

**PACKAGE OF PRACTICES
FOR
RABI CROPS OF ASSAM
2009**

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&
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FOREWORD

The Workshop on Package of Practices for *Kharif & Rabi* crops of Assam was jointly organized by Assam Agricultural University, Jorhat and Department of Agriculture, Govt. of Assam, Guwahati at A.A.U., Jorhat on January 21, 2009, where a good number of new crop varieties and technologies were recommended for the farming community of the state. In this Handbook on “Package of Practices for *Rabi* Crops of Assam” the recommended crop varieties and technologies have been incorporated.

It is hoped that this publication will be of great help to farmers, scientists and extension workers of Assam.

I wish to keep on record my thanks and appreciation to the editorial group which checked the manuscript and improved the presentation.

May 18, 2009

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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*)

Boro Rice

Varieties:

Variety	Sowing time	Planting time	Harvesting time	*Duration (Days)	#Agro-climatic Zone	Average yield (t/ha)
Boro 1	Nov.	Dec./Jan.	Apr./May	150	N,U,C,L,B	3.0
Boro 2	Nov.	Dec./Jan.	May	165	N,U,C,L,B	3.0
Culture 1	Nov.	Dec./Jan.	Mid April	140-145	N,L,B	2.0
Kalinga 3	Nov.	Dec./Jan.	Mid May	175	U,L	3.0
Krishna	Nov.	Dec./Jan.	April	145-155	B	3.5
**Mahsuri	Oct.	Nov./Dec.	May	180-190	N,U,C,L	4.0
**IR-50	Nov./Dec.	Dec./Jan.	Apr./May	155-160	C,B	3.0
Cauvery	Nov./Dec.	Dec./Jan.	Apr./May	150-155	B	3.0
Banglami	Nov./Dec.	Dec./Jan.	Apr./May	155-160	B	3.5
Joymati	Nov./Dec.	Dec./Jan.	May/Jun.	175	C,L	5.1
Bishnuprasad	Nov./Dec.	Dec./Jan.	Apr.	165	All zones	4.5
Jyotiprasad	Nov./Dec.	Dec./Jan.	Apr.	165	All zones	4.5

Newly recommended varieties:

Variety	Sowing time	Planting time	Harvesting time	*Duration (Days)	#Agro-climatic Zone	Average yield (t/ha)	Disease reaction
Dinanath	Nov	Dec./Jan.	Apr./May	160-165	N,U,C,L,B	6.28	MR to blast & sheath blight
Swarnabh	Nov	Dec./Jan.	Apr./May	160-165	N,U,C,L,B	6.16	R to blast & MR to sheath blight
Kanaklata	Dec	Jan-Feb	May/June	165-175	U,C,L,B	5.0-5.5	T to BLB & Sheath blight; MS to blast & sheath rot

- * Durations of the varieties are based on experiments at RARS, Titabar. In areas with slightly higher winter temperature the duration will be shortened.
- ** Not recommended for blast endemic areas
- # Refer to page iii for full forms of the abbreviations

Land selection: Low-lying typical boro areas or irrigation command areas are to be selected.

Seed selection: Seeds are to be put in plain water and the healthy seeds be selected.

Seed treatment with chemicals:

(a) **Wet method:** After selection, the seeds are to be soaked directly in any one of the following fungicidal suspensions for 24 hrs.

Fungicide	Concentration (g/lit of water)	Cost of fungicide to treat seeds required for one ha
Mancozeb	2.5	Rs. 34.00
Captan	2.5	Rs. 40.00
Carbendazim	1.0	Rs. 56.00

One litre of fungicidal solution is required to treat one kg of seed.
Seed selection in water Fungicidal ->24 hrs.
Incubation for - >48 hrs.

(b) **Dry method:** Seeds and any one of the following fungicides are to be put in a closed container and then agitated for five minutes for thorough mixing.

Fungicide	Concentration (g/lit of water)	Cost of fungicide to treat seeds required for one ha
Mancozeb	2.5	Rs. 34.00
Captan	2.5	Rs. 40.00
Carbendazim	2.5	Rs. 56.00

Raising of Seedlings:

(a) Seed-bed Preparation:

Flat seedbed is recommended. Beds should be 125 cm wide and 10 m long with 30 cm gap in between two beds. Six to eight such beds are required for transplanting 1 bigha. Low polytunnel (height: 75cm, width: 125cm, length: as per convenience) should be used for raising seedlings during cold period (end of December to mid January). Poly tunnel is a portable structure constructed with polythene sheet fixed on to a frame made of bamboo sticks. The structure is placed over the seedlings on the seed bed to ensure favourable temperature for the growing seedlings. Any gap between the polytunnel and the soil should be sealed with mud, to maintain warmth inside the tunnel during night. The structure should be removed for 1-2 hrs daily, starting from the 7th day before uprooting in order to allow the seedlings to acclimatize. The duration of removal should be increased gradually and the seedlings should finally be kept completely exposed for about 2 days.

(b) Seed rate:

Pre-germinated seeds are to be sown @ 650g-1kg per bed. Seed requirement for transplanting one ha of main field is 40-45 kg.

(c) Plant protection in seed bed:

- a) Spraying with carbendazim @ 1 g/lit of water or ediphenphos 1 @ 1 ml/lit of water is to be done as soon as one-two blast spots are seen.
- b) In root-knot nematode and stem borer endemic areas, carbofuran granules @ 3 g/sq.m or phorate @ 1 g/sq.m or Diazinon @ 1 g/sq.m is to be applied after 5 days of sowing.

In case, nematode is not a problem any one of the following schedule is followed for control of nursery insect pests as and when

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necessary. Generally an insecticidal spray at 5 to 7 days after sowing is effective against most pests

Insecticide	Dosage (ml/10 sq.m)
Chlorpyrifos	0.10
Quinalphos	0.15
Monocrotophos	0.12
Phosphamidon	0.07
Endosulfan	0.14

High volume spray: 400 ml of water/10 sq.m

Low volume spray: 100 ml of water/10 sq.m

(d) Preparation of seedlings for initial protection in the main field

After washing the roots of the uprooted seedlings the root portion is to be dipped in 0.02% solution of chlorpyrifos (1 ml/lit of water) along with 1% urea for 3 hrs. as a protective measure against stem borer, gall midge and hoppers.

Alternatively, either carbofuran @ 3 g/sq.m or phorate 1 g/sq.m may be applied in the seed bed 5 to 7 days before uprooting of seedlings, or chlorpyrifos 0.05% may be sprayed in the nursery bed before uprooting of seedlings.

(e) Age of seedlings:

5-6 leaf stage is suitable for planting.

Field preparation:

The field should be ploughed 3-4 times followed by laddering. Leveling should be done properly to retain water uniformly in the field.

Cereals : Boro Rice

Fertility Management:

Land situation	Nutrient requirement (kg/ha)			Fertilizer requirement (kg/bigha)		
	N	P ₂ O ₅	K ₂ O	Urea	SSP	MOP
Low lying area	0	0	0	0	0	0
Periphery of low-lying area	40	20	20	12	18	4
Irrigated area	60	30	30	18	27	6

N.B. For Barak Valley Zone and Central Brahmaputra Valley Zone, in the periphery of low lying area NPK dose of 20:10:10 kg/ha (5 kg urea, 9 kg SSP and 2 kg MOP/bigha is recommended).

Time of application:

In marshy areas whole of super phosphate and muriate of potash is to be applied and entire quantity of urea is to be top dressed after 21-25 days of transplanting. For irrigated area, 1/3rd urea as basal and 1/3rd at the time of tillering and the remaining part at panicle initiation stage are to be applied. Super phosphate can also be incorporated into the soil at active tillering stage 25-35 days after transplanting along with second dose of N.

Transplanting:

Variety	No. of seedling per hill for marshy area	Depth of planting (cm)	Spacing row × plant (cm)
Mahsuri, Boro 1, Boro 2	2	5	25×20
Kalinga 2, Krishna	2	5	20×20
Culture 1 (Kalinga 3)	3	5	20×20

Gap filling:

The dead hills are to be replanted within 7-10 days of transplanting.

Water management:

Irrigation water is to be applied to maintain 5±2 cm of standing water in the field after 2-3 days of transplanting upto 7-10 days before harvest. But under constrained availability of water, 7 cm irrigation water may be applied one day after disappearance of ponded water.

Interculture:

Two weedings are to be given preferably at 20 and 40 days after transplanting. Weeder can also be used after top dressing to incorporate the nitrogenous fertilizer with the soil.

Pre-emergence application of pretilachlor 0.75kg a.i./ha or butachlor 1.0kg a.i./ha followed by rotary paddy weeder at 40 days after transplanting.

Plant protection:

Insect Pests:

Plant protection measures to be adopted against insect pests at their Economic Threshold Levels (ETLs) are given in the Table 1.

Diseases:

Blast: As soon as one or two spots on leaf are seen, the following spraying schedule is to be followed immediately.

Fungicide	Concentration
Ediphenphos	0.1% (1 ml/lit)
Mancozeb	0.2% (2g/lit)
Cu-oxychloride	0.4% (4g/lit)
Thiophanate methyl	0.1% (1g/lit)
Carbendazim	0.1% (1g/lit)

Volume of spray solution required is 525-750 lit /ha.

Spraying is repeated at 10-15 days intervals till the disease is controlled.

Sheath blight:

For control of this disease, carbendazim @ 0.05% (0.5 g/lit) or hexaconazole (2 ml/lit) @ 525-750 lit of spray solution/ha is to be sprayed. Two sprays are required, the first at the appearance of the disease and another 10 days after the first spraying.

**Rice (*Oryza sativa*)
Hybrid Boro rice**

Varieties:

Variety	Duration (days)	Yield (t/ha)
Pro Agro 6444	170-175	7.5
DRRH 1	165-170	7.1
KRH 2	175-180	6.0

Land selection: Area with assured irrigation facilities are to be selected.

Seed treatment:

a) Wet method: Seeds are to be soaked directly in any one of the following fungicidal suspensions for 24 hours.

Fungicide	Concentration (g/lit of water)
Mancozeb	2.5
Captaf	2.5
Captafol	2.5
Carbendazim	1.0

b) Dry method: Seeds and one of the following fungicides are to be put in a closed container and agitated for five minutes for thorough mixing.

Fungicide	Concentration (g/kg of seed)
Mancozeb	2.5
Captaf	2.5
Captafol	2.5
Carbendazim	2.0

Raising of seedlings:

Seed bed preparation: Flat seed bed with 1.25m width, 10.0m length and 30cm gap between two beds is to be prepared. Land is to be thoroughly puddled.

Seed rate: Pre-germinated seeds are to be sown @ 250-300g/bed. Seed requirement for transplanting one hectare of main field is 7.5kg.

Manures and fertilizers : 20-30kg FYM or compost, 80g urea, 80g SSP and 40g MOP are to be applied in each bed.

Sowing time: 15-30 November

Water management: Standing water in the furrows between beds is to be kept to maintain saturated condition in the seed beds. Irrigation up to submergence of beds before uprooting of seedlings facilitates the process.

Plant protection: Same as *boro* rice.

Preparation of seedlings for initial protection in the main field:

After washing of roots of the uprooted seedlings, the root portion is to be dipped in 0.02% solution of chlorpyrifos (1ml/lit of water) along with 1% urea for 3 hours as a protective measure against stem borer, gall midge and hoppers.

Age of seedling: 45 days old seedling (5-6 leaf stage).

Main field preparation:

1. The field should be ploughed properly and leveled to retain water uniformly in the field.
2. First irrigation for soaking the land is to be applied before preparatory tillage. Second irrigation is to be applied at 10-12 days prior to transplanting followed by ploughing, laddering and puddling accompanied by repairing and mud plastering of bunds. Thereafter, irrigation is to be applied for land submergence.

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3. The final puddling is to be done just before transplanting. One irrigation is to be applied before final puddling.

Fertility management:

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	100	Urea	217	29
P ₂ O ₅	60	SSP	375	50
K ₂ O	60	MOP	100	13

Time of application of fertilizer: One fourth of total urea, full doses of SSP and MOP at the time of final puddling are to be applied as basal dressing. The 2nd one fourth, 3rd one fourth and 4th one fourth of urea are to be applied as top dressing and incorporated with soil at maximum tillering, panicle initiation and booting stages, respectively.

Spacing: 20cm X 15cm (33 hills/sq.m)

No. seedlings per hill: 1(one)

Depth of planting: 5cm.

Gap filling: The dead hills are to be transplanted within 7-10 days of transplanting.

Water management: Irrigation water is to be applied at a depth of 5cm 3 days after disappearance of ponded water from transplanting.

Intercultural operation: Two weedings are to be given at 3-4 weeks and 6-7 weeks after transplanting. Paddy weeder can be used after top dressing to incorporate the nitrogenous fertilizer with soil.

Plant protection: Plant protection measures against insect pests and diseases are same as for *boro* rice.

**Rice (*Oryza sativa*)
Early Ahu (Direct Seeded)**

Varieties:

Varieties	#Agroclimatic zone	Duration (days)	#Reaction to blast
A. Semi Dwarf			
IR50*	U,C	110-120	S
Bala	N	110-120	T
DR92(Subhadra)	N	115-125	S
Pusa 2-21*	N,U,C,L	120-125	S
Cauvery	L	115-120	T
Rasi	N,U,L	125-130	T
IR36		120-130	-
Culture 1 (Kalinga 3)	N,U,C,L	90-100	T
Luit	N,U,C,L	95-100	T
Kapilee	N,U,C,L	95-100	T
B. Tall			
Ch63	N,C	120-130	T
Banglami	N,L	115-120	S
Rangadoria	N,U	115-120	S
Dubaichenga	N,U	115-120	S
Ahujaha	N	110-120	S
Dagaranga	N	85-95	S
Kalasopila	C	-	-
Ihajit	C	-	-
Panjasali	C,L	110-115	S
Fapori ahu	C	-	-
Koijapori	L	95-105	S
Hasakumra	L	80-85	-
Guni	L	80-85	S
Kolamanik	L	115-120	S
Koimurali	B	95-100	-
Nilajee	U,L	-	S
Harin Kajali	L	115-120	-

*Not recommended for blast endemic areas

Refer to page iii for full forms of the abbreviations

Newly recommended variety:

Variety	Plant height (cm)	Duration (days)	Sowing time	Transplanting time	Age of seedlings (days)	Yield (q/ha)	*Agro-climatic Zone	Disease reaction
Kanaklata	125	130-135	February	March	25-30	40-45	U,C, L,B	MS to blast & sheath rot, and T to BLB & sheath blight

Land selection

Low lying areas having sufficient soil moisture even during January and February should be selected.

The land should be prepared by ploughing 3 to 4 times followed by laddering. Proper leveling has to be done so as to retain water uniformly in the field..

Fertility management:

Compost or FYM @ 10 t/ha (15 q/bigha) is to be applied during initial ploughing.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
A. Dwarf variety				
N	40	Urea	88	12
P ₂ O ₅	20	SSP	125	18
K ₂ O	20	MOP	33	4
B. Tall variety				
N	20	Urea	44	4
P ₂ O ₅	10	SSP	62	9
K ₂ O	10	MOP	16	2

N.B.: For problem areas, like flood affected areas of Majuli, where farmers have to take some risk in growing early *ahu* crop before flood, need-based fertilizer is to be recommended.

In absence of SSP, Diammonium phosphate (DAP) can be applied in proportion to the quantities of N and P₂O₅ as suggested above.

1. Full dose of phosphatic fertilizer is to be applied at the time of final ploughing.
2. Half of nitrogenous and potassic fertilizers have to be applied during 15-25 days after germination or after first weeding.
3. The second top dressing with the remaining quantities of nitrogenous and potassic fertilizers should be done during 45-50 days after germination or after second weeding, but not later than panicle initiation stage.

Sowing time:

The optimum time of sowing is middle of February. For Barak Valley Zone, the broadcast sowing should be done in March.

Seed selection: Same as in *boro* rice.

Seed treatment with chemicals:

A. Wet method: Same as in *boro* rice

B. Dry method: Same as in *boro* rice

Seed rate and sowing:

Sowing is done in lines with an inter-row spacing of 20 cm. Seeds are to be sown @ 75 kg/ha (10 kg/bigha)

Broadcasting:

For broadcast crop seed rate of 85-105 kg/bigha is to be used.

Interculture:

1. Weeding is preferably done with wheel hoe, dry land weeder or *bindha* followed by laddering after 3 to 4 weeks from sowing. The second weeding should be done with wheel hoe or dry land weeder at 2-3 weeks after the first weeding. If wheel hoe or dry land weeder

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is not available, manual weeding should be given. Weeding should precede fertilizer application.

- Pre-emergence herbicide butachlor @ 2.0 kg a.i./ha after 2-3 days of sowing or post-emergence herbicide 2,4-D @ 0.8 kg a.i./ha at 2 to 3 leaf stage of dicot weeds and sedges or 25-30 days after emergence of rice should be applied.

Plant Protection

A. Insect pests:

Plant protection measures should be adopted against insect pests at their economic threshold levels as given in Table 1. Wherever threshold level is not mentioned, control measures are to be taken with the appearance of the pest.

B. Root-knot nematode:

Any one of the three granular pesticides is to be applied 5-7 days after sowing to protect against root knot nematode during early stage of crop growth in nematode endemic areas.

Carbofuran 3G@ 3 g/sq. m

Phorate 10G@ 1 g/sq. m

C. Diseases

Blast: As in case of *boro* rice.

Sheath blight: As in case of *boro* rice

Water management: As in case of *boro* rice

Rice (*Oryza sativa*) Transplanted Early *Ahu*

Varieties:

Varieties	#Agroclimatic zone	Duration** (days)	Grain character	Reaction to blast
A. Semi dwarf				
Pusa2-21*	N,U,C,L,H	125-130	Short bold	S
Rasi	N,U,C,L,H	130-135	Medium slender	T
Saket-4	N,U,C,L,B	125-130	Long slender	S
IR-50*	N,U,C,B	115-125	Long slender	S
Govind	N,U,B	115-125	Long slender	T
DR- 92 (Subhadra)	LB	120-130	Long bold	S
IR-36	C,L,B	125-135	Long slender	T
Cauvery	LB	120-125	Short bold	T
Ratna	N,L,B	125-130	Long slender	T
Krishna	C,B	130-135	Medium slender	-
Jaya	N,U,C,B,H	140-145	Long bold	-
IR-8	U,C,B,H	140-145	Long bold	-
Culture 1	U,C,L,B	100-105	Long slender	T
Luit	U,C,L,B	100-105	Long slender	T
Kapilee	U,C,L,B	100-105	Long slender	T
B. Tall				
Panjasail	C,L	115-125		S
Koijapori	L	95-105		S
Laujuli	L	115-120		S
Hasakumra	L	80-85		

Refer to page iii for full forms of the abbreviations

* Not recommended for blast endemic areas

** Durations of semi dwarf modern varieties are based on experiments conducted at Titabar. Durations of traditional varieties are collected from Field trials stations of respective zones.

Land selection:

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

Seed selection:

Seeds are to be put in plain water, stirred well and floated ones are rejected.

Sowing in nursery bed:

Seeds should be sown in nursery bed during mid February.

Seed treatment with chemicals:

A. Wet method: Same as in *boro* rice.

B. Dry method: Same as in *boro* rice

Raising of seedlings:

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

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

c) Seed rate: Well germinated seeds are sown @ 650 to 1000 g per bed. Seed requirement for transplanting one hectare of main field is 40-45 kg.

d) Plant protection in seed bed:

- 1) As soon as one or two blast spots are seen. Carbendazim @ 1 g/lit or ediphenphos @ 1 ml/lit of water is to be sprayed.
- 2) In root knot nematode and stem borer endemic areas carbofuran 3G granules @ 3 g/sq.m or phorate 10G @ 1.0 g/sq.m or diazinon 10G @ 1 g/sq.m is to be applied 6-7 days after sowing.
- 3) In case nematode is not a problem, any one of following insecticides is to be sprayed against nursery insect pests as and when necessary. Generally an insecticidal spray 5 to 7 days after sowing is effective against most pests.

Insecticide	Dose (mg/10 sq.m)
Chlorpyriphos	0.10
Quinalphos	0.15
Monocrotophos	0.12
Phosphamidon	0.07
Endosulfan	0.14

High volume sprayer: 400 ml of water/10 sq. m

Low volume sprayer: 100 ml of water/10 sq. m.

e) Preparation of seedlings for initial protection in the main field:

The roots of uprooted seedlings are to be washed and then dipped in 0.02% solution of chlorpyriphos (1 ml/lit of water) along with 1% urea for 3 hours as a protective measure against stem borer, gall midge and hoppers.

Alternatively, either carbofuran 3G @ 3 g/sq.m. or phorate 10 G or diazinon 10G @ 1 g/sq.m. is to be applied in the nursery bed 5 to 7 days before uprooting of seedlings; or chlorpyriphos 0.05% is to be sprayed in the nursery 5 days before uprooting.

f) Irrigation: Standing water in the furrows between beds are to be kept to maintain saturated condition in the seed beds. An irrigation upto submergence of beds before uprooting of seedlings facilitates the process.

Field preparation:

1. First ploughing is to be given at 21-24 days prior to transplanting. Irrigation for soaking the land is to be applied before preparatory tillage.
2. Second irrigation is to be applied at 10-12 days prior to transplanting followed by ploughing, laddering and puddling accompanied by repairing and mud plastering of bunds. Thereafter irrigation is to be applied once again for land submergence.

3. The final puddling is done just before transplanting. Irrigation is applied before final puddling (depth of each irrigation 5 ± 2 cm). Excess water, if any, should be drained out from the field.

Fertility management:

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

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	18
K ₂ O	20	MOP	33	4
B. Tall varieties				
N	20	Urea	44	6
P ₂ O ₅	10	SSP	62	9
K ₂ O	10	MOP	16	2

In absence of SSP, Diammonium phosphate (DAP) can be applied in proportion to the quantities of N and P₂O₅ as suggested above.

Above rate of fertilizer will be valid for most of the rice growing areas of Assam. In case of poor soil, fertilizer rates may be increased to the extent of 60:30:30 kg/ha of N, P₂O₅ and K₂O respectively. Amrit or granular mixed fertilizers could be used with proper adjustment.

Time of application of fertilizers:

Only one third of the total area, full doses of super phosphate and potash at the time of final puddling are to be applied. The 2nd one third and 3rd one third doses of urea are to be applied at tillering and panicle initiation stages respectively. Top dressing of urea should be preceded by weeding. Super phosphate can also be incorporated in to

the soil at active tillering stage (25-35 days after transplanting) along with 2nd dose of nitrogenous fertilizer.

Use of Azolla to supplement nitrogenous fertilizer:

Nitrogenous fertilizers can be supplemented by using *azolla*. About 500 kg fresh *azolla*/ha is to be inoculated in the field ponded with 5-10 cm depth of water for about 2-3 weeks prior to final puddling. At the time of inoculation 8-10 kg P₂O₅/ha in the form of SSP is to be applied in the field, and the corresponding quantities of phosphatic fertilizer is to be reduced at the time of transplanting.

Fresh *azolla* @ 500 kg/ha also can be applied in the standing water in transplanted crop after establishment of seedlings. There is no need for application of additional phosphatic fertilizer in the field at the time of inoculation with fresh *azolla* after transplanting when recommended doses of phosphatic fertilizer is applied at the time of transplanting. Thereafter, *azolla* will multiply itself 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 in two weeks and then it should be incorporated into the soil. It is preferable to drain out water before incorporation taking precaution so that *azolla* is not drained out with water.

Before inoculation of fresh *azolla*, it has to be treated with carbofuran 3G @ 1 g/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 @ 3 g/sq.m on affected patches when damage is noticed.

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

Nitrogen dose can even be reduced upto 50% when *azolla* is applied /incorporated in the field.

Time of transplanting:

Transplanting is done by the end of March.

Transplanting:

Transplanting has to be done by putting 2-3 seedlings/hill at a depth of 4-5 cm. The spacing is 20×15 cm for semi-dwarf and 20×20 cm for tall traditional varieties. A wooden line marker of required spacing may be used for this purpose.

Gap filling:

Replanting of dead hills has to be done within 7-10 days of transplanting.

Water management:

Apply 5 cm of irrigation water 3 days after disappearance of ponded water.

Interculture:

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

Plant protection:

A. Insect pests:

Plant protection measures are to be adopted against insect pests at their Economic Threshold Levels (ETLs) as given in Table 1.

B. Diseases:

(i) Blast : Carbendazim @ 1 g/lit is to be sprayed at tillering stage followed by two sprayings of ediphenphos @ 1ml/lit at panicle initiation and when the tip of the panicle just come out.

(ii) Sheath blight: Two sprayings of carbendazim (0.5 g/lit) are to be given, the first at the appearance of symptoms and the other 10 days after the first spraying or apply hexaconazole @ 2 ml/lit of water.

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	Chlorpyrifos 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	
			Chlorpyrifos 20EC	0.02	
Presence of dead heart	Stem borer	Moderate to severe	Chlorpyrifos 20EC	0.02	3 gm/sq.m
			Monocrotophos 40EC	0.04	1 gm/sq.m
			Carbofuran 3G	-	
			Phorate 10G	-	
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	Chlorpyrifos 20 EC	0.02	30 kg/ha
			Carbofuran 3G	-	

Crop stage and damage identification	Key pest	EIL	Insecticide (Technical Name)	Concentration (%)	Dose
Leaf tissues scrapped in white parallel lines	Hispa	1 adult or 1 damaged leaf/hill	Chlorpyrifos 20EC	0.02	30 kg/ha
			Quinalphos 25EC	0.025	
			Monocrotophos 40EC	0.04	
			Phosphamidon 100EC	0.025	
			Phosalone 35EC	0.035	
			Dichlorvos 100EC	0.05	
			Carbofuran 3G	-	
Presence of dead heart	Stem borer	1 egg mass/sq.m or 5% dead hearts	Chlorpyrifos 20EC	0.02	30 kg/ha
			Quinalphos 25EC	0.025	
			Fenitrothion 50 EC	0.05	
			Monocrotophos 40EC	0.04	
			Phosphamidon 100EC	0.025	
			Carbofuran 3G	-	
			Phorate 1G	-	
Yellowing and withering of plants	Leaf and plant hoppers	10 insects/hill or 2 insects/hill in tungro endemic areas	Chlorpyrifos 20EC	0.02	10 kg/ha
			Monocrotophos 40EC	0.04	

Crop stage and damage identification	Key pest	EIL	Insecticide (Technical Name)	Concentration (%)	Dose
Presence of silver shoots (galls)	Gall midge	1 silver shoot/sq.m in endemic areas or 5% silver shoots in non endemic areas	Monocrotophos 40EC	0.04	30 kg/ha
			Phosphamidon 100 EC	0.025	
			Carbofuran 3G	-	
			Phorate 10G	-	
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	10 kg/ha
			Monocrotophos 40EC	0.04	
Leaves are folded along margins by webbing them together	Leaf folder	More than 1 damaged leaf per hill	Chlorpyrifos 20EC	0.02	30 kg/ha
			Quinalphos 25EC	0.025	
			Fenitrothion 50 EC	0.05	
			Monocrotophos 40EC	0.04	
			Phosalone 35EC	0.035	
Phosphamidon 100 EC	0.025				

Crop stage and damage identification	Key pest	EIL	Insecticide (Technical Name)	Concentration (%)	Dose
Presence of silver shoots (galls)	Gall midge	1 silver shoot/sq.m. in endemic areas or 5% silver short in non-endemic areas	Chlorpyrifos 20EC	0.02	30 kg/ha 10 kg/ha
			Phosphamidon 100EC Carbofuran 3G Phorate 10G	0.025 - -	
Leaf tissues scrapped in white parallel lines	Hispa	1 adult or 1-2 damaged leaves per hill	Chlorpyrifos 20EC	0.02	30 kg/ha
			Quinalphos 25EC	0.025	
			Monocrotophos 40EC	0.04	
			Phosphamidon 100EC	0.025	
			Phosalone 35EC	0.035	
			Dichlorovos 100EC Carbofuran 3G	0.05 -	
Presence of dead heart	Stem borer	More than 5% dead heart	Chlorpyrifos 20EC	0.02	30 kg/ha 10 kg/ha
			Quinalphos 25EC	0.025	
			Fenitrothion 50 EC	0.05	
			Monocrotophos 40EC	0.04	
			Phosphamidon 100EC	0.025	
			Carbofuran 3G Phorate 10G	- -	

Crop stage and damage identification	Key pest	EIL	Insecticide (Technical Name)	Concentration (%)	Dose
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.	Chlorpyrifos 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	Chlorpyrifos 20EC	0.02	
			Quinalphos 25EC	0.025	
Presence of shed grains or panicles at the base of the plant	Climbing cutworm	1 larva/hill	Chlorpyrifos 20EC	0.02	
			Quinalphos 25EC	0.025	
			Monocrotophos 40EC	0.04	
			Dichlorovos 100EC	0.05	

Wheat (*Triticum aestivum*)

Varieties:

Varieties	Duration (days)		Yield (q/ha)	
	Rainfed	Irrigated	Rainfed	Irrigated
Sonalika	102-107	115-120	18-20	30-35
UP 262	106-111	120-125	19-25	30-35
K 7410	106-111	120-125	17-22	30-35
WH 291	106-111	120-125	20-25	30-35
WL 410*	120-125	-	20-25	-
HDR-77	110-115	-	20-22	-

*For hills in addition to the above varieties

New varieties recommended:

Varieties	Sowing time	Duration (days) (q/ha)	Grain yield zone	*Agro-climatic	Pest reaction
DBW-14	Nov 5- Dec 15	100-105 (irrigated condition)	30-35	All zones except B & H	Tolerant to Leaf blight, Insect attack negligible
HUW-468	Nov 5- Dec 15	105-110 (irrigated condition)	25-30	All zones except B & H	Tolerant to Leaf blight, Insect attack negligible

Refer to page iii for full forms of the abbreviations

Soil:

Sandy loam to silty loam soils, rich in organic matter are suitable. Clayey soil is not suitable for wheat.

Field preparation:

The land is to be ploughed thoroughly and leveled properly. The first ploughing is done preferably about one month ahead of sowing.

Four to five ploughings followed by laddering are required to obtain a good tilth.

In rice-wheat cropping system, zero tillage with the use of Zero-till-cum-seed-cum-fertilizer drill for sowing of wheat is recommended in light textured soil of Central Brahmaputra Valley Zone and Upper Brahmaputra Valley Zone.

Time of sowing:

Zone (Districts)	Period
Central Brahmaputra Valley Zone (Nagaon & Morigaon) and Lower Brahmaputra Valley Zone (Kamrup, Borpeta, Bongaigaon, Nalbari, Goalpara, Dhubri & Kokrajhar)	November 5 to December 15
Upper Brahmaputra Valley Zone (Sibsagar, Jorhat, Golaghat, Dibrugarh & Tinsukia) and Hills Zone (Karbi Anglong & N. C. Hills)	November 5 to 30
North Bank Plain Zone (Lakhimpur, Dhemaji, Sonitpur & Darrang)	November 5 to 20

N.B.

- i) In Sadia sub-division, middle of October is favourable time for sowing of wheat variety "Sonalika".
- ii) The optimum time of sowing of wheat is when the mean temperature of 25°C prevails in the areas.
- iii) Growing of wheat after short duration rice is feasible in medium lowland situations. Transplanting rice in mid July and sowing wheat in late November with full recommended dose of fertilizers for both the crops is necessary.
- iv) Early sowing helps in utilizing residual soil moisture and escaping pre-monsoon rains.

Seed treatment:

Seed priming should be done by soaking the seeds overnight before sowing, for faster emergence and uniform crop establishment.

Seed treatment should be done with the following fungicides.

Fungicide	Dose/kg of seed	Diseases
Captan	3 g	Root and foot rot
Carboxyn	3 g	Loose smut
Carbendazim	3 g	-
do-		

Seed rate, spacing and method of sowing:

A seed rate of 100-120 kg/ha is adequate. Row to row distance of 20 cm is to be maintained for optimum plant population. Depth of sowing should be 3-5 cm but not deeper than 5 cm. After sowing the seeds in furrows, laddering should be done along the furrows followed by another laddering across the furrows. This ensures compaction resulting in uniform and quick germination. Seeds can be sown in line by 'Pora' 'Kera' or 'Sirolua' methods.

Surface seeding of wheat is recommended for low land rice-wheat cropping system where excessive soil wetness is the main constraint for taking another crop after harvest of rice in Central Brahmaputra Valley Zone.

Fertility Management:

Fertilizer is to be applied in furrows 10 cm deep, mixed and covered by 5 cm of soil. The fertilizer can also be applied by broadcasting before last ploughing and mixed thoroughly with the soil.

Under noted dosages of fertilizers are recommended sub-division wise for irrigated conditions.

District	Agril. Sub-division	Dosages (kg/ha)		
		N	P ₂ O ₅	K ₂ O
Kokrajhar	Kokrajhar	80	46	42
	Sidli	80	46	42
Dhubri	Dhubri	80	46	42
	Goalpara	60	34	42
Goalpara	Mancachar	60	34	42
	Kamrup	45	34	42
Kamrup	Guwahati	80	46	42
	Rangia	80	46	42
Nalbari	Nalbari	80	46	42
Barpeta	Barpeta	80	46	42
Sonitpur	Tezpur	80	34	42
	Biswanath	80	34	42
Darrang	Mongoldoi	60	34	46
Nagaon	Nagaon	60	45	42
	Morigaon	60	35	42
	Hojai	60	45	42
Sivasagar	Sivasagar	60	45	42
	Charaideo	-	-	-
Jorhat	Jorhat	80	46	42
	Majuli	60	30	20
Golaghat	Golaghat	80	46	42
	Sarupathar	80	46	42
Dibrugarh	Dibrugarh	80	46	30
Tinsukia	Tinsukia	80	34	24
Lakhimpur	Lakhimpur	80	34	12
	Dhemaji			
	Jonai			
Karbi	Karbi	80	23	36
Anglong	Anglong			
N. C. Hills	N. C. Hills			

Package of Practices on Rabi Crops

Under irrigated condition half of N and whole quantity of P_2O_5 and K_2O is to be applied as basal and remaining half of N at CRI stage just before first irrigation.

Under rainfed condition NPK @ 40:20:20 is recommended for all the zones.

In absence of SSP, DAP can be applied in proportion to the quantities of N and P_2O_5 suggested above. Granulated mixed fertilizers can be used for basal application only.

On the basis of availability, sufficient quantity of FYM should be incorporated in the soil at the time of field preparation.

Irrigation schedule:

In case of dry top soil, pre-sowing irrigation is to be applied 3-4 days before sowing for quick and uniform germination of seeds.

Two irrigations of 6 cm depth have been recommended for all the agro-climatic zones. The first irrigation has to be applied at CRI stage (20-25 days after sowing) of the crop and the second one at heading stage (70-75 days after sowing).

Irrigation should be avoided when ground water table remains within 50 cm of the root zone.

Weed management:

Weeding is to be done when plants attain 4-5 leaf stage. Post emergence application (30-35 days after sowing) of isoproturon @ 1.00 kg a.i./ha + metsulfuron methyl 4.00g/ha, or sulfosulfuron 25g/ha in 700 litres of water controls weeds effectively. Running twin wheel hoes in between rows once at 20 days after seeding controls weed effectively.

Cereals : Wheat

Plant protection:

Pesticides/Operation Disease	Dose/ha	Conc.	Time of application	Insect/pests
Rouging of affected plants	-	-	As soon as noticed	Loose smut
Zineb or Mancozeb	1.25 to 1.5kg	0.25%	As soon as the spots appear spraying should be done at an interval of 10 days till diseases subside	Leaf blight and Leaf spot
Malathion 5% dust	30-35 kg	-	Just before sowing of seeds where insects are common	Cricket, mole cricket, red ant, white ant
Malathion 50 EC	3 lit	1.5 ml/lit	As soil drench	-do-
Phosphamidon 100 EC	250-300 ml	0.05%	As soon as noticed	Aphids and stem borer
Malathion 50 EC	1.0-1.25 lit	0.1%	-do-	-do-
Aluminium phosphide	1-2 tab/hole	-	-	Rat
Zinc phosphide poison bait		-	Apply in bait stations	Rat
Composition				
Atta/crushed maize	: 80 g			
Gur	: 10 g			
Dry fish or fried fish	: 5 g			
Zinc phosphide	: 5 g			

N. B.: Micronutrient preparations should be applied as foliar spray when micronutrient deficiency is suspected.

Harvesting:

Wheat is to be harvested during sunny days as soon as it matures. The mature grain produces a cracking sound when passed between teeth.

Storage:

Steps for storage of wheat for seed purpose are as follows:

1. Seeds should be collected from disease free fields.
2. Wet seeds should not be kept for seed purpose.
3. Seeds must be dried for 4 to 6 days or more to bring the moisture content below 12 per cent.
4. Malathion 5% dust @ 2.5 g/kg of seeds should be added as a protective measure against stored grain pests.
5. Seeds can be preserved in sealed thick polythene bags or in tightly closed metallic containers or 'Juria duli'. When stored in 'Juria duli' or metallic bin, grains may be fumigated with EDB @ 3 ml/q of seed.
6. Seeds should be examined periodically and if necessary it should be dried and repacked.

Rabi Maize
(Zea mays)

Varieties:

Varieties	Duration (days)	Yield (q/ha) under assured irrigation
Hybrids :		
Ganga 101	145-150	50-55
Ganga 5	150-155	55-60
Deccan Hybrid	160-165	65-75
Composites :		
Kishan	150-155	50-55
Vijay	155-160	55-60
Pratap	155-160	40-45
Diara*	110-120	30-35
Hunius*	110-115	30-35

*Specially recommended for flood affected areas in agro-climatic zones U, L, N and B for sowing in the middle of November

In case hybrids are grown, it is advised not to keep seeds from previous year's harvest for sowing in the following years. However, seeds from composite varieties can be kept for sowing in the following year, without appreciable decrease in yield.

Land selection:

Well drained sandy loam soil is to be selected. Field should never be water-logged.

Field preparation:

Field should be ploughed thoroughly to obtain a deep, fine and firm tilth. Laddering should be done properly for leveling as well as to conserve moisture in the soil.

Time of sowing:

The optimum time of sowing of *rabi* maize is middle of September to middle of October. Sowing may be delayed up to middle of November, under exceptional circumstances, but this results in delayed maturity. No sowing should be done after November 15.

Seed treatment:

Seeds are to be treated with captan @ 3 g/kg or carboxyn @ 2 g/kg or carbendazim @ 2 g/kg seeds. Seeds procured from NSC are usually pretreated.

Seed rate, spacing and method of sowing:

A seed rate of 22.5 kg/ha (3 kg/bigha) is required for line sowing. Seeds are to be dibbled in lines at a spacing of 60 cm × 25 cm to maintain a plant population of around 60,000 to 65,000/ha. A seeding depth of 3 cm is optimum for quicker germination.

Fertility management:

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	60*- 80**	Urea	130-175	18-24
P ₂ O ₅	40	SSP	250	33
K ₂ O	40	MOP	65	8

* For short duration varieties, ** For long duration varieties

FYM @ 4.5 t/ha (6 q/bigha) should be applied at the time of field preparation. Whole of P₂O₅ and K₂O and half of N are to be applied in the furrows before sowing. The remaining quantity of N is to be top dressed at 30 days after emergence of seedlings. Where irrigation facilities are available, N should be applied in 3 split doses, one fourth, half and one fourth at sowing, 30 days after seedling emergence (knee-high stage) and at the time of silking respectively. Placement of fertilizer is more effective than broadcasting.

Interculture:

Light hoeing is to be given as and when necessary for better control of weeds. Simazine or Atrazine should be applied @ 0.5-1.0 kg a.i./ha in 1000 lit of water as pre-emergence spray.

Plant protection:

A. Insect pests:

Stem borer: When stem borer infestation is noticed any one of the following insecticides may be sprayed.

Insecticide	Quantity	Volume of water (lit /h)	
		Power sprayer	Hand sprayer
Phosphamidon 100 EC	500 ml	200-250	700-800
Fenitrothion 50 EC	1.0 lit	200-500	700-800
Endosulfan 35 EC	1.5 lit	100-150	700-800

In addition to this all the dead hearts should be pulled out and destroyed to kill the lingering stage, of the pest in the stubbles.

Termites: Termites take a heavy toll of the crop especially in the *rabi* season. To prevent this 25 kg/ha of 4% endosulfan dust should be mixed in the soil before sowing in termite prone areas.

Cutworm: Use malathion 5% dust or endosulfan 4% dust @ 25 kg/ha as soil treatment or endosulfan 4% dust @ 25 kg/ha as foliar treatment on seedlings.

Aphids, cob borers, jassids and mites: Methyl demeton 25 EC, monocrotophos 36 WSC, phosphamidon 100 EC or Endosulfan 35EC should be sprayed @ 1ml/lit against these pests.

B. Diseases:

Maydis leaf blight: Use of protective fungicides of thiocarbamate group (Mancozeb, zineb) @ of 2.0-3.0 kg a.i./ha in 1000-2000 litres

of water at the time of appearance of the disease symptoms or at knee-high stages.

Turcicum leaf blight (also known as southern corn blight): The disease can be controlled by 2-3 foliar sprays with 0.25% to 0.3% mancozeb or zineb at 10-15 days interval. Application of urea followed by a light irrigation also helps to minimize the disease as it sometimes becomes serious due to poor management.

Seed rot and seedling blight: The best recourse to these problems is to sow certified seeds from a reliable source, which is pretreated with desired fungicides. If one wants to use his own seed, seed treatment is a must.

Pythium stalk rot: Apply Captan or Thiram @ 2.5 kg/100 litres of water/ha at the lower internodes of plants 30-35 days after planting. Drain out excess rain water from the field.

Charcoal rot: Sow resistant cultivars e.g. Diara, Hinius etc.

Banded sclerotial disease: In areas where this disease is noticed the plant should be sprayed with carbendazim @ 0.05% @ 700 lit/ha at an interval of 12-15 days.

C. Bird damage:

The mature cobs can be protected from bird damage by tying the cobs with leaves of the same plant. Shinning, coloured strips may also be used to scare away the birds.

Irrigation:

Irrigation is needed at grand growth period, and tasseling and grain setting stages of the crop, which will vary according to duration of varieties as mentioned below:

Irrigation No.	Stage of crop	Short duration variety	Medium duration variety	Long duration variety
1 st	Grand growth period	35-40 DAS	-	45-50 DAS
2 nd	Tasseling	55-60 DAS	-	70-75 DAS
3 rd	Grain setting stage	85-95 DAS	100-115 DAS	110-115 DAS

Excess irrigation should be avoided as maize cannot withstand waterlogging.

Harvesting

Cobs are harvested when the husk cover turns pale yellow. This does not necessarily coincide with complete drying of the plant, and therefore, one should not wait till the plant become bone dry. It should not be harvested immediately after a shower. The harvested ears should be sundried before shelling.

Grains should again be dried after shelling and stored in gunny bags.

Use of Maize:

Maize or corn flour is used as *atta* by mixing with wheat flour. Mixed with soybean flour, it makes good *atta* for making *chapatti*. Corn flakes are delicious diet for man of all ages. Corn flour can also be made to good *halwa*. Crushed grains are nutritious feed for cattle, poultry and fish. Stovers are also used as cattle-feed by making pieces with chaff-cutter. Maize starch is used by modern industries for manufacture of various fabrics. Corn (maize) oil is an important cooking medium.

Buckwheat (*Dhemchi*)*(Fagopyrum esculentum L. syn. Polygontum fagopyrum)***Variety:** Local**Duration:** 90-110 days**Soil type:** Sandy loam**Land preparation:**

The land should be ploughed thoroughly and leveled properly. Four to five ploughings followed by laddering are sufficient to obtain a good tilth. The first ploughing should be done preferably about one month ahead of sowing.

Time of sowing:

Sept-Oct for Upper Brahmaputra Valley Zone and Oct-Mid Nov. for Lower Brahmaputra Valley Zone

Seed rate: 20 kg/ha (2.7 kg/bigha)**Spacing:** 30 cm between rows**Method of sowing:**

Furrows of about 5 cm depth are to be prepared at a distance of 30 cm. Seeds are to be sown in the furrows preferably at 3-5 cm depth but not deeper than 5 cm. Then laddering is to be done along the furrows which will cover the seeds with soil and ensure soil compaction resulting in uniform and quick germination.

Fertilizer management:

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	20	Urea	44	6
P ₂ O ₅	10	SSP	63	9
K ₂ O	10	MOP	15	2

All the fertilizers are to be applied by thoroughly mixed with soil, preferably one day before sowing.

Weed control:

Weeding should be done before the weed plants attain 4-5 leaf stage. Dryland weeder may effectively be used.

Plant protraction:

Aphid: When the aphid attack is heavy, any of the following insecticides may be applied.

Dimethoate @ 500 ml/ha (67 ml/bigha)

Chlorpyrifos @ 500 ml/ha (67 ml/bigha)

Phosphamidon @ 200 ml/ha (27 ml/bigha)

Spray solution requirement for hand sprayer and power sprayer are 500-700 lit/ha (65-90 lit/bigha) and 200-250 lit/ha (25-30 lit/bigha) respectively.

Bee pollination:

For enhancing yield through increased pollination, 5-6 honey bee colonies/ha of buck wheat is recommended.

Harvesting:

Harvesting should be done when the grains turn blackish and ears are dry. After harvesting, the plants are to be kept in field for 2-3 days for sun drying.

Threshing is done by treading with bullocks or beating the plants by sticks.

Average yield: 12-15 q/ha**Uses:**

After threshing, the grains are to be dehusked in *dhenki*, a locally used dehusking device. The dehusked grains are pure white and flour is made out of the grains. The flour is used to make *chapattis*. Sometimes it is mixed with wheat and barley flour. The tender green plants are used as green vegetables and the straw of plants are used for cattle feed. The dried plants can be used as firewood.

Foxtail Millet (Cawn)
(*Setaria italica*)

Variety: Local (Yellow grain type)

Duration: 100-120 days

Soil type: Silt loam to Sandy loam

Field preparation:

The field should be prepared thoroughly by giving 4-6 ploughings followed by one laddering to obtain a fine tilth.

Time of sowing:

Middle of January to middle of February (the best time is last week of January).

Seed rate:

Seed rate is 8-10 kg/ha, which may be increased to 15 kg/ha under broadcast sowing.

Spacing: 25 cm between rows.

Method of sowing:

Furrows of 5 cm depth are to be prepared at 25 cm apart. Seeds are to be placed in the furrow preferably at 3-5 cm depth but not below 5 cm depth. Laddering should be done along the furrows to cover the seeds with a soil layer of about 3-5 cm. Laddering also ensures compaction of soil which results in uniform and quick germination.

Fertilizer:

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	20	Urea	44	6
P ₂ O ₅	10	SSP	63	9
K ₂ O	10	MOP	17	2

Full doses of inorganic fertilizer are to be applied in soil preferably one day before sowing. The fertilizer should be thoroughly mixed with soil.

Weed control:

Weeding should be done manually before the weed plants attain 4-5 leaf stage. Dry land weeder may effectively be used in case of line sowing.

Plant protection:

Gandhi bug: When the attack of gandhi bug is observed in the field, dusting of malathion 5% @ 20 kg/ha may be done for its effective control.

Harvesting:

Harvesting should be done when the millet panicles turn yellowish.

Threshing:

Immediately after harvest, threshing is to be done by treading with bullocks or by foot.

Uses:

The grains are to be dehusked with '*dhenki*', a locally used dehusking device. The dehusked grains can be cooked like rice. It makes good porridge. It is also used in making flour and '*laddus*'. The straw can be used as cattle feed.

Average yield: 12 q/ha.

FORAGE CROPS

Oats

(*Avena sativa*)

Varieties:

Varieties	Duration (days)	Green forage (q/ha)	Dry forage (q/ha)	No. of Cuttings
Kent	128	483	96.6	2
HJ 114	128	475	95.0	2
JHOS 19	121	463	92.6	2

Soil: Well drained silty loam, sandy loam soils are suitable. In such soils it can be grown after *sal* paddy.

Field Preparation : Oats need fine compact seed bed.

Time of Sowing : Mid October to December

Seed Rate : 100 kg/ha. (13-14 kg/bigha)

Spacing : Seeds are to be sown in rows 25-30 cm apart in furrows at a depth of 4-5 cm.

Fertility Management:

Per hectare				Per bigha			
FYM	N	P ₂ O ₅	K ₂ O	FYM	N	P ₂ O ₅	K ₂ O
4t	40kg	20kg	20kg	6q	9kg	3kg	3kg

Application of 54 kg urea, 125 kg SSP and 33 kg MOP per hectare as basal dose and 34 kg urea after first cutting (60-70 days after sowing) as top dressing is essential. 50% recommended dose of fertilizer+ vermicompost @ 2.5t/ha + FYM @ 2.5t/ha should be applied if oat is grown in fodder based cropping sequence.

Irrigation:

Oats can be grown successfully as rainfed crops. If the soil is dry, first irrigation is to be applied immediately after sowing, second at maximum tillering (45 days after sowing) and third immediately after the first cutting.

Interculture:

One weeding is necessary 3 to 4 weeks after sowing.

Cutting:

First cutting is to be done at 60-70 days after sowing, and second cutting at 50% flowering. The crop should be cut at a height of 8 to 10 cm from the ground level.

Seed Production:

Oats seeds can be obtained by allowing the crop for seed setting after the first cutting. One fifth of a hectare produces seeds sufficient for sowing one hectare.

Lucerne
(*Medicago sativa*)

Varieties:

Varieties	Duration (days)	Green forage (q/ha)	Dry forage (q/ha)	No. of Cuttings
LL-Comp 5	75	298	49.66	1
T 9	75	280	42.42	1

Spacing : Rows 25 cm apart

Seed Rate : 20 kg/ha

Time of Sowing : October to November

Manuring:

Per hectare				Per bigha			
FYM	N	P ₂ O ₅	K ₂ O	FYM	N	P ₂ O ₅	K ₂ O
3t	25kg	87kg	40kg	4q	3.3kg	11.5kg	5.3kg

Irrigation:

Two to three irrigations are necessary at weekly intervals for establishment of the crops and subsequent irrigations depend upon soil moisture status.

Cutting Details:

Numbers of cutting: As many cutting as possible

Time of cutting: First cutting is to be done at 55 to 60 days after sowing and subsequent cuttings at an interval of 30 to 35 days.

Subabul
(*Leucaena leucocephala*)

Varieties:

Varieties	Spacing	Green forage stem & leaves (q/ha)	Green leaves (q/ha)	Dry leaves (q/ha)
Hawain	1 m x 20 cm	850.00	83.33	51.41
Common	1 m x 30 cm	1128.83	162.50	87.07

Seed Rate : 3 to 4 kg/ha

Seed Treatment : Dipping seeds in boiling water at 80°C for proper germination is necessary.

Manuring:

Per hectare				Per bigha			
FYM	N	P ₂ O ₅	K ₂ O	FYM	N	P ₂ O ₅	K ₂ O
3t	20kg	50kg	-	4q	2.66kg	6.6kg	-

Time of Sowing: March to September.

Cutting Management:

First cutting should be taken at 50 days after sowing, leaving 60 cm stubble height; and 2nd and 3rd cuttings at 40 days interval with stubble heights of 75 cm and 90 cm respectively. Rest of the cuttings will also be taken at 40 days interval with 90 cm stubble height.

PULSES

Summer black gram (*Vigna mungo*)

Varieties:

Varieties	Duration (days)	Days to first picking	Grain yield (q/ha)	Reaction to diseases
T 9	75-85	65-70	10-13	Tolerant to YMV and Cercospora leaf spot
Pant U 19	-do-	-do-	10-12	-do-
UG 157	-do-	-do-	10-12	-do-
JU 78	-do-	- do-	10-12	-do-

Time of Sowing:

The optimum time for sowing summer blackgram is from mid February to March

Toil Type:

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

Field Preparation:

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

Fertility Management:

Application of FYM or compost @ 4-5 t/ha or 6 q/bigha not only adds fertility but also improves soil structure.

Pulses : Summer black gram

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
A. Without Rhizobium culture				
N	15	Urea	32	4.5
P ₂ O ₅	35	SSP	220	30
K ₂ O	0	MOP	-	-
B. With Rhizobium Culture :				
N	10	Urea	22	3
P ₂ O ₅	35	SSP	220	30
K ₂ O	0	MOP	-	-

For Upper Brahmaputra Valley Zone, Lower Brahmaputra Valley Zone and North Bank Plains Zone, 10 kg/K₂O/ha is recommended in addition to normal doses of N and P. For Central Brahmaputra Valley Zone, 15kg K₂O/ha is recommended as basal dressing.

Diammonium phosphate (DAP) @ 75 kg/ha or 10 kg/bigha can be applied in lieu of urea and SSP in non-inoculated crop. NPK may also be supplied in the form of mixed fertilizers.

Application of Lime:

CaCO₃ in the form of dolomitic lime @ 65.5 kg/bigha should be applied 15 days before seeding and incorporate in the soil in area where multiple cropping is practiced.

Seed Inoculation:

For seed inoculation with Rhizobium, any one culture of Shillongani, Ahatguri, Kamalabari or other suitable strains should be used. Seeds are to be inoculated with 150 g of culture/3-4 kg of seeds.

Seeds are to be moistened carefully with clean water so as to avoid excessive wetting. Rhizobium culture is to be mixed with seeds @ 45 g/kg so that a thin layer of inoculum is deposited on the seed coat. Treated seeds are to be dried under shade. Inoculated seeds should not be exposed to sun.

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Seed Rate:

Line sowing : 25.00 kg/ha (3.0-3.3 kg/bigha)

Broadcast : 27.00 kg/ha (3.6 kg/bigha)

Spacing:

Row to row : 30 cm

Plant to plant : 10 cm

Interculture:

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

Plant Protection

Disease/ Insect pest	Fungicide/ Pesticide	Dose	Concentration	Spraying interval
Diseases:				
Leaf spot	Cu-oxychloride	1.8-2.0kg in 600-700lit of water	0.3%	7-10 days
	Carbendazim	300-500g in 600-700lit of water	0.05%	12-15 days
Blight	Carbendazim	300-500g in 600-700lit of water	0.05%	12-15 days
Powdery mildew	Wettable sulphur	1-1.4kg/ha in 500-700lit of water	0.2%	As soon as disease appears
Insect pests :				
Aphids, jassids	Malathion 50EC	1-1.5lit in 500-700 lit of water	0.1-0.15%	Repeat spray if necessary
Flea beetle	Malathion 50EC	1-1.5lit in 500-700lit of water	0.1-0.15%	necessary
	Or Malathion 5% dust	20kg	-	Repeat dusting if necessary
White fly (to control YMV)	Dimethoate 30EC	2ml/lit of water	0.06%	1 st spray 10 days after germination, then at 15 days intervals
	Or Endosulfan 35EC	-do-	0.07%	
Hairy caterpillar	Endosulfan 35EC	2ml/lit of water	0.07%	-do-

Pulses : Summer black gram

Harvesting:

Harvesting is to be started when pods mature indicating full darkish colour and brittle on slight pressure. Harvesting should be completed in 2 to 3 pickings.

Protection against storage pests:

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

Summer green gram
(*Vigna radiata*)

Varieties:

Varieties	Duration (days)	Grain yield (q/ha)	Days of 1 st picking	Reaction to diseases
T 44	70-80	10-12	65-70	Susceptible to YMV and <i>Cercospora</i> leaf spot
Kopergaon	70-80	8-9	65-70	-do-
K 851	70-75	10-12	60-65	Tolerant to YMV and <i>Cercospora</i> leaf spot
ML 56	70-80	12-16	-do-	-do-
PIMS 1	-do-	10-13	-do-	-do-
ML 131*	-do-	10-12	-do-	-do-
AAU 34	65-75	-do-	-do-	Resistant to <i>Cercospora</i> leaf spot & susceptible to YMV
AAU 39	-do-	-do-	-do-	-do-
Pratap (SG-1)	65-75	10-14	-do-	Tolerant to <i>Cercospora</i> leaf spot & susceptible to YMV

* ML 131 is recommended for North Bank Plains Zone only. All other varieties, except ML 131, are suitable for all Zones.

Soil:

Well drained sandy loam soil is preferable.

Field Preparation:

Field is to be ploughed 2-3 times followed by leveling. Surface drains are to be provided to facilitate quick removal of excess water from the field.

Time of Sowing:

The optimum time of sowing is from mid February to mid March.

Fertility Management: Same as in black gram.

Application of Lime:

CaCO₃ in the form of dolomitic lime @ 65.5 kg/bigha should be applied 15 days before seeding and incorporate in the soil in areas where multiple cropping is practiced.

Rhizobium Culture:

Seed inoculation: For inoculation with Rhizobium culture, either Majuli 19 or any other suitable strains may be used. Seeds are inoculated @ 150 g/304 kg of seeds. Detailed instructions are available in each packet of culture (for details of procedure for seed inoculation, refer to black gram).

Seed rate: The following seed rates are recommended.

Varieties	Line sowing		Broadcast	
	(kg/ha)	(kg/bigha)	(kg/ha)	(kg/bigha)
AAU 34 and AAU 39	20-25	2.7-3.0	25.5	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 is to be done at 20-25 days after sowing.

Plant Protection: Same as in black gram

Harvesting:

Harvesting is to be done when 75% of the pods turn darkish in colour and splits on pressure. Harvesting should be completed in 2-3 pickings.

Protection against storage pests:

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

Lentil
(*Lens culinaris*)

Varieties:

Varieties	Plant type	Maturity (days)	Yield (q/ha)	Other characters
B-77	Erect, branched, 25-30cm tall	110-120	8 –12	Seeds medium sized,1000 seeds wt. 12-15g
L-9-12	Erect, branched, 20-30 cm tall	120-130	8 –12	Seeds medium sized,1000 seeds wt. 15-19g
PL 406	Branched semi spreading, 35-40 cm tall	120-125	10-12	Seeds medium sized,1000 seeds wt. 17-19g
PL 81-4	Branched semi spreading, 35-40 cm tall	120-125	11-13	Seeds medium sized,1000 seeds wt. 15-17g

Soil type : Loam or silty loam is preferable.

Time of Sowing : Mid October to mid November.

Field Preparation: The field is to be ploughed 3-4 times to obtain a good tilth.

Fertility Management: FYM/Compost should be applied @ 4-5 t/ha or 6 q/bigha.

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Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
A. Without Rhizobium culture				
N	15	Urea	32	4.5
P ₂ O ₅	35	SSP	220	30
K ₂ O	0	MOP	-	-
B. With Rhizobium Culture :				
N	10	Urea	22	3
P ₂ O ₅	35	SSP	220	30
K ₂ O	0	MOP	-	-

Diammonium phosphate (DAP) @ 75 kg/ha or 10 kg/bigha is to be applied in lieu of urea and SSP in non-inoculated crop. NPK may also be supplied in the form of mixed fertilizer. 15kg K₂O as basal dose is recommended for Central Brahmaputra Valley Zone.

Application of Lime:

CaCO₃ in the form of dolomitic lime @ 65.5 kg/bigha should be applied 15 days before seedling and incorporate in the soil in areas where multiple cropping is practiced.

Seed Inoculation with Rhizobium Culture:

Seeds are to be moistened with clean water avoiding excess wetting and Rhizobium culture @ 150 g/3-4 kg of seeds or a prescribed rate given on the packet of the culture be mixed thoroughly and dried in shade before sowing.

Seed Rate:

The optimum seed rate is 30 kg/ha or 4 kg/bigha.

Spacing:

The seeds are to be sown in line at a spacing of 25 cm between rows and 5-7 cm from seed to seed.

Interculture:

One weeding 20-25 days after sowing.

Pulses : Lentil

Irrigation:

If necessary and available, one light irrigation is to be given during pod filling stage.

Plant Protection:

Disease	Fungicide/other measures	Dose/ concentration	Mode of application
Wilt	Carbendazim or	2 g/kg of seed	Seed treatment
	Captan or thirum	3g/kg of seed	-do-
	Carbendazim	0.1%	Soil drenching in localized patches
Wet rot or white blight	Infected plants are to be collected along with sclerotia & burnt. The following spray schedule may also be adopted.		
	Carbendazim	0.05% (0.3-0.35 kg mixed with 600-700lit of water/ha)	Foliar spray
	Or Ziram	0.3% (1.8-2.0 lit mixed with 600-700lit of water/ha)	-do-
	Or Mancozeb	0.2% (1.12-1.14kg mixed with 600-700lit of water/ha)	-do-

Protection against storage pests:

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

Pea
(*Pisum sativum* L)

Varieties:

Varieties	Plant type	Maturity (days)	Yield (q/ha)	Other characters
T-163	Medium tall(100-120cm), double-podded variety	110-120	10-11	Pods 7-8 cm long, light green, 5-6 seeds per pod. 1000 seeds wt. 150-200g. Susceptible to powdery mildew and fusarium root rot.
Boneville	Medium tall (100-120cm),double-podded variety, used as vegetable	100-120	10-12	Seeds wrinkled, light greenish to white. Pods light green, straight, 8-9 cm long with 5-6 seeds per pod. Susceptible to powdery mildew and fusarium root rot.
HUP-2	Tall (130-140 cm), semi spreading & semi leafless	115-125	13-15	4-5 seeds per pod, seeds white, 1000 seeds wt 200-250 g. Resistant to powdery mildew and downy mildew.
KFPD 1	Plants are dwarf (50-60 cm)	100-105	18-20	5-6 seeds per pod, Seeds white and bold, 1000 seeds wt 250-300g. Susceptible to powdery mildew but escapes the disease because of earliness
Rachna	Tall (135-138 cm)	120-125	10-12	Almost similar to T-163, tolerant to powdery mildew

Pulses : Pea

New variety recommended:

Varieties	Sowing time	Duration (days)	Yield (q/ha)	Agro-climatic zone	Pest reaction
FP-255 (Pant-14)	October	108	11.49	Hill Zone	Moderately resistant to rust

Soil Type:

Peas can be grown on variety of soils, well drained light soils is suitable.

Liming:

After soil test to bring pH around 6.0, requisite quantity of lime is to be applied at least 21 days before sowing.

Time of Sowing:

The optimum time of sowing is mid October.

Field Preparation:

Pease generally require reasonably deeply worked soils. The field is to be ploughed 3 to 4 times to obtain a good tilth.

Seed Rate: T-163	:	50 kg/ha or 7 kg/bigha
Boneville	:	60 kg/ha or 8 kg/bigha
HUP-2	:	65 kg/ha or 8.5 kg/bigha
KFPD-1	:	77 kg/ha or 10 kg/bigha

In riverine tracts recommended seed rate is 4-6 kg/bigha

Relay Cropping of Pea:

Pea seeds at 25-50% higher seed rate are to be broadcast in the standing crop of rice about 15-20 days before harvest provided the soil is in moist condition.

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In rice + pea relay cropping seeding of pea at 20 days after 50% flowering of rice with a seeding rate of 90 kg/ha is recommended in medium *sali* land for Hills zone. Pea seeds are to be soaked overnight before sowing.

Seed Treatment:

Seed treatment with carbendazim or benomyl @ 2 g/kg of seed or captan or thiram @ 3 g/kg of seed is recommended.

Spacing:

The seeds are to be sown in lines at a spacing of 30 cm between rows and 10 cm between plants.

Fertility Management:

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

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
A. Without Rhizobium culture				
N	20	Urea	45	6
P ₂ O ₅	46	SSP	285	40
K ₂ O	0	MOP	-	-
B. With Rhizobium culture				
N	10	Urea	22	3
P ₂ O ₅	46	SSP	285	40
K ₂ O	0	MOP	-	-

For Upper Brahmaputra Valley Zone, Lower Brahmaputra Valley Zone and North Bank Plains Zones, 10 kg K₂O/ha is recommended in addition to normal dose of NPK. In North Bank Plains Zones, 10 kg Borax/ha is also recommended.

Diammonium phosphate (DAP) @ 100 kg/ha or 13 kg/bigha should be applied in lieu of urea and SSP in noninoculated crop. NPK may also be supplied in the form of mixed fertilizers.

Pulses : Pea

Application of lime:

CaCO₃ in the form of dolomitic lime @ 65.5 kg/ha or 13 kg/bigha should be applied 15 days before seeding and incorporate in the soil in areas where multiple cropping is practiced.

Weed Control:

Fluchloralin 45% EC @ 1.5 kg a.i./ha as pre-emergence spray one day before sowing be incorporated in the soil with light hoeing.

Suitable Rhizobium Culture:

PAU and IARI or any other suitable strains can be used.

Irrigation:

If required and available, one irrigation should be given at 40-50 days of sowing.

Plant Protection:

A. Insect Pests

Insecticide	Concentration	ml/lit of water	Insect pests
Dichlorovos 100EC	0.05	0.5	Pod borer,
Malathion 50EC	0.1	2.0	leaf miner,
			aphid

B. Disease:

Disease	Fungicide	Dose/ha	Concentration	Mode of application
Wilt	Carbendazim or benomyl or captan	2 g/kg of seeds	-	Seed treatment
	Thiram	3 g/kg of seeds	-	-do-
	Carbendazim	-	0.1%	Drenching the soil in localized patches
	or benomyl			

Disease	Fungicide	Dose/ha	Concentration	Mode of application
Rust	Tridemorph or	500-700 ml in 500-700 lit of water	0.1%	As soon as disease appears
	Mancozeb	1.0-1.4 kg in 500-700 lit of water	0.2%	-do-
Powdery mildew	Wettable sulphur or	2.5 to 3.5 kg in 500-700 ml in 500-700 lit of water	0.5%	-do-
	Tridemorph or	500-700 ml in 500-700 lit of water	0.1%	-do-
	Dinocap	500-700g in 500-700 lit of water	0.1%	-do-

Harvesting:

Harvesting should be done when 75-80% of the pods turn yellow.

Protection against storage pests:

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

Soybean (*Glycine max*)

Soybean is an important pulse as well as oilseed crop of the State. Short duration soybean varieties like JS-2, Moti and Pusa Soybean 1 can be easily fitted in between two rice crops *sali* and *ahu*, i.e. the period from January to April or first week of May in a medium land situation after harvesting of HYV rice.

Varieties:

Varieties	Duration (days)	Plant type	Grain yield (q/ha)		Percentage	
			Irrigated	Rainfed	Oil	Protein
JS-2	85-90	Erect	20-22	-	20	42
Moti	85-100	-do-	-do-	11-12	20	42
Pusa Soybean-1	90-100	-do-	-do-	-	22	43

Soil:

Soybean can be grown on a wide range of soils but it grows best on fertile and well drained loamy soils. Water logging is injurious to the crop. In acid soils where pH is below 6.0, lime is to be added @ 2 t/ha at least 21 days before sowing. Liming is necessary once in three years.

Time of Sowing:

Under irrigated condition sowing is to be done in January. When the crop is grown under rainfed condition, the optimum time of sowing is middle of January to middle of February.

Land Selection:

Medium type of land is suitable for rainfed condition, where there is sufficient moisture during January and February.

Field Preparation:

Well prepared seed bed with good tilth is essential for soybean.

Fertility Management:

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	20(10)	Urea	45(22)	6.5(3)
P ₂ O ₅	60	SSP	53.5	40
K ₂ O	40	MOP	70	10.5

N.B.: The figures in parentheses indicate the requirement of N where rhizobium culture inoculated seeds are sown.

The whole quantity of fertilizers are to be applied in furrow at a depth of 5-7 cm below the seeds before sowing and covered with a layer of 3-4 cm soils and make it leveled 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 can be sprayed at the flower bud 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 is as follows.

Quantity of MOP (kg/ha)	Quantity of water (lit/ha)	Strength of MOP solution (%)	No. of sprays
12.00	400	3	1

Application of lime:

CaCO₃ in the form of dolomitic lime @ 65.5 kg/bigha should be applied 15 days before seeding and incorporated in the soil where multiple cropping is practiced.

Seed Treatment:

Seed are to be treated with Phytohormone + enzyme complex (pl. refer p. ... for trade name) to enhance germination during winter.

For this purpose, seeds are sprayed with small hand sprayer @ 1 ml of the chemical in 100 ml of water for 10 kg seed one day ahead of sowing.

Seed Treatment:

Seeds are to be moistened with clean water carefully so as to avoid excessive wetting. Rhizobium culture is to be mixed with seeds @ 15 g/kg so that a thin coat of inoculum is deposited on the seed coat. Treated seeds are to be dried under shade. Inoculated seeds should not be exposed to the sun.

Seed Rate: A seed rate of 75 kg/ha or 10.5 kg/bigha is required to obtain about 5 lakhs plants/ha (70,000 plants/bigha).

Method of Sowing:

Seeds are to be sown in lines 25 cm apart and 5 cm between seeds at a depth of 2-5 cm. If the soil is dry, a pre-sowing irrigation of 2-5 cm depth is needed for proper germination at least 2 days ahead of sowing.

The rows are to be covered with a thin layer of paddy straw for better conservation of soil moisture.

Interculture operation:

Weed control: Two manual weedings, one at 15 days and another at 35 days are necessary to control weeds. A light earthing up may be given at the time of second weeding to keep the plants erect.

Chemical weed control: Pre-emergence application of fluchloralin 1.0-1.5 kg/ha) immediately after sowing controls weeds effectively. The grain yield is comparable to that of two hand weedings.

Irrigation: Two irrigations one at flowering and the other at pod formation stage are needed for proper growth and pod filling.

Moisture Conservation:

Under rainfed culture, soil moisture can be conserved by application of straw mulch over the rows after sowing. In such a case, only one weeding is needed at 30-35 days after sowing.

Plant Protection:

Seeds are to be treated with thiram @ 3 g/kg of seeds. When seeds are already treated with thiram, there is no need for retreatment. To control YMV, hairy caterpillar, spraying of dimethoate or dichlorvos @ 1-1.5 lit in 800-1000 lit of water/ha is advocated.

Threshing:

Paddy Thresher is the best for threshing, especially for seed purpose. Threshing by power tiller is suitable for consumption purpose.

Storage for Seed Purpose:

Seed are to be dried for 5-6 days under bright sun, packed in cloth bags and kept in 250 gauge polythene bags under air tight condition. Seeds thus stored contain about 10% moisture.

Drenching:

The trypsin inhibitor present in the soybean has to be removed before any kind of use. This can be done by boiling the seeds for 20 minutes in 0.5% solution of sodium bicarbonate @ 21/kg of seeds and then washing 2 to 3 times with plain water.

Utilization:

Besides preparation of various foods, the crushed grains can be used as feed for cattle, poultry and fish.

Soybean milk:

1. Seeds are to be soaked in water for 12 hours, changing water at least three times. Sometimes seeds are required to be soaked for 24 hours.

2. The seed coats are to be removed by hand rubbing.

3. A paste has to be made by crushing the peeled seeds.

Water is to be added at the ratio of 1: 3 and boiled while stirring with a ladle. The milk should not be over boiled; otherwise its nutritive value may be lost. Addition of a few drops of ginger juice/bey leaf will remove the 4 beany odours. Soybean milk is useful for maintaining 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 *chapatti, kachuri, malpowa, bhujia, ladu, chutni, cake* etc.

Soybean curd: To prepare soya curd, soya milk is to be poured in an appropriate container while it is moderately hot.

Green Beans: Green soybeans are widely used as much in the same way 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 vegetables. The green bean is also used in salads. In order to secure the best flavours, the bean should be cooked when they remain affixed in the pods. In such cases they are to be soaked in boiling water for a few minutes when it becomes easy to shall them.

Rajmah or French bean (Pulse type)
(Phaseolus vulgaris)

Variety:

Uday (PDR-14): A promising variety selected by Directorate of Pulses Research, Kanpur. Plant type is erect, branched, determinate type, 35-50cm in height. Matures in 10-120 days. Grain yield is 15-20 q/ha. Pods are 10-12 cm long, 3-4 seeds per pod, 15-20 pods per plant.

New varieties recommended:

Varieties	Sowing time	Duration (days)	Grain yield(t/ha)	Zone	Remarks
HUR-301	Mid Oct. to mid Nov.	95-105	2.00	All zones	Resistant to wilt, leaf crinkle & BCMY
HUR-203	-do-	95-105	2.00	-do-	Resistant to major insect pests

Soil type: Sandy loam.

Time of Sowing: October 15 to November 30.

Field Preparation:

Land should be prepared thoroughly to a fine tilth. Avoid sowing in highly moist soil.

Seed rate: 75 kg/ha

Seed Treatment:

Seeds should be treated with captan @ 3 gm/kg of seeds or mancozeb @ 2.5 g/kg of seeds before sowing.

Pulses : French bean (Pulse type)

Spacing: 30 cm x 20 cm

For North Bank Plains Zone, spacing of 40 cm x 30 cm is recommended.

Manures and Fertilizers:

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

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	30	Urea	66	9
P ₂ O ₅	40	SSP	250	33
K ₂ O	20	MOP	34	45.5

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

Since no nodulation takes place, the variety “Uday” responds to high nitrogen fertilizer (up to 120 kg/ha). For better yield of rajmah, a higher fertilizer dose of 60:80:40 kg NPK/ha for North Bank Plains Zone is recommended.

Application of Lime:

CaCO₃ in the form of dolomitic lime @ 65.5 kg/bigha should be applied 15 days before seeding and incorporated in the soil in areas where multiple cropping is practiced.

Interculture:

First weeding should be given 20-25 days after emergence, and subsequent weeding as and when necessary. Earthing up should follow immediately after weeding.

Irrigation:

Two irrigations one at flowering (40 days after sowing) and other at early pod formation stage (65-70 days after sowing) are needed for proper growth and pod filling. Water logging should be avoided.

Plant Protection:

For controlling aphids, jassids and beetles, spray dimethoate or malathion @ 1-1.5 in 800-1000 lit of water/ha.

Harvesting:

Harvesting should be done when 75-80% of the pods turn brownish in colour. Delayed harvesting leads to pod shattering.

Grass pea (*Khesari*)
(Lathyrus sativus)

Variety:

Variety	Duration (days)	Seed yield (q./ha)	Agro-climatic zone	Special features
Ratan (BioL 212)	110-120	10-12	All zones (except Hills Zone & Barak Valley Zone)	Negligible ODAP content (<0.1%), suitable for utera cultivation

Soil type:

Sandy loam and clay loam soils are suitable.

Sowing time:

Mid October to mid November

Land preparation:

The field is to be ploughed 3-4 times to obtain a good tilth.

Seed rate:

40 kg/ha or 5.3 kg/bigha

Spacing:

A spacing of 30cm between rows and 10cm between plants should be maintained.

Fertilizer:

Compost @ 1t/ha (1.33q/bigha) should be applied.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
A. Without Rhizobium culture				
N	15	Urea	33	4.5
P ₂ O ₅	35	SSP	220	30
K ₂ O	15	MOP	25	3.3
B. With Rhizobium culture				
N	10	Urea	22	3
P ₂ O ₅	35	SSP	220	30
K ₂ O	15	MOP	25	3.3

Diammonium phosphate (DAP) @ 75 kg/ha or 75 kg/bigha is to be applied in lieu of urea and SSP in non-inoculated crop. NPK may also be applied in the form of mixed fertilizer.

Seed inoculation:

Seeds may be inoculated with suitable Rhizobium culture @ 50g/kg of seed. Inoculation method is same as in case of lentil.

Interculture:

Hoeing in inter-row spaces and weeding at 20-25 days after sowing.

Relay cropping of grass pea (*Khesari*) with winter rice:

Land situation: Medium land

Sowing time: 15-20 days before the harvest of winter rice when the soil is in moist condition.

Method of sowing: Broadcast

Seed rate: 50kg/ha or 6.7kg/bigha

Seed priming: Soaking of seeds in water for 6hrs.

Foliar nutrition: Foliar spray of 2% urea at branching and pod initiation stages.

Plant protection:

A. Insect pests:

Insecticide	Dose (ml/lit of water)	Concentration (%)	Insect pests
Malathion 50EC	2.00	0.10	Aphids and pod borers
Dimethoate 30EC	2.00	0.06	Aphids and pod borers

B. Diseases

Disease	Fungicide	Dose (g/kg of seed)	Concentration (%)	Mode of application
Wilt	Carbendazim	2.00	-	Seed treatment
	Or Thiram	3.00	-	-do-
	Carbendazim	-	0.1	Drenching the soil in localized patches

Harvesting:

Harvesting should be done when 75-80% of the pods turn yellow or brown.

Protection against storage pests:

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

OILSEEDS

Rapeseed – Mustard
(*Brassica campestris*) - (*Brassica juncea*)

Varieties:

Varieties	#Agro-climatic zone	Duration (days)	Yield (q/ha)	Oil content (%)
Rapeseed:				
<i>(Toria)</i>				
TS-38	All zones	90-95	10-12	-
M-27	All zones	90-95	10-12	44.6
TS-29	All zones	85-90	10-12	44.0
TS-36	All zones	90-95	10-12	
Mustard:				
TM-2	U,C,L,H	105-115	12-16	36.40
TM-4	U,C,L	105-115	12-16	36.40
Varuna	L,H	110-120	12-16	36.40

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

New varieties recommended:

Varieties	Sowing time	Duration (days)	Yield (q/ha)	#Agro-climatic zone
Lakshmi (TS 46)	Mid Oct- mid Nov	85-90	10-12	C

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

Soil Type:

Rapeseed – mustard generally do well in sandy soils. However, other light soils are also equally good.

Field Preparation:

A fine seed bed is essential for rapeseed – mustard. The field should be ploughed 4-6 times followed by laddering in order to obtain a fine tilth.

Fertilizer Management:

Application of FYM or compost @ 2-3 t/ha is beneficial for the crop.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha

(a) Plains:**Rainfed condition**

N	40	Urea	87	12
P ₂ O ₅	35	SSP	220	30
K ₂ O	15	MOP	25	25

Irrigated condition

N	60	Urea	130	18
P ₂ O ₅	40	SSP	250	33
K ₂ O	40	MOP	66	9

(b) Hills**Rainfed condition**

N	65	Urea	140	20
P ₂ O ₅	35	SSP	220	30
K ₂ O	0	MOP	0	0

Central Brahmaputra Valley Zone**Rainfed condition**

N	60	Urea	130	18
P ₂ O ₅	30	SSP	190	27
K ₂ O	30	MOP	50	6

Package of Practices on Rabi Crops

If SSP is not used as source of P, sulphur @ 20 kg/ha in the form of gypsum (133 kg/ha) should be used.

NPK may be supplied in the form of mixed fertilizers. Nutrient requirements are to be adjusted according to contents in fertilizers. Rapeseed-mustard have been found to respond well to the application of borax in some agro-climatic zones of Assam. For higher yield of rapeseed and Mustard in the North Bank Plains Zone, a fertilizer dose of 60:40:40 kg NPK/ha is recommended. However, the earlier doses of 40:35:15 and 40:20:20kg NPK/ha have also been recommended for those farmers who cannot afford a higher dose. Borax @ 10 kg/ha for North Bank Plains Zone, 5-10 kg/ha for Upper Brahmaputra Valley Zone and 7.5kg/ha for Central Brahmaputra Valley Zone are recommended, in addition to recommended dose of fertilizers.

The crop booster 'Green Harvest' is recommended @ 25g/10lit of water at 30 days after planting.

Application of Lime: CaCO₃ in the form of dolomitic lime @ 65.5 kg/bigha should be applied 15 days before seeding and incorporate in the soil in areas where multiple cropping is practised.

Seed Treatment:

Seed treatment with metalaxyl 35 WS @ 6 g/kg of seed is recommended for eliminating downy mildew and White rust.

Seed Rate:

Seed rate of 10 kg/ha (1.3 kg/bigha) for *toria* has been found to be optimum.

For TM 2, TM 4 and Varuna, seed rate will be 8 kg/ha and plant population should be maintained at 3 to 3.5 lakh/ha. A seed proportion of 75:25 of *toria* + lentil mixed is recommended for Hills Zone only. As pure crop, a seed rate of 6-8 kg/ha is recommended for Hills Zone. After sowing, the land is lightly laddered.

Seed rate of rain fed late sown *toria* after *sali* paddy (rice-*toria*

Oilseeds : Rapeseed – Mustard

sequence) should be 13 kg/ha, i.e. 33% higher than normal recommended rate of 10kg/ha.

Time of Sowing:

The optimum time of sowing is middle of October to middle of November. Early sowing helps in escaping the attack of aphids.

In Barak Valley Zone, rapeseed and mustard can be sown as late as November 30 in upland condition and up to third week of November in medium upland condition. However, the seed rate of rainfed late sown *toria* grown as succeeding crop in rice (*Sali*)-*Toria* sequence should be 33% higher than normal recommended rate, i.e. 13.0kg/ha.

Irrigation:

One irrigation of 6 cm depth of water may be applied either at 50% flowering or at early siliqua formation stage. In case a rainfall of 20-25 mm is received during this period, no post sowing irrigation is essential. Pre-sowing irrigation is normally not required for timely sown crop. However, in dry areas one pre-sowing irrigation may be applied.

As moisture conservation tillage practice for rapeseed after *sali* rice, one cross ploughing by power tiller incorporating rice stubbles is recommended. The situation for this practice should be medium land with medium textured soil, field capacity 23-25%, soil moisture at the time of land preparation around 22.5%, and time of sowing 4th week of November to 1st week of December.

Interculture:

Normally no weeding is required. Whenever necessary, one weeding at 15-20 days after sowing is sufficient to keep the field weed free.

(a) Insect pests:

Aphid and saw-fly are major pests of rapeseed-mustard. Against these pests following spray schedule should be adopted

Package of Practices on Rabi Crops

Insecticide	Quantity (lit/ha)	Volume of water (lit/ha)	
		Hand sprayer	Power sprayer
Dimethoate 30EC	0.5	500-700	200-250
Chlorpyrifos 20EC	0.5	500-700	200-250
Phosphamidon 100EC	0.2	500-700	200-250
Oxydemeton methyl 25EC		500-700	200-250
Deltamethrin 2.8EC	0.4	500-700	200-250

In *orobanche* endemic areas continuous cropping of toria-mustard should be avoided. Crop rotation with other cereals and legumes may be followed to reduce attack of the parasite.

Bee pollination:

For enhancing yield through increased pollination, 5 honey bee colonies/ha is recommended in rapeseed-mustard.

Harvesting:

The crop is ready for harvest when 75-80% siliquae turn yellow. The crop is harvested by pulling out whole plants or cutting by sickle.

Linseed
(*Linum usitatissimum*)

Variety:

T-397 : Duration 130-135 days, average yield 8-10 q/ha, oil content 44%.

Soil Type: Loamy soils are preferred.

Field Preparation:

The field is to be ploughed 3-4 times, followed by 1-2 laddering to obtain a fine tilth.

Fertility Management:

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	40	Urea	88	12
P ₂ O ₅	20	SSP	125	18
K ₂ O	10	MOP	16	2

NPK may also be supplied in the form of mixed fertilizers.

Application of Lime:

CaCO₃ in the form of dolomitic lime @ 65.5 kg/bigha should be applied 15 days before seeding and incorporate in the soil in areas where multiple cropping is practiced.

Time of sowing:

Optimum time of sowing is from middle of October to middle of November. In Barak Valley Zone sowing can be done in December after harvest of *sali* paddy.

Seed Rate: 15-20 kg/ha

Spacing:

Seeds are to be sown in lines at a distance of 30 cm from row to row and 18 cm from plant to plant. Spacing recommended for Central Brahmaputra Valley Zone is 25cm x 10cm.

Weeding:

One weeding at 20-25 days after sowing is needed.

Plant Protection:

Wilt: For control of wilt disease:

- i) Seeds should be treated with benomyl or carbendazim @ 2 g/kg of seed or Captan or Thiram @ 3 g/kg of seed before sowing.
- ii) Suitable crop rotation should be followed in the affected fields.

Harvesting:

The crop is ready for harvest when plants become dry and the leaves fall off completely.

Niger (*Gujiti*)
(*Guizotia abyssinica*)

Varieties: Local (NG-1)

GA-5 and KEC-3 (for central Brahmaputra Valley Zone).

Duration: 100-110 days

Soil Type: Silt loam to sandy loam

Land Preparation:

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

Time of Sowing:

October (September to middle of October for Lower Brahmaputra Valley Zone).

Seed Rate:

For line sowing: 8 kg/ha (1.1 kg/bigha)

For broadcasting: 12 kg/ha (1.5 kg/bigha)

Spacing: 25 cm between rows and 5-7 cm between plants

Method of sowing:

Furrows of 5 cm depth are to be prepared at 25 cm apart. Seeds are to be placed in furrows preferably at 3-5 cm depth. Then laddering should be done along the furrows to cover the seeds with a soil layer of about 3-5 cm. This ensures compacting of soil resulting in quick and uniform germination.

Fertility Management:

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	20	Urea	44	6
P ₂ O ₅	10	SSP	63	9
K ₂ O	10	MOP	17	2

Plant protection: As no serious pests and diseases have been observed, plant protection measures are not required.

Bee pollination:

For enhancing yield through increased pollination, 5 honey bee colonies/ha of niger is recommended.

Harvesting:

Harvesting should be done when leaves die out and turn blackish in colour. At maturity, the grains also turn black.

Average Yield: 5 q/ha

Groundnut (*Rabi/ Summer*)
(Arachis hypogaea)

Variety: JL-24

Soil Type:

Well drained, light textured, loose, friable, sandy loam soil with medium organic matter content is suitable. The desirable pH range is 5.5 to 7.5.

Land Preparation:

The soil should be prepared thoroughly to get a fine tilth which helps in obtaining good germination.

To get rid of water logging, broad bed and furrow system should be adopted. In this system, raised bed of 15 cm height and 1.2 m width should be prepared.

Time of Sowing:

Rabi groundnut: Mid-September to Mid-October (if sowing time is delayed, crop duration will be increased).

Summer groundnut: Mid January to February.

Seed Selection and Treatment:

Bold and well filled pods should be selected and shelled just before sowing since the viability in the stored kernels deteriorates fast. The small shriveled, damaged and broken kernels should be treated before sowing with 5 g of thiram or 3 g of mancozeb per 1 kg kernels.

Seed rate: For bunch type 120 kg/ha

Method of Sowing:

Seed should be sown in line at 5-6 cm depth of soil.

Spacing:

Row to row : 30 cm

Plant to plant : 10 cm

Manures and Fertilizers:

Compost of FYM @ 10 t/ha should be applied. The following amounts of fertilizer should be applied basal.

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

Interculture:

Weeds should be controlled manually 30-35 days (flower initiation stage) after sowing.

Water Management:

Groundnut crop requires on an average 400-500 mm of water. The critical stages are flowering, pegging and pod development. If the crop does not receive rain during the critical stages, life saving irrigation is to be given.

Plant Protection:

A. Disease:

The most common diseases occurring on groundnut are: *Cercospora* (Tikka) leaf spots, rust, collar rot, dry root rot, stem rot and bud necrosis. These diseases can be effectively controlled by adopting the following control measures:

Tikka and rust: Carbendazim 0.05% plus mancozeb @ 0.2% should

be given as soon as the initial symptoms are detected followed by a second spray after 15-20 days.

Collar rot, stem rot and dry root rot: The seeds should be treated with 5 g thiram or 3 g mancozeb or 2 g carbendazim per kg of kernels.

Bud necrosis: Since this is caused by a virus, no control measure is available. To minimize infestation, thrips (the vector transmitting the disease) should be controlled. Cultural methods like early planting, closer spacing and intercropping with tall crop which act as a barrier for the migration of vector, will reduce the disease.

B. Insect Pests:

Insect pests which cause economic losses are jassids, thrips, leaf miner, aphids etc. These could be controlled by spraying phosphamidon 100 EC @ 0.5 ml per litre of water or dimethoate 30EC @ 0.5 ml/lit of water. To control other soil insects like white ants, red ants etc., malathion 5% dust can be applied.

Harvesting:

The prominent symptoms of maturity are yellowing of foliage and dropping of old leaves. The pod is mature when it becomes hard and there is dark tannin discolouration inside the shell. The seed becomes unwrinkled and the testa develops colour. A common method used to predict optimum time for harvesting is to dig plants when 75% of the pods are fully mature. Generally, *rabi* groundnut (bunch varieties) matures at 125-130 days, while summer groundnut (bunch varieties) matures at the age of 115-120 days.

Drying and Storage:

Rabi/summer groundnut loses viability if dried in the open sun. The pods could safely be preserved for the next year as follows:

- a) Add NPK fertilizers @ 60: 100: 100 kg/ha to the FYM substrate and mix properly.

Package of Practices on Rabi Crops

1. If the crop is irrigated, delay harvest (at least one week) after giving the last irrigation to lower the pod moisture level.
2. After uprooting the plants tie them up with pods intact into small bundles and keep the bundles in a small layer with pods upward under shade.
3. When the bundles are dried, the pods may be detached from the plants and spread in a thin layer under shade for further lowering the pod moisture level to 7-8%. The drying of the pod can be judged from the following tests.
 - (a) The pods should give a rattling sound when shaken.
 - (b) When a karnal is pressed between thumb and index finger, it should easily split into 2 cotyledons.
 - (c) When the surface of the kernel is rubbed hard a portion of the testa should come off.
4. The dried pods may be stored in airtight containers so as to prevent entry of moisture inside the pods during the monsoon period.

TUBER CROPS

Potato

(Solanum tuberosum)

Varieties:

Name	Duration (days)	Yield (q/ha) Rainfed Irrigated	Plant characters	Tuber characters	Tolerance to diseases
Kufri Chandramukhi	80-100	85-100 150-160	Medium tall, erect	Oval, slightly curved, skin white, eyes flat	Leaf roll & virus Y
Kufri Jyoti	110-120	85-100 150-160	Tall, erect	Oval, flat, skin white, eyes flat, flesh dull white	Late blight
Kufri Sindhuri	110-120	85-100 100-160	Tall, erect	Round, skin light, eyes red, flesh pale yellow & sticky.	Moderately tolerant
Kufri Megha	100-120	120-150 175-200	-	White round oval tubers of medium size, white eyes, Flesh dull white, good keeping quality & no tuber cracking	Late blight resistant

Potato variety Kufri Megha can be grown late (up to Mid December) in Upper Brahmaputra Valley Zone.

Soil Type:

Well drained sandy loam and loam soils, rich in organic matter are suitable. A pulse crop should preferably be included in the rotation to improve the soil condition.

Field Preparation:

Field should be thoroughly ploughed to obtain a good tilth. It should be leveled for uniform distribution of irrigation water or to maintain soil moisture uniformly under rainfed situation. The furrows should be prepared at 50 cm apart.

Time of Planting:

The optimum time for planting is mid October to mid November. In case of Kufri Sindhuri planting may be extended up to middle of December.

Method of planting:

The sprouted tubers should be planted in furrows with sprouts facing upward. Care should be taken to avoid sprout damage handling the tubers.

Seed Selection:

Virus free, healthy, medium sized sprouted tubers are to be selected for planting. Ideal size is about 2.5 cm in diameter (25-40 g). Bigger sized tubers may be cut into pieces longitudinally with 2-3 eyes in each piece.

Seed Sources:

Certified seeds of the recommended varieties are to be procured from Govt. or other recognized agencies.

Seed Treatment:

In case of cut seeds, the pieces are to be dipped in Mancozeb @ 5 g in 1 litre of water for about 10 minutes. Benomyl 0.1% solution

may be used if other chemical is not readily available. After treatment, the seeds are to be spread thinly and dried under shade for 48 hours, or should be covered with moist gunny bags for 2-3 days for suberization.

Seed Rate:

The seed requirement is 22.5-25 q/ha when size of the tubers are about 2.5 cm in diameter (about 25 g) and planted with an intra row spacing of 15 cm. Intra row spacing is increased with bigger sized tuber.

Fertility Management:

Ten tonnes or 5 truck loads or 20 cart loads of well decomposed FYM should be applied per hectare in the furrows before planting.

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
Rainfed				
N	60	Urea	133	19
P ₂ O ₅	50	SSP	312	45
K ₂ O	50	MOP	83	12
Irrigated				
N	60	Urea	133	19
P ₂ O ₅	100	SSP	624	90
K ₂ O	100	MOP	168	24

Entire quantity of fertilizers should be applied in furrows as basal application and be covered with a thin layer of soils so that tubers do not come into direct contact with the fertilizers.

The crop booster ‘Green Harvest’ is recommended @ 25 g/ 10lit of water at 30 days after planting.

Mulching:

Adoption of mulching under rained situations increases tuber yield. Water hyacinth plant materials are applied to cover the entire field after planting of tubers under flat method. Of course, skin of the tubers may turn green due to exposure to sunlight or shrinkage of mulching materials on drying.

Tubers become unsuitable for consumption on greening, however, quantities may be reduced by applying mulching materials in furrows just after planting of tubers, immediately followed by light soil cover. Such practices also reduce rodent damage of tubers considerably.

Irrigation:

The furrow method of irrigation has to be adopted. Three irrigations should be applied, first at 25 days (stolon formation stage), second at 60 days (tuber formation stage) and third at 80 days (tuber development stage) after emergence of sprouts. In case of application of mulching materials in furrows, only two irrigations are to be applied at 25 and 60 days after emergence of sprouts. At the time of application of irrigation, care should be taken not to submerge the ridges completely.

Weeding and Interculture:

Earthing up is to be done just before first and second irrigation. Under rainfed condition, this should be done at stolon and tuber formation stages. One or two interculture operations may be necessary when weed infestation is high.

Plant Protection:

A. Insect Pests:

In areas where infestation of red ant and other soil insects are common, application of phorate 10% granules @ 15 kg/ha or malathion 5% dust @ 40 kg/ha in the soil at the time of earthing up should be done to control insects efficiently.

Application of mustard oil cake @ 150 kg/ha at the time of earthing up reduces red ant and white ant infestation to a great extent.

For aphids and epilachna beetle, application of malathion 50 EC @ 1.5 lit in 500-600 lit of water or phosphamidon @ 1.5 lit in 500-600 lit of water/ha is recommended.

B. Diseases:

I. Against late blight, six spraying with mancozeb 75% a.i. @ 0.25% (2.5 g/lit) at an interval of 12 days.

Or

II. Combo fungicide with 64% mancozeb + 8% metalaxyl @ 2 g/lit followed by mancozeb (2.5 g/lit) in alternate application (3 sprays with the combo fungicide & 3 with mancozeb) at an interval of 12 days give very good control if used at the following rates with high volume sprayer.

Early stage (1st month): 600 lit of water/ha

Mid stage (2nd month): 800 lit of water/ha

Late stage (3rd month): 1000 lit of water/ha

The first spray should be given between December 10 to 15. Use of sticker Triton (0.5 ml/lit) will be essential in the spray solution for spraying during rainy weather.

Depending upon weather conditions, particularly in cloudy weather, mancozeb should be sprayed as prophylactic measure. Alternatively, Zineb @ 0.25% (25 g in 10 lit of water) can be used. If disease appears, spraying should be done at an interval of 7 to 10 days depending upon weather conditions. While spraying, care should be taken to ensure wetting of the lower sides of the leaves.

Practices for On-farm storage of seed potatoes:

- The seed tubers for preservation in on-farm storages should be harvested from fully matured potato crop.
- Among the different tuber grades, small sized (5-15g) tubers can be kept suitably in on-farm stores as compared to big sized tubers (>20g).
- Loading density of 75g/m proved beneficial than higher loading density for stored tubers under traditional stores.
- Seed potatoes collected from the main field should be cured properly for 10-15 days in cool place and then treat the healthy tubers with 3% boric acid for 30min followed by 0.25% mancozeb for 20min. After shade drying, the tubers should be loaded in the bamboo rakes fitted in the store.
- Treat potato tubers with malathion 5% dust @ 1.25g/kg of seed to prevent potato tuber moth (PTM) incidence during storage. Chemicals should not be applied in the ware potatoes.
- Use 4cm thick layer of shade dried ‘Neem’ or *Eucalyptus* leaves under and over stored tubers help in controlling potato tuber moth.
- Stored potatoes should be covered with mosquito nets in PTM endemic areas.
- Frequent inspection of the tubers in the store is essential. Remove the rotten tubers periodically.
- Sprout breaking during August is essential in order to minimize over-shrinkage and shriveling of tubers.

PACKAGE OF PRACTICES FOR GROWING OF POTATO CROP FROM TRUE POTATO SEEDS

The potato crop can be grown from True Potato Seeds (TPS). The three methods are as follows:-

1. **Transplanted crop:** Seedlings are transplanted in the field after raising in nursery. About 70% of the total produce is marketable and remaining quantity of small sized tubers is used as seedling materials in subsequent season.
2. **Tuberlet production:** TPS are sown in nursery beds and 70-80% is produced as tuberlets, which are used as planting materials.
3. **Planting of Tuberlet:** Mainly commercial tubers are produced on planting of tuberlets, though tuberlets can be used as planting material during subsequent years.

Varieties:

Varieties	Transplanted crops q/ha	Tuberlet production From direct seeding q/ha	Tuberlets as planting Materials q/ha
HPS 1/13	229	265	314
HPS 7/67	251	276	282
HPS 11/13	220	231	294
TPS C-3	257	290	308

Characteristics of the varieties:

- i) Resistant to Late Blight disease
- ii) Reduced pathogen transmission
- iii) Higher yield potential

- iv) Tuber space may be round and oval
- v) Skin smooth with fleet and medium deep eyes.

1. Transplanted Crop:

1.1 Preparation of nursery bed for raising seedling:

- I. Make the nursery beds of one meter breadth and of convenient length (preferably 3 m)
- II. Prepare a raised nursery bed by filling 7-8 cm with soil, FYM substrate. Prepare the substrate for the seed bed by mixing sterilized soil and well rotten and dried FYM or compost or bio-gas slurry in 1:1 ratio. Apply fertilizer @ 4-5 g N, 6-8 g P₂O₅ and 10 g K₂O/sq.m in the substrate and mix thoroughly. After 2-3 days, the bed is ready for sowing of TPS. The soil could be sterilized by drenching the soil with 4% formalin followed by covering with ploythene or locally available materials (like banana leaf/straw etc.) for 72 hrs and then remove the cover.
- III. Cover the top of the nursery beds with 2-3 cm thick layer of finely sieved FYM. Thus the nursery bed is raised to about 10 cm. from the field level.

1.2 Seedling Raising:

- a. Prepare the seeds for sowing in nursery during the 1st week of October (TPS germinate well when the daily minimum temperature touches 20°C and maximum temperature is 30°C)
- b. Soak the TPS in water for 24 hrs and then incubate in FYM + soil mixture(1:1) for 2-3 days. Pre-germinated seeds are to be sown in nursery bed.
- c. Lightly irrigate the nursery beds a day before TPS sowing to keep the bed in moist conditions.
- d. Sow the pre-germinated TPS in 0.5cm deep furrows drawn 10cm apart across the breath of the bed @ 2 g seeds/sq.m and cover

these with 0.5cm layer of finely sieved FYM. Seedling raised per 10 sq. m nursery can cover 1500-1600 sq. m area. About 120g TPS and a nursery bed area of 75 sq. m are required for raising seedlings for transplanting in one hectare. Sprinkle water on the seed beds 2-3 times a day for about a week after sowing the TPS using a sprayer or a gardeners water can to keep the seed bed moist (avoid excess water). Care should be taken so that seed are not distributed during irrigation and to avoid run off waters. Subsequently sprinkle water once or twice a day.

- e. Protect the nursery beds from direct bright sun light by providing thatch grass shade during mid day for 10-12 days after sowing. Remove the cover in the late afternoon and put it by morning (8-10 am). However, shade should be provided to protect the seedlings from rain, whenever necessary.
- f. Nursery bed should be weed free.
- g. After the germination is completed and the leaves start emerging (around 10 days) spray on the seedlings every 4-5 days interval with 0.1% urea (prepared by dissolving 1g urea in 1litre of water), till these are ready (4-5 leaf stage) for transplanting. The seedlings are ready for transplanting after 25-30 days of sowing.

1.3 Field preparation and seedling transplanting:

- a. Prepare the field as per normal recommended practice.
- b. Basal application (broadcasting) of N, P₂O₅ and K₂O (60:100:100 kg/ha) at the last round of field preparation. Apply FYM @ 10 t/ha during field preparation.
- c. Prepare the ridge at 50 cm apart in East-West direction. Irrigate the furrows one day before transplanting of seedlings. However, irrigation may not be applied if sufficient moisture (around field capacity) remains in the soil, particularly on ridges.

Package of Practices on Rabi Crops

- d. Carefully uproot the seedlings from nursery beds and carry them to the field in a basket. Transplant one seedling per hill in north facing ridges at 10 cm. spacing. Transplanting should be done preferably in the afternoon.
- e. Irrigate the furrows after transplanting to keep the soil moisture in root zone (ridge) at field capacity. While irrigating, care should be taken not to submerge the seedlings. Irrigate the crop every third/ fourth day subject to the moisture condition of the soil, till the seedlings get established. Thereafter, frequency of irrigation can be restricted to one in 8-10 days.
- f. Gap filling should be done within a week of transplanting.
- g. Spray 0.2% dursban on 4th day after transplanting to protect the seedlings from cut worms.
- h. Light manual interculture operation (using *khurpi*) to be performed at about 10 days to loosen the soils in the root zone.
- i. Earthing up should be done 20-25 days along with the application of 25 kg of N/ha. Care should be taken during earthing up so that seedlings come to lie in the center of the ridges and maximum nodes are covered with soil leaving open the top 5-6 upper leaves.
- j. Second earthing up should be done at tuberization stage (45-50 days). The remaining cultural operations to be followed are similar to standard cultivation practices for potato crop. However, fungicides should be applied only when disease symptoms are visible on the leaves.
- k. Dehaulm the crop after 105-110 days of transplanting.
- l. Harvesting is done 10-12 days after dehaulming.

2. Seedling Tuber Production:

1. To produce seedling tubers, the procedure to be followed for nursery bed preparation are identical to the methods recommended in raising

Tuber crops : Potato (TPS)

seedling for transplanted potato crop, except the practices mentioned below :

- a) Add NPK fertilizers @ 60: 100: 100 kg/ha to the FYM substrate and mix properly.
- b) Irrigate the nursery beds a day before sowing of TPS.
- c) Mark the rows in the nursery beds at 10 cm. inter row distance. Sow 2-3 seeds at 10 cm intra-rows distance at a depth of 0.5 cm and cover them with 0.5 cm. thick layer of fine sieved FYM.
- d) Irrigate the seed bed twice or thrice a day or as needed for a week after sowing, using water cane or sprayer, ensuring that the soil is kept moist (field capacity) without any run off water. Subsequently, irrigate once or twice in a day to keep the beds moist.
- e) Provide shade initially as mentioned in earlier method to protect from rain, bright sunshine etc.
- f) After 10 days of emergence, spray the seedlings with 0.1% urea on every third or fourth day for boosting up the growth and vigour of the seedlings. Spraying of urea solution should be stopped when the seedlings become vigorous.
- g) When the seedlings attain a height of 15cm, cover the lower most three internodes of the seedlings with additional quantities of substrate mixture and repeat the earthing up three times at an interval of 7-8 days.
- h) Proper and timely weeding is essential. Follow the usual cultural practices like irrigation, plant protection etc.
- i) Cut haulm at the age of 90-95 days.
- j) Harvest the seedling tubers after 12-15 days of haulm cutting.

Cultivation of Potato crop from Tuberlets:

The seedling tubers produced either by direct seeding of TPS or from transplanted potato crop are planted in the field in the next season.

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The method is similar to the recommended conventional cultivation practices of potato crop, Except the variation in spacing according to seed rate and seed size.

Tuberlet size (g)	Inter-row spacing (cm)	Seed rate (q/ha)
20-40	20	25
10-20	15	17
*5-10	10	12

In case of 5g two tuberlets should be planted. Moreover, seedling tubers (tuberlets)

can be used for 3-4 successive years if seed plot technique is followed appropriately.

OTHER CROPS

Tobacco

(*Nicotiana spp.*)

Variety: Hemti, Bitri, DD437 and HD 65/40

Soil type: Sandy to sandy loam

Raising of seedlings:

a) Seed bed preparation: Raised seed beds about 15cm above ground level, 90cm wide with convenient length are to be prepared.

b) Manure: Well-rotten and semi-dry powdered FYM @ 2kg/sq.m (2t/ha) is to be applied. After preparing the beds, application of super phosphate @ 35g/sq.m (350kg/ha) is needed.

c) Time of sowing: End of September to make the seedlings ready for planting in the middle of November.

d) Seed rate: 0.6g/sq.m

e) Method of sowing: Seeds are to be mixed with fine sand and sown evenly. After sowing, the top soil has to be worked with fingers and leveled. The beds should be covered with bamboo strip mats or jute sticks. Whenever there is bright sun light the cover should be removed.

f) Interculture: Stirring the soil around the seedlings with a sharp edged bamboo poker to break the soil crust is necessary. Seedlings can be removed in three instalments, rejecting all weak and diseased seedlings.

g) Age of seedlings: 35-40 days.

Field Preparation:

The field should be ploughed 3-4 times followed by laddering.

Fertility Management:

Nutrient	Requirement (kg/ha)	Form	Fertilizer requirement	
			kg/ha	kg/bigha
N	50	Urea	108	15
P ₂ O ₅	50	SSP	312	46
K ₂ O	50	MOP	83	11

Package of Practices on Rabi Crops

FYM should be applied @ 10 t/ha (13.3 q/bigha). The entire quantity of SSP and MOP and 3/4th of urea should be applied before planting and remaining 1/3rd urea should be applied 45 days after planting.

Time of Transplanting: November

Spacing: 75 cm x 60 cm

Gap filling:

The gap should be filled within 15 days after transplanting

Interculture:

Use of hand plough at weekly intervals after the establishment of transplant is essential. One or two weeding cum clod crushing are required.

Irrigation:

Depending upon the irrigation facilities and moisture content in the soil two to three light irrigations or pot watering are required.

Topping and De-suckering:

When some flowers have opened, the terminal floral buds are to be topped leaving 8 leaves on the plant excluding the sand leaves. After topping, the auxiliary buds starts emerging and develop as sucker rapidly, which are to be removed when needed.

Harvesting and Curing:

Fully matured leaves which develop yellowish tinge and copper/brown coloured spots, are to be harvested by priming in 3-4 installments. The primed leaves are to be left in the field for about 8-10 hours for wilting under sunlight. The wilted leaves are tied into bunches of 8-10 leaves and cured for 4-6 weeks. Then they are to be arranged in bulks and fermented.

Yield: Average yield of dry leaf 7 q/ha.

Tea (*Camellia sinensis*)

Soil and Climate:

Tea can be grown on a wide range of soils but well drained sandy loam to clay loam soils having pH 4.5-5.5 are most suitable for tea cultivation. Water-logging is injurious to the tea plant. Hot and humid climate with a high and even distribution of rainfall (2000 mm to 40000 mm/annum) throughout the year is beneficial for tea cultivation.

Some Recommended Planting Materials:

Clone : TV 1, TV 18, TV 20, TV 21, TV 22, TV 23, TV 24, TV 25, TV 26, PL 26A, S3A/I, Tin Ali-17/1/54 etc. and other clones approved by the Tea Board.

Seed: TS 450, TS 462, TS 464, Betjan Jat, Tingamira Jat and other seed stock and Jats approved by the Tea Board.

Selection of suitable planting material for a locality should be made, however, by judging the performance of the material in the adjoining tea plantations.

Nursery:

a) **Seed Nursery:** Before sowing in the nursery, seeds are to be placed in a germination pit filled with a thin layer of clean moist sand. On cracking, seeds should be transferred to the nursery. Seedling may be raised in "beds" (1.2m wide and of convenient length laid in East-West direction in fertile soil) or in 'polythene sleeves' {20-25 cm long 17 cm (lay flat) wide & 150 gauge thickness}. Sleeves should be filled up with a mixture of good jungle soil and well rotten cattle manure (3:1 ratio) along with super phosphate @ 500 g/cubic meter soil mixture at least 3-4 weeks before sowing.

i) Sowing Time: November-December. Seeds, as soon as received, should be placed in the germination bed as delay in sowing impairs germination.

ii) Spacing and Depth of Sowing: Seeds should be sown at a spacing of 20 cm x 20 cm in the bed and at a depth equal to the diameter of the seeds. While sowing the scar (eye) should face downwards.

iii) Shade: The nursery is to be protected from strong sun and wind. For this an over head is to be erected with enclosure on all sides. The roof should be slanting towards the South (height 2.1 m on northern side and 1.5 m on the southern side) and covered with a thin layer of thatch or other suitable material. Similar material may be used to construct the enclosure.

iv) Manuring : One Young Tea Dose (YTD), i.e. a mixture of NPK (10:5:15) mixed with dry soil at 1:9 ratio should be applied around the collar (5 cm away from the collar) per 30 running meters of 1-2 m wide nursery bed, from June to August, at fortnightly interval. In addition, 2% urea solution as foliar application may be sprayed 4 times in that period to ensure health and vigour of nursery plants, wherever necessary.

v) Irrigation: Irrigation should be provided on alternate days depending on the moisture status of the soil.

b) Clonal Nursery:

i) Cutting: 2.5 cm long single leaf internode cuttings of correct maturity should be used for propagation.

ii) Time : April – May of September – October

iii) Planting: Cuttings should be raised in “beds” or ploythene sleeve as stated earlier.

iv) Spacing: 15 cm x 15 cm.

v) Shade, Manuring and Irrigation: As practised in seed nursery.

Land Preparation:

(a) Virgin land: The field should be cleared by cutting down or uprooting unwanted big trees leaving the litters *in situ* at least one year ahead of planting. The stump and roots should be completely uprooted. Leveling should be done with minimum soil disturbances. In undulating lands, topographical survey should be done for planning proper drainage and planting.

(b) Area previously used for other cultivation: Area debilitated due to previous cultivation should be rehabilitated properly. Rehabilitation should be done by deep ploughing, harrowing, leveling followed by growing grasses like Guatemala, Hybrid Napier, Citronella and legumes like *Mimosa invisa*, *Crotalaria anagyrioides* for at least one year or suitable pulses may be grown.

Drainage:

Subsidiary drains should be dug 15 m – 25 m apart (depending on soil type) before planting tea. In undulating area, graded contour drains should be dug based on contour map. Drains should be 90 cm deep and 60 cm wide with slopping sides and they should be connected with natural outlet like ‘*nallahs*’ or paddy fields.

Planting:

Field planting should be done in March-April or September – October.

(i) Age of the plant: Vigorous plants about one year old having a girth of near pencil thickness (0.7 cm approx.) should be used for planting. Weak nursery plants should not be used.

(ii) Spacing (double hedge-staggered) :

120 cm x 60 cm x 60 cm (18518 plants/ha)

or

120 cm x 75 cm x 60 cm (14814 plants/ha)

(iii) **Method:** 45 cm deep and 30 cm wide trenches should be dug along the row; plants with 'bheti' should be placed in the trench and rammed properly. To avoid water stagnation, top of the 'bheti' should remain 1 cm above the ground level.

(iv) **Manuring:** Super phosphate @ 1 kg/16 running metre (of the trench) should be applied after thoroughly mixing with the excavated soils along with dry well rotten cow dung @ 65 kg/16 m trench.

(v) **Mulching:** After planting, the area should be mulched with green materials like Guatemala, water hyacinth, spent Citronella grass etc. Paddy straw may be used as mulching material. When paddy straw is used for mulching, it is essential to apply 20 kg nitrogen per hectare, preferably in the form of ammonium sulphate over the mulch. Mulching should be done 10cm away from the collar of the plant.

Green Cropping:

For the initial two years, 'Bormedelua' *Crotalaria anagyroides* may be grown in between two alternate hedges of tea by line sowing. Lopping the tops and sides of the green crop should be done and the litters be kept *in situ*. During gestation period, some pulses may be grown in between the hedges.

Shade:

Temporary shade tree species like *Indigofera teysmanii* should be planted at a spacing of 3.6 x 3.6 m in between the two lines of a hedge immediately after planting of tea. Lopping should be done to avoid over shading and temporary trees should be removed when permanent shade trees attain maturity. Permanent shade tree species like *Albizia odoratissima*, *A. lebbek* etc. should be planted at 12 m x 12 m spacing along the tea rows. Thorny species like *Acacia lenticularis* should be used in elephant infested area.

Manuring:

(a) Young Tea :

Manuring should be started when plants establish in the field. 0 year – 5g YTD/plant, 3 times at 8 weeks interval by ring method,

leaving 10cm around the collar.

+ 1 year – 10 g YTD/plant as above

+ 2 year – 16 g YTD/plant as above

+ 3+4 year – 900 kg YTD/ha in single application in strip method leaving 15 cm from the collar of the plant on either sides.

(b) Mature tea :

From fourth year onwards, 90-135 kg N, 40 kg P₂O₅ and 60 kg K₂O/ha should be broadcast in single dose in clean ground in April when the monsoon rain moistens the soil down to a depth of about 45 cm.

N should be applied in the form of urea for two years followed by ammonium sulphate in every third year.

Bush formation of young tea:

Year	Month	Planting pruning and centering operations	Plucking
0	Sept./Oct.	Planting	
+1	Jan./Feb.	Cut across at 35 cm and decentre below 18 cm. Single stemmer plants are to be 'lung' pruned at 12-15 cm	Tip at 50-35 cm
+2	Jan./Feb.	Cut across at 40 cm (first frame formation prune) and decentre if necessary	Tip at 60 cm. Raise table by leaf when plucking table is full.
+3		-	-do-
+4	December	Cut across at 45 cm (final frame formation prune). Thereafter follow normal cycle.	Tip at 65 cm.

Pruning and Tipping:

(a) **Time:** For light pruning –December 1 to 15. For skiffing – December 15 to January 15.

(b) **Pruning cycle:** 3 or 4 year pruning cycle may be followed.

(i) **3 yr. cycle:** Light prune (LP) – Level-off skiff (LVS) - Deep skiff (DS) –LP.

(ii) **4 yr. cycle:** LP-Medium skiff (MS) – DS light skiff (LS)-LP.

(c) Height of Pruning and Tipping :

(i) LP-Prune at 2 cm above the previous pruning height. Tip leaving 5 newly grown leaves above the pruning level.

(ii) DS-Skiff at 8-10 cm above the LP mark. Tip leaving two leaves.

(iii) MS-Skiff at 12-15 cm above LP mark. Tip leaving one leaf.

(iv) LS-Skiff at 20 cm above the LP mark. Tip at the same height leaving the *janam*.

(v) LVS-Skiff-removing the projecting shoots above the plucking table. Tip at the same height leaving the *janam*.

Plucking:

Pluck should be done up to ‘*Janam*’ in 7 days plucking round. Care should be taken to maintain the table as even as possible.

Green Leaf Handling:

Plucked leaves should not be kept in sun or be compressed in the basket tightly to avoid leaf damage due to generation of excessive heat and bruising of the leaves. All care should be taken to avoid ‘reddening’ of leaves.

Weed Control:

In the first year, hand weeding around the collar region of the plant and cheeling between the hedges should be done. Herbicide sprays

at appropriate @ 350 to 500 lit per hectare (depending on weed infestation) may be used at suitable intervals to control weeds in mature tea from April to September. Care must be taken to avoid herbicide sprays falling on the tea plants.

(i) **Grass weed infested area :** Spray paraquat @ 1.0 l in 300 l of water which may be followed by application of dalapon (2.5 kg in 300 lit water) or glyphosate (2-2.5 lit in 300 lit water)

(ii) **Broad leaf weed infested area:** Spray 2, 4-D (0.75 kg in 300 lit water) or a mixture of 2, 4-D (0.75 kg) and paraquat (0.5 lit) in 300 lit water.

(iii) **Mixed weed infested area:** Spray paraquat (1.0 lit in 300 lit water) or a mixture of 2,4-D (0.75 kg) and dalapon (2.5 kg) in 300 lit water or glyphosate (2.25 lit) in 300 lit water. .

Pest Management:

(a) Mite & Insect Pests:

(i) **For all Mites** including red spider, spray dicofol, or ethion in 1:400 dilution, from mid February onwards. Depending on the intensity of infestation 4-6 applications are necessary.

(ii) **For defoliators** like caterpillar, borer etc., spraying endosulfan in 1: 400 dilution is necessary.

(iii) **For sucking insects** like tea mosquito bug, aphids, thrips, bugs etc, malathion should be applied @ 1.0 lit/ha in 1:400 dilution at 2 weeks intervals.

(iv) **For soil borne insects** like termite, cricket, cockchafer grub, insecticides like malathion 50 EC @ 1.0 lit/ha around collar in 1:500 dilution are to be applied. White grubs may be controlled by endosulfan spraying @ 1.0 lit/ha in 1:500 dilution. For eelworm (nematode), carbofuran 3G @ 1 g/sleeve or 5 g/plant should be applied.

(b) Diseases:

(i) For Nursery Diseases like brown root rot or collar rot, the infected plants must be removed, 0.25% suspension of copper oxychloride should be applied as preventive measure, before onset of rain and repeat spray after one month. For damping off disease, which is mainly caused due to heavy soil condition and over watering, copper oxychloride be applied @ 1.5 kg/ha after first shower, followed by a repeat spray after 3 weeks (1:400 dilution).

(ii) Primary root diseases like brown root rot, charcoal stump rot, terry root rot or purple root rot are incurable. In case of incidence of such diseases, an isolation trench should be dug enclosing 3.5 m radius around the infected plant. All plant parts along with their root systems should be thoroughly removed and burnt. The pit so formed, should be rehabilitated properly before replanting.

(iii) For secondary root diseases like violet root rot, diplodia, thorny blight etc., the infected bush along with its root system should be removed. Improvement of drainage and other cultural practices, thereby increasing the bush vigour, will reduce the possibility of such diseases.

(iv) Leaf and Stem Diseases: Blister blight infected plants should be sprayed with copper-oxychloride @ 625 g/ha in 1:800 dilution by a high volume sprayer. Six to 8 repeat sprays, each at 7 days interval (after each plucking) ensure better control.

For black rot or red rust, same fungicide should be sprayed @ 1.5 to 2.5 kg/ha (depending on the prevalence of the disease) by a hand sprayer in 1: 400 dilution. Four repeat sprays each at 2 weeks interval (during March/April) should be given.

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)

F) CROPPING SYSTEM FOR FORAGE CROP PRODUCTION

A) Sequential cropping:

i) Intensive forage production

1) Cowpea – Teostine/Maize/Dinanath – Oats

2) Cowpea/Rice bean – Cowpea/Rice bean-Oats/Maize

3) Maize+ Cowpea-Teostine+Cowpea-Oats

4) Maize + Cowpea – Dinanath – 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

B) Mixed/intercropping

i) Forage crop mixture

1) Oats +Pea

2) Oats + *Khesari(Lathyrus)*

3) Maize + Pea/ *Khesari(Lathyrus)*

4) Maize + Cowpea/Rice bean

5) Toestine+Cowpea/Rice bean

6) Sorghum + Cowpea

ii) Food-Forage mixture

1) Pea (grain) + Oat (F)

2) Rapeseed/Niger + Oats (F)

3) Lentil/Gram + Oats (F)

4) Rice + Cowpea (F)

5) Green gram - Cowpea (F) – Rapeseed

6) Maize-Cowpea (F)-Sesamum-Rapeseed

7) Rice (direct seeded) – Cowpea (F) - Oat

iii) With perennial grass

1) Guinea/Setaria+Ricebean/Cowpea-Dinanath/Cowpea/Ricebean-Oats/Pea/*Khesari*

2) Hybrid Napier + Cowpea-Cowpea-Oat

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)

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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 <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

Intensive Cropping Systems

Cow pea (Fodder)	Rice (T)	<i>Toria</i>
Lady's finger	Rice (T)	Rice (T) (Irrigated Lowland)
Jute	-	<i>Toria</i>
		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/ Summer pulse	Fallow	Potato/Vegetable/ Toria/ 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.

(In Upper Brahmaputra Valley Zone, pea and *Rajmah* 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.

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.

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.

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 is 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 chlorobenzilate 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.

APPENDIX I Micronutrients

High yielding varieties of crops are fertilizer responsive, and hence lead to removal of both major and micronutrients from soil proportional to the production of crops. Commercially available high analysis fertilizers supply enough of major nutrients and little of micronutrient required for the crop. Replenishment of micronutrients removed by crops to soil is not generally practiced and as such crop derives micronutrients from native source. Due to continuous cropping, the soil is depleted of available micronutrients and thereby the productivity of the land gradually declines.

The studies on micronutrients status in Assam soils and crop responses to application of different micronutrients (straight chelated and blended forms) revealed beyond doubt that the application of micronutrients, particularly zinc and boron are necessary to enhance the yields of various field and horticultural crops in the state. Since molybdenum contents in Assam soils are below the critical limit, responses to Mo is also conspicuous on leguminous crops as it is essential for efficient functioning of *Rhizobium* spp. for nitrogen fixation.

Zinc sulphate, borax and sodium or ammonium molybdate are common sources for supplementing Zn, B and Mo, respectively. However, there are large numbers of micronutrient products available in the market for soil application and foliar spray as given below. But considering the possibility of developing residual toxicity in some specific situations due to continuous soil application, and taking the price of micro-nutrients and labour wages together, foliar spray is advantageous. Although the use of micronutrient should be based on soil test values, a generalized recommendation of its use particularly Zn and B appears to be useful for enhancing the crop yield.

Micronutrient	Products with trade name*
Zn (chelated form as Zn-EDTA 12%)	Zincmax, Chelamin, Estazine
Zn and B	Boromax (9.3% B and 13% Zn)
Mo	Molymax (50% Mo)
Zn, B, Cu, Mn, Fe and Mo	Multiplex, Polymax or Anusar, Shaktyapray, Tracel, Agromin, Microphate, Agroma, Agrimic (a substitute for organic manure)

*Mentioning trade name(s) does not mean promoting the product(s)

APPENDIX II

Use of lime for integrated management of acid soil

Application of liming material @ 1/10th of lime requirement (LR) of soil (Based on SMP method) in furrows integrated with FYM @ 2t/ha together with 50% recommended dose of NPK is recommended for soils of pH < 5.5 under rainfed/irrigated upland and medium land. The recommendation is meant for seasonal application of lime as a fertilizer, but not as an amendment, for various pulses/oilseeds/vegetable crops of the region.

The liming material of 60-80 mesh size used to correct the rhizosphere soil acidity should be applied in furrows with a thin cover up with soil to serve as a barrier to the fertilizer to be applied over it, followed by seeding over a thin layer of soil.

Integrated use of lime and fertilizer may be done with the help of seed-cum-fertilizer drill. For very dry soil, water should be sprinkled to get the best use of lime.

Seasonal application of lime should be done based on soil test for pH measuring less than 5.5.

APPENDIX III

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 (10⁷ 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 IV

Technical and Trades Names of Insecticides & Acaricides

**Technical name
and formulation**

Trade name

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, Folphion 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

Package of Practices on Rabi Crops

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
Chlorpyriphos 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

Package of Practices on Rabi Crops

Fenthion 100 EC	Lebaycid-1000
Diazinon 10G	Basudin 10G, Deviginon, Ditaif, 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 V

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

Technical name and formulation	Trade name
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
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E. Miscellaneous fungicide

Dinocap	Karathane
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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

K. Plant derived products

Neem products Achook, Neemazal, Neem Gold, Nimin (neem oil)

Cymbopogon product Wanis

L. Antagonists

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

**APPENDIX VI
 Technical and Trade Names of Herbicides**

Technical name and formulation	Trade name
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

Package of Practices on Rabi Crops

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 VII

**Technical and Trades Names of Rodenticides, Fumigants and
Nematicide and Micronutrient formulation**

Technical Name and formulation	Trade name
RODENTICIDES	
1. Aluminium Phosphide	Celphos, Phostoxin, Quickphos
2. Zinc Phosphide	Ratox, Zinc Phosphide, Ratol, Commande
3. Warfarin	Ratafrin, Rodafarin Warfarin
NEMATICIDE:	
Carbofuran	(Please see Appendix II)
Micronutrient formulation	
	Tracel, Agromin, Borax Sulphate, Zinc Sulphate

APPENDIX VIII A

Conversion Table (Nutrient-Fertilizer)

1 Kg N	2.17 Kg Urea
1 Kg P	6.25 Kg SSP
1 Kg K	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 VIII 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 IX

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 X

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 XI

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 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. Dibromochloropropan (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 Persistence rating	Overall Rating
		Fish	Bird	Bee	Average		
Azinphos-methyl ⁴		3	2	4	3.0	3	10.0
<i>Bt</i>	1	1	1	1	1.0	3.1	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	4	3.3	2	9.3
Chlorpyrifos	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

Package of Practices on Rabi Crops

Insecticide	Mammalian Toxicity rating	Non-target Toxicity rating				Environmental Persistence rating	Overall Rating
		Fish	Bird	Bee	Average		
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, carbufuran, 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.