be sprayed with the same volume of water.

In areas where banded sclerotial disease (*Rhizoctonia solani*) is noticed, the plants should be sprayed with carbendazim 0.05% (0.5 g/lit water) @ 700 lit/ha of spray solution at an interval of 12-15 days. Matured cobs can be protected from bird damage by tying cobs with leaves of the same plant.

Harvesting:

Harvesting should be done as soon as the husk covers turn brown and the silks are completely dry. Harvesting immediately after a shower should be avoided. Ears (cobs) should be thoroughly dried in the sun before shelling or storing unshelled.

Finger Millet (*Marua*) (*Eleusine coracana*)

Varieties : INR 1008, TANU-9 promising varieties collected from BHU, Banaras and local varieties.

Plan type: Erect, medium tall and significantly higher yielder than local variety

Duration: 80 – 90 days.

Grain yield: 18-20 q/ha (transplanted)

Other Characters: Average length of fingers/panicle 6-7 cm

Soil Type: Sandy loam

Time of sowing: One month old seedlings are to be transplanted in the 1st week of September.

Seed bed: For seed sowing a raised (10 – 25 cm) seed bed of size 10 × 1.25m with 30 cm gap between the beds should be prepared; 20-30 kg cowdung/bed should be applied and mixed thoroughly with the soil. 150g of seeds should be sown per bed.

Seed rate: 12 kg transplanting one hectare.

Spacing: 25 cm × 15 cm.

Manures and Fertilizers:

Apply FYM/Compost @ 5t/ha or 6q/bigha.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	40	Urea	88	12.00
P ₂ O ₅	20	SSP	125	16.50
K ₂ O	20	MOP	32	4.25

Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed 30 days after transplanting.

Interculture: First weeding at 20-25 days after transplanting and subsequent weeding as and when necessary.

Plant Protection: There is no major pest and disease in the *marua* crop. However, tricyclazole/ediphenphos/carbendazim @ 0.1 percent significantly controls blast disease which occurs sometimes.

Harvesting: Harvesting should be done when 75-80% of the panicles turn yellowish.

Use: It is used as substitute of rice by the farmers. It is also used for making porridge, *sattu*, *akhoi* and preparation of flour and beverage.

PULSES & OILSEEDS

Black gram (*Vigna mungo* L.)

Varieties:

*Varieties	Duration (days)	Grain yield (q/ha)	Reaction to diseases
T 9	80-90	10-12	Tolerant to MYMV and <i>Cercospora</i> leaf spot
T 27	80-90	10-12	-do-
Pant U 19	80-95	10-12	-do-
T 122	80-90	10-12	Susceptible to MYMV and <i>Cercospora</i> leaf spot
Saonia mah (SB 121)	70-80	10-12	-do-
KU 301	80-90	13-15	Resistant to <i>Cercospora</i> leaf spot and YMV
USJD113	80-90	13-15	-do-

**Suitable for all zones, except Saonia mah, which is recommended for Central Brahmaputra Valley Zone only.*

New black gram varieties recommended for delayed sowing (up to 30 September)

	Duration (days)	Yield (q/ha)	Disease reaction
Beki (SB 27-3)	80-85	12-13	Resistant to CLS, YMV and WB
Kolong (SB 25-19)	80-85	12-13	Resistant to CLS, YMV and WB.

New black gram varieties recommended for normal sowing

	Duration (days)	Yield (q/ha)	Disease reaction	Protein content (%)	Season and area of adaptation
Sonkush (SB 23-5)	80-90	9.17	Resistant to CLS, YMV and WB	25.10	Kharif season under delayed sowing
Manas (SB 32-13)	80-90	10.00	Resistant to CLS, YMV and WB		
SBC 40	75-85	11.89	Resistant to CLS & YMV, moderately resistant to WB	25.20	
SBC 47	75-80	14-16	Resistant to CLS and YMV	25.50	Suitable for all zones of Assam except BVZ

Sowing Time:

Mid August to mid September

Saonia mah: Mid July to mid August.

Soil Type:

Black gram can be grown on a wide range of soils, but sandy loam soil is preferable.

Land Preparation:

The land is to be ploughed 2-3 times followed by leveling.

The stubbles are to be removed. Surface drains should be provided to facilitate quick removal of excess water from the field.

Liming:

Requisite amount of lime is to be applied after soil test in order to bring the soil pH around 6.0.

Manures and Fertilizers:

Compost or FYM @ 1t/ha or 1.3q/bigha should be applied.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
Without Rhizobium culture*				
N	15	Urea	32	4
P ₂ O ₅	35	SSP	220	30
K ₂ O	15	MOP	25	3.5
With Rhizobium culture				
N	10	Urea	22	3
P ₂ O ₅	35	SSP	220	30
K ₂ O	15	MOP	25	3.5

*For Upper Brahmaputra Valley, Barak Valley and North Bank Plains Zones, NPK fertilizer dose of 15:35:10 kg/ha respectively have been recommended. For Central Brahmaputra Valley Zone, 15kg/ha of K₂O is also recommended

The quantity of N is to be reduced proportionately to the quantity of N added in the form of FYM (each tonne of FYM contributes about 5 kg N). Diammonium phosphate (DAP) 75 kg/ha or 10 kg/bigha should be applied in lieu of urea and SSP in non inoculated crops.

Seed Inoculation:

For seed inoculation with *Rhizobium* cultures of either Shillongani, Ahatguri, Kamalabari or any other suitable strains should be used. Seeds are inoculated with 50 g/kg of seeds. However, detailed instructions are available in each packet of the culture. Also inoculate seeds with PSB @ 50 g/kg seed alongwith rhizobium.

Seed Rate:

Varieties	Line sowing		Broadcast	
	kg/ha	kg/bigha	kg/ha	kg/bigha
T 122	20.0	2.7-3.0	25.0	3.0-3.3
T 27	20.0	2.7-3.0	25.0	3.0-3.3
Saonia mah	20.0	2.7-3.0	25.0	3.0-3.3
T 9	25.0	3.0-3.3	27.0	3.6
Pant U 19	25.0	3.0-3.3	27.0	3.6

Spacing:

Row to row : 30 cm

Plant to plant : 10 cm

Interculture:

One weeding at 20-25 days after sowing is to be done. Or Apply Pendimethalin @ 1.0 kg/ha as pre-emergence.

Plant Protection:

A. Diseases:

Leaf spot (*Cercospora* spp.): As soon as disease appears spray copper oxychloride @ 0.3% (1.8 – 2.0 kg/ha in 600-700 lit of water) at an interval of 7-10 days. Alternatively carbendazim @ 0.05% (300-350 g in 600-700 lit of water/ha) at an interval of 12-15 days should be sprayed.

Web Blight (*Rhizoctonia solani*): On appearance of this disease carbendazim @ 0.05% (300-350 g in 600-700 lit of water/ha) should be sprayed. This will control leaf spot and powdery mildew disease also.

Rhizoctonia solani induced damping off, root rot and seedling blight can be effectively managed by seed treatment with slurry method using commercial formulations of *Trichoderma* spp. @ 5 g/kg of seeds.

B. Insect Pests:

i) Against aphids, jassids, flea beetle, pod borers, pod bugs and leaf folder, spray malathion 50 EC @ 1.0 – 1.5 lit/ha in 500-700 lit of water.

ii) The spread of yellow mosaic virus (YVM) can be checked by controlling white fly (*Bemisia tabacci*) as follows:

Two to three sprayings of dimethoate or endosulfan @ 2 ml/lit of water are to be given; first spray 10 days after germination and subsequent sprays at 15 days interval.

iii) For control of nematode *Meloidogyne incognita*, seed soaking with carbosulfan 25 EC @ 0.01% for 6 hrs should be done.

Harvesting:

Harvesting is to be started when 75% of the pods mature indicating full darkish pod and brittle on slight pressure.

Protection against Storage Pests:

Properly dried black gram seeds should be mixed thoroughly with black pepper seed powder @ 3g/kg of seed, against bruchid infestation during storage. Treated seeds should be kept in polybags with outer covering of gunny bags.

Green gram (*Vigna radiate* L.)

Varieties:

*Varieties	Duration (days)	Grain yield (q/ha)	Reaction to diseases
T 44	60-70	10-12	Susceptible to MYMV and <i>Cercospora</i> leaf spot
Kopergaon	60-70	8-9	-do-
K 851	60-70	10-14	Susceptible to MYMV and web blight and tolerant to <i>Cercospora</i> leaf spot
ML 56	65-70	10-14	-do-
ML 131	65-70	10-14	Susceptible to MYMV and <i>Cercospora</i> leaf spot
SG 1 (Pratap)	60-70	12-14	Resistant to <i>Cercospora</i> leaf spot & tolerant to MYMV
SG 21-5	60-70	12-14	Resistant to cercospora leaf spot & MYMV

New green gram varieties recommended for normal sowing

	Duration (days)	Yield (q/ha)	Disease reaction	Protein content (%)	Cooking quality	Adaptation
SGC 16	65-68	12.52	Resistant to CLS, YMV & moderately resistant to WB	24.50	Very good	
SGC 20	65-68	12-13	Resistant to CLS & YMV	24.40	Very good	Suitable for all zones of Assam except BVZ
Sonai (SG 21-5)	-	9.93	Resistant to CLS, YMV and MR to WB	24.70		Kharif season

Sowing Time:

Sowing time is mid August to mid September. August is the suitable month for sowing in Central Brahmaputra Valley and Hills Zones. Sowing can be delayed up to 1st week of September without seed inoculation with PSB and up to 2nd week of September with seed inoculation with PSB @ 50g/kg of green gram seed in Central Brahmaputra Valley Zone.

Soil Type:

Well drained sandy loam soil is preferable.

Land Preparation:

The land is to be ploughed 2-3 times followed by leveling. Stubbles should be removed completely. Surface drains should be provided to facilitate quick removal of excess water from the field.

Liming:

Requisite amount of lime is to be applied after soil test to bring soil pH around 6.0.

Manures and Fertilizers:

Compost or FYM @ 1 t/ha or 1.3 q/bigha should be applied.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
Without Rhizobium culture*				
N	15	Urea	32	4
P ₂ O ₅	35	SSP	220	30
K ₂ O	15	MOP	25	3.5
With Rhizobium culture				
N	10	Urea	22	3
P ₂ O ₅	35	SSP	220	30
K ₂ O	15	MOP	25	3.5

* For North Bank Plain zone, Upper Brahmaputra Valley Zone and Lower Brahmaputra Valley Zone, a NPK fertilizer dose of 15:35:10 kg/ha respectively has been recommended. For Central Brahmaputra Valley Zone, 15kg/ha of K₂O is also recommended

The quantity of N is to be reduced proportionately to the quantity of N added in the form of FYM (each tonne of FYM contributes about 5 kg N).

Diammonium phosphate (DAP) @ 75 kg/ha or 10 kg/bigha may be applied in lieu of urea and SSP in non inoculated crop.

Seed inoculation with Rhizobium and PSB culture :

Seed inoculation: For seed inoculation with rhizobium culture, either Majuli 10 or any other suitable strains may be used. Seeds should be inoculated with 150 g/3-4 kg seeds. Detail instructions are available in each packet of culture. Also inoculate seeds with PSB @ 50 g/kg seeds alongwith Rhizobium.

Seed Rate:

Varieties	Line sowing		Broadcast	
	kg/ha	kg/bigha	kg/ha	kg/bigha
Kopergaon	20-22	2.7-3.0	25.0	3.3
Other varieties	15-18	2.0-2.5	20-22	2.7-3.0

Spacing:

Row to row : 30 cm
Plant to plant : 10 cm.

Interculture:

One weeding at 20-25 days after sowing is to be done. Or Apply Pendimethalin @ 1.0 kg/ha as pre-emergence.

Drainage: Excess rain water can be drained out through surface drainage channel of 25 cm wide, 15 cm deep spaced at 6 m distance.

Plant Protection:

A. Diseases :

- Leaf spot** (*Cercospora* spp) : As soon as disease appears spray copper oxychloride @ 0.3% (1.8-2.0 kg in 600-700 lit of water/ha) at an interval of 7-10 days. Alternatively carbendazim @ 0.05% (300-350g in 600-700 lit of water/ha) at an interval of 12-15 days should be sprayed.
- Blight** (*Rhizoctonia solani*): On appearance of this disease carbendazim @ 0.05% should be sprayed as stated above. It will also control leaf spot and powdery mildew diseases.

Rhizoctonia solani induced damping off, root rot and seedling blight can be effectively managed by seed treatment with slurry method using commercial formulations of *Trichoderma* spp. @ 5 g/kg of seed.

B. Insect Pests:

- i) Against aphids, jassids, flea beetle, pod borers, pod bugs and leaf folder, spray malathion 50 EC @ 1.0-1.5 lit/ha in 500-700 lit of water/ha should be applied. In addition, endosulfan 35EC @ 2 ml/lit of water are recommended for control of the above pests.
- ii) The attack by yellow mosaic virus (YMV) can be checked by controlling white fly (*Bemisia tabaci*) as follows:
- iii) Two to three spraying of dimethoate or endosulfan @ 2 ml/lit of water are to be given, first spray 10 days after germination and subsequent sprays at 15 days interval.
- iv) For control of nematode *Meloidogyne incognita*, seed soaking with carbosulfan 25 EC @ 0.01% for 6 hrs.
- v) Treat the seeds with Neem Seed Kernel Powder (NSKP) @ 5 g/kg and *T. viride* @ 5 g/kg separately for the management of root-knot nematode, *Meloidogyne incognita* in mung;

Harvesting:

Harvesting is to be done when 75% of the pods turn darkish in colour and brittle on slight pressure.

Protection against Storage Pests:

Properly dried green gram seeds should be mixed thoroughly with black pepper seed powder @ 3g/kg of seed, against bruchid infestation during storage. Treated seeds should be kept in polybags with outer covering of gunny bags.

Cowpea (*Vigna unguiculata*)

Varieties:

RC 19: Recommended for all zones. Plant type erect and height is 80-120 cm. It bears 6-12 pods per plant and pods are 10-12 cm long. Average 100 seed weight is 10 g. Average yield 10-14 q/ha.

TVX 644-02E: Recommended for all zones. Plant type erect and height is 100-120 cm. Pods are long containing 10-14 seeds per pod. Seeds are creamy in colour and bold. Average 100 seed weight is 15g. Average yield 12-15 q/ha.

Sowing Time: August

Soil Type:

It can be grown on all types of soils. But well drained sandy loam soil is most suitable.

Land Preparation:

The land is to be ploughed 2-3 times followed by leveling.

Seed Rate:

The seed requirement is 30-35 kg/ha or 4.0-4.5 kg/bigha.

Spacing:

A spacing of 30 cm between rows and 10-15 cm between plants is to be given.

Manures and Fertilizers:

Compost or FYM @ 4-5 t/ha or 6 q/bigha is to be applied.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	15	Urea	32	4
P ₂ O ₅	35	SSP	220	30
K ₂ O	0	MOP	-	-

Interculture:

One weeding is to be done at 20-25 days after sowing.

Plant Protection:

A. Disease: No serious disease has so far been observed.

B. Insect Pests: Malathion 50 EC @ 1-1.5 litres mixed in 500-700 litres of water is to be sprayed in one hectare against insect pests like- aphids, jassids, flea beetles, pod borers, pod bugs and leaf roller

Harvesting:

Cowpea for grain purpose is harvested by picking the mature pods. Threshing can be done by beating the dried pods.

Uses:

Cowpea grains contain 24% protein and a rich source of carbohydrate, calcium, phosphorus and iron. The grain can be used as a pulse, either as whole or as *dal* and also as flour after husking or with husk. The pods can be used as vegetables when tender.

Pigeon pea (*Arhar*) (*Cajanus cajan* L.)

Variety:

T-21 is recommended for all zones. It is a semi spreading, medium tall (170-185 cm in height) variety. Crop duration is 170-200 days.

Time of Sowing: June – July.

Soil Type:

Well drained sandy loams to loamy soil are most suitable.

Land Preparation:

The land is to be ploughed 3-5 times followed by harrowing and removing weeds.

Seed Rate: 12-15 kg/ha or 1.6-2.0 kg/bigha.

Spacing: 75 cm between rows and 30 cm between plants.

Manures and Fertilizers:

Compost or FYM @ 4.5 t/ha or 6 q/bigha is to be applied.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
Without Rhizobium culture*				
N	15	Urea	32	4
P ₂ O ₅	40	SSP	250	35
K ₂ O	0	MOP	-	-
With Rhizobium culture				
N	10	Urea	22	3
P ₂ O ₅	40	SSP	250	35
K ₂ O	0	MOP	-	-

Interculture:

One weeding is to be done at 20-25 days after sowing.

Plant Protection:

A. Diseases:

Wilt: The pathogen inhabits in the soil and perpetuates. Rogueing and burning of diseased plants partly help in controlling the disease.

B. Insect Pests:

Against, pod borer, apion borer, aphids, jassids, flea beetle and leaf roller; spray malathion 50 EC @ 1.0-1.5lit or fenitrothion @ 1.0-1.5lit mixed in 500-700 litres of water/ha.

To control pod and apion borers, any one of the above insecticides should be sprayed in 3 occasions from the time of flower initiation at an interval of 15 days. For control of flea beetle, leaf roller, pod bugs and jassids, insecticides should be applied if felt necessary.

Average Yield: 12-15 q/ha.

Intercropping of *Arhar* with Greengram, Blackgram and Sesamum:

Intercropping of *arhar* with green gram/black gram and sesame for the hill slope (20-25%) either in single/double row or broadcasting in between rows of *arhar* is recommended. The crops are to be sown in lines across the slope. A basal dose of 15 kg N and 40 kg P₂O₅/ha are to be applied. To get optimum yield from both main and intercrop, the crops should be sown within last week of July to first week of August.

Soybean (*Glycine max*)

Varieties:

Varieties	*Agro-climatic zones	**Duration (days)	**Grain yield (q/ha)
Bragg	C,L,B	120	25
JS2	N,U,L,H	90-95	25
PK 71-21 (Alankar)	U,H	115-120	25
Ankur	U,L,H	120-125	25
UPSM 19 (Silajit)	U,H	120-125	26
#DS 73-16 (Pusa soybean)	U,C,H	100-106	25
#PK 327 +	N,U,B,H	105-110	25
#PK 271 +	N,U,H	110-115	26
#PK 262 +	U,B,H	110-115	27
PK 308	U	115-120	25
Moti	N,U,C,H	95-100	27
Kalitur (Fodder)	All zones	120-125	20

* Refer to pageiii for full forms of agro-climatic zones

** Duration and grain yield are based on Jorhat centre.

These varieties can be sown even during first fortnight of September for seeds.

Sowing Time:

May-June: North Bank Plains Zone, Upper Brahmaputra Valley Zone & Central Brahmaputra Valley Zone

Mid May-Mid June: Hills Zone

June- April: Lower Brahmaputra Valley Zone & Barak Valley Zone

Soil:

Soybean can be grown on wide range of soils but it grows best on fertile well drained loamy soils. Water logging is injurious to the crop. In acidic soils where pH is below 6.0, lime (200 mesh powder form) should be added @ 2t/ha, at least 7 days before sowing. Liming is necessary once in three years.

Land Preparation:

Soybean should be grown on well pulverized bed. Land should be prepared by giving deep ploughing followed by laddering. There should be provision of surface drains with gentle slope for good drainage.

Fertilizers:

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	20	Urea	45	6
P ₂ O ₅	60	SSP	375	50
K ₂ O	40	MOP	70	10

Potash is required for healthy development of seeds. Foliar application of MOP is recommended in soils with low potash content.

Fertilizer should be placed in furrows at a depth of 5 to 7 cm below the seeds and should be covered with a layer of 3-4 cm soil and make it level with the field. In case placement is not possible, the fertilizers should be evenly broadcast and incorporated in the soil.

Foliar-Spray of MOP:

MOP should be sprayed at the flower initiation stage in between 30 and 35 days after sowing with hand sprayer for proper grain filling in pods.

Preparation of MOP solution for spraying with hand sprayer :

Quantity of MOP (kg)	Quantity of water (l/ha)	Strength of MOP solution (%)	No. of spray	Type of sprayer
12.00	400	3	1	Hand Sprayer

Seed Inoculation:

The seed should be moistened with clean water with care so as to avoid excessive wetting. Rhizobium culture should be mixed with seeds @ 15 g/kg so that a thin coat of inoculum is deposited on each seed. The inoculated seeds should not be exposed to the sun. One packet (150g approx.) of AAU culture which is available in the Production Unit of AAU is sufficient to inoculate seeds required for one bigha of land.

Seed Rate and Time of Sowing:

For branched type soybean varieties (Bragg, Alnkar, Ankur, Silajit, PK 271, and PK 262) the seed rate is 60 kg/ha or 8.5/bigha when sown early, normal and late to obtain a plant population of about 0.2 million/ha. For less branching type soybean varieties (JS 2, Moti, Kalitur and Pusa soybean) the seed rate is 75 kg/ha or 10.5 kg/bigha for the same period of sowing to obtain a plant population of 0.4 million/ha. For late sown crop, seed rate is 80 kg/ha or 11.5 kg/bigha for a population of 0.6 million/ha. Germination is affected if it rains within 72 hours of sowing.

Seed are sown in lines 45 cm apart at a distance of 5 to 10 cm between seeds. Depth of seedling should not exceed 4 cm. The depth can further be reduced to 2 to 3 cm if moisture content in soil is high. The rows should be covered with a thin layer of paddy straw for better germination.

Interculture Operations:

Two manual weedings at 15 and 36 days after sowing should be done.

Plant Protection:

A. Diseases:

Soybean seeds should be treated with Thiram @ 3 g/kg of seed. Soybean is susceptible to yellow mosaic virus. In order to stop spread of the vector of yellow mosaic disease in field, spray dimethoate 30 EC @ 1 to 1.5 l in 800 to 1000 l water/ha.

Rhizoctonia solani induced dry root rot in soybean can be effectively managed by seed treatment with *Trichoderma* spp by slurry method @ 5 g/kg of seed.

B. Insect Pests:

Spraying of dichlorvos 100 EC @ 0.5 ml/l or chlorpyrifos 20 EC @ 1 ml/lit should be done against hairy caterpillar, semilooper, leaf roller and flea beetle.

Harvesting:

At maturity all the leaves turn yellow and fall off and the stalks stand only with pods. Harvesting can be done at this stage by cutting the plants with sickle or by breaking at the base.

Seed Storage:

The grains should be dried before storage to ensure that the moisture content of seeds does not exceed 10 per cent. Seeds can be stored in dry bins or polythene bags. (250 gauge

thickness) in airtight condition. Bins should be kept on wooden racks so that it does not come in direct contact with the ground. Treatment of seeds with Thiram (@ 3g/kg of seed) is absolutely necessary when stored for seed purposes.

Drenching:

Drenching of soybean seeds should be done before any kind of soybean preparation. For this purpose 0.5% sodium carbonate solution be prepared and mixed with seed @ 2 litre/ kg of seed and boiled for 20 minutes. Then the boiled seeds should be washed with plain water 2-3 times to remove the trypsin inhibitor.

Use of Soybean:

Soybean contains 40% protein and 20% high quality oils. Besides this it is also a source of vitamin B complex, thiamine and riboflavin. Several food products can be prepared from soybean.

Soybean Milk:

1. Seeds should be soaked in water for 12 hours.
2. Seed coats should be removed by rubbing the soaked seeds between palms.
3. A paste should be made by grinding the peeled seeds.
4. The paste should be boiled in water which should be about three times its weight and the milk should not be over boiled. Otherwise its nutritive value may be lost. A few drops of ginger juice and a few bay leaves should be added for removing the beany odour.

Soybean milk is useful against intestinal disorder. It prevents summer diarrhoea. It is easily digestible and can be used as diet for old debilitated and convalescents. Soybean can also be used for preparation of *Chapati, Kachuri, Malpowa, Bhujia, Ladoo, Chutni, Bor, Cake* etc.

Soybean Curd:

To prepare curd, soy milk should be poured in an appropriate container while it is moderately hot.

Green Beans:

Green soybeans are widely used as much in the same way as the pea is used. When the bean reaches its full size, but yet green and tender, it is collected from the plant. It is usually boiled and taken as green vegetable. Green beans are also used in salads. In order to secure the best flavour, the beans should be cooked when they still remain affixed in the pods. In such cases, they are soaked in boiling water for a few minutes to make it easy to shell.

Poultry Feed:

Soybean and maize mixture is an excellent poultry feed.

Sesamum
(*Sesamum indicum*)

Varieties	Duration when sown in the 1 st fortnight of August (days)	Yield (q/ha)	Seed colour
SP 1181(Madhavi)	70-75	8-9	Brown
Gouri	75-80	7-8	-do-
Vinayak	75-80	8-9	-do-
ST 1683	90-95	5-9	Black
Punjab Til No. 1	75-85	8-9	White

Newly recommended Sesame /Til variety

	Duration (days)	Seed yield (q/ha)	Adaptation	Recommended for	Seed colour	Disease & pest reaction	Oil content	Seed coat : seed ratio
AST-1 (AAUDT 9304-14-4, IC 551415)	80-90	8-10	Kharif; Hills Zone of Assam	Hills Zone	Black	MR to root rot, phyllody, bacterial blight & mite.	46%	0.3

All the varieties are susceptible to *Phytophthora* blight and bacterial wilt to varying degrees. However, Punjab Til No. 1 is less susceptible to both the diseases.

A second crop, e.g. mustard is possible after sesamum if quick maturing varieties, viz., SP 1181 (Madhavi), Gouri and Vinayak are grown.

Soil:

Well drained sandy loam soils are preferable.

Land preparation:

Land should be prepared to a fine tilth by 3-4 ploughings followed by laddering.

Time of Sowing:

July to first fortnight of August for *Phytophthora* blight endemic areas

Spacing:

30 cm between rows

15 cm between plants

Seed Rate: 4 kg/ha for both broadcasting and line sowing.

Manures and Fertilizers:

Compost or FYM should be applied @ 10 t/ha. Fertilizer requirement are as follows:

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	30	Urea	65	9
P ₂ O ₅	20	SSP	125	17
K ₂ O	20	MOP	33	5

Apply the whole quantity of fertilizer at the time of sowing.

Drainage :

Provide surface drains of 15 cm depth and 25 cm width spaced at 6 m distance connected to a collector drain by the side of the field.

Weeding and Interculture:

One weeding should be done at 20 days after sowing by *khurpi* or hoe. The crop should be thinned out simultaneously to maintain the required spacing within the rows.

Plant Protection:

Seeds should be treated with carbendazim or captan @ 2g of each fungicide/kg of seed against stem rot as well as phytophthora blight. Alternatively seeds should be treated with a commercial formulation of *Trichoderma* spp. @ 5 g/kg of seeds against stem rot and phytophthora blight.

In phytophthora blight endemic areas, sesamum is to be rotated with cereals at every two years. In the case of phyllody disease, the infected plants should be rouged out.

In case of attack of shoot webber (*Conogethes catalaunalis*) spray dichlorvos 100 EC @ 0.5 ml/lit or monocrotophos 40 EC @ 1 ml/lit.

Harvesting:

The crop should be harvested when the leaves and stems turn yellow and defoliation starts, or one or two capsules at the bottom start cracking from the tip.

Yield: -6-8 q/ha.

Summer Sesamum
(*Sesamum indicum*)

(For Hills Zone only)

Varieties:

Varieties	Duration (days)	Yield (q/ha)	Grain colour	Percent oil content
TC 25	92	7.08	White	49.0
Vinayak	96	5.61	Brown	42.0

Sowing Time:

First week of March to first week of April
Other practices are same as in *kharif* sesamum.

Groundnut (*Arachis hypogaea*)

Varieties:

Varieties	Plant height (cm)	No. of branches/plant	No. of nuts/kg	Shelling recovery %	Oil content %	Protein content %	Yield q/ha (nuts)
TG-1A	61.5	10.5	727	75.75	48.0	29.5	38.9
JL-24	64.0	9.0	752	75.00	46.9	29.0	36.9

Soil Type: Well drained sandy loam soil is suitable.

Land Preparation:

Land should be prepared to a fine tilth by 3-4 ploughings followed by laddering. Deep ploughing should be avoided. Ploughing depth should not exceed 15 cm.

Time of sowing: June – July.

Seed Rate: 65-70 kg kernel/ha.

Seed Treatment:

Treat the selected kernels with 3g of Thiram or Captan/kg of kernel.

Method of Sowing:

Seed should be sown in line at 5 cm depth.

Spacing: Row to Row : 35 cm
Plant to Plant : 15 cm

Manures and Fertilizers:

Compost or FYM @ 10 t/ha should be applied

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	20	Urea	44	6
P ₂ O ₅	40	SSP	250	33
K ₂ O	30	MOP	50	7

Weeding and Earthing up:

One weeding should be given at 30-35 days (i.e. flower initiation stage) after sowing the seeds followed by earthing up to promote easy penetration of pegs into soil.

Plant Protection:

- 1) Spray carbendazim @ 0.5 g/lit of water to control leaf spot (*Tikka*) disease. The first spray should be given as soon as the initial symptoms are detected followed by a second spray after 20 days of the first spray.
- 2) To control the major insect pests (i.e. aphid, leaf miner etc.) spray phosphamidon 100 EC @ 0.5 ml/ litre of water.

Harvesting:

The stage of harvesting is attained when the vine begins to turn yellow and leaves start shedding. Harvesting is done by digging out the pods.

Yield: 15 – 20 q/ha

Rice bean (*Vigna umbellata*)

(For Central Brahmaputra Valley Zone only)

Varieties:

Variety	Sowing time	Duration (days)	Grain yield (q/ha)	Disease reaction
RBL 4	Mid August to mid September	88-93	19-21	Resistant to YMV and Cercospora leaf spot
RBL 5	-do-	90-95	19-21	-do-
Beziamah	-do-	90-95	20-22	-do-

Sowing Time:

Mid August to mid September

Soil Type:

Preferably sandy loam soil

Land Preparation:

Fine tilth is not necessary for cultivation of rice bean. The land is to be ploughed 2-3 times followed by leveling. The weeds should be removed completely. Surface drains should be provided to facilitate quick removal of excess water from the field.

Liming :

Requisite amount of lime is to be applied after soil test in order to bring soil pH around 6.0.

Manures and Fertilizers:

Compost or FYM should be applied @ 4-5 t/ha.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	20	Urea	44	6
P ₂ O ₅	40	SSP	250	33
K ₂ O	0	MOP	0	0

Seed Rate:

Variety	kg/ha	Kg/bigha
RBL 4 and RBL 5	22-27	3.0-3.5
Beziamah	15-20	2.0-2.7

Spacing:

Row to row : 30 cm
Plant to Plant : 10 cm

Interculture:

One weeding at 20-25 days after sowing

Plant Protection:

Insect pests:

Jassids/Flea beetle/Hairy caterpillar: Spraying of malathion 50EC @ 1.0-1.5 lit/ha in 500-700 lit of water or dusting with malathion 5% dust @ 20-25 kg/ha controls these pests.

Harvesting:

Harvesting is to be started when 75% of the pods mature indicating full darkish pod, brittle on slight pressure.

SUGAR CROP

Sugarcane (*Saccharum* sp)

Varieties:

Varieties	Maturity	Harvesting time (%)	Cane yield (t/ha)	Gur recovery (%)	Sucrose content (%)	Reaction to Insect Pests	Special Feature
Doria	Early	Dec-Jan	70-80	10-12	18-19	Moderately susceptible to top and plassey borer	Profuse tiller, good ratooner and non flowering
Kalang	-do-	-do-	-do-	-do-	-do-	-do-	-do-
Barak	-do-	-do-	-do-	-do-	-do-	-do-	Profuse tiller, good ratooner, tolerant to lodging and non flowering
Co 997	Early as well as mid	Dec-Jan	70-80	10-12	18-20	-do-	Profuse tiller, good ratooner & drought resistant
Dhansiri	-do-	-do-	-do-	10-12	18-20	-do-	Profuse tiller, quick growing & tolerant to water logging
Luhit	-do-	Dec-March	-do-	10-12	18-20	-do-	Profuse tiller and good ratooner
Co 740	Mid early as well as late	Jan-Mar	80-100	10-11	18-19	-do-	Tolerant to periodical submergence
Co 1148	Early to mid late	Dec-Feb	60-70	-	18-20	-	Suitable for chewing purpose
CoBln 94063 (Nambor)	Early	Dec-Jan	70-90	1-12	18-19	Moderately resistant to borers and red rot	Profuse tiller, good ratooner, tolerant to water logging of 10-30cm depth from June to Sept.

							and flood of 5-6ft depth during July/Aug.
CoBln 9006 (Kapilpar)	Mid late	Feb-Mar	70-85	10-12	20-21	-do-	-do-
CoBln 02173 (Doiyang)	-do-	-do-	70-80	11-13	20-21	-do-	Profuse tiller, good ratooner,

Selection of Setts:

Top tender portion of the cane (sett) is especially suitable for planting. Late shoots and late planted canes also provide good planting materials. Each sett should be 3 or 4 budded. Setts should be free from red rot and borer infestation. It is necessary that planting materials are collected from fields/areas free from red rot.

For obtaining good quality planting materials in large quantities, it is advisable raise a separate seed crop with extra care. Late planted crop i.e. planted in June-July provides good quality setts for planting in next spring. Besides the usual fertilizer dose of 135:70:60 kg/ha N: P₂O₅: K₂O an extra dose of 65 kg N (145 kg urea) should be top dressed to the crop in October. Adequate plant protection measures should also be taken to keep the crop free from pests/diseases.

For planting late in season (April-May) use of pre-germinated materials is beneficial. For this purpose top portions of cane are to be germinated first in nursery by keeping them horizontally under light earth cover for a month and made to shorter cuttings with 3 buds in each, for planting. The leaves of the shoots be clipped off and planting should be done in rainy or cloudy weather.

Treatment of Setts:

Setts are to be treated before planting by dipping them in 0.2% solution of captan, mancozeb or 0.1% carbendazim. In the process of treatment of setts when the solution gets reduced by about 50% it should be brought to the original volume by adding solution of equal strength.

Selection of site and Land preparation:

Up lands and areas free from water stagnation should be selected. Trenches/furrows (25cm width and 20cm depth) should be made in well prepared soil at distance of 75-90 cm. Bottom of the trenches should be loosened by light hoeing before application of manures and fertilizers.

Manures and Fertilizers:

Compost or FYM has to be applied @ 10 t/ha in trenches/furrows before planting cane. Besides, the following fertilizers are to be applied.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	135	Urea	300	40
P ₂ O ₅	70	SSP or MRP	440	60
K ₂ O	60	MOP	350	50
Alternatively the following fertilizers may be used :				
N	135	Urea	100	34

P ₂ O ₅	70	DAP	150	20
K ₂ O	60	MOP	100	15

Granulated mixed fertilizer may also be used instead of the above fertilizers. The per hectare requirement of mixed fertilizer of 15:15:15 grade is 450 kg (64 kg/bigha) which should be applied in trenches/furrows at planting followed by top dressing of urea @ 150 kg/ha (21 kg/bigha).

Time and Method of Application of Fertilizers:

Entire quantity of phosphatic and half of potassic fertilizers are to be applied in furrows/trenches and mixed well with the soil before planting the setts. Nitrogenous fertilizers are to be applied in two splits, 1/3rd at planting and 2/3rd at first earthing up. The remaining half of the potassic fertilizer may be top dressed along with urea. Application of nitrogenous fertilizer should be completed within 90-100 days of planting.

Method of Planting:

Three or four budded setts should be planted by end to end method in trenches/furrows. Setts should be covered lightly with about 5 cm of soil.

Seed Rate:

About 45,000 to 52,000 setts (6.5 to 7.5 t) are required for planting one hectare. The requirement per bigha would be about 6,000 to 7,200 setts weighing about 1 tonne.

Time of Planting:

March is suitable for planting sugarcane (spring planting). Early planting (late January-February) is advisable where irrigation facilities are available. When autumn planting (October planting) is done it is necessary to put a companion crop of mustard (single row) in between cane rows.

Weed Control:

One weeding should be given within 30-35 days of planting followed by another within 60-90 days of spring planted crop. In October planted crops weeding should be done as and when necessary.

Pre-emergence application of 2, 4 -D (Na-salt) @ 0.8-1 kg a.i/ha followed by one weeding is economical as well as satisfactory. Alternatively Diuron @ 0.8-1 kg a.i/ha or atrazine @ 2 kg a.i/ha may be used as pre-emergence herbicide. About 500-700 litres of water will be required to spray one hectare with hand sprayer.

Or

For controlling weeds in plant crop, post emergence herbicide 2,4-D (amine-salt) 1.0 kg a.i/ha+ paraquat 0.5 kg a.i/ha in mixture should be sprayed directly in between the rows after 3 weeks of planting.

Irrigation:

Three irrigations of 6 cm depth during April, October and November at alternate furrows.

Earthing Up:

A light earthing up should be given to fill trenches/furrows within 1½-2 months after planting. The second earthing up should be done 1 ½ -2 months after the first earthing up. The second earthing up will transform the trenches/furrows into ridges. The furrows thus made in between the ridges will facilitate drainage of excess water during high rainfall.

Stripping and Propping:

During the growth period of cane the old and dry leaves should be removed. The canes should be provided mechanical support to prevent lodging.

Plant Protection:

a) Termites, red ants and white grubs :

Malathion 5% dust @ 20-25 kg/ha should be applied to the trenches/furrows before planting. Alternatively chlorpyrifos 20 EC of 0.02% strength may also be used.

b) Borers :

Spread of stem borer attack in May-July can be checked by burying/burning of infested canes. Any of the following insecticides may also be used against these pests. Two to three rounds of fortnightly spraying starting from the rush of egg laying should be given.

Insecticides Technical names	Quantity	Water requirement (lit)	
		Hand sprayer	Power sprayer
A) Per hectare :			
Phosphamidon	400-500 ml	800	200
Fenitrothion	1 – 1.5 lit	1000	250
Endosulfan	1 – 1.5 lit	1000	250
Monocrotophos	1.01 lit	1000	250
B) Per bigha :			
Phosphamidon	60-70 ml	120	30
Fenitrothion	150-200 ml	120	30
Endosulfan	150-200 ml	150	35
Monocrotophos	150-200 ml	150	35

C) Woolly aphids, mealy bugs and thrips:

These pests can be controlled by the application of any one of the following insecticide, if felt necessary.

Insecticides	Quantity	Quantity of water in spray (lit)	
		Hand sprayer	Power sprayer
A) Per hectare :			
Malathion	1.5 lit	800	200
Phosphamidon	400-500 ml	800	200
Dimethoate	1.0 lit	800	200
B) Per bigha :			
Malathion	200 ml	100-200	25
Phosphamidon	60-70 ml	120	30
Dimethoate	150 ml	150	25

Red Rot (*Colletotrichum falcatum*):

Red rot infested canes dry up and ultimately die. The canes become shriveled, the leaves and the leaf sheaths dry up and when the stem is split open characteristic reddening of internal tissue with white transverse bands are observed.

Disease free setts should be used to prevent the spread of red rot. Setts from diseased cane or diseased field should be avoided. Water stagnation in the field should be avoided and rogueing of the affected plants should be practiced. Canes of the disease affected field should be harvested early and stubbles should be burnt. Field should be newly planted after 4-5 months. Rotooning should be discouraged.

Wilt (*Cephalosporium sacchari*):

Measures recommended for red rot should be adopted.

Harvesting:

Sugarcane should be harvested at the ground level. Late suckers should be removed at the time of harvesting.

Sugarcane is ready for harvest when the desired level of sucrose is attained in juice of different varieties.

In non flowering varieties the maturity is indicated by cessation of growth characterized by leaves appearing to emerge from a single point. In the case of flowering varieties the harvesting has to be completed within two months of flowering.

Sett Preservation:

During dry months (December to April) setts can be preserved by adopting “deep trench trash-cover” method in which three-budded setts are dipped in a solution of chlorpyrifos 20EC @ 2ml/lit for 30min before keeping in narrow trenches. Setts are to be covered with dry trash and water should be sprinkled atleast twice a month.

Ratoon Management:

Field should be properly cleaned after harvesting and ridges should be broken down by hoeing or ploughing. Stubbles should be cut with a sharp knife at ground level for uniform establishment of the ratoon.

Gaps in ratoons need to be filled up by planting pre-germinated materials within a month of harvesting of the crop. One three-budded pre-germinated piece of sett for each 25 cm gap is sufficient.

Cowdung/compost should be applied immediately after breaking of ridges. Nitrogen, Phosphorus and Potash @ 150 kg (N), 70 kg (P_2O_5) and 60 kg (K_2O) per ha respectively should be top dressed in two splits. Half of fertilizers should be applied at first earthing up and remaining half should be applied at second earthing up, within 60 days of stubble shaving.

For better control of weeds in ratoon, 2, 4-D (amine) 1 kg a.i/ha should be used as pre-emergence followed by the same as post emergence application after 3 weeks of stubble shaving.

Other cultural practices are same as in plant cane. Special attention should be paid on plant protection measures.

The ratoon crops can be raised profitably by proper management practices. Ratooning for more than two years usually makes the crop liable to greater damage by insect pests and diseases. Ratooning of red rot or heavily insect pest infested crop should be avoided.

FIBRE CROPS

Jute

(*Corchorus sp.*)

Varieties:

Variety	Sowing time	Fibre yield (q/ha)	Reaction to stem rot	Remarks
A. C. capsularis :				
JRC 212 (Sabujsona)	Mar-April	22-26	Moderately resistant	Suitable for mid and high land
JRC 321 (Sonali)	Mid Feb-April	21-26	Moderately susceptible	Suitable for low lying areas
UPC 94 (Reshma)	Mid Feb-April	21-26	Moderately resistant	Suitable for low lying areas
B. C. olitorius :				
JRO 524 (Navin)	Mid March to May	25-30	Resistant	Suitable for medium low land, resistant to premature flowering
JRO 7835 (Basudev)	Mid March to May	25-30	Moderately resistant	-do-
JRO 632 (Baisakhitosa)	Mid April to May	25-30	Moderately resistant	Suitable for mid and high land
Tarun	End of Mar to May	31.50	Resistant to stem rot and root rot	Suitable for all Agroclimatic zones

Newly recommended *C. capsularis* variety

Variety	Sowing time	Fibre yield	Reaction to diseases	Adaptation	Fibre quality
Apeswaree (<i>C capsularis</i>)	Mid Feb to April	Av. 25.5 q/ha	Resistant to stem and root rot	Suitable for upland, medium and low land situation	Better with high Fibre Tenacity, 25 g/tex

Soil: Loam or sandy loam is preferable.

Land Preparation:

Jute requires a clean and fine seed bed. Land is to be ploughed and laddered 5-6 times to obtain a fine seed bed.

In termite and cricket infested fields, the soil is to be treated with malathion 5% dust @ 30 kg/ha.

In soils where pH is below 5.5, lime should be applied atleast 21 days before sowing @ 20-30 q/ha once in every 3 years.

Seed Rate:

A) For Line sowing:

C. capsularis : 6-7 kg/ha or 800-900 g/bigha.

C. olitorius : 5-6 kg/ha or 660-800 g/bigha.

B) Broadcast:

C. capsularis : 10-11 kg/ha or 1300 – 1500g/bigha.

C. olitorius : 6-7 kg/ha or 800 - 900g/bigha.

Seed inoculation :

Inoculate seeds with biofertilizers i.e. Azotobacter @ 50 g/kg seed and PSB @ 50 g/kg seed.

Spacing:

For line sown crop, the spacing is 22-25 cm between rows and 5-7 cm between plants.

Optimum plant stand should be 60-70/sq.m after thinning.

Manures and Fertilizers:

Wherever possible cowdung or compost should be applied @ 5t/ha during land preparation; and the amount of nutrients thus supplied will be reduced by corresponding reduction from the recommended dose of fertilizer. One tonne of cowdung or compost supplies approximately 5 kg N, 2-5 kg P₂O₅ and 5.0 kg K₂O.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
A. For Capsularis:				
N	40	Urea	88	12
P ₂ O ₅	25	SSP	156	20
K ₂ O	30	MOP	50	7
B. For Olitorius:				
N	30	Urea	66	9
P ₂ O ₅	25	SSP/MRP	156/125	20/15
K ₂ O	25	MOP	42	6

Note: In case of phosphatic fertilizers “Mussorie phos” can be substituted for SSP in olitorius jute at least 3 weeks ahead of final land preparation.

Mode of Application:

Apply 50% and 50% P₂O₅ and 100% K₂O as basal dressing at the time of final land preparation and the remaining fertilizers at 4-6 weeks after sowing (CBZ, BVZ & NBPZ).

Top dressing of fertilizer mixture grade 8:10:12 at 15 DAS and MOP with subsequent foliar spray of urea is recommended.

Foliar Spray of Urea:

Where top dressing is not possible, foliar spray of urea is advocated. Urea (11.5 kg N/ha) is sprayed between 40-60 days after sowing. The first dose of urea should preferably be given 40-50 days after sowing with low volume power sprayer (Micronette) and the second spray is to be given after 10-15 days. With Aspee Bolo sprayer, three sprayings are required, the first spray being followed by two more sprays at an interval of 10 days. With hand operated (high volume) sprayer, it will be necessary to spray 2 times; the first one (40-45 DAS) being followed by another spray at 55-60 days after sowing.

Preparation of Urea Solution for Foliar Spray:

Amount of Urea (kg)	Amount of water (lit)	Strength of urea solution (%)	Nos. of spray	Type of sprayer
12.50	90	14%	2	Micronette power sprayer
8.50	85	10%	3	Aspee Bolo power sprayer

12.50	420	3%	2	Hand sprayer
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Interculture:

Thinning of the plants should be done 3-4 weeks after emergence. One hand weeding is to be given at the time of thinning. Wheel hoeing between rows within 4-5 weeks after sowing suppresses weeds considerably.

In broadcast crop *bindha* should be used 2-3 times at 2-3 weeks of crop age. Thereafter, thinning should be done to maintain a spacing of 12-13 cm between plants to ensure a population of about 6-7 lakh/ha (60-70 plants/m²).

Chemical Weeding:

Fluchloralin @ 3 lit/ha in 1000 litre of water is to be applied as pre-emergence spray 3 days before sowing.

Harvesting and Retting:

Jute is to be harvested at the small pod stage to get optimum yield and good quality fibre. If jute is succeeded by rice it can be harvested even at 100-120 days to facilitate timely ploughing for rice crop. Plants are to be cut close to the ground.

The harvested plants should be made in bundles of 15-20 cm diameter and left in the field in standing position for 2-4 days not only for shedding of leaves but also to facilitate the retting process. Thin and thick plants must be bundled separately.

Retting is the most important factor responsible for producing fine quality of jute fibre. The bundles are to be arranged side by side in water and tied together so as to form regular platform (*Jak*) and if possible, a second layer of bundles may also be placed on top and covered with materials like water hyacinth, *keturi* leaf, paddy straw thatch etc. The '*Jak*' should be submerged by putting weight of concrete slabs, bricks, stone or dry log, use of mud clods, banana stems and freshly cut logs as materials for weight should scrupulously be avoided.

Optimum temperature of water for retting ranges from 32-34⁰C. Depending upon the temperature condition the retting process takes about 10-30 days to complete when the fibre separates out easily from the wood. Over retting and under retting should be avoided.

To accelerate the process of retting one or two sticks of *Dhaincha* or Sunhemp should be inserted in each jute bundle before steeping. This provided substratum for quick microbial activity leading to multiplication of microbes and intensification of retting process.

The fibre is to be extracted from each jute stalk separately and the stripped fibre should be washed thoroughly in clean water and dried in mild sunlight over bamboo bar for 2-4 days.

Crop Rotation:

Crop rotation in jute field is most important to maintain soil fertility and also to minimize the incidence of insect pests and diseases. The sequences of jute-rice-rapeseed and jute-rice-wheat have been found profitable and are recommended for adoption wherever possible.

Jute based cropping system for upland rainfed situation: A cropping sequence of Jute (JRO 524 or JRO 7835) - Blackgram (SB-121 or Saonia mah) - *Toria* (TS-38 or M-27 or TS-36) has been recommended for upland rainfed conditions.

Plant Protection:

A. Insect Pests :

Jute hairy caterpillar, Semi looper, Yellow mite, Stem weevil:

- (a) Hairy caterpillar egg masses and caterpillars are to be hand picked and destroyed by putting them in kerosenized water. For semilooper, perches may be fixed in jute field or nearby to facilitate predatory birds to sit on.
- (b) For control of these pests, fenitrothion 50 EC 0.5% (1 ml/ lit of water) or Quinalphos 25 EC 0.05% (2 ml /lit of water) or monocrotophos 40 EC 0.06% (1.5 ml /lit of water) should be

sprayed 3 times, starting from mid June at 15 days interval or from first appearance of the pests, preferably in the upper portion of the plant. The volume of water to be used/ha (high volume sprayer) are 600,650 and 700 litres in 1st, 2nd and 3rd spray respectively. In case of low volume sprayer 200-250 lit/ha of spray solution should be used.

Cricket:

In the standing crop damage can be checked by poison baiting made of 10 kg of wheat or rice bran with 500g *gur* or molasses and 300 g Malathion 5% dust. Alternatively chloropyriphos 20 EC of 0.02% strength may also be used.

B. Diseases:

Root rot, stem rot, seedling blight and anthracnose :

- a) Seeds should be treated with carbendazim @ 2g/kg of seed.
- b) Soil pH should be raised to 5.5 by application of lime.
- c) Application of potash should be increased up to 50 kg K₂O/ha.
- d) When disease appears, plants should be sprayed either with carbendazim @ 1g/lit or mancozeb @ 3g/lit of water.
- e) Jute-Rice crop rotation should be followed.
- f) Moderately resistant varieties like JRC 212, JRC 7447, UPC 94, JRO-524 and resistant variety Tarun should be grown. Among the fungicides mentioned above, Bavistin is the most effective.
- g) For managing damping off, apex rot and seedling blight : For managing these diseases caused by soil borne *Macrophomina phaseolina*, seed treatment with slurry method using commercial formulation of *Trichoderma* spp. @ 5g/kg seed is effective.

C. Nematode

For Control of nematode, *Meloidogyne incognita*: Apply carbofuran 3G @ 2 kg a.i. /ha as soil application in furrows at the time of sowing.

Application of Carbofuran @ 1 kg a.i./ha and Biofor pf @ 2.50 kg/ha (with vermicompost at 1:10 ratio) one day before sowing of seeds for the management of root-knot nematode, *Meloidogyne incognita* and *Ralstonia solanacearum* in jute.

Integrated pest and disease management module for *olitorius* jute :

- Soil application of *Trichogramma viride* @ 2.5 Kg /ha (mixed with 150 Kg FYM, covered with moist gunny bag and incubated for 48 hours in shade) in soil at the time of sowing.
- Manual weeding at 3-4 weeks after sowing
- Hand picking and destruction of egg masses and larvae of Bihar hairy caterpillar
- Erection of bamboo perches @ 40 Nos./ha
- Two sprays of neem oil @ 4 ml/lit of water at 2nd week of June and 1st week of July.
- One spray of recommended insecticide (if necessary).

Jute (Seed Crop) (*Corchorus sp.*)

Land preparation:

Land is to be ploughed, cross ploughed and laddered 5-6 times. Weeds and stubbles are to be removed to obtain a fine and clean seed bed.

Soil

Loamy and sandy loam in upland situation

Time to Sowing:

June for Central Brahmaputra Valley Zone
July and August for other zones

Seed Rate:

For line sowing

Capsularis : 6 kg/ha or 800 g/bigha
Olitorius : 4 kg/ha or 550 g/bigha

For broadcasting:

Capsularis : 10 kg/ha or 1.5 kg/bigha
Olitorius : 7 kg/ha or 1.0 kg/bigha

Spacing:

Line sowing: 30 cm × 15 cm (ensuring plant population about 2.2 lakh/ha)

Manures and Fertilizers:

Compost or FYM @ 5t/ha or 7 q/bigha should be applied. The quantity of nitrogen is to be reduced proportionately. Each tonne of FYM /compost supplies 5 kg of nitrogen.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	20	Urea	44	6
P ₂ O ₅	20	SSP	125	16
K ₂ O	20	MOP	32	4.5

The whole quantity of P and K fertilizers should be applied as basal dressing and full dose of N fertilizer should be applied as top dressing at 3-4 weeks of crop age. Musooriphos can be substituted for SSP.

Interculture:

Usually two manual weedings are to be given, first at 3-4 weeks along with thinning operation and second weeding at 5-6 weeks of crops age.

Plant Protection:

A. Insect Pests:

For control of Jute semi-looper and hairy caterpillar, spray Quinalphos 25EC 0.05% (2 ml/lit water) two to three times at 15 days interval from the first appearance of pests.

B. Diseases:

For control of stem and root rot, carbendazim @ 1g/lit water is to be applied for effective control of diseases.

Harvesting:

Harvesting is to be done at full maturity but before the pods start shattering. The jute plants should be well dried on threshing floor and seeds be expelled by beating. Seeds are then winnowed, sun dried and kept for storage.

Average Seed Yield:

Capsularis : 4-5 q/ha.
Olitorius : 3-4 q/ha.

Mesta (*Hibiscus spp*)

Varieties:

HC 583 and AMC 108

Time of Sowing:

April – mid May

Soil:

Well drained loam to clayey loam soil is suitable.

Land Preparation:

Land should be ploughed and laddered 5-6 times to obtain a fine tilth.

Manure and Fertilizers:

FYM or compost @ 7-8 t/ha should be applied during land preparation. The quantity of N is to be reduced from the fertilizer on the basis of 5 kg N per tonne of FYM/compost applied in the field.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	40	Urea	90	12
P ₂ O ₅	20	SSP	125	16
K ₂ O	20	MOP	32	5.2

Mode of Application of Fertilizers:

The entire quantity of phosphatic and potassic fertilizers should be applied at the time of final land preparation. Nitrogenous fertilizer should be top dressed in two equal splits at 4-5 and 7-8 weeks after emergence.

Seed Rate:

a) Line sowing : 13-15 kg/ha (1.8-2.0 kg/bigha)

b) Broadcasting : 18-20 kg/ha (2.5-3.0 kg/bigha)

Spacing: 30 cm between rows
15 cm between plants

Weeding and Thinning:

One hand weeding at 20-30 days after emergence is to be given and plants are thinned out simultaneously to maintain requisite plant population. In line sown crop. Wheel hoe at 2 and 5 weeks after emergence should be used.

Plant Protection:**A. Insect Pests:**

For controlling jassids, two spraying at 15 days interval with Quinalphos 25EC 0.05% (2 ml/lit water) or dimethoate (0.06%) should be given during the vegetative phase of crop.

Retting and Extraction of Fibre:

The process of retting and extraction of fibre are similar to that of jute.

Fibre Yield: 22-25 q/ha.

Cotton (*Gossypium* spp)

Varieties:

Varieties	Plant height (cm)	No. of branches/plant	No. of balls/plant	Seed cotton yield (q/ha)	Ginning (%)
A. Long staple :					
MCU 4	94	7.7	19.0	10.50	34
MCU 1	105	5.7	31.3	12.26	33
Laxmi	120	7.7	19.0	8.12	31
Buri	102	7.4	29.9	12.23	31
J 34	130	11.6	44.3	12.21	32
MCU	-	-	-	19.91	-
B. Short staple :					
Garo	171	3.0	41.6	6.29	28
Mizo Khaki	183	3.0	38.6	6.53	23
Dambuk	147	3.0	39.6	5.68	35
Phelopi	155	3.7	25.7	3.71	24

Soil:

Cotton can be grown on a variety of soils. It requires well drained soil as it cannot tolerate water logging.

Land Preparation:

Cotton does not require fine seed bed preparation. Deep tilled coarse seed bed is required; 3-4 ploughings followed by laddering are sufficient.

Time of Sowing: July

Treatment of Seed:

Seeds are rubbed with a paste consisting of a mixture of cowdung and moist earth and then dried for sometime in shade.

Method of Sowing:

Dibbling of 4-5 seeds/hole in line

Seed Rate: 20 – 25 kg/ha

Spacing: 45 cm between rows and 30 cm between plants.

Depth of Seedlings: 1.5 cm to 2.0 cm.

Manure and Fertilizers:

Compost or FYM should be applied @ of 10-20 t/ha.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	60	Urea	130	18
P ₂ O ₅	30	SSP	187	27
K ₂ O	30	MOP	50	7

Compost or FYM is to be incorporated with the soil during first ploughing. The entire quantity of P and K and half of N fertilizers should be applied as basal dressing during final land preparation before sowing. Remaining half of N should be applied 40 days after sowing at flowering stage.

Interculture:

One hand weeding along with thinning is to be given 15 days after sowing.

Plant Protection:

After 30 days of sowing, spray endosulfan 35 EC @ 2 ml/lit of water at an interval of 20 days from first spray. A total of 4 sprayings will be needed. For each spray 600-800 lit spray solution is required.

Picking:

The cotton is ready for first picking by the end of November. Generally 3-4 pickings are required. Picking in the morning hours is better to avoid admixture of dried leaves and bracts. Seed cotton is dried for a few hours after picking and then stored.

Yield:

Average yield 8-12 q/ha (seed cotton) for long staple varieties and 4-6 q/ha (seed cotton) for short staple varieties.

Ramie
(*Boehmeria nivea*)

Varieties:

R 1411, R 1449, R 1452, R 67-34 (Kanai)

Type of Soil: Sandy loam to loam having a pH value of 5.5-6.0

Climate: Warm (25-31⁰C) and moist

Altitude: Below 300 m above mean sea level.

Propagation: Mainly by rhizome, seed and stem cuttings.

Time of planting: May – September.

Spacing: Row to row 60 cm and plant to plant 30 cm

Depth of planting: 5-6 cm.

Time of staging: 3rd week of April in the next year

Fertilizer: N: P: K (kg/ha) 30:15:15 kg/per cutting

Requirement/ha:

- | | | |
|------------------|---|----------------------|
| a) Rhizome | : | 375-400 kg |
| b) Lime | : | 3.5 – 4t (if acidic) |
| c) Urea | : | 65 kg/cutting |
| d) SSP | : | 94 kg/cutting |
| e) MOP | : | 26.0 kg/cutting |
| f) Ramie compost | : | 20.0 t/year |
| g) Cowdung | : | 10-12 t/year. |

Harvesting: Four cuttings are taken per year. 1st cutting 50 DAP, 2nd cutting 45 days after 1st cutting, 3rd cutting 45 days after 2nd cutting, 4th cutting 50 days after 3rd cutting.

Yield:

Fibre yield: 16-22 q/yr/ha

Rhizome yield: 10-12 t/ha after 5th year.

FORAGE CROP (ANNUAL)

Dinanath grass

(*Pennisetum pedicellatum*)

Varieties:

JP-12, Pusa 3 and Pusa 19

Land Preparation:

Well drained land should be selected. One ploughing by mould board plough followed by 3 to 4 harrowings and planking are sufficient for land preparation. Growth of seedlings is very slow at early stage i.e. upto 35 to 40 days. It is therefore very important to keep the field free from weeds at this stage.

Time of Sowing: April to June.

Seed Rate: 8 kg/ha

Spacing: Row to row : 30 cm

Plant to plant: 10 cm

Manures and Fertilizers:

Apply compost or FYM @ 4-6 t/ha or 6-8 q/bigha

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	60	Urea	132	18
P ₂ O ₅	30	SSP	186	25
K ₂ O	0	MOP	-	-

30 kg N and full dose of P₂O₅ should be applied as basal dressing i.e. at the time of final land preparation and rest 30 kg N as top dressing after first cutting.

Number of Cuttings: Two cuttings may be done. First cutting at 60 days after sowing and the 2nd cutting is to be done at 45 days after the first cutting.

Green Fodder Yield: 50-60 t/ha in two cuttings.

Cowpea (Fodder)
(*Vigna unguiculata*)
and
Rice Bean (Fodder)
(*Vigna umbellata*)

Varieties:

Cowpea : No 10, No. 42/1, EC 4216

Rice bean : K-1

New rice bean varieties recommended:

Variety	Sowing time	Duration upto 50% flowering stage (days)	Green forage yield (q/ha)	Dry matter yield (q/ha)	Disease & insect pest incidence	Agro-climatic zone
Bidhan rice bean-1	July-Aug	70-80	250-290	50-60	Less	All zones except Hills zone
Bidhan rice bean-2	-do-	70-80	250-300	50-60	Less	-do-
Shyamalee-1	-do-	70-80	300-320	50-65	Less	All zones

Land Preparation:

Well drained land should be selected. One ploughing by mould board plough followed by 2 to 3 harrowings is sufficient to prepare the land.

Time of Sowing: April – May.

Seed Rate:

Cowpea : 50 kg/ha

Rice bean : 25 kg/ha

Spacing:

Row to row : 35 cm

Plant to plant : 10 cm

Manures and Fertilizers:

Apply compost or FYM @ 3-4 t/ha or 4-6 t/bigha.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	20	Urea	44	6
P ₂ O ₅	40	SSP	248	35
K ₂ O	20	MOP	32	5

Time of Cutting:

One cutting at 50% flowering stage (after 70 days of sowing)

Green Fodder Yield : 20 – 25 t/ha.

Maize Fodder (*Zea mays*)

Varieties:

Ganga 5, Vijoy and African Tall

Land Preparation:

For maize crop, a good seed bed is very much essential. The field should be initially ploughed and harrowed 4-5 times followed by planking.

Time of Sowing : Before June

Seed Rate : 60 kg/ha

Spacing : Row to row : 30 cm

Plant to plant : 10 cm

Manures and fertilizers:

Apply compost or FYM @ 3-4 t/ha or 5-6 q/bigha.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	60	Urea	132	18
P ₂ O ₅	30	SSP	186	27
K ₂ O	30	MOP	82	7

30 kg N, the whole of P₂O₅ and K₂O should be applied as basal dressing at the time of final land preparation and 30 kg N as top dressing after 40 days of sowing.

Irrigation:

Normally rainy season crop does not require irrigation. When there is no rain and soil becomes dry the crop should be immediately irrigated.

Number of Cuttings:

One cutting in a year after 75 days of sowing is recommended. To get optimum yield, maize should be cut for green fodder at silking stage.

Teosinte (*Euchlaena maxicana*)

Varieties: Sirsa, TL 16, TL 2

Soil Type: Well drained sandy loam soil is preferable.

Land Preparation:

One ploughing by mould board plough followed by 4-5 harrowings and plankings are sufficient for land preparation. Stubbles and weeds are to be removed completely. Surface drains should be provided for immediate removal of excess water from the field.

Time of Sowing: April to June

Seed Rate: 40 kg/ha

Spacing : Row to row : 40 cm

Plant to plant : 15 cm

Manures and Fertilizers:

Apply compost or FYM @ 3-4 t/ha or 5-6 q/bigha.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	60	Urea	132	18
P ₂ O ₅	30	SSP	188	25
K ₂ O	20	MOP	33	5

40 kg N, the whole of P₂O₅ and K₂O should be applied as basal dressing at the time of final land preparation and 20 kg nitrogen as top dressing after 40 days of sowing.

Interculture: One weeding at 25-30 days of sowing is sufficient.

Irrigation:

Normally rainy season crop does not require irrigation. When there is no rain and soil becomes dry the crop should immediately be irrigated. The first irrigation should be given before sowing of seeds to get optimum soil moisture for proper germination of seeds. Subsequent irrigation will depend upon rainfall.

Time of Cutting:

One cutting is to be taken at 70-80 days of sowing. To get optimum yield, teosinte should be cut at silking stage.

Green Fodder : Yield : 30 tonnes/ha.

FORAGE CROP (PERENNIAL)

Hybrid Napier

(*Pennisetum purpureum*)

Varieties: NB 21, IGFRI-6, CO-2

Soil Type: Well drained soils should be selected.

Land Preparation:

One ploughing by mould board plough followed by 2-3 harrowings and puddlings are sufficient to prepare the land.

Time of Planting: April to June

Spacing: Row to row : 50 cm
Plant to plant : 50 cm

Manures and Fertilizers:

Apply compost or FYM @ 8-10 t/ha or 1-1.5 t/bigha.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	120	Urea	265	35
P ₂ O ₅	50	SSP	310	45
K ₂ O	30	MOP	48	7

Nitrogenous fertilizer should always be applied in 4 splits. Entire quantities of phosphatic and potassic fertilizers along with the first split of nitrogen are to be applied as basal dressing and the other 3 splits at the time of intercultural operation and after alternate cutting.

Fertilizer savings to the tune of 50% could be possible by application of vermicompost and FYM @ 2.5t/ha each along with 50% recommended dose of fertilizer.

Irrigation:

First irrigation should be given immediately after planting. Subsequent irrigation will depend upon amount of rainfall.

Number of Cuttings:

During first year 4-6 cuttings may be done. First cutting is done 3 months after planting and subsequent cuttings are done at an interval of 5-7 weeks.

Green fodder yield : 80 – 100 t/ha

Setaria grass
(*Setaria sphacelata*)

Varieties : Kazungula, Nandi and PSS-1

Soil Type : Well drained upland soils rich in organic matter should be selected.

Land Preparation: One ploughing by mould board plough, followed by 2-3 harrowings and plankings are sufficient to prepare the land.

Time of Planting : April to June

Spacing : Row to row: 50 cm

Plant to plant: 50 cm.

Rooted Slips Requirement: 40,000/ha (5,000/bigha)

Manures and fertilizers:

Apply compost or FYM @ 5t/ha or 7q/bigha

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	120	Urea	265	35
P ₂ O ₅	50	SSP	310	45
K ₂ O	30	MOP	48	7

Nitrogenous fertilizer @ 40 kg/ha should be applied as basal and the rest amount of nitrogenous fertilizer should be applied @ 20 kg/ha after each cut. The entire quantities of phosphatic and potassic fertilizers are to be applied along with the basal dose of nitrogen (40 kg/ha).

Fertilizer savings to the tune of 50% could be possible by application of vermicompost and FYM @ 2.5 t/ha each along with 50% recommended dose of fertilizer.

Interculture: Intercultural operation in the form of light hoeing is necessary at 30-35 days of planting and also after each cut.

Irrigation: First irrigation should be applied immediately after planting if a dry spell prevails. Subsequent irrigation will depend upon rainfall.

Number of cuttings: First cutting is to be taken at 60-65 days after planting and subsequent cutting at an interval of 45-60 days.

Management of old stand of setaria grass:

Stubble shaving at ground level or burning of stubbles in the month of February along with intercultural operation after each cut is recommended.

Green Forage Yield: 800 to 1000 q/ha

IMPROVED PRACTICES IN *JHUM* CULTIVATION

The Hill Zone of Assam occupies an area of 15.222 sq km in the districts of Karbi Anglong and North Cachar Hills. The hilly areas of Karbi Anglong and North Cachar Hills are 66 per cent and 85 per cent of the total areas of the districts, respectively. As such *Jhum* cultivation is practiced widely in the whole zone except in the flat land in Karbi Anglong district which is about 34 per cent of the land area of the district. Karbi Anglong district has 5452 sq km and North Cachar Hills has 2597 sq km area under *Jhum* cultivation which is more than 50 per cent of the total geographical area of the zone. This is a mixed cropping system under slash and burn agriculture. The uneconomical agriculture, heavy soil erosion and continued depletion of soil fertility are the major problems of the zone.

In order to achieve improvement over the traditional practices of *Jhum* cultivation in the zone, a model of improved practices has been recommended with 20-25 per cent slope with an annual rainfall of 1000-1200 mm.

- i) Replace traditional crop varieties with improved recommended varieties.
- ii) Grow pumpkin, cucumber, pineapple, turmeric, ginger and colocassia in the border with their respective recommended cultural practices.
- iii) Grow field crops like rice, maize, cotton and sesamum by placing in the middle portion of the cultivated area with a common fertilizer dose of 40:20:20 of N, P₂O₅ and K₂O kg/ha. Sow maize and cotton at 2 m row distance in alternate rows. In between maize and cotton rows, sow rice and sesamum in alternate strip.
- iv) Practice line sowing/planting across the slope.
- v) Grow blackgram in *kharif* with recommended cultural practices after harvest of rice, maize, sesamum and pumpkin grown in the preceding summer season.
- vi) Both guinea (*Panicum maximum*) and citronella (*Cymbopogon winteroanus*) are recommended as strip crop in the 20% hill slopes. The width of the grass strips would be 75 cm to be grown along the contour. Rice (summer) followed by greengram (*kharif*) are to be grown as per Package of Practices in between grass strips at a width of 4-5 metres. Grass strip cropping also helps in controlling soil erosion, run off and formation of terrace naturally.

TECHNOLOGIES FOR INTENSIVE CROPPING IN DIFFERENT AGRO-CLIMATIC ZONES OF ASSAM

Situation: Upland

A) Upper Brahmaputra Valley Zone

i) Annual crop

Sugarcane (spring) + Cowpea

Sugarcane (autumn) + *Toria*

Pigeonpea + Ginger/turmeric

Summer rice/vegetables

Blackgram/greengram (Sept)/Pea/*Rajmah* (Oct)/Vegetables (Chilli + French bean + Cucumber)

Cowpea/maize (fodder) Soybean/*Toria*

ii) Perennial crop

Arecanut + Banana + Pineapple

Arecanut + Black pepper + Banana + Pineapple

B) North Bank Plains Zone

Summer greengram - Groundnut/Potato/Pea/*Toria*

Summer rice - Vegetables/lentil/Pea/*Rajmah*

C) Central Brahmaputra Valley Zone:

Summer greengram - *Kharif* vegetables

Lentil/pea/*Toria*

Summer rice - *Kharif* vegetables/*Rabi* vegetables

Vegetables - *Kharif* vegetables/*Rabi* vegetables

Rice - *Kharif* vegetables/*Rabi* vegetables

Sesamum + Blackgram (1: 1)

Pigeonpea + Sesamum

D) Lower Brahmaputra Valley Zone:

i) Annual

1) As in CBV and Rice-Blackgram-Potato Rice-Sesamum-Wheat.

2) Vegetables+vegetable; Vegetables+flower intercropping.

Brinjal+Frenchbean/Knolkhol/*Methi*

Pea + Tuberose

Coriander + marigold

ii) Perennial crop

1) Coconut + ginger + Turmeric

Coconut + betelvine + Assam lemon + banana + Pineapple + Ginger.

E) Hills Zones (Slopes of 20-25%)

Rice (DS) - Blackgram/greengram

Rice (DS) - Cotton

Rice - Greengram - *Toria*

Pigeonpea + Sesamum/blackgram/greengram

Rice (DS) + Greengram/Blackgram (2 : 1)

Situation: Medium/Medium Lowland:

A) Upper Brahmaputra Valley Zone

i) March-June

June-Oct

Nov- Feb/March

Early rice(T)

Toria/Niger/ILinseed

Early rice(T)

Potato/Pea/Vegetables

(for light textured soils)

Rice (DS)

Rice (T)

Toria/Relay pea/Pat (F)

ii) April-July	July – Nov	Nov/Dec-Feb.
Rice (T)	Rice (T)	Oat (F)/Wheat (irrigated)
Vegetables	Rice (T)	Vegetables (Chilli / Radish + French bean/Tomato / Potato)

First rice crop of sequence is of 100-110 days duration viz., Luit, Kapilee, second rice of 130-140 days duration, viz., Mahsuri, Jaya, Satya.

B) North Bank Plain Zone:

March-July	July/Aug-Nov	Nov/Dec –Feb
Green gram	Rice (T)	Potato
	Rice (T)	<i>Toria</i> (with low input level)
	Rice (T)	<i>Rajmah</i> /pea
	Rice (T)	Wheat/vegetables
	Rice (T)	Oat (fodder)

First rice crop of 100-110 days duration, 2nd one of long duration 150 days in two crop sequences.

C) Central Brahmaputra Zone:

March-June	July – Nov	Nov-Feb/March
Jute	Rice (T)	<i>Toria</i> /Wheat
Summer moong	Rice (T)	Pea/vegetables
	Early Rice (T)	Vegetables
Cow pea	Rice (T)	<i>Toria</i>
(Fodder)	Rice (T)	Rice (T) (Irrigated Lowland)
Lady's finger	Rice (T)	<i>Toria</i>
Jute	-	Wheat/ <i>Toria</i> /Pea/Potato

D) Lower Brahmaputra Valley Zone:

March-July	July/Aug-Oct/ Nov	Oct/Nov-Feb
Rice (DS)	Rice (T)	Potato
Greengram	Rice (T)	<i>Toria</i>
	Rice (T)	Vegetables/Pea
Jute	Rice	Potato

E) Barak Valley Zone:

Rice (T)	Rice	-
Early rice (T)	-	Pea/ <i>Toria</i> /Niger
Rice (T)	Rice (T)	<i>Toria</i> /Pea

Post-rice mustard can be sown till late November, while niger/linseed can be sown till December.

F) Hills Zone:

Maize	Greengram/Blackgram/Pigeon pea	
Rice (DS)	Greengram	<i>Toria</i>
Rice (DS)	Blackgram	Wheat

Flood Prone Areas :

Flood prone areas are spreading along the river systems are found in all the districts of the state. Though the advent of flood differs in different areas and the intensity differs from year to year in the same area, the features of the areas are almost identical; hence the recommended technologies apply to all the areas.

Feb-May	Late Aug-Nov	Dec- Feb
Early summer rice (DS)	Late winter rice (T)	
Summer vegetables	-do-	Pea-potato
Summer vegetables	-do-	Groundnut/Pea
Summer rice/	Fallow	Potato/Vegetable/
Summer pulse		<i>Toria</i> / Wheat/Pea
Groundnut/melons	Fallow	Early pulse/Vegetables
Summer rice (Feb-June)	-	Sweet potato (Sept-Feb)

For late planting seedlings of 50-55 days of age can be used in closer spacings of 15 cm × 15 cm and 20 cm × 15 cm for semi-dwarf and tall varieties, respectively.

Rice varieties of short duration for pre and post flood situations are – Luit, Kapilee, (100-110 days duration) and also Lachit, Govind (120 days duration), Kalinga 3, Sonamukhi, Heera. In post flood situation sprouted seeds to be sown in wet condition.

Technologies for Management of Specific Systems

Rice (T) –Wheat:

Rice transplanting – Mid July, Wheat sowing – Mid Nov

Recommended fertilizer for both the crops

Need based irrigation for wheat

Rice (T) – *Toria/Rajmah/Pea*

Rice-Mid duration variety

Toria- Sowing to be completed by early November, varieties –TS-36, TS-38, M-27

Application of organic manure at 5t/ha and 25% of recommended level of fertilizers to both the crops increase yields.

Rajmah/Pea – Sowing to be over by early November.

Rice – relay pea

Pea to be sown 7-10 days before rice harvested with 25-50% higher seeding rate.

Residual soil nutrients available from preceding sali rice grown with the application of vermicompost (1 t/ha) and FYM (2.5 t/ha) under low input (N:P₂O₅:K₂O @ 20:10:10 kg/ha) condition to produce significant higher pea yield without any additional doses of fertilizers when pea is relayed with sali rice and one irrigation of 4 cm depth in pea at flowering stage. (In Upper Brahmaputra Valley Zone, pea to be harvested by the end of February)

Rice (T) – Oat (fodder)

Oat can be sown after rice till late December. Two cuttings can be taken from early sown oat.

- Cutting of rice stubbles at ground level.
- Application of minimum tillage with one cross ploughing.
- Application of recommended dose of fertilizer @ 20:20:20:: N : P₂O₅ : K₂O kg/ha
- Seed inoculation with *azospirillum* @ 40 g/kg seed and PSB @ 40g/kg seed.
- Sowing of seeds behind the plough with row spacing 25 cm
- Top dressing N@ 20 kg/ha after the first cut at 50 DAS.

Rice (T) – Rice (T)

Substitution of 25-50% of inorganic N in one of the crops through Azolla/FYM or straw helps cutting down fertilizer requirements. FYM/cut residue is to be applied @ 270-540 kg/bigha at the time of puddling. Azolla @ 22-44 kg/ha is to be inoculated one week after transplanting.

Closer spacing of 15 × 15 cm or 15 × 10 cm for short duration varieties like Luit/Kapilee.

Second rice var. is to be of long duration (150-160 days) for low land, viz., Ranjit, Bahadur, Kushal, Moniram to be transplanted in July.

Direct seeding of the first rice crop in wet condition with application of (pre-emergence) herbicide, viz., butachlor @ 2.0 kg a.i./ha and with supplementary irrigation is recommended.

Preemergence application of pretilachlor @ 0.75 kg a.i./ha at 3-5 days after transplanting (DAT) is recommended for autumn rice. In succeeding winter rice, preemergence application of butachlor 1.0kg a.i./ha at 3-5 DAT, followed by post emergence application of readymix of chlorimuron + metsulfuron methyl at 4g/ha at 2-3 leaf stage of weed (20-25 DAT) is effective.

Intercropping of pulse crops with sesame :

- Intercropping system
 - (a) Sesame + blackgram in 1: 1 row proportion
 - (b) Sesame + greengram in 2: 2 row proportion
- Sowing time: Mid August – Mid September
- Row spacing: 30 cm
- Fertilizers: 30:20:20 N:P₂O₅:K₂O/ha

Intercropping of lathyrus with oats after Sali rice :

- Cutting three rows of rice stubbles at ground level leaving next three rows without cutting
- Application of FYM @ 2 ton /ha along with 10:20:20 kg/ha N:P₂O₅:K₂O as basal
- Broadcasting the seeds of Lathyrus to the strips with rice stubbles using seed rate 25 kg/ha.
- Sowing of seeds of oat in lines behind the plough to the three row strips without stubbles with seed rate 50 kg/ha and row spacing of 25cm.
- Top dressing of N @ 10 kg/ha to be done after first cut at 50 DAS.

Rice – Pulses/Oilseed:

Green manuring with *S. aculeata*, *S. rostrata* or green leaf manuring for the rice crop is beneficial in the establishment of *rabi* crops after rice.

Use 60 kg P₂O₅ as rock phosphate 20 days ahead of planting the 1st rice crop and no phosphatic fertilizer for the second crop.

Jute-Toria:

75% of recommended dose of NPK through chemical fertilizers and 25% N through water hyacinth compost in jute, and 50% of recommended dose of fertilizer in *toria* are recommended.

Crop sequences for Hill Zone :

- On 25-40% hill slopes of Hill Zone, following crop sequences under rainfed conditions:
 1. Direct seeded ahu rice (var. Inlongkiri) – Toria (var. TS 38)
 2. Direct seeded ahu rice (var. Inlongkiri) – Blackgram (var. KU 301)

Green gram - Wheat :

- Seed inoculation in greengram with rhizobium @ 50 g/kg seed and PSB @ 50 g/kg seed.
- Basal application of 40 kg P₂O₅ kg/ha in greengram along with recommended N and K
- Basal application of 30 kg P₂O₅ kg/ha in wheat along with recommended N and K

Cropping System For Forage Crop Production:

A) Sequential cropping

i) Intensive forage production.

- 1) Cowpea-Teosinte/maize/Dinanath grass-oats
- 2) Cowpea/Ricebean-Cowpea/Ricebean-Oats/maize.
- 3) Maize + Cowpea-Teosinte + Cowpea-Oats
- 4) Maize + Cowpea-Dinanath grass-Oats.

ii) With food/Commercial crops :

- 1) Rice-Oats
- 2) Cowpea-Rice-Oats
- 3) Rice(S)-Cowpea/Ricebean-Maize
- 4) Rice+Ricebean/Cowpea-Rice-Oats/Maize
- 5) Green gram-Cowpea (Fodder)-Rapeseed
- 6) Maize+Cowpea(Fodder)-Sesamum-Rapeseed

B) Mixed/intercropping:

i) **Forage crop mixture**

1. Oats + Pea
2. Oats + *Khesari*
3. Maize + Pea/*Lathyrus*
4. Maize + Cowpea/Ricebean
5. Teosinte + Cowpea/Ricebean
6. Sorghum + Cowpea.

ii) **Food-Forage mixture**

1. Pea (Grain) + Oat (F)
2. Rapeseed/Niger + Oat (F)
3. Lentil/gram + Oat (F)
4. Rice + Cowpea (F)

iii) **With perennial grass:**

- 1) Guinea/Seteria + Ricebean/Cowpea-Dinanath grass/Cowpea/Ricebean-Oat/Pea/*Khesari*
- 2) Hybrid Napier + Cowpea-Cowpea-Oat

iv) **Growing of guinea grass in Agro-forestry system:**

Growing of guinea grass in agro-forestry system , i.e. under shade tree with 50% higher dose of recommended fertilizer(80:40:40::N:P:K kg/ha).

B. Fertilizer Management in Forage based Cropping System:

Application of lime (20% of L.R) + recommended dose of fertilizer + VAM to rice bean crop during *kharif* is recommended in Rice bean- Oat cropping sequence.

APICULTURE

Honeybees are essential for pollination of many cross-pollinated crops, and also for production of honey which generates income to the farmers. There are four major honeybee species viz., Rock bee (*Apis dorsata*), little bee (*Apis florea*), Indian bee (*Apis cerana*) and Western bee (*Apis mellifera*). Out of them, former two are wild and the latter two are domesticated species. Indian bee is a brownish black, locally available domesticated Asiatic species. The beekeeping practice of North-East India is mainly based on this species. This is indigenous to India with average honey yield of 12 kg per hive per annum and the foraging range is 0.8-1 km. Western bee is an exotic golden yellow species most widely and commercially reared in the world. This is larger in size than Indian bee having average honey yield of 35-40 kg per annum with the foraging range of 2 km. The species is successfully introduced in Northern India and effort is being made to introduce in Assam including North East India.

Apiary site:

An apiary is a place where honeybee colonies are reared. Site with proper sunlight, air circulation and shade should be selected for apiary. Good apiary location is one with abundance of nectar and pollen producing plants. Commercial beekeepers generally migrate their colonies from one place to another for flora and produce more than one api crop of several types. Some of the important bee foraging crop-plants are rapeseed-mustard, niger, buckwheat, sunflower, safflower, sesamum, bottle gourd, pointed gourd, pumpkin, ridge gourd, sponge gourd, maize, soyabean, *jamun*, *litchi*, mango, drumstick, guava, citrus, coconut, areca nut, date palm, pummelo, ironwood, tamarind, mayflower, pomegranate etc..

Beehive and other equipments:

Honeybees are reared in the modern beehive based on principle of bee space. Beehive is composed of brood chamber and honey chamber. The brood chamber is meant for rearing progeny and the super or honey chamber is used for secreting honey. The following beekeeping equipments are required for honeybee rearing.

i) Beehive:

- (a) ISI A type 8 frame for Indian bee, ISI B type 10 frame for Indian bee.
- (b) Langstroth 10 frame for Western bee.

- ii) Smoker to produce smoke for effective handling of the colony
- iii) Bee veil to prevent bee stinging during handling of the colony
- iv) Hand gloves for effective handling of the colony
- v) Swarm-catcher for collection of colony from natural source
- vi) Honey extractor for extraction of honey
- vii) Uncapping knife

Rearing Season:

Seeds or colonies are normally available during spring i.e. February to March as this is a peak-breeding season of the honeybees. Colonies can be collected from the natural sources or may be procured from the beekeepers. Rearing can be started with three or four frame worker bee having one year mated queen. During winter (December to January) and in spring (February to March) are the best seasons to start beekeeping.

Seasonal Management:

There are generally three seasons for bee management.

Spring Management:

Beekeepers calendar starts with the activity of honeybee colonies after prolonged rain and winter cold. As this is a major flowering season, worker bees become busy for collecting nectar and pollen from flowers and thereby help in building the colonies. This is known as honey-flow season and in this season mostly extraction operation is done. However, there is a

problem with swarming, which is acute in Indian species but less in western species. Swarm prevention can be done by frequent inspection of the colony, removing the queen cell, dividing the strong colony and helping the weak one.

Summer and Rainy season management:

In the summer management, honeybee colonies should be kept under shade just to protect from scorching sun. As there is continuous rainfall in Assam during the rainy season, honeybee colony should be provided with artificial diet, composed of carbohydrate, protein and water. Effective artificial diet comprises of sugar (as carbohydrate); black gram or green gram or soybean powder (as protein source) and water @ 1 kg of sugar and 100 gm protein powder mixed in 1 lit of water. It should be administered as per requirement of the colony.

Winter management:

The honeybee colonies should be taken out from the shade and exposed to the sunlight.

Migration of the colony:

During winter, honeybee colonies should be migrated to the oilseed crop fields (mainly rapeseed-mustard crop) and then to spring blooms of fruit, forage crops and forest plantations. In this practice both the beekeepers and farmers will be mutually benefited in terms of honey and crop production. Migration is essential for getting substantial yield of crops as well as honey.

Disease and Enemy Management

Several diseases, viz., and fungal, bacterial, viral and protozoan diseases infect honeybees. Out of these, viral and protozoan diseases are most serious ones in Assam.

Sac-brood disease:

This is a viral disease caused by Thai-sac strain. The symptoms of this disease are

1. The larvae become pale; then turn brownish-black and gradually dry up.
2. The punctured capping with dead pupa within the cell.
3. The infection is usually in worker, seldom in drone and spread by drifting nurse bees.

Control:

Dequeening and Requeening:

Create broodlessness for some time by dequeening and requeening through production of new queen cell. Infected colony should be treated with antibiotics like Teramycin, 250 mg @ one tablet per 4 lit of sugar syrup.

Nosema disease:

Nosema disease is found in adult Western bee colony. The infected bees show the symptom of crawling, disjointed wings and the mid-intestine becomes swollen with pale colour.

The treatment with hydroxy quinoline mixed with sugar @ 250 mg/4 litre of sugar syrup will give effective control. Against fungal disease, proper aeration and exposure to the sunlight prove to be effective.

Natural Enemy:

Almost half a dozen natural enemies such as lizard, wasp, waxmoth, cockroach, birds, ants and mites infest honeybee colonies. Out of them, waxmoth and predatory wasp are most serious enemies.

Waxmoth, *Galleria mellonella*:

Waxmoth lays eggs on the stored combs or on the spare combs in the colony. Larvae develop by feeding on wax and pollen in comb cells. Wax moths are most active in summer and rainy seasons. To manage this pest; store combs by removing extra combs from the colony. Fumigate stored combs in air-tight space (in hive chambers, sealed between with mud or dung) and treated with acetic acid or formalin. But fumigation with sulphur smouldering in

most effective. Removal and destruction of infected portion of the comb is also recommended. The biocontrol practice of treatment with *Bt* formulation var. *kurstaki* @ 0.5 gm/100 ml. of water per hive gives effective control of the pest.

Predatory wasp:

Among the wasps, the burrowing (*Vespa magnifica*.) and aerial wasps (*Vespa cincta*) are two common species in Assam, which predate on honeybees. To protect the colonies from the wasp, practices such as destruction of wasp nest in the vicinity of the apiary and artificial net covering (with nylon net of 1 cm mesh size) over the bee hive colonies are found to be effective.

For controlling bee mites, honey bee colonies should be exposed to the sunlight and in acute cases chlorbenzilate fumigation gives effective control. Sulphur dusting @ 200 mg/hive on top bars of frames is also effective.

Honey bees in crop production

Honey bees are essential for pollination of all the cross pollinated crops. It has been clearly demonstrated through experimentation at AICRP on Honeybee scheme AAU, Jorhat that honey bee colonies enhance crop yield to the tune of 1.5 to 2 times as shown below:

Crop	Colony requirement	Yield (q/ha)	Per cent yield increase over open pollination
Mustard	5	12.2	157.65
Niger	6	6.1	146.98
Buckwheat	5-6	14.2	152.68
Litchi	5-6	66.7	142.75
Assam lemon	4		

Hence honeybee colonies are considered as essential input for increasing productivity of cross pollinated crops. Migration of honeybee colonies is necessary for both crop and honey yield.

Pesticidal Poisoning to Honey Bees:

In order to protect the honeybees from pesticide poisoning eco-friendly pesticides, which are less toxic to honeybees should be recommended. Moreover, the application of pesticide on flowering crops should be done in the afternoon when the bee activity stops in the field. Some of the bee friendly pesticides with inorganic and organic compositions are oxydemeton methyl, endosulfan and deltamethrin and botanicals. Biopesticides such as *Bt* formulation, NPV etc. which are having less or no residual toxicity should be incorporated in the Integrated Pest Management Packages.

Recommendation of *Bt* Formulation against Wax moth

Wax moth, *Galleria mellonella* is one of the most serious pests of honeybee causing severe damage to the colonies. Various remedial measures such as cultural, chemical were adopted without having any full proof effect. In order to have effective management of this pest, biocontrol experiments with *Bt* Formulation, var. *kurstaki* @ 0.5 per cent controlled the waxmoth effectively. Hence, *Bt* var. *kurstaki* 0.5 gm/hive/litre of water has been recommended against wax moth.

Package of Practices for Rice Hispa Management

To manage rice hispa, the following strategies are suggested:

Monitoring:

1. As the initial population build up of hispa takes place on *boro* and early *ahu* from February onwards, appropriate protection measures must be taken when the population reaches economic threshold level (ETL) of 1 adult or 1 damaged leaf/hill.

2. Routine monitoring at weekly intervals must be taken up from April onwards to detect the initial population build up in and around rice fields followed by similar surveillance from July onwards. Monitoring is advisable for the next year in the hispa affected areas during middle of February to April.

Cultural Control:

3. Draining out of water at the time of population build up for 2 to 3 days helps in decreasing hispa population.
4. Weed free cultivation should be encouraged.
5. In areas where rice is not widely grown during *boro* and *ahu* seasons, small, swampy areas and roadside pits having alternate hosts serve as the breeding pockets of hispa during February to April. Such infested pockets which are not very large in rice areas are easily identifiable from a long distance because of their characteristic withered conditions and burnt appearance. Therefore, it is advisable to destroy these weeds (alternate hosts) by mechanical methods (cutting and burning). This operation will minimize further multiplication and dispersal of adults into the rice crop. Use of insecticides cannot be advocated in the swamps as these are used as grazing land and natural fisheries.
6. Early transplanting helps to escape hispa attack. Whenever and wherever possible, staggered transplanting should be discouraged.
7. After harvesting of rice, stubbles should be burnt in November-December to kill the hibernating adults.
8. Deep ploughing of hispa affected fields should be done during February - March.

Mechanical Control

9. Clipping of leaf tips of seedlings before transplanting must be done.
10. Clipping and destroying of affected leaves up to about 6 inches from the tip should be done as these leaves contain eggs, larvae and pupae.
11. Awareness campaign and community involvement make hispa management more effective. Collection of adult in rice field, hand picking of grubs in the roadside swamps and pits may be encouraged among school children and village youths.

Biological Control

12. Insecticide spraying during October may be avoided, as the natural enemies are more abundant during this period. Apply *Beauveria bassiana* impregnated RHSDRB medium @ 3 kg/ha. On preparing the solution in water containing liquid detergent, the solution will contain 10^7 spores /ml.

Chemical Control

13. Initial protection of the seedlings in the main fields may be provided by following standard package of practices (apply carbofuran 3 g/m² in the moist seed bed 5-7 days before uprooting if seedlings). Seedlings may also be prepared by dipping the root portion in 0.02% solutions of chloropyrifos (1 ml/lit of water) along with 1% urea for 3 hours.
14. All the currently recommended insecticides (Table 1) are effective; however, chloropyrifos and quinalphos show superior performance. Though enlisted as an effective insecticide, the use of endosulfan should be restricted considering its toxicity to aquatic fauna.
15. Spraying operation should be done during early morning and late afternoon hours as the adult activities of hispa are maximum during this period.

Awareness Campaign

16. Bringing people to an understanding of the rice hispa problem is the best way to deal with this problem. Hence farmers, students and youths should be trained up on hispa problem and its management. No programme is more successful than the degree of commitment made by the people involved.

17. Farmers must be educated on the importance of applying recommended insecticides at proper dose and spray volume. It should be kept in mind that application of insecticides at doses below the recommended ones are not effective, rather it produce some undesirable effects, such as development of resistance in insects, resurgence (abrupt increase of target pest) and secondary pest outbreak.

MANAGEMENT OF *PARTHENIUM*

Parthenium (*Parthenium hysterophorous*), commonly known as carrot weed, congress weed, white top, is one of the seven most dreaded weeds of the world. It is a native of Mexico, West Indies, North and South America and believed to have been introduced in India through wheat seeds imported from the USA under PL-480 during 1956. In Assam, within a short span of time, the weed has spread in different places with varying degree of infestation, affecting primarily the roadside vegetation, amusement parks, railway tracts, industrial areas, city dwelling habitats, etc. High seed production ability as well as efficient dispersal mechanism, absence of natural enemies, completion of 3-4 life cycles in a year, adaptability to the extremes of the climate, possessing allelopathic effects, etc. are some important factors enhancing rapid invasion and colonization of the weed. Among the districts, the degree of infestation and abundance are relatively high in Bongaigaon, Kamrup, Golaghat, Tinsukia, Dibrugarh, Jorhat and Nagaon. The abundance of the weed is comparatively less in the districts situated on the North Bank of river Brahmaputra. The weed is also observed in the two hill districts of Karbi Anglong and North Cachar of the state.

For effective control of *Parthenium hysterophorous*, metribuxin 0.2% is recommended.

Control of *Ipopmoea carnea* (BAM-KOLMOU)

For control of *Ipopmoea carnea* (BAM-KOLMOU), application of post-emergence herbicide Glyphosate @ 1.5 kg/ha + 2,4-D (amine salt) as tank mix with a spray volume of 500-600 liter/ha at active growing stage with repetition of the spray when new leaves appear.

CULTIVATION OF MILKY MUSHROOM (*Calocybe indica*)

Special characters of milky mushroom:

1. Can be grown at higher temperatures (28 to 35°C)
2. Good keeping quality
3. Good texture mushroom (texture is retained after cooking)
4. Requires casing similar to that in button mushroom
5. Requires a special type of cropping room
6. Requires more light in comparison to oyster or button mushroom
7. Possesses the highest biological efficiency, up to 140%

Season: May to September

Variety: APK-2 from TNAU, Coimbatore

Steps in cultivation:

Substrate: Wheat straw and paddy straw is the best substrates. Mushroom yield is higher when a blend of wheat straw + paddy straw (1:1 w/w) is used.

Preparation of substrate: Straw is cut into small pieces of 3-5 cm size. It is soaked in cold water for 4 hrs.

Hot water treatment: Water is boiled in a big aluminum sauce pan. The wet straw is immersed in hot water (80-90°C). The boiling of straw is continued for 1 hr.

Sun drying: The boiled straw is spread on a clean cement floor. The straw is allowed to dry for 1 to 2 hrs depending on the prevailing weather. The moisture content of the straw should be brought down to 60 to 70%. Sometimes, the growth of the mycelium is inhibited after one week of spawning. This is the biggest problem in the cultivation of milky mushroom. About 20 to 50% of straw in the beds is colonized by the mycelium of milky mushroom. The remaining portion of straw is not colonized. A clear zone of inhibition is seen at the edge of the white patches of growth. There will be no further colonization of the straw after one week of spawning. Ink caps start emerging from the uncolonised straw.

The major reason for the stoppage of mycelium of milky mushroom is believed to be the excess moisture content in the straw at the time of spawning. Therefore, correct moisture level in the straw is the crucial factor for the mycelial run of milky mushroom.

Spawning: High density polypropylene bags of 30 cm × 60 cm are used. Twenty holes are made with a single punch machine. The bottom of the bag tied with a thread to give a cylindrical shape to the bed. A spawn rate of 5% of the weight of wet straw is used. An increase in spawn rate i.e. above 5% will give faster mycelial run and increase in yield. The bag is filled with alternate layers of straw and spawn. There will be 4 layers of spawn and 5 layers of straw. A ventilation pipe of PVC is placed at the centre of the bed at the time of filling. The beds are incubated at 28 to 30°C for spawn run.

Spawn running: The spawn run is completed in 15 to 20 days. Twenty days old spawn is better for spawn running and mushroom production. Light intensity of 600 to 800 lux favours fast growth of mycelium in beds. The growth of mycelium is slow in darkness. This is a contrasting character between milky mushroom and oyster mushroom.

Casing: Casing means covering the top surface of bags after spawn run with pasteurized casing material in a thickness of 4 cm. Composition of casing soil:

- i. One year old FYM + loam soil 1:1 w/w
- ii. Vermicompost
- iii. Soil + dried moss 1:1 w/w

Besides the above, spent tea waste from tea stalls or ash from burnt rice husk can also be used for blending with casing soil. Moss is the best casing materials because of its water holding capacity. Moss grows on walls in shady places. Chalk powder @ 10% is mixed with the

casing material in order to raise the pH to 8.4. The casing soil is pasteurized in an autoclave or in a pressure cooker at 15 lbs/sq.in. for one hour.

After completion of spawn run the mouth of the bag is opened and folded black. Casing soil is applied above the newly exposed surface of the beds. The beds are kept in special type of cropping room.

Cropping room: The success of growing milky mushroom depends on the design of the cropping room. The Horticultural polyhouse can be converted into a cropping room for milky mushroom, with small modifications. In Assam, temperature during May to September remains below optimum for milky mushroom. The polyhouse is able to increase inside temperature above 30°C. The roof is made of UV stabilized low density polyethylene film. Netlon agro shade of 75% is placed above the UV film in order to reduce the intensity of light. The roof is supported by brick wall on four sides. Bamboo racks with 3-tiers are constructed inside the room. The size of the room is 4.5m in width and 6 to 10m in length. Milky mushroom requires light for spawn run as well as fruiting. Maximum yield of mushroom is obtained when there is 1600 lux light in the cropping room.

Pinning: The pinheads appear 6 to 8 days after casing. The mushrooms attain harvesting stage one week after pinning. A second and third crop of mushroom comes up at 10 days interval. A mist of water is sprayed every day on casing soil. The beds are retained up to 50 days after casing for mushroom production. Mushrooms should be harvested before the cap is fully opened.

Yield: 220g/bed of 1/2 kg straw (dry wt.) in two flushes.

Shelf life: The shelf life of the mushroom is 5-7 days at room temperature. They can be stored in a refrigerator in perforated polypropylene bags for 20 days.

Problems:

1. Growth of mycelium is stopped after one week. Ink caps will emerge from uncolonised straw. This is because of high moisture content in straw. Straw should be dried on a cement floor in bright sun for 2 hrs. The moisture content should be 60-70%. The spawn rate should be increased to 6%.
2. Mother cultures die when stored in refrigerator. Cultures should be kept at room temperature and sub cultured at every 2 month interval.
3. Numerous ink caps of *Coprinus sp.* sprout from casing soil. These ink caps should be nipped everyday, before they open. A light spray of formaldehyde @ 5 ml/l is given over the surface of casing soil just after casing was done, in order to check *Coprinus sp.*

Cooking (Recipes): Milky mushroom has pungency. This is the only negative point. The pieces of mushrooms should be blanched by dipping in boiling water for 2 minutes and then rinsing with cold water. The pungency is removed by this process.

1. Curry

Ingredients:

Milky mushroom – 250g	Onion - 2 nos. big size
Tomato – 2 nos. big size	Turmeric powder – 1 tsp.
Garlic paste – 1 tsp.	Chopped ginger – 1 tsp.
Cinnamon – 3 nos.	Cardamom – 2 pieces
Oil – 3 tbsp.	Salt – to taste

Method:

- i. Chop the onion into pieces and make a paste
- ii. Cut the tomato into pieces and keep aside
- iii. Heat the oil in a *kadahi* and add the cinnamon and cardamom to it.
- iv. Add the onion paste and fry it to golden brown colour at low flame. Pour the tomato pieces and fry till the oils come out and the contents leave the sides of the *kadahi*.
- v. Now add the mushroom pieces and cook at low heat for about 15 minutes.

2. Pickle

Ingredients:

Milky mushroom – 200g Onion paste – 20g
Garlic paste – 1 tsp. Ginger paste – 1 tsp.
Chili power – 1 tsp. Cumin powder – 1 tsp.
Black pepper powder – ½ tsp. Vinegar – 3 tbsp.
Mustard seed powder – 20 g. Turmeric powder – 1 tsp.
Oil – 50 ml. Salt – to taste

Method:

- i. Let the mushroom pieces dry for 1 h after blanching
- ii. Heat oil in a *kadahi*, fry the onion paste till light brown colour. Add garlic and ginger paste and fry for sometime.
- iii. Add cumin powder, chili powder, turmeric powder and the mushroom pieces and fry by stirring.
- iv. Now add mustard powder, vinegar, salt and cook for 10 minutes.
- v. Remove from heat and sprinkle black pepper powder.

Economics of milky mushroom production with a capacity of 5 kg mushroom per day for 100 days in a year

Milky mushroom grows well in the temperature range of 28 to 35°C. It can be grown during the months of May, June, July and August. It needs a special mushroom house with plastic roof for increasing the inside temperature. One hundred days in a year are considered for production of milky mushroom. The same facilities can be utilized for growing oyster mushroom during the remaining period of a year.

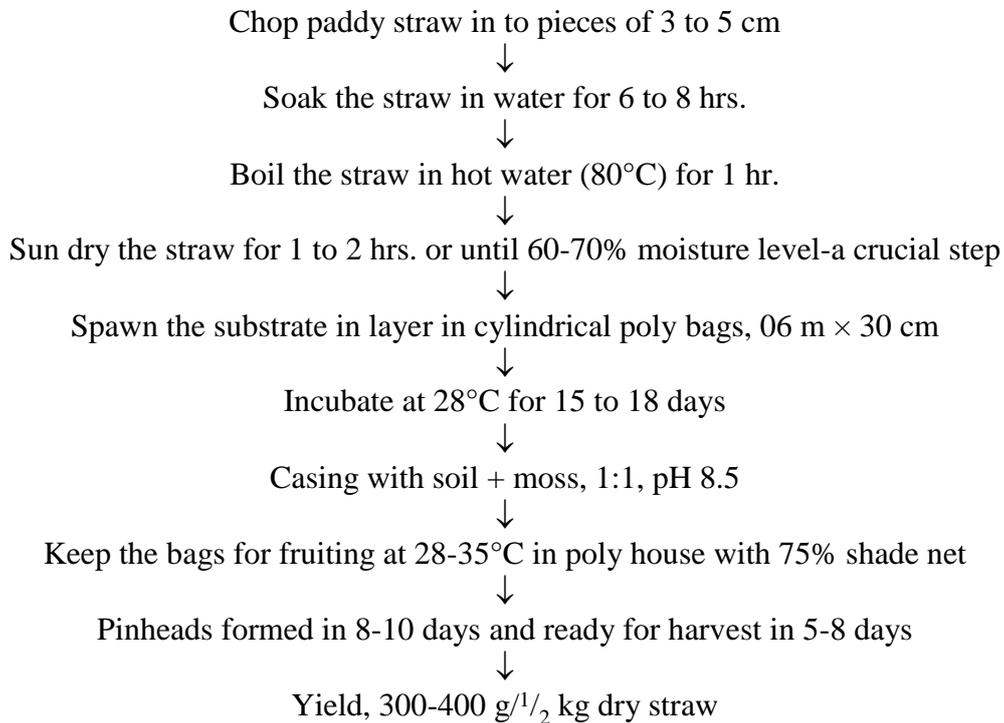
	Rs.
A. Fixed capital	
1. Mushroom cropping room (poly house of 3m × 6m. with a capacity to hold 250 beds at a time	20,000.00
2. Spawn running room with tin roof, 3m × 6m with a capacity to hold 250 beds at a time	20,000.00
3. Chaff cutter, electrically operated	10,000.00
4. Aluminum sauce pan for boiling of straw, 120 litres capacity	3,000.00
5. Sprayers – two	800.00
6. Fuel efficient chullah	1,000.00
Total	54,800.00
B. Fixed cost	
1. Interest @ 10% for 4 months of crop season	1,826.00
2. Depreciation on items 1 to 6 @ 10% for 4 months	1,826.00
Total	3,652.00
C. Working capital	
1. Paddy straw, 0.5 ton	800.00
2. Spawn, 500 packets of 200 g each	5,000.00
3. Polythene bags	1,200.00
4. Labour, 100 man days @ 100/-	10,000.00
5. Fungicides	700.00
6. Miscellaneous	800.00
Total	18,500.00
D. Cost of mushroom production	
1. Working capital plus fixed capital	22,152.00
2. Cost of production of 1 kg of mushroom (1600/500)	44.30
E. Income	
1. By sale of 5 kg mushroom/day @ 80/- for 100 days	40,000.00

- | | |
|-------------------------------|-----------|
| 2. Total cost of production | 22,152.00 |
| 3. Net income out of 4 months | 17,848.00 |

Supply of spawn (seed)

The spawn of milky mushroom is available from April to August in the Department of Plant Pathology, Assam Agricultural University, Jorhat – 785 013, Ph: 0376-2341393.

Cultivation of milky mushroom, *Calocybe indica*



CULTIVATION OF PADDY STRAW MUSHROOM (*Volvarella volvacea*)

Advantages:

- i. Quickest growing mushroom – sowing to harvesting takes only 14 days
- ii. Tastes better as compared to oyster
- iii. Method of cultivation is easy – boiling of straw is not required.

Disadvantages:

- i. The keeping quality of this mushroom is very poor.
- ii. Huge quantity of straw is required.
- iii. Bioefficiency is less – 13-15%, i.e. 100 kg of straw (dry wt.) will give only 13-15 kg of mushrooms.

Season: May to September. The month of August supports maximum production. The optimum range of temperature is 28° to 35°C.

Raw material: Paddy straw is the best substrate. If the straw is of poor quality (exposed to rain), weed mushroom (*Coprinus* sp.) will cause problem.

Steps in cultivation:

Tying of straw into bundles: Straw is tied into bundles of 85 cm length and 12 cm diameter. Each bundle weights 800 g to 1 kg. Twenty four such bundles are required to construct one bed of mushroom. Twenty kgs of straw is required for a standard bed.

Trimming of straw bundles: Both the ends of the bundles are chopped with a hatchet to give sharp ends.

Soaking of straw bundles: The bundles are immersed in water for 12 hrs. Straw bundles are taken out. Excess water is drained off by holding the bundles for a few minutes on bamboo bars.

Bamboo platform: Bamboo platform of 90 cm × 90 cm × 15 cm height is constructed for each bed.

Mushroom house: The size is 3m in breadth, 6 m in length and 1.5 m in height at all sides. The roof is of thatch. The floor is of cement. The walls on all the four sides are made of bamboo. There should be an inner lining of plastic sheet in order to create high humidity and warm temperature. This house can hold 8 beds at a time.

Spawn: Three hundred gram of spawn is required to prepare one mushroom bed of 20 kg straw. The rate of spawning is 1.4% of the dry weight of straw. The spawn is divided into 3 lots- 75g, 75g and 150g.

Red gram dal powder as supplement: Red gram dal powder is absolutely necessary for quick growth of mycelium and optimum yield. Two hundred and forty gram of finely ground dal powder is required for each bed. Divide the powder into 3 parts – 60g, 60g, and 120g.

Construction of mushroom bed:

- Place 6 bundles of straw in a row on the platform.
- Place small bits of spawn in rows at 5 cm distance over the bundle of straw. Seventy five gram of spawn is used for the first layer.
- Leave 7 cm margin on all sides of bed without spawning
- Sprinkle 60 g of dal powder over the bits of spawn.
- Place the 2nd layer of 6 bundles in the opposite direction of the 1st layer.
- Sow 75 g of spawn and sprinkle 60 g of dal powder.
- Put 3rd layer of 6 bundles in the opposite direction of the 2nd layer
- Place 150 g of spawn and sprinkle 120 g of dal powder.
- Cover the bed with a polythene sheet of 2m × 2m and tuck the edges of sheet under the frame.

- Remove the polythene cover after 10 days of sowing. Mushrooms will be ready for harvesting in 13 to 15 days of sowing. Egg stage is the best stage for picking.

Problems: Straw mites (*Tyrophagus dimidiatus*) are the most serious problem. Good control of mites can be achieved by spraying ethion 50 EC @ 2.5 ml/l on straw, one hour before sowing.

Economics

The economics for a cottage unit with a production capacity of 20 kg mushroom in each cropping period of 20 days duration was worked out as follows :

Rs.

A. Fixed capital

1. Mushroom house, 3m × 6m of thatch roof and brick floor with a capacity to hold 8 beds of 1 sq.m at a time	7,000.00
2. Water tank, 1.1m × 1.1m × 1m made of brick and cement	3,000.00
3. Hand sprayer of 5 lt.	700.00
4. Bamboo platform – 8	400.00
5. Polythene sheet of 2 sq. m – 8	160.00
6. Plastic buckets – 2	300.00
Total	11,560.00

B. Fixed cost

1. Interest @ 10% on fixed capital for 20 days (one crop)	63.34
2. Depreciation @ 15% for 20 days	95.00
Total	158.34

C. Working capital

1. Rice straw – 160 kg @ 0.80	128.00
2. Spawn – 2.4 kg @ 50/-	120.00
3. Pigeonpea dal powder – 2 kg @ 50/-	100.00
4. Labour – 7 mandays @ 100/-	700.00
Total	1,048.00

D. Cost of cultivation

1. Working capital including interest on fixed capital	1206.00
2. Cost of production of 1 kg of mushroom (Rs. 785/20 kg)	60.00

E. Income

1. Gross return from 20 kg mushroom @ 80/- in 20 days	1,600.00
2. Net income for 20 days	242.00
3. Net profit from 7 crops in a growing season of 5 months	1,694.00

CULTIVATION OF WHITE BUTTON MUSHROOM (*Agaricus bisporus*)

Button mushroom can be grown in Assam as a seasonal crop

Season: The cropping period is December and January

Species: *Agaricus bisporus*, Strain S-1 1

Yield: 10-14kg/100kg compost.

Preparation of compost: By long method, 28 days. The composting process should be started by 20th September.

Compost formulae:

Rice straw or wheat straw – 1000 kg

Wheat bran – 25 kg

Urea – 18 kg

Gypsum – 35 kg

Water – 3000 litres

The straw is chopped into pieces of 5 cm. A minimum of 3 quintals of straw should be used.

0 – day: Bran, urea mix is blended with the straw. The straw is stacked in a wooden mould of 1.5m height and 1.5m in width. The moisture content of straw should be 75% to 77%. The temperature inside the stack will rise up to 65° – 70°.

1 - day: Wash the compost yard with 2% formalin. Spread the straw up to 9"-12 " height. Pour water for soaking of straw and leave for 24 hrs. Wheat bran and urea are mixed. Water is sprinkled to make it moist. Leave the heap as such for 24 hrs.

6th – day: First turning is given. Break the heap, loosen the straw for exchange of air and restack.

10th – day : 2nd turning is given.

13th – day : 3rd turning is given. Gypsum is added

16th – day : 4th turning is given

19th – day : 5th turning is given

22nd – day : 6th turning is given

25th – day : 7th turning is given

26th – day : Fill the compost in bas.

Spawning: Rate of spawning is 0.5 to 0.7% of the weight of compost. Mix spawn with compost in a clean tub. Fill the compost in polythene bags of 85 cm width and 60 cm height. The depth of compost should be 30 – 35 cm. Compress the compost by hand to drive out the air. Close the mouth of the bag by folding the extremity of the bag. Keep the bags at a temperature of 24°C, in a room with the doors and windows closed. The spawn running will take 3 weeks.

Preparation of casing soil:

Farm yard manure (2 yrs. old) + loam soil (1:1 v/v) or moss + soil (1:1 v/v)

Casing material should have 20% moisture. Pasteurize the casing soil at 80° C for 1½hr. Alternatively, the casing soil can be treated with formalin. For this, mix 1 litre of concentrated formalin with 1 ton of casing soil. Cover the heap for 4 days. The soil is raked every day to allow the fumes to go out. The casing will be free from formalin after 14 days.

Casing: Put a layer of 4 cm thick casing soil. Maintain a temperature of 25°C for 10 days. After complete case run, open the ventilators and let in fresh air. The temperature should be 16° – 18°C for fruiting. Water should be sprayed everyday. Fruiting will start 10 days after case run. Put fresh casing in areas from where mushrooms have been removed.

Economics for an oyster mushroom production unit for a period of 240 days (8 months, 8 crops) is worked out as follows:

Rs.

A. Fixed capital

1. Mushroom house of 6 m × 10 m size with thatched roof and brick floor with a capacity to hold 250 beds at time	7,000.00
2. Spawn running room of same size without brick floor	4,000.00
3. Chaff cutter (manual)	10,000.00
4. Bamboo racks	3,000.00
5. Sprayer (one)	3,000.00
6. Sprayer (two, small)	500.00
7. Bucket (four, large)	2,000.00
8. Hessian cloth	2,000.00
9. Big drum for wetting straw	1,000.00
10. Big an for boiling straw	1,000.00
11. Bamboo mat (Dhari), two	300.00
12. Balance	4,000.00
Sub total	37,800.00

B. Fixed cost

1. Interest @ 10% on fixed capital for 240 days	2,589.00
2. Depreciation @ 15% for 240 days	3,884.00
Sub total	6,473.00

C. Working capital

1. Rice straw (to tons) @ 1000/-per ton	2,000.00
2. Span : 180 kg @ 50/- per kg	9,000.00
3. Polythene bags (60 × 40 cm) @ Rs. 100/- per kg – 10 kg	1,000.00
4. Firewood @ 1000/- per ton – 3 tons	3,000.00
5. Jute/plastic thread @ 100/- per kg – 3 kg	300.00
6. Fungicide/insecticide	500.00
7. Labour : 240 mandays @ 100/- per day	24,000.00
Sub-total	39,800.00

D. Cost of mushroom production

1. Working capital + interest on fixed capital	46,273.00
2. Cost of production of 1 kg mushroom (46273/1400)	33.00

E. Income

1. Gross return from 1400 kg mushroom @ Rs. 80/- per kg in 240 days	1,12,000.00
2. Net income for 240 days	65,727.00

COMMERCIAL PRODUCTION OF BIO-FERTILIZER

The two biofertilizer agents in *Azospirillum* and PSB group, *Azospirillum amazonense* A10 and *Bacillus megaterium* P5 have been found to be superior and their utility as biofertilizer in integrated nutrient management of rice has been demonstrated. The material and steps involved in production of biofertilizers of these microorganisms are presented. These two strains can be cultivated in broth at $30\pm 2^{\circ}\text{C}$. Potato dextrose agar can be used for growing the organisms in broth.

The process of biofertilizer production:

Steps	Material required	Source
A. Cultivation of the strains in culture broth	i. Microbial strain ii. Housing for the equipment iii. (Civil work) iv. Equipments <ol style="list-style-type: none"> A laminar flow Shakers 4 nos. (50 nos. of flask holder platform) or 20 lit capacity fermentor* Autoclave Glass wares Incubator Environmental shaker 	AAU
B. Production/ Purchase of carrier**	From vegetation biomass, rice mill-rice husk ash, rock phosphate mix or charcoal powder	
C. Mixing and packaging	a. Manual mixing or mechanical mixture b. Sealing machine c. Plastic packets d. Carrier material	

* Normally, fermentors are used for cultivation of microbial strains, but to reduce cost, shakers can be used to multiply the strains under ambient temperature with the following schedule.

Production schedule in shaker under ambient temperature

March – Aug	Sept. – Nov.
↓	↓
Use in ahu and sali rice and early rabi vegetable	Use in <i>toria</i> , wheat, vegetables
↓	↓
Can be produced 200 kg in 4 days in 180 days 18,000 kg.	In 90 days, 9000 kg can be produced

Total production in a year using 6 shakers each with capacity to carry 15 flaks of 1 lit capacity is 27,000 kg.

** Production of carrier (compost)

Most biofertilizer producers use charcoal powder as carrier material for the microbial agents. But AAU has developed technique to produce compost as carrier material. The shelf life of the biofertilizer is also longer (eight months) in the compost than in charcoal. For every 1000 kg of compost (on oven dry basis), the requirement is 2105 kg dry mass of

cowdung *sali* rice straw, weed biomass, legume leaf, rock phosphate, lime sludge and rice husk ash. On fresh weight basis the biomass requirement will be 3600 kg during Jan-April. This compost contains 2.3, 2.8, 4.0, 1.26, 0.019 and 0.006% total N, P, K, Ca + mg, Zn and Cu, respectively.

(For every 1000 kg)

Type of materials in the composting mix	Jan-April	May-Sept
<i>Sali</i> rice straw	810	-
Weed biomass	41	800
Legume leaf	82	92
Fresh compost	3.3	3.3
Type of materials in the composting mix	Jan-April	May-Sept
Kalmoce	(In available substitute some % rice straw)	
Water hyacinth	(do)	
Fresh cowdung	16	16
Legume stover	(If available substitute some % rice straw)	
Mustard straw	(do)	
Lime sludge (paper mill waste if available)	16	16
Rock phosphate	16	16
Rice husk ash	12	12
Time of composting (approx)	2½ months	2 months

Since availability of composting materials (raw materials) depends upon the season, the individual entrepreneur will choose most available materials. Although AAU used materials of Jan-April (above) for the research, the nutrient content of the compost prepared from materials of other seasons is not likely to change.

Pit Size for Compost Production: The pit size is 2 m length × 1 m breadth × 20 cm depth. Depending upon availability of composting mix space, manpower and capital, pit number will vary. Each pit accommodates 700-1000 kg composting mix to a height of 100 cm from the surface. Materials in pit are packed in layers. Few bamboo sticks are inserted in the compost heap for aeration.

Stirring, mixing and watering: Occasional stirring is done by shaking the bamboo sticks. After one month materials are remixed once. Watering is done regularly. Covering the heap with jute sheet is useful for conserving moistures.

Materials and labour cost in production of compost per 1000 kg fresh weight

Item	Amount(kg)	Price rate	Amount (Rs.)
<i>Sali</i> rice straw	810	Rs. 50/100 kg	405.00
Weed biomass	41	(1 hr labour cost)	8.00
Legume leaf	82	(2 hr)	16.00
Fresh compost		Rs. 2.00/kg	6.60

Fresh cowdung	16	Rs. 1.00/kg	16.00
Lime sludge	16	Carrying charge	32.00
Rock phosphate	16	Rs. 5.00/kg	80.00
Rice husk ash	12	Carrying charge	2.00
Labour cost in digging pit, setting, stirring, watering etc (7 mandays)			420.00

Rs. 985.00

Cost benefit analysis of biofertilizer production :

Fixed cost:

(1) Equipment cost	:	Rs. 4,55,000.00
(2) Van for transportation	:	Rs. 5,00,000.00
(3) Civil work (3 rooms)	:	Rs. 3,00,000.00
(4) Water and electricity (Installation)	:	Rs. 60,000.00
Total of fixed cost	=	Rs. 13,15,000.00

Running cost for 1000 kg biofertilizer

(1) Culture medium cost (if potato dextrose agar is used the cost will be half)	:	Rs. 7,390.00
(2) Cost of Carrier materials	:	Rs. 1000.00
(3) Electricity and water supply @ Rs. 1000/month)	:	Rs. 444.00
Total	:	Rs. 8834.00

Manpower cost:

For five year: Two skill worker @ Rs. 100.00 day = Rs. 3,60,000.00

One manager @ Rs. 12,000.00 = Rs. 7,20,000.00

Total = Rs. 10,80,000.00

50% of the fixed cost is the amount accounted for five year : Rs. 6,57,500.00

Total production in five years $27,000 \times 5 = 1,35,000$ kg

Total return in five year Rs. $1,35,000 \times 60 =$ Rs. 81,00,000.00

Total cost of production in five years Rs. 6,57,500.00 (fixed cost) + Rs. 10,80,000.00 (manpower) + Rs. 11,92,590.00 (recurrent cost) = Rs. 29,60,090.00

In five years net return = Rs. 81,00,000.00 – 29,60,090.00 = Rs. 51,39,910.00

If even in 25% of *sali* rice area of Jorhat district alone uses biofertilizer based INM the annual demand is 1.35 kg and there lies a profit of ~ Rs. 50 lakhs

Technical guidance: The biofertilizer agents at a nominal charge and free technical guidance will be available from AAU.

METHODS OF APPLICATION OF *Trichoderma* spp.

1. Slurry seed treatment: Take 5-6 g of *Trichoderma* formulation per kg. of seed. Mix well with 10 ml of water. Air-dry the seeds for 30 minutes to 1 hour before sowing.

2. Wet seed treatment/Dip method: Dissolve 20-25 g of *Trichoderma* in 1 litre of water. Dip 1 kg seed or appropriate nos. of seedlings/sets/rhizomes in the solution for 1 hour. Dry under shade for 1 hour before sowing/planting.

3. Soil drenching: Dissolve 20-25 gm of *Trichoderma* in 1 litre of water for spot application by jerry cane or sprayer whenever felt necessary.

4. Soil application:

- Mix 100 kg of dried cow dung with 10 kg of Mustard Oil Cake. Moisten by sprinkling water.
- Add 1 kg commercial formulation of *Trichoderma*, mix thoroughly and cover with news paper or banana leaf for 3 days.
- On 4th day open the cover, mix thoroughly, sprinkle water and cover it again.
- On 7th day mix thoroughly the final product and apply to soil before planting.

For 1 hectare of land, the requirement is approximately 500 kg of dried cow dung, 50 kg. of Mustard oil cake and 5 kg of *Trichoderma* formulation.

SOME ECONOMICALLY FEASIBLE FARMING SYSTEMS

Some of the major farming systems being practiced in different agro-climatic zone of Assam have been presented below. These systems have been identified while carrying out research on Farming System (FSR) under ARIASP. Some of the economically feasible farming systems for different agro-climatic zone of Assam have been worked out by the Nodal Scientific Team and presented below.

(I) Lower Brahmaputra Valley Zone

Crop + Dairy Cow + Goatery + Poultry + Duckery

Crop + Dairy cow + Goatery + Piggery + Poultry + Duckery + Pigeon + Fishery

Crop + Dairy cow + Piggery + Poultry

Crop + Dairy cow + Buffalo + Piggery + Poultry + Duckery + Pigeon

Crop + Dairy cow + Goatery + Poultry + Duckery + Fishery

(II) Central Brahmaputra Valley Zone

Crop + Dairy + Goatery + Poultry + Duckery + Fishery

Crop + Dairy + Goatery + Poultry + Fishery

Crop + Dairy + Goatery + Poultry + Fishery

Crop + Dairy + Goatery + Poultry + Duckery + Pigeon + Fishery

(III) Upper Brahmaputra Valley Zone

Crop + Sericulture + Dairy + Goatery + Duckery + Poultry + Piggery + Fishery

Crop + Dairy + Goatery + Duckery + Poultry + Piggery + Pigeon + Fishery

Crop + Dairy + Duckery + Fishery

Crop + Dairy + Goatery + Duckery + Pigeon + Fishery

(IV) North Bank Plain Zone

Crop + Dairy + Apiary + Fishery

Crop + Dairy + Goatery + Duckery + Piggery + Apiary

Crop + Dairy + Poultry + Apiary + Sericulture

Crop + Dairy + Duckery + Goatery + Piggery + Pigeon + Apiary + Fishery

Crop + Dairy + Goatery + Poultry + Fishery

(V) Barak Valley Zone

Crop + Dairy + Poultry

Crop + Fishery

Crop + Dairy + Fishery

Crop + Dairy + Poultry + Duckery + Fishery + Pigeon

Crop + Dairy + Poultry + Fishery

Crop + Dairy + Fishery + Poultry + Pigeon

(VI) Hills Zone

Crop + Goatery + Poultry + Fishery + Poultry + Sericulture

Crop + Dairy + Goatery + Poultry

Crop + Piggery + Poultry + Fishery + Forestry + Sericulture

APPENDIX I
Disease reaction of recommended rice varieties

Varieties	Reaction to			Remarks
	Leaf blast	BLB	Sheath blight	
Semidwarf:				
Prasad	R			
IR 36	R			
Ratna	R			
Pankaj	T	T	T	Resistant to heat and cold
Biraj	S			
Kmj 1-19-1	-			
Govind	R	R		
IR 50	R		S	
Bala	R		S	
Cauvery	T			
Krishna	S			
TTB 14-1	S			
TTB 15-1	S			
IET 6666 (Lakhimi)	R	T	T	
Tall:				
Monohar Sali	R	R	R	Not susceptible to brown spot and bakanae disease
Mahsuri	S	T	S	
Phulpakhri	T			
Banglami	S			
Rangadaria	S			
Ahujaha	S			
Kolasopila				
Maibee	S			
Dimro	S			

S = Susceptible, T = Tolerant, R = Resistant.

APPENDIX II

IPM Module for managing insect pests of rice in Assam

The IPM module recommended for insect pest management in rice crops of Assam is as follows-

Varietal Resistance: Any resistant/ tolerant variety

Chemical control:

- Seed treatment with carbendazim/ captan/ mancozeb @ 2.5g/kg seed
- Nursery treatment with carbofuran 3G @ 1kg a.i. /ha 5-7 days before uprooting of seedlings
- Need based application of pesticide based on Economic Threshold Level (ETL) (Table 1)

Cultural control:

- Timely planting (as per recommendation)
- Optimum plant population (as per recommendation)
- Balanced fertilizer application and split application of N (as per recommendation)
- Clean cultivation
- Regular pest monitoring (use of pheromone traps @ 8 traps/ha for YSB)

Biological control:

- Release of egg parasitoids *Trichogramma* spp. @ 50,000/ha (six releases) on observing the moths of YSB
- Application of *Beauveria bassiana* impregnated Rice Husk Saw Dust Rice Bran (RHSDRB) medium @ 3kg/ha in 600 litres of water (10^7 spores/ml)

ITKs:

- Use of bamboo perches to encourage predatory birds. Remove the perches as the crop reaches milky grain stage.
- Use of *Eupatorium odoratum* twigs and leaves in the field to repel insects like case worm
- Use of neem leaf (soil incorporation) against case worm and stem borer

APPENDIX III
Technical and Trades Names of Insecticides & Acaricides

Technical name **Trade name**
and formulation

INSECTICIDES

Organochlorine group :

Endosulfan 35 EC	Thiodan, Devisulfan, Endosulfan, Asafan, Hexasulfan, Speed, Endoveer, Thionel, Endocel, Endosaan, Agcel 35, Dawn 35, Endocin, Endomaal 350, Endoset, Endostar, Endotaf, Endovip, Parasulfan, Parrysulfan, Alfasulfan, Spicsulfan
Lindane 20 EC	Agrolindane, Devidayal Lindane 20EC, Dhanuka Lindane, Kilzex 6.5WP, Gamma-001

Organophosphorus group :

Dichlorvos 76% w/w EC	Nuvan, Divap-100, Fast 76 EC, Grovan, Marvex Super, Vepomin, Suchlor, Vapona, Alphavip
Dimethoate 30 EC	Rogor, Tara 909, Daragor 30EC, Demacin, Dimesaan, Dimoken 30, Diveer, Hexagor, Methovip, Parry Dimate, Romal 300, Ultragor, Agromat
Fenitrothion 50 EC	Sumithion, Acothion, Folthion 50, Agrothion, Hexafen, Rentokil, Sandothion, Utkal Fenitrothion
Malathion 5% dust, 50EC	Cythion, Devimalt, Agracide, Malaphos, Malataf, Lakshya 50EC, Hilthion, Agromal 50, Agrithion 50, Rickthion, Kropmal 5D, Alphathion
Monocrotophos 36 WSC	Monocil, Monocin, Monocrown, Monofos, Monokil, Monomol 360, Monosaan, Monostar 36SL, Monoveer, Monovol SL, Monovip, Parryfos, Phoskil, Sufos, Nuvacron, Macrofos, Milphos 36 SL, Monocrotophos, Kadett, Kacil-phos, Atom, Balwan, Bilphos 36SL, Cobra 36SL, Gyphos, Hilcron 36SL
Phosphamidon 100 EC	Dimecron, Cildon, Daracron, D-Don, Deecron, Hydon, Har-Agrophosphamidon, Parrydon, Phosmin, Polycron 850, Rickdon, School, Sumidon, Alphadon
Quinalphos 5% G, 25EC	Bayrusil, Ekalux, Flash, Krush, Nag 25 EC, Quinalmol 250, Quinaltaf, Quinalveer, Quinalvip 25EC, Quinasaan, Quinocin, Spicquinal 25EC, Starlux 25EC, Suquin, GrowLux
Chlorpyrifos 20 EC	Blaze, Chlorosan, Chlorvip, Classic 20, Dursban, Fantom 20EC, Gayachlor, Gold 25EC, Growban, K-BAN, Lethal, Mig

	20TC, Pyrivol, Radar 20, Strike 20EC, Suban 20EC, Tricel 20EC, Trishul 20EC, Durmet, Coroban, Pestaban, Kargroban, Agrofos, Ruban
Phorate 10G	Forcin, Parry-tox, Phoromol 505, Phoril, Sandartox, Srifort, Thimet, Tuskar, Volphor, Granutox, Phoratox
Parathion methyl 20% dust, 50 EC	Folidol, Metacid 50, Agrogold, Agrothion, Daracid 50EC, Devithion, Growcid, Kemidol, Missile 50, Rickmethyl, Alphamethyl, Sutacid
Oxydemeton-methyl 25 EC	Metasystox, Hymax, Kemptox 25EC, Metamol 250, Sritox 25, Superkiller 25EC
Fenthion 100 EC	Lebaycid-1000
Diazinon 10G	Basudin 10G, Deviginon, Ditaf, Suzon, Vinash
Formothion 25EC	Anthio, Sandothion
Phosalone 35EC	Zolone 35EC
Carbamate group	
Carbaryl 5% dust, 10% dust, 50% WDP	Sevin 50WP, Sevin Flo 42% , Taffin5DP, Taffin 50WDP, Sevidol 4:4G (Carbaryl + Lindane)
Carbofuran 3G	Furadan, Carbogran, Difuron 3G, Furin, Hexafuron
Biopesticide	
<i>Bacillus thuriangiensis</i> var. <i>kurstaki</i>	
Delfin, Halt	
Acaricides	
Organochlorine	
Dicofol 10% 5% EC	Kelthane, Colonel-S, Dicomol 185, Diumite, Flush 18.5EC, Hexakel, Hondakel, Hycofol
Organophosphorus	
Ethion	Ethion 50EC, Acaron, Dhanumit, Force 50EC, Fosmite, Gromit, MIT 505, Rickmit, Alphamit, Srimite 50, Tafethion, Veer

APPENDIX IV

Technical and Trade Names of Fungicides/Antibiotics/Plant Products/Antagonists

<u>Technical name</u> <u>and formulation</u>	<u>Trade name</u>
A. Inorganic copper compounds	
Copper oxychloride	Akomin, Blitox-50, Fytolan, Kilex, Fycop, Nagcoper, Dhanucop, Fycop, Blue Copper 50, COC 50WP, Copsaan, Coprex, Copsin, Cupravit, Hondacop
B. Elemental inorganic sulphur compounds	
Wettable sulphur	Hexasul, Thiovit, Sulfex, Akrisulf, Appu, Cosavet-DF, Microsulf, Mitex S, Pesto Sulfur 80WP, Sulfasaan, Sulphur 85WP
C. Organic sulphur (carbamates)	
Mancozeb	Dithane M-45, Indofil M-45, Uthane M-45, Abis M-45, Amicozeb, DARA m-45, Dhanuka M-45, Hilthane M-45, Hondazeb M-45, Kamyab 75WP, Kohinoor M-45, Kosib, Manocin, Mancokil 75, Manzate 75, Parry M-45, Pradhan 75WP, Rasayan M-45, Raze M-45, Sandozeb, Savior M-45, Shaktiman, Shield 75, Sparsh, Veer M-45, Zeb 75, Zebra, Zebtane
Ziram	Cuman L, Dhanuka Z-27, Fuksalin
Thiram	Thiram-75, Agrorum, Furam
Zineb	Dithane Z-78
D. Heterocyclic nitrogenous compound	
Captan	Captan 75 WP, Captaf 75 WP, Hexacap, Kohicap, Phytocap, Topas
E. Miscellaneous fungicide	
Dinocap	Karathane
F. Systemic fungicide	
Carbendazim	Bavistin 50WP, Bavistin 5G, Derosal, Dhanustin, Agni, Akozim, Bensaam, Carsin, Polystin 500, Shark 50WP, Sten, Volzim
Carboxin	Vitavax, Hiltavax
Edifenphos	Hinosan
Pyroquilon	Fongoren
Thiophanate methyl	Topsin- M 70 WP, Roko 70 WP, Alert, Baynet, Maxim, Milduvip
Tridemorph	Calixin
Tricyclazole	Beam, Trooper
Propiconazol	Tilt, Radar

IBP	Kitazin 50 EC
Hexaconazole	Sitara, Hexazole, Montaf, Contaf
Propineb	Antracol

G. Combo fungicide (Mixture)

Metalaxyl 8% + Mancozeb 64%	Ridomil MZ 72, Krilaxyl MZ 72, Unilax, Matco
Carbendazim 12% + Mancozeb 63%	Saaf, Companion

H. Antibiotics

Streptomycin sulphate +Tetracycline	Streptocyclin
Hydroxy quinoline	Entakon-M

I. Fungal antibiotics

Validamycin	Sheathmar
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K. Plant derived products

Neem products	Achook, Neemazal, Neem Gold, Nimin (neem oil)
Cymbopogon product	Wanis

L. Antagonists

<i>Pseudomonas fluorescens</i> based product	Biofor-PF (Jaiva Kiran), Pseudocon
<i>Trichoderma</i> spp. based products	Bicure F, Trich-X-P, Viricon-L, Bioderma, Trichostar

APPENDIX V

Technical and Trade Name of Herbicides

<u>Technical name and formulation</u>	<u>Trade name</u>
2,4-D	Fernoxone, 2,4-D/28L, Agrodone 48, Agrodone 18WP, Agroweed 34EC, Allout 34 EC, Champion 78SL, Cut-out, Herbonil 34EC, Knockweed 38, Weedburn 38EC, Weedkil 38EC
Butachlor	Punch, Delchlor, Agrochlor 50EC, Alachlor Terr, Butakil 50, bilchlor, Buchlor, Bumper 50, Butacin, Butaveer, Butamol 500, Darachlor 50EC, Hiltachlor 50EC, Trapp 50, Widkil
Fluchloralin	Basalin
Diuron	Karmex, Diuron, Agromex- Diuron WP, Klass, True 80WP
Atrazine	Atrataf, atramol 500, Mebazine, Solano 50WP, Srizon
Dalapon	Dowpon, Dalapon
Isoproturon	Graminon, Arelon, Taurus, Delron, Agrolon, Avonil, Bilron 75WP, Dararon 75WP, Dhar, Gold Medal, Haragron 75, Hilproturon 75WP, Iso 50, Isocin, Isof\guard 75WP, Isokil 75, Isomol 750, Isopar, Isoveer, Isovip, Nocilon 75
Simazine	Tefazine, Aquazine, Salute 50WP, Weedex
Methabenzthiazuron	Tribunil
Pretilachlor	Rifit
Anilofos	Arozin, Aninoguard, Anilokil 30, Anilotaf, Anilveer, Avail 30EC, Dhanumon, Sardar Guard, Strong 30EC, Surya, Weedonil

APPENDIX VI

Technical and Trade Name of Rodenticides, Fumigants and Nematicides

**Technical Name
and formulation**

Trade name

RODENTICIDES

1. Aluminium Phosphide
2. Zinc Phosphide

Celphos, Phostoxin, Quickphos
Ratox, Zinc Phosphide, Ratol,
Commande

3. Warfarin

Ratafrin, Rodafarin Warfarin

NEMATOCIDE:

Carbofuran

(Please see Appendix II)

Micronutrient formulation

Tracel, Agromin, Borax
Sulphate, Zinc Sulphate

APPENDIX VII A

Conversion Table (Nutrient-Fertilizer)

1 kg N	2.17 kg Urea
1 kg P ₂ O ₅	6.25 kg SSP
1 kg K ₂ O	1.66 kg MOP
1 kg DAP	2.875 kg SSP and 400 g Urea
1 kg N + 1 kg P + 1 kg K	6.66 kg Sulphala (15-15-15)

APPENDIX VII B

Conversion Table (Area)

1 hectare	=7.5 bigha	=10,000 sq.m
1 katha	=0.2 bigha	=267 sq.m
1 bigha	=0.13 hectare	=5 katha
	=1333 sq.m	

APPENDIX VIII

Micro Preparation and Measurements for Agro-Chemicals

Micro Preparation

1 milligram of substance in 1 litre of water = 1 parts per million (ppm) solution

Measurements for agro-chemicals

1 tea spoonful of liquid chemical = 5 ml (approx.)
1 matchbox full of powdered chemical = 7-9 g (approx.)

APPENDIX IX

Pesticide calculation formulae

$$1) \text{ Pesticide required} = \frac{\text{RR} \times \text{A} \times 100}{\% \text{ a.i.}}$$

Where- RR = Recommended rate
A = Area in ha
% a.i. = Per cent active ingredient in the formulation

$$2) \text{ Millilitre of pesticide to be mixed per litre of water} = \frac{\text{DC} \times 100}{\% \text{ a.i.}}$$

Where- DC = Desired concentration (%)
% a.i. = Per cent active ingredient in the formulation

Appendix X

Ready reckoner for milliliter or grams of a commercial pesticide to be added to one litre of water in order to obtain the required concentration of spray solution

Toxicant in the pesticide(%)	Concentration (%) of the spray solution required													
	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.20	0.30	0.40	0.50
10	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	20.00	30.00	40.00	50.00
15	0.67	1.33	2.00	2.67	3.33	4.00	4.67	5.33	6.00	6.67	13.33	20.00	26.67	33.33
20	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	10.00	15.00	20.00	25.00
25	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00	8.00	12.00	16.00	20.00
30	0.33	0.67	1.00	1.33	1.67	2.00	2.33	2.67	3.00	3.33	6.60	9.90	13.33	16.67
45	0.22	0.44	0.89	0.88	1.11	1.33	1.56	1.78	2.00	2.22	4.44	6.66	8.89	11.11
50	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00	4.00	6.00	8.00	10.00
55	0.18	0.36	0.55	0.73	0.93	1.10	1.27	1.45	1.64	1.81	3.64	5.45	7.27	9.09
60	0.17	0.33	0.50	0.67	0.83	1.00	1.17	1.33	1.50	1.67	3.33	5.00	6.67	8.33
65	0.15	0.31	0.46	0.61	0.77	0.92	1.08	1.23	1.38	1.54	3.08	4.62	6.15	7.69
70	0.14	0.29	0.43	0.57	0.71	0.86	1.00	1.14	1.28	1.42	2.85	4.28	5.71	7.14
75	0.13	0.27	0.41	0.53	0.67	0.80	0.93	1.07	1.20	1.33	2.67	4.00	5.33	6.67
80	0.13	0.25	0.38	0.50	0.63	0.75	0.89	1.00	1.13	1.25	2.50	3.75	5.00	6.25
85	0.12	0.24	0.35	0.47	0.59	0.71	0.82	0.94	1.06	1.18	2.35	3.53	4.71	5.88
90	0.11	0.22	0.33	0.44	0.56	0.67	0.78	0.89	1.00	1.11	2.22	3.33	4.44	5.55
95	0.11	0.21	0.32	0.42	0.53	0.63	0.74	0.84	0.95	1.05	2.11	3.16	4.21	5.26
100	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00

APPENDIX XI

Package of practices for Rodent management in rice

1. Synchronous planting/harvesting
2. Bund trimming (>20 cm).
3. Regular trapping with local bamboo traps preferably one month after transplanting.
4. Clean cultivation to reduce alternate source of food, particularly weeding of tall weeds on bunds such as *Eleusine indica*.
5. Two applications of bromadiolone 0.005% as cake, first at panicle initiation stage and second at milky stage of rice crop.
6. Poison baiting is also essential for rodent pest management. Prebait prepared out of 1 kg cereal + 20 gm vegetable oil + 10 gm dried fish may be applied @ 10 gm/live burrow for 3 days. This treatment should be followed by addition of Zinc phosphide @ 25 gm/kg bait on the 4th day.

APPENDIX XII A

Pesticides banned for manufacture, import and use in India (25 nos.)

Source: Central Insecticides Board & Registration Committee, Directorate of Plant Protection,
Quarantine & Storage, Ministry of Agriculture, Faridabad
(Web site: http://www.cibrc.nic.in/list_pest_bann.htm)

1. Aldicarb
2. Aldrin
3. Benzene Hexachloride
4. Calcium Cyanide
5. Chlorobenzilate
6. Chlordane
7. Copper Acetoarsenite
8. Dibromochloropropane (DBCP)
9. Dieldrin
10. Endrin
11. Ethylene Dibromide (EDB)
12. Ethyl Mercury Chloride
13. Ethyl Parathion
14. Heptachlor
15. Maleic Hydrazide
16. Menazon
17. Nitrofon
18. Paraquat Dimethyl Sulphate
19. Pentachloro nitrobenzene (PCNB)
20. Pentachloro phenol (PCP)
21. Phenyl Mercury Acetate (PMA)
22. Sodium Methane Arsonate (MSMA)
23. Tetradifon
24. Toxaphene
25. Trichloro Acetic Acid (TCA)

APPENDIX XII B

Pesticides/Pesticide formulations banned for use but their manufacture is allowed for export (2 nos.)

1. Nicotene sulfate
2. Captafol 80% powder

APPENDIX XII C

Pesticides withdrawn (8 nos.)

1. Dalapon
2. Ferbam
3. Formothion
4. Nickel Chloride
5. Paradichlorobenzene (PDCB)
6. Simazine
7. Warfarin
8. Metoxuron

APPENDIX XII D

Pesticides restricted for use in India (12 nos.)

1. Aluminium Phosphide
2. DDT
3. Lindane
4. Methyl Bromide
5. Methyl Parathion
6. Sodium Cyanide
7. Methoxy Ethyl Mercuric Chloride (MEMC)
8. Monocrotophos (banned for use on vegetables)
9. Endosulfan (banned in the state of Kerala)
10. Fenitrothion
11. Diazinon (banned for use in agriculture)
12. Fenthion (banned for use in agriculture)

APPENDIX XIII

Pest Management Rating of Commonly Used Insecticides

Insecticide	Mammalian Toxicity rating	Non-target Toxicity rating				Environmental Average	Overall Persistence rating	Overall Rating
		Fish	Bird	Bee				
Azinphos-methyl	4	3	2	4	3.0	3	10.0	
<i>Bt</i>	1	1	1	1	1.0	31	3.0	
Carbaryl	2	1	1	4	2.0	2	6.0	
Carbofuran	5	2	5	5	4.0	3	12.0	
Carbophenothin	4	2	4	4	3.3	2	9.3	
Chlorpyriphos	3	3	3	5	3.7	3	9.7	
Cryolite	1	1	1	2	1.3	4	7.3	
Demeton	5	2	5	2	3.0	2	10.0	
Diazinon	3	2	5	4	3.7	3	9.7	
Dicofol	2	1	2	1	1.3	4	7.3	
Dischlorvos	-	Toxic	-	Toxic				
Diflunenzuron	1	1	1	4	2.0	4	7.0	
Dimethoate	3	1	4	5	3.3	2	8.3	
Endosulfan		4	4	2	22.7	3	9.7	
EPN	4	2	3	4	3.0	4	11.0	
Ethion	3	2	3	-	-	2	7.0	
Fenvalerate, Permethrin	2	4	2	5	3.7	2	7.7	
Malathion	2	2	1	4	2.3	1	5.3	
Methomyl	4	4	3	4	3.7	2	9.7	
Methoprene	1	1	1	2	1.3	2	4.3	
Methoxychlor	1	3	2	1	2.0	2	5.0	
Mevinphos	5	3	5	4	4.0	1	10.0	
Naled	2	2	3	4	3.0	1	6.0	

Insecticide	Mammalian Toxicity rating	Non-target Toxicity rating				Environmental Average	Overall Persistence rating	Overall Rating
		Fish	Bird	Bee				
Ovex	1	2	1	1	1.3	4	6.3	
Oxydemeton methyl	3	2	4	2	2.7	2	7.7	
Phorate	5	4	5	2	3.7	3	11.7	
Quinalphos	-	Safe	-	Toxic	-	-		
Phosphamidon	4	1	5	3	3.0	2	9.0	
Stirofos	1	4	1	4	3.0	1	5.0	
TEPP	5	2	5	5	4.0	1	10.0	
Trichlorfon	2	1	2	1	1.3	1	4.3	

N.B.

- A. Lower the rating safer the insecticides.
- B. The insecticides *viz.*, endosulfan, phorate, stirofos, fenvalerate, methomyl are highly toxic to fish; hence their use should be restricted in fish cum paddy culture.
- C. Insecticides such as azinphos-methyl, carbaryl, carbofuran, carbophenothionm, chloropyriphos, diazinonm, fenvalerate, diflubenzuron, dimethoate, mevinphos, EPN, methomyl, malathion, naled, stirophos, TEPP, dichlorovos and quinalphos are highly toxic to bees, hence their use should be restricted in the oilseeds, vegetables and fruit orchards.
- D. All insecticides mentioned in the list do not necessarily constitute our recommendation and the rating is based on available literature.