

# AGRO-TECHNOLOGY FOR HIGHER RICE PRODUCTIVITY IN ANDAMAN & NICOBAR ISLANDS

R.K. Gautam, P.K. Singh, Ajanta Birah, Krishna Kumar,  
A.K. Singh, Naresh Kumar, S. Swain, S.K. Zamir Ahmed,  
Ajmer Singh, N. Ravisankar, K. Devakumar and S. Dam Roy



तमसो मा ज्योतिर्गमय



Division of Field Crops  
Central Agricultural Research Institute  
Port Blair - 744101  
Andaman & Nicobar Islands



# Agro-technology for higher rice productivity in Andaman & Nicobar Islands

R.K. Gautam, P.K. Singh, Ajanta Birah,  
Krishna Kumar, A.K. Singh, Naresh  
Kumar, S. Swain, S.K. Zamir Ahmed,  
Ajmer Singh, N. Ravisankar,  
K. Devakumar and S. Dam Roy



Central Agricultural Research Institute  
Port Blair – 744 101  
Andaman & Nicobar Islands



Citation : Gautam, R.K., Singh, P.K., Birah, A, Kumar, K., Singh, A.K., Kumar, N., Swain, S., Zamir Ahmed, S.K., Singh, Ajmer, Ravisankar, N., Devakumar, K and Dam Roy, S. (2013)

*Agro-technology for higher rice productivity in Andaman & Nicobar Islands*

Technical Bulletin, Central Agricultural Research Institute, Port Blair, Andaman & Nicobar Islands, India, 42pp.

Year of publication : 2013

Published by : Director,  
Central Agricultural Research Institute, Port Blair,  
Andaman & Nicobar Islands - 744101, India

Printed at : Capital Business Service & Consultancy  
B-51, Sahid Nagar, Bhubaneswar  
E-mail : capital.a1press@gmail.com

## P R E F A C E

Rice is the principal food crop of Andaman and Nicobar Islands in India. At present the requirement of rice for consumption is almost three times more than the production in the islands. To narrow the gap between actual production and requirement, horizontal expansion of rice area is difficult due to forest preservation for addressing ecological requirements. Alternatively, vertical growth in terms of rice productivity enhancement is quite attractive and achievable option.

The developments in rice science and technology generation have enabled the realization of higher productivity levels in different states in the mainland. However, under island situation, productivity enhancement has to be essentially achieved in tandem with environmental concerns. It implies that twin objectives of production elevation and preservation of fragile eco-system can be achieved by careful and prudent approach.

In this direction, we endeavored to put together different technological approaches in a holistic manner in this document. The information on suitable varieties, crop production and protection aspects should be quite useful to the developmental departments, stakeholders and farmers for achieving higher rice productivity and food security in Andaman and Nicobar Islands.

**(Authors)**



## CONTENTS

No	Particulars	Page No.
1.	Introduction	01
2.	Climate	03
3.	Soil	04
4.	Improved rice varieties	04
5.	Seed rate and treatment	09
8.	Nursery raising	10
9.	Field preparation	15
10	Fertilizers	15
11.	Seedling treatment	16
12.	Transplanting	16
13.	Weeds and their management	17
14.	Rice diseases and their management	19
15.	Insect- pests and their management	26
16.	Post harvest management in rice	33
17.	Value added by-products from paddy	40
18.	Economics of rice cultivation	41



## Introduction

The Andaman and Nicobar group of Islands has a total geographical area of about 8249 sq.km, out of which only 6% is available for agriculture. The arable land inclusive of fallows is about 22451 ha. Of this, paddy occupies the maximum area of about 8390 ha followed by vegetables, pulses and spices. Rice is the staple food of the island populations and thus occupies nearly half of the cultivable area in Andaman & Nicobar Islands. Though the total production is about 24000 t per year, the actual requirement is about 60000 t. Therefore additional gap of about 36000 t has to be met from shipment from mainland or enhancing local production. The shipment involves transport costs and thus puts burden on national exchequer. Alternatively the demand can be met through enhancing local production of rice. Though horizontal expansion of rice area is not feasible due to forest preservation policy, large scope exists for augmented production through appropriate varieties complemented with matching package of production.

Among the three districts in the Andaman and Nicobar Islands, the North and Middle Andaman district has the major share of rice growing area followed by the South Andaman and Nicobar districts. During the year 2004, the Indian Ocean tsunami has rendered a large area of cultivable land unfit due to the intrusion of sea water in the cultivable land. Extensive damage took place and about 9% (4206 ha) of pre-tsunami agricultural land is under permanent submergence. Paddy is the main crop during *kharif* season covering about 17% of total cultivable land. The high annual rainfall of about 3100 mm is also favourable for rice cultivation in the islands. The geographical and agro-climatic conditions of A & N are quite conducive for rice based cropping system. Generally, mono-cropping of paddy is practiced only in *kharif* season whereas *rabi* rice is not practicable due to water shortage in the dry season. However, post rice crops like pulses, oilseeds and vegetables are cultivated during *rabi* season.



In such scenario medium duration rice variety which vacates fields in time for the timely sowing of succeeding crops may be useful.

**Table 1: The area under cultivation, production and productivity during 2010 -11 of various field crops in A & N islands**

Crop	Area(ha)	Production(Tons)	Yield(t/ha)
Paddy	8390.00	23916.00	2.85
Maize	163.54	367.62	2.25
Pulses	2910.00	1154.50	0.44
Oilseeds	94.30	51.90	0.55
Spices	1661.00	3067.25	1.85

Source: Basic Statistics, Directorate of Economics and Statistics, Andaman and Nicobar Islands, 2011

In Andaman, there is a trend of stagnation in the area under cultivation mainly due to government policies with respect to forest cover and the level of subsidies for various activities.

**Table 2: Socio-economic parameters of the various tehsils of the Andaman and Nicobar Islands**

Tehsil	Population	Literacy (%)	Size of land holding (ha)
<b>A. North &amp; Middle Andaman district</b>			2.13
Diglipur	42877	75.61	
Mayabunder	23912	80.97	
Rangat	38824	79.84	
<b>B. South Andaman district</b>			1.52
Port Blair	142317	85.13	
Ferrargunj	48624	82.47	
Little Andaman	17528	NA	
<b>C. Nicobar district</b>			2.47
Car Nicobar	20292	74.14	
Nancowry	13562	70.62	
Great Nicobar	8214	NA	

Based on crop production and land specific parameters, North & Middle Andaman district forms the most important district for food production point of view. Obviously, the supply of critical inputs is also highest in this district followed by South Andaman. So, this district is the focal area for all the government policies formulations and technological interventions so as to work towards meeting islands, requirements and self-sufficiency in food production. To address one particular district for policy and technological interventions, the study of its socio-economic profile is very important for an effective policy development and its proper execution as the productivity has direct relation with socio-economic variables and resource endowment of the farmers. The response of improved technologies and inputs depends largely on the socio-economic parameters of cultivators.

**Table 3: Agricultural characteristics of Andaman and Nicobar Islands**

Particulars	Andaman and Nicobar Islands
Total geographical area (in sq km)	8249.00
Current fallow (ha)	2634.30
Other fallow (ha)	3281.60
Net area sown (ha)	14710.07
Area sown more than once (ha)	1825.15
Total cropped area (ha)	16535.22
Rice area (ha)	8390.00
Rice production (ton)	23916.00
Rice productivity (t/ha)	2.85
Distribution of paddy seeds (tons)	18.80

Source: Basic Statistics, Directorate of Economics and Statistics, Andaman and Nicobar Islands, 2011

### Climate

Rice is indigenous to the humid areas of tropical and subtropical regions. The climatic factors that influence rice production are temperature, day-length, humidity and water availability. These factors cumulatively influence the total production and productivity.



Rice is more suited to high rainfall regions because it requires abundant moisture either through rainfall or irrigation to keep the soil under saturation throughout its life period. Therefore, the practice of rice cultivation is mostly dependent on the rainfall conditions.

For successful cultivation of rice in Andaman and Nicobar islands, the prevailing range of maximum day temperatures during the months of July-October has to be exploited to the maximum advantage. To get the maximum yield advantages, the critical period of 30 days between the flowering stage and the grain hardening stage should coincide with the maximum day temperature (below 29°C) which normally prevails in state between August and early November. Therefore the sowing of the rice crop should be taken up during late May so that the seedlings are ready for transplanting by the last week of June.

### Soil

The soils most suited for the cultivation of rice are clay and clay loam. Such soils are capable of holding water for long period. The low land valley areas having soil depositions from the hill catchments are ideal for rice cultivation in the islands. These soils have invariably high organic matter. However sea coastal areas have problems of salinity and acid sulfate soils which need specific management and varieties.

Following package of practices can enhance production and productivity of rice and rice based system in Andaman & Nicobar Islands

### Improved rice varieties

So far five varieties of rice have been developed by CARI, Port Blair and recommended by A & N State Variety Release Committee for general cultivation. These are CARI Dhan 1, CARI Dhan 2, CARI Dhan 3, CARI Dhan 4 and CARI Dhan 5. CARI Dhan 1, CARI Dhan 2 and CARI Dhan 3 are recommended for normal soils while, CARI Dhan 4 and 5 are suitable for coastal saline soils. Besides this, few improved rainfed long duration rice varieties i.e.

Varsha, Savithri, Gayatri, Ranjeet under normal soils, whereas CSR 23 and CSR 36 under saline stress conditions have also shown better performance under islands conditions. Their relative average yield in normal soil is given in Table 4.

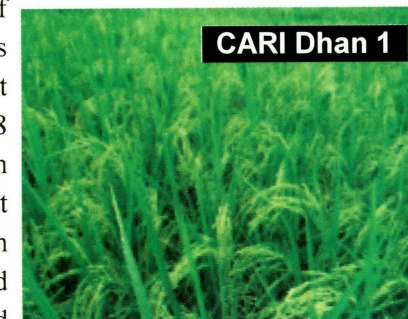
**Table 4. Grain yield performance of improved rice varieties in normal soils of Andaman and Nicobar Islands**

Duration	Varieties	Grain yield (t/ha)
<b>Medium duration (120-130 days)</b>	CARI Dhan 1	4.0 - 4.5
	CARI Dhan 2	5.0 - 5.5
	CARI Dhan 3	4.5 - 5.0
<b>Long duration (131-150 days)</b>	Varsha	3.5 - 4.5
	Ranjeet	4.5 - 5.0
	Savithri	4.0 - 4.4
	Gayatri	3.4 - 4.0
	*CARI Dhan 4	3.1 - 3.3
	*CARI Dhan 5	3.2 - 3.7

\*Salt tolerant

### A. Medium duration varieties:

**CARI Dhan 1:** It is of medium duration and matures in about 120 days. It has plant height of 115 cm with 7-8 panicle bearing tillers with panicle length of 24 cm. It gives 4.0-4.5 t/ha yield in normal soils of Andaman and Nicobar Islands and

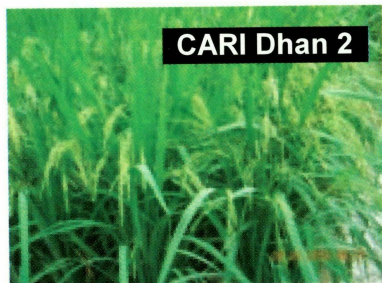


possesses long medium grains. It is moderately resistant to sheath blight, bacterial blight, leaf spot and tolerant to stem borer and water logging.

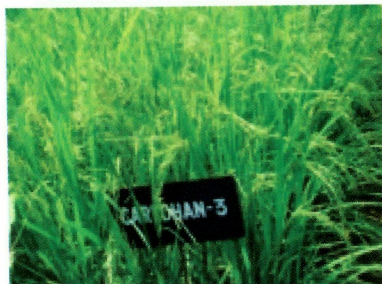
**CARI Dhan 2:** It is medium duration variety (120 days) with a plant height of 110 -125 cm. It bears 7 to 8 effective tillers/plant and has panicle length of 25 cm. It gives yield from 5.0 to 5.5 t/ha in lowland,



rained conditions in coastal areas. The grain of this variety is long medium. It is tolerant to sheath blight, leaf spot, bacterial blight and tolerant to water logging.



**CARI Dhan 3 :** It is a medium statured (115 cm) variety having medium duration (120 days). It bears 7-8 tillers per plant with panicle length of 26 cm. Its yield ranges from 4.5 to 5 t/ha. It has medium slender grains. It is resistant to sheath blight, bacterial blight and leaf spot and tolerant to stem borer and water logging.



### B. Long duration varieties:

**Varsha:** It matures in about 140 days and possesses short bold grains. It bears 4-5 tillers per plant with panicle length of 25 cm. It gives grain yield of 3.5 to 4.5t/ha.

**Ranjeet:** It is a long duration (150-155 days), short medium grain variety for rainfed, shallow lowland. It bears 5-6 tillers per plant with panicle length of 24 cm. Its yield ranges from 4.4 to 4.7 t/ha in normal soils of Andaman. It is moderately resistant to bacterial leaf blight. However, it has been observed to be sensitive to salinity stress and hence should be avoided in problem soil.



**Savithri:** It is a long duration (150 days) and short bold grain variety. It bears 5-6 tillers per plant with panicle length of 23 cm. Its yield ranges from 4.0 to 4.4 t/ha in normal soils. It is moderately susceptible to bacterial leaf blight, blast, sheath blight and tolerant to stem borer.



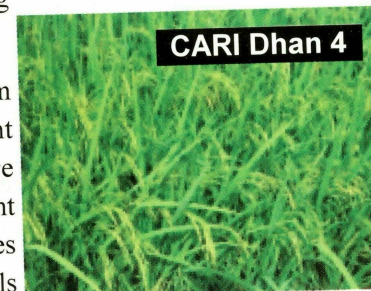
**Gayatri:** It is a long duration (145 days) variety and possesses short bold grains. It bears 4-5 tillers per plant with panicle length of 23 cm. It yields between 3.4 to 4.0 t/ha in normal soils. It is moderately susceptible to bacterial blight and moderately resistant to blast and gall midge pest.



### C. Salt tolerant rice varieties:

Rice has long been traditionally grown in the islands and coastal regions where salinity coupled with acid sulphate soils and water logging is a perpetual problem. The salinity is due to inundations from the sea and intrusion of sea water through rivers, estuaries etc. Though traditional land races are tolerant to these conditions, their yields are quite low. Therefore, efforts were made to introgress their salinity tolerance in high yielding varieties.

**CARI Dhan-4:** It is a medium duration (145 days) salt tolerant variety and has medium stature (120 cm) with 6-8 tillers per plant and panicle length of 25 cm. It gives yield of about 4 t/ha in normal soils





and about 3.2 t/ha in moderately saline conditions. It is resistant to both sheath blight and leaf spot.

**CARI Dhan-5:** It is a long duration (150 days) variety for saline soils with short stature (95.5 cm). It bears 9-10 tillers per plant with panicle length of 24 cm. Its grain yield ranges from 4.4 to 4.7 t/ha in normal soils and 3.2 to 3.7 t/ha in saline soil conditions. It is resistant to sheath blight and leaf spot.



**CSR 23:** It is a medium duration (135 days) variety released by CSSRI, Karnal for saline and sodic soils. It has medium slender grain. It bears 3-4 tillers per plant with panicle length of 23 cm. It exhibits yield of



3.5 to 4.0 t/ha in normal soils and 1.7 to 2.0 in saline soils of Andaman. It possesses resistance to bacterial blight and is moderately resistant to blast and gall midge. It has exhibited tolerance to relatively moderate salinity.

**CSR 36:** It is a long duration (145 days) variety released by CSSRI, Karnal for sodic soils. It gives relatively higher grain yield under high salinity stress situation. It bears 4-5 tillers per plant with panicle length of 23 cm. It possesses long slender attractive grains. Its yield ranges from 3.15 to 3.43 t/ha in



normal soils. Among all varieties tested, it gave maximum yield of 2.17 t/ha under salinity stress situation under Andaman conditions. It is resistant to bacterial blight and moderately resistant to blast and gall midge.

### Seed Rate:

Following seed rate is recommended depending upon method of seeding, planting and type of soils.

Growing condition	Seed rate (kg/ha)
Transplanted	25
Direct wet seeded	50
SRI	7.5

\* A higher seed rate of 30 kg/ha is recommended for growing rice in problem soils (Saline/sodic, acid sulphate, Fe toxic and Al toxic soils.)

### Seed sorting

Seed sorting for unfilled / damaged seeds is a must in order to save the land and water resources used to raise the nursery. Dip dry seeds in 1 % NaCl (10 g common salt in one litre of water) and remove floating seeds. Collect the good seeds which are in bottom and wash the same with fresh water before sowing.

### Seed treatment

1. A large number of diseases caused by fungi, bacteria and viruses as well as insect pests are transmitted through the seeds. Therefore, seed treatment is a necessary practice in rice cultivation. Rice is mainly affected by blast, *Helminthosporium*, stem rot, sheath blight, brown leaf spot, false smut, leaf smut, bacterial blight and bacterial leaf streak diseases. Treatment of seed by soaking it for 12 hours in a mixture of Streptocycline (0.15 g in one litre of water) and wettable Ceresan (0.035%) followed by hot water treatment at 52-54°C for 30 minutes can control most of the diseases. Seed can also be treated by Agrosan GN or Ceresan or Thirarm or Carbendazim or Tricyclozole. The dust of these chemicals can be mixed with



the seeds @ 2.5 g/kg of seed in case of Agrosan GN or Ceresan or Thirarm and @ 2 g per kg seed when treated with Carbendazim or Tricyclozole and seed should be sown in the field.

2. Seed treatment with *Pseudomonas fluroscens* @ 10 g + 3 packets of *Azospirillum* /kg of seed is also useful.
3. Care should be taken to treat the chemicals first followed by bio control agents. If it is done reversely, treatment of biocontrol agents will not be effective.

### Nursery raising

To transplant one hectare of field, a nursery area of 800 m<sup>2</sup> is sufficient. Wet and dry bed method of nursery is suitable for Island conditions. However, dry bed method is found to be safer in the event of heavy downpour immediately after sowing.

#### A. Methods

The selected nursery site should be nearer to the water source. Wet nursery, wet and dry bed, MAT type are the three methods which can be used for raising seedlings under Islands conditions.

##### 1. Wet nursery

This method is commonly practiced by the farmers of Islands. Field bunds are strengthened to harvest the rain water during initial monsoon period. The field is puddled for 3 to 4 times and then levelled. Sprouted seeds are sown evenly on the prepared field. Keep thin films of water while sowing for uniform spreading in the wet nursery method. Drain out the water immediately in order to give aeration. There should not be continuous stagnation of water for long time for the initial 4 to 5 days as this will affect the germination. Chances of splashing of seeds by heavy downpour are much higher in this method. If any



symptom of raining occurs, immediately flood the nursery, so that damage of sprouted seeds by raindrops can be avoided. This practice will reduce the impact of rain drops on splashing of seeds. Around 800 m<sup>2</sup> area is required for planting one hectare area.

##### 2. Wet bed method

The seed beds should be prepared 25-30 days before planting. The field is ploughed once and harrowed twice or thrice until the soil becomes well puddled. The beds are made slightly raised of 1-1.5 m in width and convenient length with drainage channels of 15 cm height in between the bed. The total area of nursery should be 800 m<sup>2</sup> for planting one hectare area. Beds should be kept moist constantly.

Plough the nursery field twice under dry condition. Apply 10 quintal decomposed farm yard manure for 800 m<sup>2</sup> and puddle the same in standing water (2-3 cm) three to four times preferably at intervals of five days. Level the field perfectly after final puddling and prepare seedbeds of 1 to 1.5 m width and of any convenient length leaving 30 cm wide channels in between the beds. Timely sowing of nursery crop (second fortnight of May to the end of June) and well nourished seedlings should be used for transplanting after 25-30 days of sowing. The seed should be soaked in water for 24 hours and subsequently incubate for 48 hours with occasional sprinkling of water. After the seeds have sprouted, broadcast these seeds uniformly over the seed bed and keep the beds moist for 4-5 days. Gradually raise and maintain water to a depth of 2-5 cm.

##### 3. Dry bed method

This is mostly adopted in the high rainfall areas having no irrigation facilities, but due to high rainfall, water logging is an anticipated problem during the season.





Preferably light soils are chosen for this purpose. The land is ploughed, harrowed and levelled but never puddled. Thus the soil is pulverized in the absence of water and raised beds of 8-10 cm height, 1-1.5 m width and 8-10 m length are made with 30 cm wide range channels between the beds. On an average 50-60 such beds are needed to supply seedlings sufficient for planting one hectare area.

#### 4. MAT Nursery

Around 100 m<sup>2</sup> area is required for planting of 1 hectare area. A thin polythene sheet has to be evenly spread on the even surface. Locally available stem portion of arecanut was used to form the small squares. The frames should be filled with mixture of garden soil and FYM at 1:1 ratio. Compaction can be given through wooden planks. Seeds are sown @ 80 g/m<sup>2</sup>. After sowing seeds are covered with thin layer of dry Farm Yard Manure. In order to protect the seeds from the birds and rainfall, the frames should be covered with polythene cover for 2 days. Watering should be given in the evening using rose cane.



On 8<sup>th</sup> days of sowing, depending upon the nutrient requirement judged through Leaf Colour Chart (LCC) or if any yellowish symptom, 0.5 to 2 % urea solution (5 to 20 g in one litre of water) should be sprinkled using the rose

cane in the evening. Healthy and robust seedlings are ready by 14<sup>th</sup> day after sowing for transplanting. Since seedlings form mat, pulling out of seedlings, rolling and transportation is easy and less time consuming compared to traditional method.

#### Economics of MAT Nursery

Operations	Amount (Rs.)
Investment on Polythene sheet to raise nursery for one ha area	500.00
Total cost of raising seedlings for one ha crop of rice. The benefit of raising seedlings is in terms of saving (i) seed and (ii) labour	266.00
Seed saved	42.5 kg / ha
Value of seed @ 10.00/kg	Rs. 425.00
Net saving due to sowing of seed (Rs 425- Rs 266)	Rs. 159
Seedling in mat type are ready in	10 to 12 days
Labour saving vis a vis Mat nursery and Conventional nursery / ha (nursery field preparation and uprooting of seedlings)	14 man days
Net benefit (14 x Rs 200)	2800.00
Total saving (Rs 159 + Rs 2800) ha/year	2559.00*

\* Saving is due to less seed rate, less labour and less nursery area

#### B. General management practices for rice nursery

##### 1. Nutrient management

- Well decomposed FYM / compost @ 50 kg/40 m<sup>2</sup> should be applied before last ploughing.
- A dose of 0.75:1.0:0.75 kg NPK/800 m<sup>2</sup> should be applied in the form of inorganic and DAP @ 1 kg/40 m<sup>2</sup> can be applied as basal dose if the nursery duration is < 25 days and if the nursery duration exceeds > 25 days apply DAP on 10 days before uprooting of seedlings.
- If the area is in black soil, there is a chance of breaking of roots while uprooting. To avoid this apply 1 kg DAP on 10<sup>th</sup> day after sowing.
- If basal dose of DAP is not given, apply 2 kg DAP/40 m<sup>2</sup> on 19 days before uprooting of seedlings.



- Apply 50 g of urea/cent on 10 -15<sup>th</sup> day after sowing if the seedlings exhibit yellowish symptom/stunted growth.
- After uprooting, dip seedling root in the 2% ZnO solution. This will improve the intake of Zn in the main field.

## 2. Water management

- Keep the nursery under moist condition in dry bed method.
- One day before uprooting of seedlings, nursery area should be moistened sufficiently which will reduce the seedlings damage while uprooting.

## 3. General care

- Remove the weeds, off types and disease affected seedlings in the nursery itself.
- One week before uprooting of seedlings, carbofuran should be applied @ 3.3g/m<sup>2</sup> area in order to prevent the early pest attack in the main field.

## 4. Management of aged seedlings

Few times, in anticipation of rainfall for preparation of main field, the seedlings get over aged. If the older seedlings of more than 25 days age are to be planted, the number of seedlings should be increased (4-5/hill), higher doses of nitrogen should be used at the time of basal application and spacing should be reduced. This adjustment would help in bringing required plant population as older seedlings generally produce less number of tillers/hill.

### Gist of management of rice nursery

Particulars	Wet/ dry bed method	MAT nursery
Area	800m <sup>2</sup>	100 m <sup>2</sup>
Seed	25-30 kg/ha depending on varieties	8 kg/ha (SRI planting)
Seeding density	75-100 gm <sup>2</sup>	80 g /m <sup>2</sup>
Bio fertilizer	5 packets/800 m <sup>2</sup>	-
FYM	50 kg/40 m <sup>2</sup>	100 kg/40 m <sup>2</sup>

Fertilizer	83:315:62g/40 m <sup>2</sup> (Urea: SSP: MOP)	2 % urea (20 g in one litre of water) spray on 8 <sup>th</sup> DAS (days after sowing)
DAP	2 kg DAP/ 40 m <sup>2</sup> on 15 <sup>th</sup> DAS	-
Duration of nursery	21-32 days	14 -17 days

## Field preparation

The actual field where the transplanting of seedlings has to be done is ploughed under dry conditions three weeks before transplanting. Submerge the field with 5-10 cm of water. The rain water for the purpose can be stagnated in the field by raising the bunds. Add 6-8 tonnes of green manuring crops like Dhaincha, Glyricidia or Sunhemp and incorporate it by puddling. The green manuring crop can be raised upto 45 days in the main field itself followed by its incorporation in soil. Uniform levelling is essential for better management of inputs such as nutrient and water besides efficient weed control.

## Dose of fertilizers

In rice fields 12 tonnes of well rotten Farm Yard Manure or compost should be preferably applied in one hectare area at least 4 to 6 weeks before sowing.

The soils of Andaman & Nicobar Islands have become deficient not only in major plant nutrients like nitrogen, phosphorus and in some cases, potash but also in secondary nutrients, like sulphur, calcium, and magnesium. Micronutrients such as zinc, boron and to a limited extent iron, manganese, copper and molybdenum have also been deficient up to some extent due to high rainfall zone; resultantly this has become a major constraint to production and productivity of rice in this region.



**Table 5: Recommended dose of fertilizer for varying soil categories and time of fertilizer application**

Soil type	Dose		Time of application and dose (Urea: DAP: MOP kg/ha)		
	N P K (kg/ha)	Urea: DAP: MOP (kg/ha)	At the time of transplanting	After 25 days of transplanting	After 45 days of transplanting
Normal soil	90:60:40	145:130:67	73:130:67	36 : 0 : 0	36 : 0 : 0
Saline/ Sodic	90:60:40	145:130:67	73:130:67	36 : 0 : 0	36 : 0 : 0
Acid sulphate	90:60:40	145:130:67	73:130:67	36 : 0 : 0	36 : 0 : 0

DAP = Di-Ammonium Phosphate and MOP = Murate of Potash

#### Zinc sulphate

Zinc Sulphate is recommended for soil application at the rate prescribed on the basis of soil testing reports. The basal dose varies from 25 to 60 kg/ha depending on soil type, cropping intensity and crop productivity levels, to be applied once in two years.

#### Seedling treatment

Before transplanting, roots of seedlings should be dipped in Dresban or Carbofuron (0.02% solution) for 12 to 15 hours. Seedlings are also dipped in a solution of Dresban (0.02%) and Urea (1%) to protect them from insect attacks in establishment stage. The latter treatment is especially more useful when the transplanting is delayed till July last or first week of August.

To reduce the field incidence of brown spot, root dipping in Zinc oxide (1 % solution) is recommended. Dissolve 500 gm of zinc oxide in 50 litres of water and dip the seedlings in this solution for one hour before transplanting.

#### Transplanting

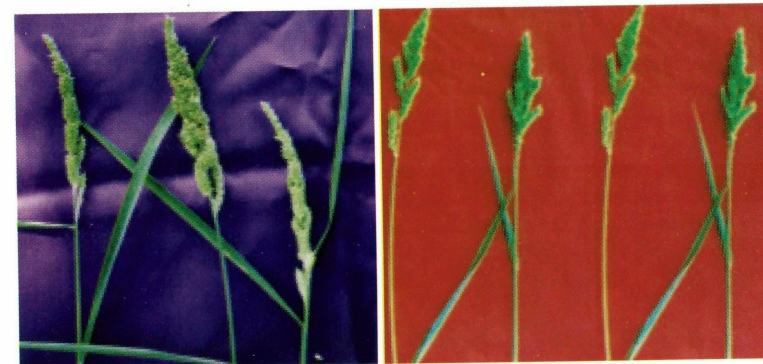
For maintaining the optimum plant population of 33 hills/m<sup>2</sup>, 2-3 healthy seedlings (25-30 days old) must be transplanted 3-4 cm deep at 20 x 15 cm spacing (row to row and plant to plant). In case of

delayed planting with old seedlings and for problem soils, plant 3-4 seedlings/hill by keeping spacing of 15 x 15 cm. The gaps between hills should be filled by planting residual seedlings twice at 7<sup>th</sup> and 14<sup>th</sup> day of planting. The transplanting of rice under Bay Islands conditions should be completed by the last week of July in order to synchronize the grain filling stage with the most ideal range of day temperatures for achieving higher productivity.

#### Weeds and their management

The hot and humid climate of the Islands favours weed growth which causes an estimated 20-25 percent yield reduction in transplanted rice crop. The major weed species in rice fields of Andaman can be classified as grasses, sedges and broad leaved weeds.

##### Grasses: *Echinocola colana*, *Echinocola crusgali*



*Echinocola colana*

*Echinocola crusgali*

##### Sedges: *Cyperus rotundus*, *Cyperus difformis*, *Fimbristylis miliacea*,



*Cyperus rotundus*

*Cyperus difformis*

*Fimbristylis miliacea*

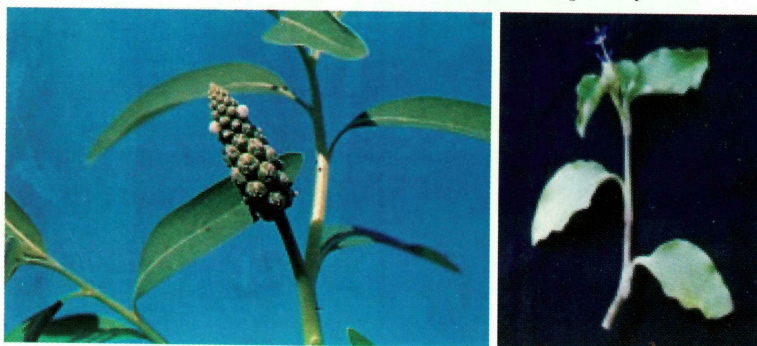


**Broad leaved weeds:** *Monochoria vaginalis*, *Marselia quadrifolia*, *Sphenoclea zeylonica*, *Eclipta prostrata*, *Commelina benghalensis*, *Cleome viscosa*



*Monochoria vaginalis*

*Marselia quadrifolia*



*Commelina benghalensis*

*Sphenoclea zeylanica*

**The general management practices to control these weeds are presented below:**

***Ensure dry ploughing:***

If no crop is grown in dry season, field should be ploughed during February - March. This reduces weed population and gives additional advantages due to other related factors.

***Use weed free seed:***

Before sowing the seeds in nursery, check them carefully. If there is any contamination of weed seeds separate them and use only the pure seeds.

***Prepare well the nursery and main field:*** Being a small area under rice nursery it is easy to prepare it well for raising healthy seedlings. One hectare nursery can serve for 20 ha of main field. The main field should be puddled nicely and levelled before transplanting.

***Ensure weeding at critical stage:***

Weeds compete more with rice in early stages. Weed control measure is considered most important for avoiding the loss in grain yields. By raising the rice crop under weed-free conditions, a considerable amount of fertilizer/nutrients depletion by weeds can be saved and good crop can be saved and a good crop can be obtained. The rice crop generally requires weed-free conditions up to 6 to 8 weeks after transplanting.

***Use fertilizers at appropriate time:***

Application of fertilizer immediately after weeding is considered to be appropriate which provides better utilization of nutrients by the crops. Apply split doses of nitrogen after weeding only.

***Manage rain water effectively:***

Since it rains during May to December (rice cropping season) with annual rainfall of about 3000 mm, no water stress is generally experienced by the crop. Maintain a thin layer of water in the field from transplanting to maturity.

***Use herbicides if needed:***

A wide range of herbicides are available. However, application of pre emergence weedicides like butachlor @ 2.0 to 2.5 kg/ha or TopStar @ 100 g/ha after 3 days of transplanting is effective. These herbicides should be applied with mixing of 20-25 kg sand in the transplanted field with standing water of 2-3 cm. However post-emergence weedicides like Nominee gold @ 200 ml/ha can also be used after 30-35 days of transplanting. Application of herbicides is particularly advantageous when labour is not available or costly.

***Rice diseases and their management***

Andaman and Nicobar Islands having hot and humid climate are characterized by high relative humidity due to coastal sea lines as



well as prolonged and intense rainfall of ~3100 mm distributed over 8 months from mid April to November. These conditions help in spread of major pathogens causing rice diseases. A variety of fungal and bacterial pathogens cause severe damage to rice production in many parts of these islands. Therefore, correct diagnosis and timely solving of field problems constitute vital component of crop management. This has to be achieved through judicious use of chemicals for enhanced productivity leading to increased profits and at the same time preservation of fragile terrestrial and marine living system.

### 1. Bacterial blight

Bacterial blight (BB) of rice caused by *Xanthomonas oryzae* pv. *oryzae* and a common rice disease has been reported from Bay Islands with yield losses up to 60 percent.



#### Symptoms

Bacterial blight symptoms appear first in the flag leaf. Lesions begin at the margin of the leaf blade near the tip as water soaked stripes. The lesions enlarge in length and width turn yellow having a wavy margin and milky or opaque water droplets may be observed on infected leaves when dew is present. Mild strains cause only small leaf lesions and may not lead to any detectable yield loss.

Symptoms in seedlings include yellowing and drying of leaves, wilting of seedlings. Fields infected with bacterial blight have a white ragged appearance compared to uniformly green, healthy fields and

discoloured spots with a water-soaked margin. The disease infected plants do not have properly emerged panicles and lot of empty grains will form and the quality of the grains is also affected. Field patches infested with this disease have a whitish and ragged appearance.

#### Disease management

1. Destroy collateral grassy weeds, infected plant material such as rice stubble etc.
2. Use resistant rice varieties
3. Select good seed for the cultivation and follow seed treatment.
4. Avoid excess application of nitrogenous fertiliser.
5. Spraying of Agrimycin-100 (250 ppm) or mixture of Agrimycin-100 and Fytolan (copper oxychloride) in the ratio of 50:500 ppm can significantly reduce the disease in the field.

### 2. Sheath blight

Sheath blight is caused by the fungus *Rhizoctonia solani*. Yield loss up to 50% are reported depending upon weather conditions in highly susceptible cultivars resulting in poorly filled grain heads and reduced plant vigour. This disease is common in lowland rice cultivation. This fungus is widespread in agricultural crops and also attacks vegetable crops like soybeans causing aerial blight. The pathogen persists on other summer crops like corn or grain sorghum and grassy weeds in and around fields. Fungal sclerotia survive for long periods in the soil and float to the surface of flooded rice fields causing infection in the next crop. The fungus can also attack a number of weed hosts, which can serve as pathogen reservoirs.

#### Symptoms

The early symptoms appear during the late tillering or early internode elongation stages as oval sheath spots (lesions) at or just above the water line often at the junction of the leaf and sheath. Early lesions are pale green to off-white with a narrow purple-brown or brown border, usually 2 mm or less wide and 1-2 mm long. Both sheaths and leaves are commonly attacked and killed as the disease grows



upward. Sclerotia of the fungus are formed on the sheaths and leaves as early as a week after leaf and sheath lesions are seen but more typically observed on infected rice in the boot to heading stages. The sclerotia are initially white and slightly fuzzy, rapidly turning brown with an irregular shape. In some cases, the bottom portion of panicles on heavily infected tillers will break if the disease occurs before grain filling stage. In case of severe disease infection, the panicle is also attacked thereby destroying all the filled grains.



### Disease management

1. Select and sow only the best quality seeds of resistant varieties.
2. Treat the seeds with Carbendazim @ 3g/kg seeds before sowing.
3. Use the recommended level of the nitrogen fertilizers in 3-4 split doses during crop season.
4. Do not exceed seedlings density beyond recommended hills rates per unit area.
5. Remove and burn all weeds in and around crop field.
6. Avoid consecutive rice crop if possible and follow crop rotation by planting rice crop in alternate year.
7. During early symptomatic stages, spray the affected crop with Propiconazole 25 EC (1ml) / Hexconazole (2ml)/ Validamycin (25ml) per liter of water respectively. In case of severe disease intensity, second spray of the above chemical is recommended within a span of 15 days interval. The spray nozzle should be directed towards base of plants.

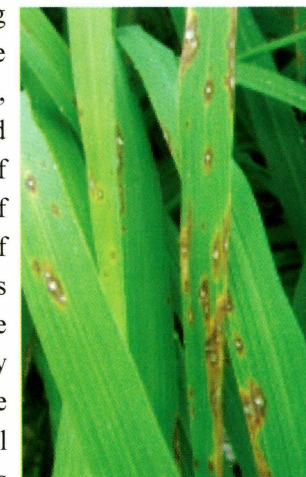
### 3. Rice blast

The disease is not serious in Bay Islands but sporadic occurrences have been seen in different years. Blast is caused by the fungus

*Pyricularia grisea*. Initially the disease symptoms are found on leaf and gradually spread to nodes of the plant. On the leaf, small spindle shaped black or brown spots with ash or whitish center are formed. Leaf spots or lesions reduce the effective leaf area for photosynthesis.

### Symptoms

Symptoms of blast differ depending upon the part of the plant attacked. These phases of the blast include leaf blast, nodal blast, collar rot, neck rot and panicle blast. In Bay Islands only leaf blast is noticed with a low severity of the disease. Generally the symptoms of the blast appear in the infected seedlings of nursery and spread the disease to the other plants. Leaf blast occurs primarily in the seedling and tillering stages of rice development. Leaf spots are elliptical and spindle shaped with pointed ends



and the centres of the spot are usually greyish or white with brown or reddish-brown margin. The spots begin as water soaked dots and rapidly expand to produce the typical leaf spot. The stem nodes are affected and turn black, and the plant above the node soon dies and the infected mature nodes turn grey, shrivel and often break over just above the node. The lesion is greyish, sometimes with a brown border and the lesion girdles the flag leaf, the leaf shrivels and dies, turns brown, and may eventually fall off.

### Disease management

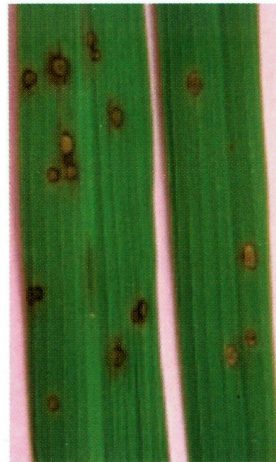
1. Seeds should be collected from disease free fields and seed should be treated with Carbendazim (2g/kg seeds) or Tricyclazole 75wp @ 1.5 g/kg seed before sowing.
2. Use blast resistant rice varieties.
3. Remove and destroy all weeds around the rice field.



- Plant for a stand of 15 to 20 plants per square foot. Apply nitrogen at recommended time and dose and maintain flood to 4-inch depth.
- If the symptoms of blast are appearing in the field, spray fungicides like tricyclazole 75 wp @ 0.6g/l or Isoprothiolane 40 EC (1.5 ml/l) or carbendazim 50 wp @ 1 g/l two times within 10-15 days duration.

#### 4. Brown spot

The disease is caused by the fungus *Helminthosporium oryzae* (Synonym) also known as *Bipolaris oryzae* (Anamorph). The fungus is seed borne and initial infection occurs on young seedlings. The stubbles of the previous crop and alternate hosts such as grasses, can be sources of secondary inoculum. It can spread from plant to plant and in the field by airborne spores. Brown spot has a worldwide distribution in all rice-growing countries and in these islands also.



#### Symptoms

Brown spot can manifest itself as seedling blight or as a foliar and glumes disease of mature plants. On seedlings, the fungus produces small, circular, brown lesions, which may girdle the coleoptiles and cause distortion of the primary and secondary leaves. Infected seedlings are stunted or killed. On the leaves of older plants, the fungus produces circular to oval lesions that have a light brown to grey center, surrounded by a reddish brown margin. On moderately susceptible cultivars, the fungus produces tiny, dark specks. When infection is severe, the lesions may coalesce, killing large areas of affected leaves. The fungus may also infect the glumes, causing dark brown to black oval spots, or the grain, causing a black discoloration. The disease can adversely affect the yield and milling quality of the grain. Severely infected leaves can die before maturity, which will produce lightweight

or unfilled kernels. Therefore, brown spot infection reduces the number of grains per panicle and the kernel weight.

#### Disease management

- Cultivation of recommended resistant varieties should be followed.
- Supply of proper nutrition for optimum plant growth and prevention of water stress seem to be the most important factors in controlling brown spot.
- Field practices such as sanitation, crop rotation, adjustment of planting date and proper fertilization should also be practiced.
- Seed treatment with thiram @ 2g/kg seeds.
- Spray of 0.2% mancozeb in the nursery and main field after the appearance of disease.

#### 5. False smut

False smut of rice is caused by the fungus *Ustilagoideia virens*. False smut of rice, once considered as a minor disease, has now become a serious disease in these Islands and other rice growing states of India. The disease is caused by a fungus and also known as Lakshmi disease of rice. Yield loss is not only due to the occurrence of the smut balls but also due to increased sterility of kernels adjacent to the smut balls. The disease also affects grain quality and seed germination rate.



#### Symptoms

Large orange to brown-green fruiting structures appearing like balls on one or more grains of the mature panicle develop. When the orange covering ruptures, a mass of greenish-black spores is exposed and the grain is replaced by one or more sclerotia. The surface spores



spread the disease to immature panicles and disease development is favoured by high humidity. The “smut balls” survive between crops in the soil.

### Disease management

1. Use resistant varieties of rice.
2. Plant for a stand of 15 to 20 hills per square foot. Apply nitrogen at the time and rate as recommended and maintain the minimum water level.
3. Remove and destroy all weeds and infected rice plants around the rice field.
4. Avoid alternate-year rice rotation if possible, and do not plant consecutive rice crops.
5. Spraying of 0.1% propiconazole @ 1 g/l during flowering can control false smut of rice.
6. Spraying of chlorothalonil 75 WP @ 2 ml/l or copper oxychloride @ 4g/l during the flowering can also reduce the disease incidence.

### Insect- pests and their management

Insect pests severely affect this crop, the attack of pest and disease is more pronounced in *Rabi* crop as compared to *Kharif*. The moderate temperature, high humidity and abundant rainfall provides niche for perpetuation of pests in these Islands. As the agriculture in these Islands is new most of the pests are introduced. Due to change in the cultivation practice many of the minor pests became major.

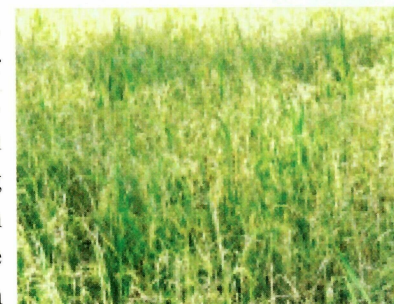
#### 1. Gundhi Bug

**Scientific Name**-*Leptocorisa orantorius*. Fab. Alydidae, Heteroptera

#### Identification

Bugs are yellowish green and slender with long antennae and legs. This bug feeds on the ripening rice grains. Attack is more during grain filling, milky and dough stages of crop. The adults and nymphs pierce grains between lemma and palea that results in empty, chaffy,

discolored and broken grains. Adults are brown and slender with long legs and antenna. Eggs are deposited in rows on leaves and panicles. The young nymphs are green but turn brown with development. The female lays dark brown eggs in single rows toward the midrib of leaves. The rice fields infested with this pest emit repugnant smell and thus this is called ‘gundhi bug’.



#### Damage symptoms

Both nymphs and adults suck juice from developing grains during milky stage and as a result some of the grains in the panicle remain empty. Black or brown spot appears around the puncture made by bugs.



#### Management

1. Avoid excess use of nitrogenous fertilizers and ensure balanced application of fertilizers.
2. This pest survives on graminaceous weeds around the field and hence the field should be kept weed free.
3. Remove weeds such as *Echinochloa* from fields and bunds.
4. Adopt synchronous planting of the crop in an area.
5. Use light traps to attract and destroy the pests. Bonfires lighted in field attract this pest and they get killed.
6. Rotting fish, snail meat mixed with insecticides like Carbaryl or chlorpyrifos attract this pest and they get killed.
7. Need-based application of Carbaryl 50 WP @ 1.5 g/l. The spray



may be repeated after 15 days depending upon the intensity or apply malathion dust @ 25 kg/ha.

8. Spray monocrotophos 36 WSC@ 1.5 l/ha or endosulfan 35 EC @ 1.5 l/ha.

## 2. Leaf Folder

**Scientific Name** – *Cnaphalocrocis medinalis*, Pyralidae, Lepidoptera

### Identification

The pest damages the leaf blades by scrapping the chlorophyll. Damage appears as white feeding areas. Adults lay eggs near leaf midrib, larvae feed on leaf and they stitch and fold the leaves. The pest pupates in leaf roll itself. The adult is small brownish yellow coloured moth. The adult rice leaf folder is a yellow-brown moth. Leaf folder caterpillars fold a rice leaf around themselves and attach the leaf margins together with silk strands. Each female lays about 300 eggs at night during its lifetime of 3-10 days.

### Damage symptoms

Damage is caused by the larvae due to the folding of leaves and feeding on the green mesophyll tissue from within the folds. This results in longitudinal white streaks causing reduced photosynthesis and plant vigour, ultimately affecting the plant growth and yield. At vegetative stage, crop generally recovers from the leaf folder damage but at reproductive stage,



feeding damage on the flag leaf significantly reduces the grain filling resulting in yield losses. Generally one larva is found in each leaf fold and after feeding on that leaf it moves to another leaf. Thus each larva feeds on a number of leaves during its growth period. Heavily infested fields show many folded leaves and a scorched appearance of leaf blades. The damaged plants also pre-dispose the

plants to fungal and bacterial infections.

### Management

1. Timely planting and wider spacing reduces the leaf folder incidence.
2. Avoid excessive use of nitrogenous fertilizers.
3. Keep the bunds clear by trimming them and remove the grassy weeds as they serve as alternate hosts.
4. Proper dosage of nitrogen should be applied in split doses.
5. Avoid using chemicals like carbofuran, phorate that cause resurgence of leaf folder.
6. Setting up of light traps at 4/ha to attract and kill adult moths.
7. Release *Trichogramma chilonis*, 5-6 times @ 1,00,000 adults/ha starting from 15 days after transplanting.
8. When the damage exceeds, spray monocrotophos 36 WSC @ 1.5ml/litre or chlorpyriphos 20 EC @ 3ml/litre or chlorpyriphos 20EC @ 1500 ml/ha.

## 3. Stem Borer

**Scientific Name**- *Scirpophaga incertulas*, Pyralidae, Lepidoptera

### Identification

The paddy yellow stem borer (YSB) is a small moth measuring 1.0–1.2 cm in length, yellowish in colour with two white spots on wings. The adult lays eggs on dorsal side of leaf blade near to leaf tip



as egg mass covered by buffy hairs. Each egg mass contains about 200–250 eggs. The larvae emerge and hang down by means of silken thread and attach themselves to culms and feed within the



stem.

### Damage symptoms

The pest attacks the crop at both tillering and panicle stage. The damage at tillering stage results in 'Dead heart' symptom wherein the leaf when pulled slightly comes off from tiller. After flowering, the damage by YSB results in 'White earhead' which leads to panicle drying and on pulling it comes off. Another paddy borer occurring mostly on second crop is white stem borer, *S. innotata*, of which all symptoms are similar to YSB but the moth is whitish in colour.

### Management

1. Transplant crop timely such that only one stage of crop is available for pest.
2. Clip the seedling tips (5 cm) to exclude YSB egg masses at the time of transplanting.
3. Release 50,000 nos. of *Trichogramma japonicum*/ha, six times at fortnightly intervals commencing from 45<sup>th</sup> day of transplanting.
4. Judicious application of nitrogen in split doses and application of potash.
5. Use light traps to attract and destroy the pests.
6. Need-based application of monocrotophos 36 WSC @ 1.5ml/litre or chlorpyrifos 20 EC @ 3ml/litre or carbaryl 50 WP @ 2 g/l especially when more than 5% white earheads are noticed.

### 4. Brown plant hopper

**Scientific Name-** *Nilaparvata lugens*, Delphacidae, Homoptera

#### Identification

Adults are 2.5-3.0 mm long, winged or without wings. The legs are hairless and the hind leg has a large, mobile outgrowth. Nymphs and adults congregate at the base of the plant and suck the plant sap

from stem and leaf sheath. Female inserts eggs in two rows on either side of the midrib of the leaf sheath. Eggs are laid in batches inside the leaf sheaths and on the leaf midrib. Nymphs are brown. Nymphs molt five times before turning to adult. Adults with long wings are attracted to light traps.

### Damage symptoms

The brown plant hopper (BPH) attacks susceptible varieties in huge numbers, causing 'hopper burn' in patches. Long winged forms lay eggs in midrib leaf sheaths and invade fields. The nymphs are short winged and they can be seen at the extreme basal portion of tiller sucking the sap. The pest develops into long winged forms and migrates to other new fields.



### Management

1. Grow resistant varieties.
2. Use early maturing varieties to reduce pest build up.
3. Apply correct and split doses of nitrogen at recommended time.
4. Avoid use of Quinolphos as it causes resurgence of this pest.
5. Dragon flies and damsel flies prey on moving adults. Similarly, spiders, water bugs and lady beetles prey on mobile stages (nymphs and adults).
6. Use systemic insecticides like, Dimethoate 1.5 ml/l at basal portion of plant after draining out of water for 2-3 days.
7. When the damage exceeds, spray monocrotophos 36 WSC @ 1.5ml/litre or chlorpyrifos 20 EC @ 3ml/litre or imidacloprid 200 SL @ 125 ml/ha.

### Rodent management

Rodent damages rice crop in all the stages of growth. They may cut/uproot newly transplanted seedlings. They make diagonal cut





to the tillers normally 5-10 cm above the water level. The damage can be easily recognized when the tillers are thickened and possess hollow tubular cross section. Damage in nursery is not much important since even if a nursery is devastated, re-sowing is usually carried out. Significant damage starts from the time of active tillering and it will be higher during early growth stages and decreases later, when feeding switches over from vegetative tissue to more nutritive panicles.

Following activities for rat management in paddy should be initiated:

1. **Deep ploughing:** Deep ploughing of the fields at the time of land preparation helps in destruction of rodent burrows which exposes the newly borne rats to the predators and the adults migrate to other areas.
2. **Reduction in bund size:** Rodents inhabit high bunds present around the crop fields, which remain undisturbed. Such bunds should be kept at minimum possible level to reduce rodent infestation.
3. **Weed free cultivation:** Rodents inhabit undisturbed areas and make burrows in bund full of weeds. Such bunds should be kept weed free to reduce rat infestation.

In case of high infestations following measures using judicious amount of chemicals can be adopted

**Pre-baiting:** Pre-baiting should be done in burrows for 2-3 days before poison baiting

a) **Pre- bait material** (If zinc phosphide baiting is to be done): for

one Kg of bait.

- (i) Take 960 g of broken rice.
- (ii) Mix 20 g vegetable oil (preferable groundnut oil) in broken rice with hands.

b) **Poison bait material:** for one kg bait.

- (i) Mix oil in broken rice as suggested above in pre- bait preparation.
- (ii) Sprinkle 20 g of zinc phosphide or 20 g of bromadiolone and stir with wooden stick till uniform mixing is achieved (no household utensil should be used for this purpose).

Rate of application of these baits/burrow are 8-10 g for zinc phosphide and 15-20g for bromadiolone. In residential area and homesteads, bromadiolone can be used as baits in bait stations (PVC pipes etc). Zinc phosphide should not be used in residential area and homesteads.

### Harvesting

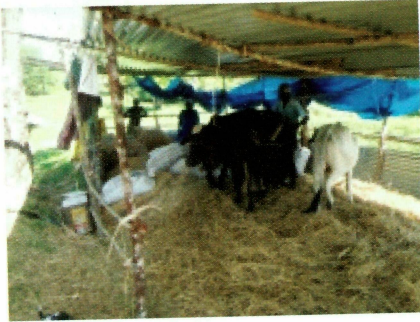
Drain out excess water when grains in the lowest portion of the panicle are in the dough stage which is about 20-30 days after 50% flowering. Allow the grains to harden. It is mention worthy that since only few dry days are experienced in the islands, it is advised to go for quick harvesting and threshing particularly for medium duration varieties which mature up to November month. Moisture content of paddy should be 20-24% at harvest. Thresh as early as possible preferably immediately after harvest. Dry gradually under shade and under direct sun light until the moisture content is brought down to 12 % which ensures better milling quality and storage.

### Post harvest management in rice

#### Threshing

If the threshing is delayed, keep the harvested paddy stalk bundles in a dry and shady place, which facilitates the air circulation and prevents excessive heating. It is advisable to thresh the paddy in the





field itself and then transport to the storage place. Traditionally, the paddy is threshed either manually by beating bundles of dried paddy stalks on wooden logs/metallic drums or by driving bullocks in circular manner on the harvested crop. Simple pedal operated threshers are also used to thresh the paddy the field. One person operates the thresher with foot pedal and one or two persons feed the bales from behind for threshing. These threshers are also motorized with single phase 1HP electric motor for threshing of paddy. The machine is run and one or two persons feed the bales from behind for threshing. These threshers can be operated both with motor and diesel engine tractors. During threshing the paddy straw is separated from grain by worm type cylinder. The straw is thrown out from the machine with the help of blower. The capacity of these machines varies from 300 kg/hour to 1500 kg/hour.

### **Cleaning**

Stones and other debris have severe, adverse effects upon successive processing operation contributing directly to losses in edible white rice during the milling operation. The paddy threshed by manual beating or by pedal operated paddy thresher is cleaned by using these fans. The hand operated and power operated winnowing fans are



commercially available. The average output has been found to be 242 kg grain/h and winnowing efficiency was found to be 88.36%. The equipment has been found to be suitable for operation by women workers also.

### **Drying**

In Andaman and Nicobar, farmers sun dry the paddy over the mat. However, inadequate drying is a major causative agent of post harvest losses, particularly in humid environments which results in serious rice-kernel cracking. Cracking causes kernel breakage during subsequent milling and losses of small fragments of white rice afterwards. Again, the paddy is subjected to losses by animal predators (principally black- birds) in open places, inadequate drying causes microbial infections causing poor quality of rice. Hence, it is advisable to dry the paddy by using mechanical dryer.

### **Storage**

It is emphasized to reduce the loss of paddy during and after harvest. Paddy is stored for varying periods to ensure proper and balanced public distribution throughout the year. The moisture content of harvested paddy is 22-24% w.b (wet basis). However after drying the moisture content has to be reduced to 14% (w.b) for storing and 12% for milling (w.b). Storage structures should be properly repaired, cleaned and disinfected. Structures should bear the load of seeds stored and do not permit contact/exchange with outside humid air. Structures should be installed in the coolest part of the house/farm.

In Andaman, farmers store the paddy in bamboo based structures where split bamboo is woven in the form of a cylinder with



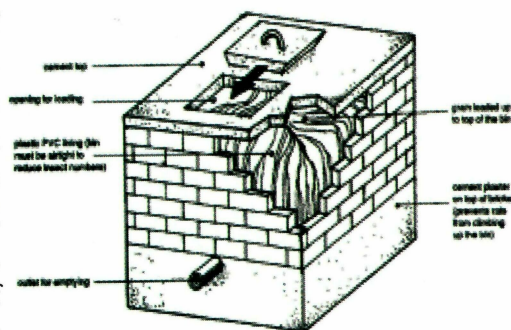


wide base and narrow mouth having capacity of 250-500 kg capacity with the life span of 5-6 years. These bamboo bins are often smothered with mud or cow dung slurry and dried afterwards to make them air proof. Then paddy is stored in these bins. In some places, wooden structure is used where local wood is painted black. At the top, 30 cm x 20 cm inlet and at the bottom 30 cm x 15cm outlet is provided. There are also modern storage structures, which can be used for better storage of harvested paddy which are discussed below.

### Pusa bin

It is a modification of the ordinary mud storage structure commonly used in villages. To provide moisture proof and airtight conditions, polyethylene film of 700 gauge thickness

has been embedded at the top, bottom and on all the sides of the mud bin. The embedding process provides mechanical support and safety to polyethylene film. The construction of outer walls with burnt bricks up to 45 cm height makes the structure rat proof as well. The bin is constructed with unburnt bricks on burnt bricks or concrete floor to avoid rat burrowing. The grain and seed both remain safe in the bin for more than one year with proper precautions.



### Metal bins

Bins made of steel and aluminium are also used for storage of grains. These bins are fire and moisture proof. The bins have long durability and produced on commercial scale. The capacity ranges from 1 to 10 tonnes. Usually steel and aluminium bins are circular in shape.

### Major storage pests in rice

Rice storage pests include insects and rodents. These pests cause losses through a combination of feeding, spoiling and contamination of both paddy and milled grain. While many different species of insects are found in rice only a few are major pests. Insects in stored rice can be classified as either primary or secondary insects. These are insects whose larvae feed entirely within the kernels of the grain. These include the rice weevil, Angoumois grain moth and lesser grain borer.

### Rodents in storage

Rats have been estimated to cause damage up to 3-5%. In addition, rodents may be vectors of a large number of diseases affecting domestic animals. For storage pest management,

- Keep the store absolutely clean. Remove any spilt grain immediately as it attracts rodents.
- Store bags in tidy stacks set up on pallets, ensuring that there is a space of 1 m all round the stack.
- Store any empty or old bags and fumigation sheets on pallets, and if possible in separate stores.
- Keep the store free of rubbish in order not to provide the animals with any places to hide or nest.
- Keep the areas surrounding the store free of tall weeds so as not to give the animals any cover. They have an aversion to crossing open spaces.

Keep the area in the vicinity of the store free of any stagnant water and ensure that rainwater is drained away, as it can be used as source of drinking water.

### Milling

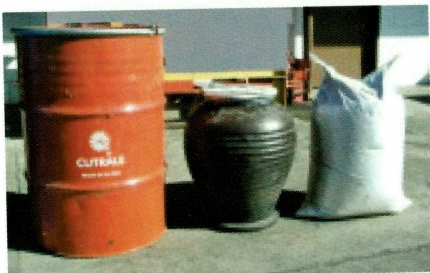
Rice milling is the oldest and the largest agro processing industry of the country. When paddy comes into the mill it contains foreign material such as straw, weed seeds, soil and other inert material. If this inert matter is not removed prior to hulling, the efficiency of the huller and the milling recovery are reduced. In Andaman and Nicobar



Islands, rice millers do not use pre cleaners and that's why the milling recovery is low.

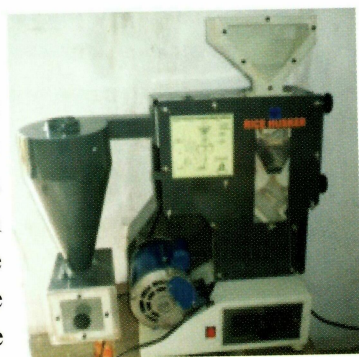
In Andaman, it is found that dehusking machines are huller type and most of them

are 25-30 years old and are diesel operated. These give only 45-50% head rice yield and large broken rice (4/8<sup>th</sup> to 6/8<sup>th</sup> of kernel portion). The husk layer is removed from the paddy by friction and the process is called either de-husking or de-hulling. The steel huller removes the husks and whitens the rice in one pass. Paddy rice is fed into the machine and passes between a revolving steel shaft and a cylindrical shaped mesh screen. They are relatively cheap. But the disadvantages are low milling efficiency, high amount of cracked and broken rice and the by-products like husk, bran and very small broken grains are often mixed. It can be overcome by using modern rice mill such as rubber roller sheller.



### Rubber roller huller

The rubber-roller huller is the most efficient hulling machine. Its use to remove the husk from paddy is becoming more prevalent in developing countries, though the economics in small-scale processing do not appear to be adequately answered. As the name suggests two rubber rollers of the same diameter are operated at different speeds to remove the husk from the paddy. One roller has a fixed position and the other is adjustable to meet the desired clearance. The adjustable roller rotates slightly slower than the fixed roller. Rubber-roll hullers have an aspirator in the base of the machine to separate the hulls from the brown rice. After separating the husk and rice, the husk is removed by suction (aspirated) and then



transported to a storage dump outside the milling plant. The roll diameter varies from 150 to 250 mm and the roller width from 60 to 250 mm. The correct clearance is dependent on the varietal characteristics and the width and length of paddy grain. This method of hulling can achieve hulling efficiencies of 85% to 90% with minimum broken or cracked grain.

### Whitening or Polishing

White rice is produced from brown rice by removing the bran layer and the germ. The bran layer is removed from the kernel by applying friction to the grain surface either by rubbing the grains against an abrasive surface or against each other. The amount of bran removed is normally between 8-10% of the total paddy weight but this will vary according to the variety and degree of whiteness required.



### Grading

Probably the most effective means of reducing rice post harvest losses would be to introduce an equitable grading system for edible unbroken white rice. It is the process of separating unbroken from broken grains or sorting of a given product according to the grades or classes. In grading of milled rice, mainly thickness or length of grain is considered and graded accordingly. Grading of rice is usually done through mechanical devices i.e. rotating graders, plansifier, triers, circular purifier, colour grader/sorter etc. Paddy grains having the same length but different thickness are graded by rotating graders, whereas, grains with the same thickness but different lengths, are separated by triers.





Sometimes both the rotating graders and the trieurs are used. The final unbroken white rice yield obtained after milling is called head rice recovery which is important commercial attribute of rice.

### Packaging

Appropriate packaging is essential to avoid spoilage and to prolong the quality of grains. The packaging materials used in packaging of rice are Jute bags, HDPE / PP bags, Polythene impregnated jute bags, poly pouches and cloth bags. Usually, the cost of a HDPE bags may be around 50-60 percent of the cost of jute bags. Rice is stored in HDPE bags for six months, whereas in jute bags for 3 months. Thus, the economics of packaging depends not only on the type of packaging material but also the duration for which the rice is likely to be stored and prevailing weather conditions. If old bags are to be used disinfect them by boiling in 1% Malathion solution for 3-4 minutes and dry them properly. Separate storage should be maintained for new and old stocks. Bags should be kept on wooden crates or bamboo mats along with a cover of polythene sheet to avoid absorption of moisture from the floor. Proper aeration should be provided in clean weather condition. Suitable number of consumer packs containing graded material of the same lot may be packed in master container.

### Value added by-products from paddy

#### Uses of rice husk

Husk is used as fuel in the rice mills to generate steam for the parboiling process. It contains about 75 % organic volatile matter and the balance 25 % of the weight of this husk is converted into ash. This ash in turn contains around 85 % - 90 % amorphous silica which can be used for special cement and concrete mixes, marine environments, nuclear power plants etc. Other uses of rice husk ash are for green concrete, refractory, ceramic glaze, insulator, roofing shingles, waterproofing chemicals, oil spill absorbent, specialty paints, flame retardants, carrier for pesticides, insecticides and bio fertilizers etc.

#### Uses of bran

Rice bran consists of pericarp, aleurone layer, germ and a part of endosperm. Rice bran obtained during milling amounts to 4 to 9 per

cent of the weight of milled paddy. True bran amounts to 4 to 5 per cent only and rest is polishing of inner bran layers and portion of the starchy endosperm. Bran is often used to enrich breads (notably muffins) and breakfast cereals, especially for the benefit of those wishing to increase their intake of dietary fiber. Bran oil may also be extracted for use by itself for industrial purposes (such as in the paint industry), or as a cooking oil. It is more economical than the other traditional cooking oils because while cooking it absorbs 20-25 % less oil as compared to other traditional cooking oils. Because of its nutritional value, it is being used as feed for poultry and livestock. Defatted/de-oiled bran contains higher percentage of protein (17-20 %) vitamins (A and E) and minerals than full fatted bran obtained from raw and parboiled paddy. Tocopherol and waxes of high melting points are the by-products of the bran oil refining industry and are suitable for various industrial uses. Rice bran is also used for manufacture of soap and rice bran wax in industries etc.

### Economics of rice cultivation:

We have attempted to work out approximate economics of rice cultivation in the islands though commercial viability of rice cultivation is becoming a point of concern. Rice is the principal commodity for food consumption and sustains livelihood of the island population. The prevailing climatic conditions and relatively minimum risk involved enable rice to be practically important and indispensable crop for the islands.

**Table 7: Economics of rice cultivation in the Andaman & Nicobar Islands**

Item	Details	Rs/ acre
<b>Fixed Charges</b>		
Depreciation on Farm buildings	5000 for 02 yrs / OH 5.325	469
Depreciation on Farm Machinery	8000 @20% / 2 seasons / OH 5.325	150
Rental value of land	One crop in a year	4000
Land revenue	One crop in a year	68
Interest on fixed capital (except land)	5000+8000=13000 @10% for 06 months / OH 5.325	122
<b>Fixed Cost</b>		<b>3309</b>



<b>Nursery raising</b>			
Land preparation	320 sq m area 200+2M*	875	1460
Seed	16*20 30	320	480
Fertilizer/ manures		200	300
Seed treatment		100	100
<b>Total</b>		<b>1495</b>	<b>2340</b>
Uprooting and transplanting	8 M @225 460	2675	3680
Land preparation	1500+2M 2000+920	1950	2920
Weeding	4M x 460	900	1840
Herbicide application	100 + 1M 200 + 460	325	660
Pesticides application	(150*2) + (1M*2) 400 + 920	750	1320
Fertilizer application	(78*4.5) + (27*4.5) + (150*2.5) + 0.5M*2	923	1500
Harvesting	8M x 460	1800	3680
Threshing	2M for 02 days x 260	900	920
Winnowing and cleaning	Fan= 400 + 4M	1300	2240
<b>Working cost</b>		<b>11523</b>	<b>18760</b>
Interest on WC	@10% for 06 months	576	1876
<b>Variable Cost</b>		<b>12099</b>	<b>20630</b>
Management Charge	10% of variable cost	1210	2083
Risk allowance	10% of variable cost	1210	2063
<b>Cost of cultivation</b>		<b>20823</b>	<b>24762</b>
Packing/grading etc		100	500
Transportation	200 + 1M	425	960
Marketing charges	Adhat 1.5/ q + mandi fees 1.0/q + 1M	275	510
<b>Total Cost</b>		<b>21623</b>	<b>26232</b>
<b>Return</b>			
Main	20 q @1100 1800	22000	36000
By-product (Straw)	24 q @ 150 200	3600	4800
<b>Gross returns</b>		<b>25600</b>	<b>40800</b>
<b>Net Return</b>		<b>3970</b>	<b>14568</b>
<b>Cost of production (Rs/q)</b>	(Total cost – value of by-product)/output main	<b>901</b>	
<b>Farmers Margin</b>	Net returns +rental for owned land + imputed value of family labour (-250+2500+ (37*0.6*250)	<b>12965</b>	
<b>Returns over variable cost(ROVC)</b>		6791	



