Preface

Rice is the major staple food crop of the Meghalaya occupied about 82.40% of the area and 86.42% of the production under foodgrain. The productivity of rice in the Meghalaya (1.91 t/ha) is much below the national productivity (2.06 t/ha). The state is still in deficit of about 2.63 lakh tons of rice grain annually. Farmer are still using local variety with, no fertilizer or manure application, no proper crop establishment techniques (as seeds are mostly broadcasted), cultivation of crop on high slopes and lack of pest and disease management practices are the major constraints of rice production. Due to unscientific cultivation practices,land degradation in the form of deforestation, soil erosion and soil fertility depletion is taking place at a massive scale in the region. The growth in productivity of rice has been slower than that of population, which may lead to food insecurity in the region. Adoption of situation based optimum production technology will enhance the rice productivity in the state.

Keeping these points in view an effort is hereby made to bring out a Technical Bulletin on the 'Rice – Technology Package for Meghalaya'for different farmingsituations (upland, lowland and *jhum* land). This research Bulletin is based on the compilation of rice research carried out by various scientists as well as field experience gained by different extension functionaries. The authors believes that this bulletin will serve as resource book for the planners, researchers, farmers and extension workers involved in enhancing rice productivity in a sustainable manner in the state.

The authors gracefully acknowledge the support and assistance received from scientific, administrative, technical and field staffs in preparing this publication.

Contents

Introduction

Rice (*Oryza sativa*) is the most widely consumed staple food for a large part of the world's human population, especially in Asia.Rice is the most important grain with regard to human nutrition and caloric intake, providing more than one fifth of the calories consumed worldwide by the human species. Rice is the major staple food crop of the north eastern region occupying 3.5 m ha, which accounts for about 7.8% of the area and 6.5% of the country's rice production.

Among the foodgrains in Meghalaya, rice is the main crop and it occupies about 82.40% of the area and 86.42% of the production under foodgrain. The productivity of rice in the Meghalaya (1.67 t/ha) is much below the national productivity (1.95 t/ha). The state is still in deficit of about 1.37 lakh tones of rice grain annually. Rice is vital for the nutrition of the population in Meghalaya, it is central to the food security.Rice is also a wage commodity for workers in the cash crop or non-agricultural sectors.Monsoon-based mono-cropping of rice is prevalent in Meghalaya mainly due to lack of short-duration varieties, irrigation facility and due to low temperature during post-kharif season, which results into spikelet sterility in rice. The major constraints in production are low coverage of high-yielding varieties, use of very low amount of manures/fertilizers, practice of *jhum* cultivation, acid soils and leaching loss of nutrients like N and K, insects and disease problems etc.

The rice crop is cultivated in three different topographical situations i.e. rainfed lowland, rainfed uplands and *jhum* land. The package for these three different situations of rice cultivation is described below.

Technology package for Lowland Rice

The crop is being cultivated in rainfed lowlands to the extent of 3/4th of total rice area in the state.

Recommended varieties

Variety	Description	Yield
Shahsarang-1	A medium duration (150 days) variety, Suitable for lowlands in mid altitude areas. Semi glutinous in nature. Resistant to iron toxicity.	4.2 -4.5 t/ha
IR 64	Short duration variety. Can be grown in prekharif season.	2.0 -3.0 t/ha
Vivekdhan 82	Prekharif short duration variety	
Lumpnah	A medium duration variety, glutinous, tolerant to blast. Suitable for lowlands in mid altitude areas.	4.2 -4.5 t/ha
Megha SA 2	Recommended for mid altitude rainfed areas upto 1000 above MSL. Resistant to blast and is non lodging. Maintains moderate aroma when grown in hills. Its duration is 149-155 days.	3.2 -3.8 t/ha
RC Maniphou4 ,5& 6	Grains medium fine, non aromatic. Recommended for early kharif (sown in June) in mid-altitude lowland areas,	4.5-5.0 t/ha
NEH Megha Rice 1. 2 & 3	Cold tolerant anddwarf variety. Grains are medium bold and the meet quality standards for export quality japonica rice. Suitable for high altitude areas of Meghalaya.	2.5 – 3.5 t/ha

1. SeedBed Preparation

Seedlings canbe prepared in following two types of nursery

Dry nursery

This is most common in Meghalaya. Prepare nursery beds, each of length 10m and width 1.00m. There should be a gap of 30cm in between beds all around for irrigation, drainage and easy movement . Plough or hoe two or three times at intervals of four to five days on receipt of first showers to a get a fine tilth. For transplanting one hectare land by conventional practice, a nursery area of 600-700 sq.m.wouldbe sufficient.

Wet nursery:

This type of seed bed is very common in Sikkim, Manipur and Tripura and it can be done under plain valley land condition. Level the field perfectly after final puddling and prepare beds of 1-1.5m width and of convenient length, leaving 30 cm channel in between two beds. Total nursery area should be 10% of the main field (1000 sq.m. for planting I hectare land).

In both the methods, at final preparation apply well rotten FYM, fertilizer and pesticides as follows.

<u>Requirement for Each Seed Bed (per 10sq.m. area)</u>

* Farm Yard Manure - 20 kg
* Urea - 80 g
* Single Super Phosphate - 80 g
* Murate of Potash - 40 g
* Furadan 3G - 40 g

Sowing Time of seed in nursery

* High altitude region - Mid April to first week of May
* Mid altitude region - May to June
* Low altitude region - June to first week of July

2. Seed treatment

For higher productivity and quality produce, use certified seeds once in three years. Use only well filled and heavy grains. Prepare brine solution (15%) by mixing 1.5 kg edible salt (NaCl) in 10 litres of water in a bucket. Now immerse the seed in salt water. The seeds with low density float on the surface of the solution, whereas the seeds with high density sink in the solution. The seeds floating on the surface of the solution are removed. Collect heavy settled grains and wash thoroughly with fresh water and soak the seed for 24 hours. It also helps to reduce blast infection to some extent.Dry the soaked seed for sometime in shade. To protect the rice plant from blast and other fungal diseases treat the seed with Carbendazim (Bavistin, Topsin etc.) @ 2g/kg rice seed nd kept overnight before sowing in the nursery.

3. Sowing of seeds in nursery

Well germinated seeds are to be sown at the rate of 650-700 g per 10 sq.mbed area. Seeds are sown on the seed bed by broadcasting method and covered them with thin layer of soil and cowdung mixture (1:1). When necessary, water the seedbed regularly to keep them under moist condition. Weeding should be done once or twice depending upon the growth of weeds. After sowing, use plant protection measures to control blast by using Bavistin @ 1gm/lit or Hinosam @ 1ml/lit of water as soon as one or two blast spots are seen.. The seedlings will be ready after 20-25 days after sowing (DAS). At the time of uprooting of seedlings, the nursery bed should be sufficiently wet to avoid root damage. The seedlings can be transplanted in the main field as per the following table.

Sl. No.	Duration of Variety	Age of seedlings (In Days)
1.	Short and Medium duration varieties (upto 120 days)	20-25
2.	Medium to Long duration varieties (120-130 days)	25-30
3.	Long duration varieties (130-160 days)	30-40

4. Main Field preparation

Prepare the field thoroughly to a depth of 15 cm with the help of plough/power tiller/spade.Two to three ploughing should be done followed by puddling and leveling. Puddling and good levelling is necessary for efficient water management, encourage quick establishment and profusedtillering. Apply well decomposed PYM (5 t/ha) after the first ploughing. All the phosphorous, potassium and 50 % of nitrogen should be applied after last puddling.

5. Transplanting

The optimum time of transplanting is first fortnight of July for low and mid altitude. In high altitude transplanting should be done before 15th June. Transplant the seedlings when they are

at 3 to 4 leaf stage. Transplant the seedlings (20-25 days old) @ 3 to 4 seedlings per hill at 5 to 6 cm depth at a spacing of 20 x 15 cm for timely transplanting. For late transplanting, use more number of seedlings (4-6/hill) and reduce the spacing to 20 x 10 cm or 15 x 10cm. Line transplanting with the help of pre-marked rope or bamboo pieces is desirable to run conoweeder in later stages.

6. Manures and Fertilizers

Judicious and balance fertilizers application are very important. Apply manure and fertilizers in the following split doses.

Nutrient	Fertilizer	Fertilizer dose (kg/ha)		
		Basal	I^{st} split (30DAS)	2^{nd} split (60 DAS)
N (80 kg/ha)	Urea	87 kg	43.5 kg	43.5 kg
P_2O_5 (60 kg/ha)	Single super phosphate (SSP)	375 kg	-	-
K_2O (40 kg/ha)	Muriate of potash (MOP)	67 kg	-	-

7. Gap Filling

Re-planting of dead hills should be done within 7-10 days of transplanting with seedlings of the same age.

8. Weed management

Weed infestation is a chronic problem in direct seeded upland rice cultivation and inadequate weed management led to severe loss in grain yield. In puddled transplanted rice, weed problem is somewhat lesser than the upland condition. Following recommendations are made for weed control and management:

(i) Only use good clean seed (free of weed seeds)
(ii) Use conoweeder in criss cross direction for 2 times (25 DAT and 50 DAT)
(iii) Two hand weeding is recommended (25 DAT & 45 DAT) in the absence of any herbicide or conoweeder availability.
(iv) Maintaining 5cms depth of water continuously from rooting stage till 15-20 days before harvesting will keep in check weed growth.
(v) Prevent weeds from growing along bunds and irrigation canals - weed seed can pass along the irrigation system to your field.
(vi) Selective herbicides like Benthiocarb 50 EC @3.0 litres/ha or Anilophos 30 EC @ 1.0 litre/ha can be used one to two days after rice sowing. 2-4 D can be applied @2.5 kg/ha to control the *Cyperus* (mootha) and broadleaf weeds after three weeks of transplanting.

9. WaterManagement

Water should be maintained up to a depth of 5cms right from one week after transplanting till two to three weeks before harvest. It should be noted that if irrigation facilities are available, water may be drained out from the field before broadcasting of fertilizers during

atop dressing. This is done to avoid undue loss of fertilizer due to runoff. The field may again be irrigated 2 to 3 days after atop dressing.

10. Integrated pest and disease management

The major insects-pests of rice in the Meghalaya which cause about 20% yield losses are the stem borer, leaf folder, leaf hopper, hispa, gundhi bug, gall midge etc. Among the diseases, rice blast, sheath blast and bacterial blight are more devastating and wide spread. Other diseases like brown spot, udbatta and false smart are also serious at certain locations in the state.

A. Pest management

i) Stem borer

Symptom of damage

- Presence of brown coloured egg mass near leaf tip.
- Caterpillar bore into central shoot of paddy seedling and tiller and feed inside the stem. It causes drying of the central shoot known as “dead heart” in early stage and when whole panicle becomes dried called “white ear”.

Management

- Grow resistant varieties like NEH Megha rice 1 & 2, RC Maniphou 4&5, Shahsarang 1, Lumpnah
- Avoid close planting and continuous water stagnation
- Pull out and destroy the affected tillers
- Set up light traps to attract and kill the moths
- Spray chlorpyriphos 20 EC @1 ml/litre or monocrotophos 36 EC @2 ml/litre. In one hectare rice field 500-700 litres of water should be used.

ii) Leaf folder

Symptom of damage

- Larvae scrapes the green tissues of the leaves and becomes white and dry.
- During severe infestation the whole field exhibits scorched appearance

Management

- Grow resistant varieties like TRC-2005-1 and TRC-2005-1 Leaves fold longitudinally and larvae remain inside.
- Clipp the affected leaves
- Keep the bunds clean
- Avoid excessive nitrogenous fertilizers
- Use light traps to attract and kill moths

- Spray carbaryl 50 WP 1 Kg or chlorpyriphos 20 EC 1250 ml/ ha.
- Apply Cholorpyriphos 5 ml in 1 lit of water. In one hectare rice field 500-700 litres of water should be used.

iii) <u>Leaf hopper</u>

Symptom of damage

- Yellowing of leaves from tip to downwards.
- Vector for the diseases *viz.,* Rice tungro virus, rice yellow & transitory yellowing

Management

- The vegetation on the bunds should also be sprayed with the insecticides
- Set up light traps
- Spray chlorpyriphos 20 EC @ 1 ml/litre or monocrotophos 36 EC @ 2 ml/litre. In one hectare rice field 500-700 litres of water should be used.

iv) <u>Rice Hispa</u>

Symptoms of damage

- Adults feed on chlorophyll by scraping and causing white parallel streaks
- White patches along with long axis of leaf.
- Grubs mine into the leaves and make blister near leaf tip

Management

- Leaf tip containing blotch mines should be destroyed
- Manual collection and killing of beetles – hand nets
- Spray chlorpyriphos 20 EC @ 1 ml/litre or chlorpyriphos 20 EC @ 1 ml/litre of water. In one hectare rice field 500-700 litres of water should be used.

V) <u>Gundhi bug</u>

It is the most serious pest of rice under upland conditions. These bugs can cause yield losses to the tune of 20 – 40%.

Symptoms of damage

- Both the nymphs and adults suck the sap from the developing grains, which results into chaffy grains.
- White patches along with long axis of leaf.
- Grubs mine into the leaves and make blister near leaf tip

Management

- During milk stage, use rotten crab in a plastic funnel trap @100/ha which attracts and controls (60%) gundhi bugs effectively.
- Dusting with carbaryl 50 WP or fenvalerate 0.4 DP @20-25 kg/ha controls gundhi bug.

vi)Gall midge:

It is a serious pest of rice in Manipur and also occurs in Meghalaya as a common pest.

Symptom of damage

- Maggot feeds at the base of the growing shoot
- Causing formation of a tube like gall that is similar to “onion leaf” or “Silver-shoot”.
- Infested tillers produce no panicles.

Management

- Early ploughing and early sowing
- Grow resistant varieties like NEH Megha rice 1 & 2, RC Maniphou 4&5, Shahsarang 1, Lumpnah
- Harvest the crop and plough immediately
- Use early maturing varieties
- Optimum recommendation of potash fertilizer
- Setup light trap and monitor the adult flies

B. Diseases management

i) Rice blast

Symptoms

- Disease can infect paddy at all growth stages and all aerial parts of plant (Leaf, neck and node).
- Small specks originate on leaves - subsequently enlarge into spindle shaped spots (0.5 to 1.5cm length, 0.3 to 0.5cm width) with ashy center. Several spots coalesce make big irregular patches

Leaf Blast :

- Severe cases of infection - entire crop give a blasted or burnt appearance- hence the name "BLAST"

Neck Blast

- Neck region of panicle develops a black color and shrivels completely / partially grain set inhibited, panicle breaks at the neck and hangs

Management

- Avoid excess N - fertilizer application and apply nitrogen in three split doses.
- Use of tolerant varieties (NEH Megha Rice 1&2, RC Maniphou 6, Shahsarang 1)
- Seed treatment at 2.0 g/kg seed with Captan or Carbendazim or Thiram or Tricyclazole.
- Spraying of Tricyclazole at 1g/lit of water or Edifenphos at 1 ml/lit of water or Carbendazim at 1.0 gm/lit.
- 3 to 4 sprays each at nursery, tillering stage and panicle emergence stage may be required for complete control.

- Avoid closure planting in field.

ii) <u>Sheath blight</u>

Symptom

- Initial lesions are water-soaked to greenish gray and later become grayish white with brown margin

Management

- Use tolerant varieties (TRC -2005-1 and TRC-2005-3)
- Apply FYM 12.5 t/ha or green manure 6.25 t/ha to promote antagonistic microflora.
- Avoid flow of irrigation water from infected to healthy field.
- Carbendazim (1 g/lit), Propiconazole (1ml/lit) may be applied.
- Reduce Nitrogen dosage and skip top dressing
- Use of biocontrol agents like *Trichoderma*

iii) <u>Bacterial leaf blight (BLB):</u>

Symptoms

- Seedling wilt
- Water-soaked to yellowish stripes on leaf blades or starting at leaf tips then later increase in length and width with a wavy margin
- Appearance of bacterial ooze that looks like a milky or opaque dewdrop on young lesions early in the morning

Management

- Grow resistant varieties (RC Maniphou 6&7, lungilaphou)
- Secure disease free seed
- Grow nurseries preferably in isolated upland conditions
- Avoid clipping of seedlings during transplanting.
- Balanced fertilization, avoid excess N - application
- Skip N - application at booting (if disease is moderate)
- Drain the field (except at flowering stage of the crop)
- Spraying streptomycin sulphate and tetracycline combination 300g +copper oxychloride 1.25 kg/ha.

11. Harvesting and threshing

Harvesting of rice should be done at the right stage for getting high quality grains. Harvesting too early will result in a larger percentage of unfilled or immature grains, which will lower yield and in cause higher grain breakage during milling. Harvesting too late will lead to excessive losses and increased breakage in rice. Harvest time also affects the germination potential of rice seed. It also helps in proper storage of grains. Harvest the crop

when 5-10% of the grains at the bottom of the panicle are still to dry but the rest of the grains on the panicle are fully matured.

Rice crop is being harvested by simple hand tools like sickle 15-25 cm above ground level, the harvest is put together in bundles to improve handling and then dried in the field. The manual system of harvesting is very effective in lodged crop conditions, however it is labor intensive.

Threshing is the process of separating the grain from the straw. It can be either done by hand, by using a paddy thresher or mechanized by using a machine.

12. Drying of rice grain:

It is very much necessary to dry the rice seed before storing for future use. Gradual drying of paddy should be done in sunlight to bring the moisture level to less than 12-13% for better milling and storage of the produce.

Store paddy in proper storage structures after adequate drying.Take precautions to avoid infestation by the the stored grain insects and the fungal infections. Use of locally available organic insect repellants like neem leaf etc. so as to prevent damage from insect and rats are also suggested**.**

13. Milling

Cleaned paddy on an average yields 72 percent rice, 22 percent husk and 6 percent bran. The traditional hand pounding or foot pounding (Dhenki) has now become noncompetitive. The rice hullers, shellers and modern rice mills have gained popularity. Hullers seldom give about 65 percent total yields with 20-30 percent broken besides, it does not give completely cleaned rice. The modern rice mills give yield recovery of 70 percent with a grain breakage of 10 percent only.

14. Cropping system/Farming system

Successful *rabi*cropping is possible inlowlandrice fallow of Meghalaya by suitable crop/varietal intervention and management practices. It is advised to grow pea, frencbean, lentil, toria and other vegetables in rice fallows. Pea, lentil and *toria* should be sown immediately after harvesting of rice under zero tillage condition (opening a very small furrow between two rice lines followed by placement of seed and covering). In some areas of Meghalaya, where soil moisture stress is not a problem or there is provision of irrigation facility, frenchbean, carrot, tomato and other vegetables can be grown after harvesting of rice.

Sowing of lentil in rice fallowunder zero tillage

Potato on raised beds and pre-kharif rice in sunken beds

Under wet and marshy valley land of Meghalaya permanent raised and sunken beds (keep width of both raised and sunken beds as I m and 30 – 40 cm height according to situation) should be made for increasing cropping intensity and diversity.

Technology package for Rainfed Rice in Uplands

Practiced in the areas with rain fall is more than 1000mm and scope of irrigation is limited. The rainfed rice area is about 24.4 million. The productivity is very low (< 0.98 tones/hectare), due to uncertainty of available water.

1.Recommended Varieties

Variety	Description	Yield
Bhalum 1, 2 ,3 & 4	A medium duration variety, suitable for uplands in mid altitude areas. Semiglutinous grain	3.5 -3.8 t/ha
IURON 514	Medium duration variety, suitable for uplands in mid altitude areas	3.5 -4.5 t/ha
RC Maniphou 6	A tall variety (120-130 cm), Recommended rainfed uplands during kharif, Tolerant to moisture stress.	3.5-4.5 t/ha
Naveen	A medium duration variety, glutinous, tolerant to blast. Suitable for lowlands in mid altitude areas.	4.2 -4.5 t/ha

2.Land preparation

This is a pre-requisite for good crop husbandry. Plowing the fields during summer season helps controlling weeds. Prepare the field by ploughing and cross ploughing early in the season followed so that the field is ready for sowing before the regular onset of monsoon. Allow the weed seeds to germinate. Adopt shallow harrowing to kill the weeds that emerge. Later on, level the field before sowing.

3. Seed treatment:

For higher productivity and quality produce, use certified seeds once in three years. Select ell filled, matured seed of desired variety. Prepare brine solution (15%) by mixing 1.5 kg edible salt (NaCl) in 10 litres of water in a bucket. Now immerse the seed in salt water.The seeds with low density float on the surface of the solution, whereas the seeds with high density sink in the solution. The seeds floating on the surface of the solution are removed. Collect heavy

settled grains and wash thoroughly with fresh water and soak the seed for 24 hours. It also helps to reduce blast infection to some extent.

Dry the soaked seed for sometime in shade. To protect the rice plant from blast and other fungal diseases treat the seed with Carbendazim (Bavistin, Topsin etc.) @ 2g/kg rice seed nd kept overnight before sowing in the nursery.

4. Time of sowing

This is a critical point to achieve the success in upland rice. The sowing of cropsshould be accomplished within second fortnight of June with the regular onset of the monsoon in Meghalaya. Timely sowing of rice helps for optimum growth of succeeding *rabi* crops.

5. Seed rates, row spacing and seeding depth

Use of row marker is very useful for proper spacing (20 cm) and reducing seed rate. Forbroadcasting a higher seed rate (25-30 kg ha-1) is required.Seeding depth plays key role for good germination. Depthshould not be kept more than 3 cm for desired level of cropstand. Placement of seeds below 3 cm adversely affectsdynamics of seed emergence because of rapid drying of theupper layer soil moisture

6. Nutrient management

Nutritional requirement should be met on the basis of soil analysis of the crop field. In absence of soil analysis,application of 60-40-40 kg N ha^{-1}, 60 kg $P_2O_5ha^{-1}$and 40 kg K_2O $ha^{-1}$is recommended. 50% dose of nitrogen and 100% dose of phosphorus and potassium should be applied at the time of sowing (basal). The remaining 50% dose of nitrogen should be given in two splits vis. 30 and 60 days after sowing (DAS). If available it is also recommended to apply 5 ton FYM/ha during land preparation (20 days before sowing). As most of the soils of Meghalaya are acidic in nature lime should be applied in (2 t/ha) at the time of land preparation once in three year.Apply manure and fertilizers in the following split doses.

Nutrient	Fertilizer	Fertilizer dose (kg/ha)		
		Basal	Istsplit (30DAS)	2nd split (60 DAS)
N (60 kg/ha)	Urea	65.2 kg	32.6 kg	32.6 kg
P_2O_5(40 kg/ha)	Single super phosphate (SSP)	250 kg	-	-
K_2O (40 kg/ha)	Muriate of potash (MOP)	66.6 kg	-	-

Greenmanuring

Dhaincha (*Sesbania aculeate*) or *Crotolaria* sp. can be grownbetween two lines of rice and after 30 days after sowing (DAS), these plants can be cut and used as mulch between the rice

lines. It increases the soil fertility as well as reducing soil erosion and moisture evaporation from the field.

7. Gap Filling

Re-sowing of seed should be done in rice lines within 7-10 after sowingwhere the seeds failed to emerge or crop establishment is very poor.

8. Weed management

Weed infestation is a chronic problem in direct seeded upland rice cultivation and inadequate weed management led to severe loss in grain yield. In puddled transplanted rice, standing water does not allowweeds to emerge. In DSR, conditions are more favorable for thegermination of weeds, which competes with rice for nutrients,moisture and sun light causing large yield losses. The losses caused by weeds ranges from 30-40% including quality detoriation of the grain. The first 15-45 days of the crop is the critical period for crop weed competition which means weeds must be controlled during the period.

Following recommendations are made for weed control and management:

(vii) Only use good clean seed (free of weed seeds);
(viii) Select varieties that are more competitive and smothering efficiency;
(ix) Direct seed in rows to facilitate hand or mechanical weeding;

For line sowing rice, conoweeder (low cost manually operated implement) is a very important tool. But it can be operated only if there is a thin layer of water in the field. Two hand weeding is recommended (20 DAS & 40 DAS) in the absence of any herbicide availability. Hoeing should follow each weeding. Selective herbicides like Benthiocarb 50 EC @3.0 litres/ha or Butachlor 50 EC @3.0 litres/ha or Anilophos 30 EC @ 1.0 litre/ha can be used one to two days after rice sowing. 2-4 D can be applied to control the broadleaf weeds after 20-30 DAS.

9. Integrated pest and disease management

The major insects-pests of rice in the Meghalaya which cause about 20% yield losses are the stem borer, leaf folder, leaf hopper, hispa, gundhi bug, gall midge etc. Among the diseases, rice blast, sheath blast and bacterial blight are more devastating and wide spread. Other diseases like brown spot, udbatta and false smart are also serious at certain locations in the state.

A. <u>Pest management</u>

i).<u>Stem borer</u>

Symptom of damage

- Presence of brown coloured egg mass near leaf tip.

- Caterpillar bore into central shoot of paddy seedling and tiller and feed inside the stem. It causes drying of the central shoot known as “dead heart” in early stage and when whole panicle becomes dried called “white ear”.

Management

- Grow resistant varieties like Bhalum 1, Bhalum 2, RC Maniphou 6
- Avoid close planting and continuous water stagnation
- Pull out and destroy the affected tillers
- Set up light traps to attract and kill the moths
- Spray chlorpyriphos 20 EC @ 1 ml/litre or monocrotophos 36 EC @2 ml/litre. In one hectare rice field 500-700 litres of water should be used.

ii) <u>Leaf folder</u>

Symptom of damage

- Leaves fold longitudinally and larvae remain inside.
- Larvae scrapes the green tissues of the leaves and becomes white and dry.
- During severe infestation the whole field exhibits scorched appearance

Management

- Clipp the affected leaves
- Keep the bunds clean
- Avoid excessive nitrogenous fertilizers
- Use light traps to attract and kill moths
- Spray carbaryl 50 WP 1 Kg or chlorpyriphos 20 EC 1250 ml/ ha.
- Apply Cholorpyriphos 5 ml in 1 lit of water. In one hectare rice field 500-700 litres of water should be used.

iii) <u>Leaf hopper</u>

Symptom of damage

- Yellowing of leaves from tip to downwards.
- Vector for the diseases *viz.,* Rice tungro virus, rice yellow & transitory yellowing

Management

- The vegetation on the bunds should also be sprayed with the insecticides
- Set up light traps
- Spray chlorpyriphos 20 EC @ 1 ml/litre or monocrotophos 36 EC @2 ml/litre. In one hectare rice field 500-700 litres of water should be used.

iv)<u>Rice Hispa</u>

Symptoms of damage

- Adults feed on chlorophyll by scraping and causing white parallel streaks
- White patches along with long axis of leaf.
- Grubs mine into the leaves and make blister near leaf tip

Management

- Leaf tip containing blotch mines should be destroyed
- Manual collection and killing of beetles – hand nets
- Spray monocrotophos 36 EC @ 2 ml/litreorchlorpyriphos 20 EC @ 1 ml/litre of water. In one hectare rice field 500-700 litres of water should be used.

v) <u>Gundhi bug</u>

It is the most serious pest of rice under upland conditions. These bugs can cause yield losses to the tune of 20 – 40%.

Symptoms of damage

- Both the nymphs and adults suck the sap from the developing grains, which results into chaffy grains.
- White patches along with long axis of leaf.
- Grubs mine into the leaves and make blister near leaf tip

Management

- During milk stage, use rotten crab in a plastic funnel trap @100/ha which attracts and controls (60%) gundhi bugs effectively.
- Dusting with carbaryl 50 WP or fenvalerate 0.4 DP @20-25 kg/ha controls gundhi bug.

vi)<u>Gall midge</u>

It is a serious pest of rice in Manipur and also occurs throughout the region as a common pest.

Symptom of damage

- Maggot feeds at the base of the growing shoot
- Causing formation of a tube like gall that is similar to “onion leaf” or “Silver-shoot”.
- Infested tillers produce no panicles.

Management

- Early ploughing and early sowing
- Grow resistant varieties like Bhalum 1, Bhalum 2, RC Maniphou 6
- Harvest the crop and plough immediately
- Use early maturing varieties
- Optimum recommendation of potash fertilizer
- Setup light trap and monitor the adult flies

vii) Root aphid

It is a severe pest in upland condition.

Symptom of damage

- The aphids feed on the roots in colonies around the upper and middle parts of roots by sucking the sap.
- The leaves of infested plants become yellowish and wilt that result in stunted growth of plant.

Management

- Treatment of seeds with 0.75 kg ai/100 kg seed or application of carbafuran 3G @1 kg ai/ha.

B. Diseasesmanagement

i) Rice blast

Symptoms

- Disease can infect paddy at all growth stages and all aerial parts of plant (Leaf, neck and node).
- Small specks originate on leaves - subsequently enlarge into spindle shaped spots (0.5 to 1.5cm length, 0.3 to 0.5cm width) with ashy center.
- Several spots coalesce make big irregular patches

Management

- Use of resitant varieties like Bhalum 1, Bhalum 2, R C Maniphou 6 etc.
- Early sowing (April-May) escapes the leaf blast in upland.
- Avoid excess N - fertilizer application and apply nitrogen in three split doses.
- Remove weed hosts from bunds and burn the straw and stubbles after harvest
- Seed treatment at 2.0 g/kg seed with Captan or Bavistin.
- Spraying of Tricyclazole at 1g/lit of water or Hinosan @ 0.1% reduces brown spot disease.

ii) Bacterial leaf blight (BLB):

Symptoms

- Seedling wilt
- Water-soaked to yellowish stripes on leaf blades or starting at leaf tips then later increase in length and width with a wavy margin
- Appearance of bacterial ooze that looks like a milky or opaque dewdrop on young lesions early in the morning

Management

- Secure disease free seed

- Balanced fertilization, avoid excess N – application and skip N - application at booting (if disease is moderate)
- Spraying streptomycin sulphate and tetracycline combination 300g +copper oxychloride 1.25 kg/ha.

10. Harvesting, threshing, drying and milling:

Same as described under lowland rice cultivation(page no-)

11. Cropping system/Farming system

Upland rice at maturity in high sloppy terrace land

Since successful *rabi*cropping is very difficult in upland of Meghalaya due to moisture stress, it is advised to adopt soybean, groundnut etc. as intercrops in rice (rice + groundnut/soybean- 4:2 ratio) for improving soil fertility and total system productivity. In some areas of Meghalaya, where soil moisture stress is not so severe, toria can be grown in rice fallow under zero tillage condition (opening a very small furrow between two rice lines followed by placement of seed seed and covering). The rice straw as well as weed biomass should be applied between *toria* lines as a mulch for moisture conservation.

Toria grown in rice fallow under zero tillage

Technology package for *Jhum* rice

Jhum land paddy can be broadly categorized into upland paddy. Jhuming (shifting cultivation) is still practiced in an area of 0.88 m ha in the North Eastern Region of India. It is the only option for poor people living in the hills where forest lands are deforested or slashed and burnt to be used for sowing of seeds. *Jhum* paddy which is a very old practice mainly followed in the hilly terrain, that constitutes around 56.20% area. Due to reduction of jhum cycle from 20-30 years to 2–3 years, land degradation in the form of deforestation, soil erosion and soil fertility depletion is taking place at a massive scale in the region. Rice occupies majority of the area under jhum and entirely rainfed. Growing local varieties, no fertilizer or manure application, no proper crop establishment techniques (as seeds are mostly broadcasted), soil erosion due to cultivation in high slopes and lack of pest and disease management practices are the major constraints of jhum rice whose productivity hardly goes beyond 1 t/ha. The goal of the study is to develop suitable crop establishment and soil fertility management practices for rice in jhum areas besides screening of suitable rice varieties for the particular region and management practices. It also aims to improve soil health for sustainable production and incomes of poor and marginal farmers of the region.

It is quite possible to enhance the productivity level of paddy in the state by following the sound management practices for soil fertility and pest control, etc.

1. Grow high yielding rice varieties like Bhalum 1, Bhalum 2, Bhalum 3, Bhalum 4,R C Maniphou 6, IURON 514 etc.
2. In respect of nutrient management, application of fertilizer under Slash and burn method of agriculture could supplement the nutrient shortfall when lands are used more than once at the same site.
3. The investigation also concludes that, continuous use of jhum land atleast for 3-5 years, if not permanently, would help motivate the jhum farmers not to abandon their fields after a year's cultivation, but atleast for two to five years through externally managed nutrient sources.
4. Adopt dibbling or chutki method instead of broadcasting
5. Apply 1ton FYM/ha at the time of field preparation
6. Use 65 kg Urea, 185 kg SSP and 33 kg MOP at the time of sowing of rice seed
7. Spray urea or DAP @2% at flowering stage for higher productivity
8. Two hand weeding (in the absence of herbicide) should be done at 25 and 45 days after sowing of seed
9. Butachlor 50 EC @3.0 litres/ha or Anilophos 30 EC @ 1.0 litre/ha can be used one to two days after rice sowing for controlling weeds
10. Grow legumes (nitrogen fixing crops) like groundnut, soybean, rice bean etc. in every alternate year for soil fertility build up and improving carrying capacity of the soil.

Contingent crop planning for weather aberration

The following practices should be followed in case of weather aberrations (monsoon fluctuations) under various stages of rice growth

Table: Contingency crop planning under various weather situations

S.N.	Circumstances	Cropping strategy
1.	Normal monsoon	*Follow the package of practices recommended for the region. *Do not plant the area under varieties of same duration. *Prefer early varieties in rainfed areas
2.	Timely onset and sudden withdrawal of monsoon	*Avoid sowing till sufficient rains have been received. *If sowing is delayed, plant short duration varieties. * Practice thinning of crop stand, reduce plant population and use the biomass as mulch, intercultural to control weeds, and use of

		mulch. *Conserve moisture in ponds/tanks/field (in-situ for application during critical growth stages). *Foliar application of nutrients may be carried out where moisture is a constraint.
3.	Delay in onset of monsoon: Maximum of three weeks from normal date for the given region	* Shift from long duration to short duration crops/varieties. * Sowing of paddy nursery at 15 days interval. May be more area put under nursery. * Conservation of pre-monsoon moisture through soil/straw/stone mulching practices *Planting of grasses on field bunds with pre-monsoon showers. Raising nursery of grasses like Napier Hybrid, guinea grass. *In case of rice adopt closure spacing and bunch planting, increase seed rate by 25 to 30%. * Raising community nurseries of rice, *Spray of B and K increases drought tolerance. *To meet the fodder needs, crops such as field bean, Anjan grass, yellow anjan. Marvel grass, Dharaf grass, Guinea grass, sorghum, cowpea, guar, Lablab bean and maize .
4.	Break in monsoon (dry spell conditions for 2 to 3 weeks consecutively):	*Choice of crops and varieties for late sowing may be as given under the scenario 2 above. * Follow water conservation and management practices. *Possibility of taking a catch crop *Conserving moisture for 'rabi' sowing *Utilizing paddy fallows for second crop
5.	Early withdrawal of monsoon: By last week of August (late season drought)	* Follow water conservation and management practices. * Efficient use of stored water for life saving irrigation * Short duration varieties of pulses, oilseeds, minor millets * Harvesting the crop at physiological maturity. * Prepare for the ensuing 'rabi' season.

New methods of rice cultivation

1. System of rice intensification (SRI):

The System of Rice Intensification, known by its acronym SRI, is gaining popularity among paddy farmers in several states in India. The method has the potential to improve the productivity of land, capital, water and labor simultaneously. SRI is a system of growing rice, some principles of which are different from traditional ways of growing rice. Fewer seeds and chemical inputs are used. The system promotes soil biotic activities in and around the root zone, through liberal applications of compost and weeding with a rotating hoe that incorporates the weeds and aerates the soil. These practices lead to enhanced yields and considerable savings in terms of seeds, water etc.

The package of practices of SRI is described below

Preparation of Modified Mat Nursery (MMN):

- Nursery for *kharif* rice should be sown during last week of May at high altitude (>1200 m MSL), mid-June at mid

altitude (800 to 1200 m MSL) and end of June at low altitude (less than 800 m MSL).

- ❖ Select high yielding variety seeds (HYV's) like Shahsarang-1, Lampnah, IR 64, etc. for mid altitude and Ranjit, Naveen, IR 64, etc. for low altitude.
- ❖ For nursery, raised beds are prepared (height: 5 to 7.5 cm and width: 1m) and properly levelled and compacted.
- ❖ A mixture of soil and FYM (2:1) should be prepared and spread on the Polythene/ banana leaf surface (3 cm)
- ❖ Spread sprouted seeds uniformly @ 50 g/m^2 on the bed and cover the seeds with the FYM and soil mixture.
- ❖ Water the bed with rose cans regularly (whenever required)
- ❖ The seedlings may scooped out with *khurpi* when ready instead of uprooting to avoid root injury

Preparation of main field for transplanting:

- Prepare uniformly levelled field for better water management
- Proper drainage channel should be made. The drainage/irrigation channel can be provided after every 8 to 10 row (2 to 2.5 m interval).
- Transplanting should be done quickly after gently scooping out seedlings from the nursery bed.
- Maintain a thin film of water for easy transplanting and seedling establishment
- Transplant single seedling using square spacing of 25 x 25 or 20 x 20 cm
- Apply sufficient organic manure (5 t/ha) along with 130 kg Urea (50 kg at transplanting, 40 kg at tillering and 40 kg at panicle initiation), 281 kg SSP and 50 kg MOP at transplanting
- Avoid continuous flooding and irrigate when field develops hairy cracks
- Control weeds through hand weeding (25 and 50 DAT) and cono-weeding at 35 DAT

Benefits of SRI

- Saving on seed cost as the seed requirement is less
- Saving on water as Irrigated – Dry method is followed
- Cost of external inputs gets reduced as chemical fertilizers and pesticides are not used
- Incidence of pests and diseases is low as the soil is allowed to dry intermittently.
- More healthy and tasty rice as a result of organic farming practices.
- Higher yields due to profuse tillering, increased panicle length and grain weight
- Seed multiplication with less quantity of parent seed.
- Farmers can produce their own quality seed.

2. Integrated crop management (ICM):

This system is somewhat in between conventional rice transplanting and SRI method. The ICM practice is very easy to follow and highly successful in ICAR Research Complex for NEH Region, Umiam, Meghalaya. In this method about 15-20 kg seeds are sufficient to transplant one hectare land. The ICM practice is given in comparison to conventional and SRI method in tabular form.

Parameters	Conventional	ICM	SRI
Seed rate (kg/ha)	40 – 50	15 – 20	5 – 7
Seedling age (days)	25 – 30	18 – 20	10 – 12
Spacing (Row x Plant) cm	20 x 15	20 x 20	25 x 25
Seedling/hill	3 – 4	2	1
NPK + FYM	80:60:40 kg/ha	40:30:20 kg/ha+FYM 5 t/ha	20:15:10 kg/ha+FYM 10 t/ha
Water management	Continuous flooding	Intermittent irrigation	Only moist condition
Water requirement (mm)	1800	1400	900
Weed management	Weeds manually removed from the field	Manual and mechanical weeding	Weeds turn down into the field by a weeder
Grain yield (t/ha)	4.0 – 4.5	4.5 – 5.0	5.0 – 5.5

Benefits of ICM

- Seed requirement is less than conventional practice
- Saving on water as intermittent Irrigation is followed
- Cost of external inputs gets reduced as organic manures and fertilizers are used in integration
- Especially good for high rainfall areas like North East India
- It is easy to handle 15-20 days old seedlings compared to 10-12 days
- Incidence of pests and diseases is low as the soil is allowed to dry intermittently
- Higher yields due to increased tillering, panicle length and grain weight

Conversion factors

Area

I ha = 10000 m^2(100m×100m or 200m × 50m etc.)
1 ha = 2.47 acre
1 acre = 4048 m^2
I litre = 1000 ml
1% = 10ml/litre
0.1 %= 1 ml/litre

Weight

I metric ton = 1000 kg
1 metric ton = 10 quintal
1 quintal = 100 kg
1 kg = 1000 kg
1 g = 1000 mg
1 Mann = 37.2 kg

Volume

1 cubic meter = 1000 litre
1 cubic ft = 28.2 litre
1 litre = 1000 ml

Percentage

1% solution = 10ml / litre
0.1% solution = 1 ml / litre
0.2% solution = 2 ml / litre

1% = 10g/kg
= 10mg/g
0.1% = 1g/kg
= 1mg/g

Fertilizer	**Nutrient supplied**	**Nutrient content**	**Conversion factor**
Urea	Nitrogen	N (46%)	N to Urea = 100/46 = 2.2
SSP	Phosphorous	P_2O_5 (16%)	P_2O_5toSSP = 100/16 = 6.25
MOP	Potassium	K_2O (60%)	K_2O to MOP = 100/60 = 1.6

Conversion	**Multiplication factor**	**Example**
N to urea	2.2	1 kg N = 2.2 kg Urea, 5 kg N = (5× 2.2) kg urea = 11kg Urea
P_2O_5toSSP	6.25	1 kg P_2O_5 = 6.25 kg SSP 8 kg P_2O_5 = (8× 6.25) kg SSP = 50kg SSP
K_2O to MOP	1.66	1 kg K_2O = 1.66 kg MOP 10 kg K_2O = (10× 1.66) kg MOP = 16.6 kg MOP

Herbicide/pesticide calculation

a.i. = active ingredient (it is the actual toxicant in commercial products which is directly responsible for its toxic effect)

Example :

1. **For applying Chlorpyriphos 20 EC @ 1 ml/litre how much chlorpyriphos will be required per litre**?

$$\text{Quantity of chlorpyriphos requirement/litre} = \frac{100}{\text{Active ingredient (\%)}} \times \text{Rate of application}$$

$$= \frac{100}{20} \times 1 \text{ ml/litre}$$

$$= 5 \text{ ml/litre}$$

2. **For applying carbafuran 3G @ 0.5 kg ai/ha, how much carbafuran will be required per hectare**

$$\text{Quantity of carbafuran requirement/ha} = \frac{100}{\text{Active ingredient (\%)}} \times \text{Rate of application}$$

$$= \frac{100}{3} \times 0.5 \text{ kg/ha}$$

$$= 16.66 \text{ kg/ha}$$

Source

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