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More Rice, Less Water
Small State, Big Results

Experience of SRI in Tripura, India

DEPARTMENT OF AGRICULTURE
GOVERNMENT OF TRIPURA

More Rice, Less Water – Small State, Big Results

Experience of SRI in Tripura, India

With Inputs from

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सत्यमेव जयते

MANIK SARKAR
Chief Minister of Tripura
Agartala-799001

MESSAGE

Date: 3rd October, 2007

I am happy to know that the 2nd National Symposium on "SRI in India – Progress and Prospects" is being held from 3rd to 5th October, 2007 at Agartala. The System of Rice Intensification (SRI) was developed in Madagascar in the 1980s. It has been tried out successfully in 25 countries across the world, providing farmers with increased productivity of 7 to 8 tonnes per hectare. The SRI method was introduced in 2001 in the state of Tripura and the area under SRI has gradually increased to about 14,000 hectares (8 per cent of the total paddy area) during 2006-07. The state of Tripura has embarked upon achieving "Self-sufficiency in Foodgrains" by 2009-10 and has made SRI a key factor to achieve this target.

I believe that the valuable deliberations and observations to be made by the group of eminent scientists from different parts of India and various countries in the National Symposium will bring further innovations in the SRI Technology and will revolutionise the prospects of increasing the production and productivity of rice in Tripura, India and across various countries.

I am also glad to note that the WWF International is bringing out a monograph on this occasion.

I convey my best wishes for the success of the 2nd National Symposium on SRI.

(Manik Sarkar)

सत्यमेव जयते

TAPAN CHAKRABORTY
Minister for Agriculture,
Health and Industries
Government of Tripura

MESSAGE

Date: 3rd October, 2007

It gives me great pleasure to know that Agriculture Department, Government of Tripura and WWF is bringing out a monograph on SRI experience of Tripura to commemorate the 2nd National Symposium on "System of Rice Intensification – Progress and Prospects" at Agartala from 3rd to 5th October, 2007.

We need to harness all possible resources, both human and financial, for the gigantic task of providing a quantum jump to agriculture in this new millennium. In Tripura food production must continue to outpace population growth to feed 35 lakh people of the state. We have recognised the significance of SRI technologies in enhancing the rice production possibilities in the farmers' fields of Tripura.

Therefore, it is timely and appropriate that under the aegis of this Symposium we could reflect upon the strengths and weaknesses of the various players in the field of Agricultural Extension to promote farm-based methods like SRI. In the spirit of cooperation and partnership we will be able to achieve greater success. I believe that the best is yet to come. With these words I wish this Symposium all success.

I would also like to congratulate the WWF and the partners for their efforts to make this Symposium memorable and highly successful.

(Tapan Chakraborty)

MESSAGE

Date: 3rd October 2007

I am glad that the World Wide Fund for Nature (WWF) is bringing out a publication on the successful efforts of promoting SRI in Tripura. This will be a great boost and encouragement to the people and the government. We appreciate the efforts of WWF for not only bringing out this publication but also providing an opportunity to share it with the rest of the country and also outside.

Besides, WWF along with other partners is also organising the 2nd National SRI Symposium titled "System of Rice Intensification in India – Progress and Prospects" in Agartala from 3rd to 5th October 2007. Being a part of the fraternity, I feel it is a privilege to be associated with this magnum opus where eminent scientists from different institutions and organisations from across the globe shall converge in this historic capital.

I hope that the farming community of this state shall bear testimony to the new findings to be put forward during the course of the symposium which shall go a long way to break new barriers in the rice production throughout the globe.

I acknowledge the sincere efforts of the organisers and wish the programme a grand success.

(Dr. G. S. G. Ayyangar)
Commissioner & Secretary
Agriculture, Election, RD Deptts.

PREFACE

The first time that I heard about Tripura's work on the System of Rice Intensification was from Dr. Baharul Islam Majumder's presentation during the 1st National SRI Symposium at Hyderabad. The data on SRI and its extent of coverage were too good to be true. I decided to check out the ground realities myself.

My visit to Tripura in April this year with a few colleagues left me impressed. It was the first time that I saw contiguous SRI fields over large areas at the village level. Tripura has done a remarkable job in bringing SRI to its people, including tribal communities. The innovations, improvements in markers and weeders using local materials are remarkable. That was when I decided to share the experience with the rest of the country.

My interactions with farmers in Tripura were followed by a meeting with Shri Tapan Chakraborty, Minister of Agriculture, Government of Tripura. During our meeting, it was decided that a booklet documenting Tripura's SRI experience would be published and Tripura would host the 2nd National SRI Symposium in Agartala. This booklet and the 2nd National SRI Symposium from 3-5th October 2007 where it will be released are the result of this meeting. I would like to thank the Government of Tripura for their support and strong commitment, which were instrumental in moving these two initiatives forward.

Tripura is a small state covering 10,492 sq. km. Its rice cultivation covers 240,000 ha. and production touches about 900,000 tonnes of paddy. The area under rice cultivation in Tripura is just 0.5 per cent of India's area and production about 0.8 per cent of the total production. The state is showing the way to produce more rice with substantially less water, seed and other inputs through SRI.

It is amazing that a state with no agricultural university and a very small budget allocated to agriculture has done a marvellous job of popularising SRI. Tripura has set a target of 30,000 ha. for SRI, which is 12 per cent of its total area.

The enabling factors – dedicated staff and policy and political support – are examples of how it is possible to rapidly scale up SRI by involving local people so that they can meet their aspirations of producing more foodgrains. Tripura's example goes to show that even modest support for such sustainable methods can lead to great results.

Tripura is now unstoppable. It is even willing to devote 100,000 ha. to SRI cultivation. If this happens, it could become the first state in the country to produce more rice in an ecologically and socially sustainable way. But this would require support from the Central Government, civil society and research agencies.

This booklet is only a snapshot and not an exhaustive documentation of what Tripura has achieved. We hope to assist the Government of Tripura in a detailed documentation of its experiences and to work with them in future.

I sincerely thank the SRI farmers, the Chief Minister, the Agriculture Minister, the Chief Secretary, the Commissioner & Secretary of Agriculture, the Director of Agriculture Department and the staff, other scientists and extension personnel for enabling this success.

Dr. Biksham Gujja
Policy Adviser,
WWF International,
Gland, Switzerland

CONTENTS

List of Tables

Chapter 1

PROFILE OF TRIPURA

Tripura is one of the seven states in the north-eastern part of India located between 22 degree and 56 minutes and 24 degree and 32 minutes north latitude and between 90 degree and 09 minutes and 92 degree and 20 minutes east latitude. Tripura is a small hilly and land-locked state with poor communication facilities. In fact, the area is handicapped because of the transportation system. The economy of the state is basically agrarian and more than 70 per cent of the population depends on agriculture for its livelihood. Features of its land and people are given in Table 1.1.

Tripura is a small hilly and land-locked state with poor communication facilities. The economy of the state is basically agrarian and more than 70 per cent of the population depends on agriculture for its livelihood.

Table 1.1: Tripura – Land and people

Location	Remotest in the north-east
Land	Total area 10.492 sq. km., 84% international border with Bangladesh (839 km)
Topography	60% hilly terrain with small hills and hillocks criss-crossing the valleys
Forest cover	60% forest cover, 39% reserve forest
Net sown area	25%
Average landholding	0.97 ha
Irrigation	36% of cropped area
Climate	Temperature varies between 10 and 35°C, average annual rainfall 2100 mm
Population	Total population 3.2 million as per 2001 Census, rural population 83%, urban 17%, ST population 31%, SC population 17%, population density 304 per sq. km.
Demography	Male 1.64 million and female 1.56 million with sex ratio 948 females per thousand
Literacy rate	73%; male literacy 81% and female literacy 64%
Major language	Bengali and Kakborak

The former princely state of Tripura was ruled by Maharajas of Manikya dynasty. After Independence of India, the administration of the state was taken over by the Government of India and Tripura became a Union Territory. Tripura attained statehood in 1972 and has four districts with fifteen sub-divisions, 40 revenue divisions, and 1039 gram panchayats. It sends three members to the Indian Parliament and has 60 members in its Legislative Assembly.

The primary sector (agricultural) contributes about 64 per cent of total employment in the state and about 30 per cent of the State Domestic Product.

The economy is primarily agrarian. The primary sector (agricultural) contributes about 64 per cent of total employment in the state and about 30 per cent of the State Domestic Product (SDP). A variety of horticultural/ plantation crops are produced in Tripura like pineapple, oranges, cashewnut, jackfruit, coconut, tea, rubber, forest plantations etc. There is ample scope for increasing the area under such plantations as well as the productivity.

The forests in the state are mainly tropical evergreen, semi-evergreen, and moist deciduous. A sizable area is covered with bamboo brakes which virtually form a "sub climax" resulting from shifting cultivation from time immemorial.

Chapter 2

AGRICULTURE, RICE AND WATER IN TRIPURA

Agriculture is the primary sector providing employment to 60 per cent of the civilian labour force. Rice is the major food crop in Tripura, with 75 per cent of its cropped area devoted to the production of rice. Tripura is one of the important rice growing states of the north-east region. In terms of production, it ranks next to Assam. Tripura is a hilly area where Jhum or shifting cultivation practices have prevailed.

Land Use Pattern

The total area under forests being 6,29,268 ha. (about 60 per cent of the total geographical area), forestry makes the best of land use. This is an advantage and has been usefully exploited for the good of the state. It is followed by agriculture. The areas under different land uses are:-

Forest	6,29,268 ha.
Under Non-Agri Use	1,54,500 ha.
Under Misc. Tree Crops	10,401 ha.
Net Cropped Area	2,55,000 ha.
Total Geographical Area	10,49,169 ha.

Small and marginal farmers constitute about 90 per cent of the total farming community of the state. The population of Tripura has increased from 27.57 lakh in 1991 to 31.91 lakh as per 2001 Census registering a population density of 304 per sq. km. There is hardly any scope of getting additional land for cultivation of food crops.

Climate and Rainfall

Tripura enjoys a typical monsoon climate with variations ranging from sub-tropical to temperate conditions in hilly areas. The rapid change in topography results in significant climate changes within a short distance. The climate of Tripura exhibits a strong seasonal rhythm; the year being divisible into four characteristic seasons, viz. (i) Winter (December-February), (ii) Pre-monsoon (March-April), (iii) Monsoon (May-September) and (iv) Post-Monsoon (October-November). The monsoon period lasting about five months from May to September is the longest season of the state. The amount of total annual rainfall in the state varies between 1500 mm and 2500 mm.

Tripura enjoys a typical monsoon climate with variations ranging from sub-tropical to temperate conditions in hilly areas. The rapid change in topography results in significant climate changes within a short distance.

Given the pressure of increasing population, the topography of the state and changes in agricultural pattern, the agricultural department has been carrying out several programmes to ensure food security for its people.

The maximum and minimum temperatures during winter are 27°C and 13°C and during summer are 35°C and 24°C respectively. The ICAR has categorised Tripura under agro-climatic zones of Humid Eastern Himalayan Region. Excessive amount of rainfall received in this region causes considerable depletion of soil, organic matter, exchangeable calcium, magnesium, sodium and potassium from the upland soils. These nutrients normally accumulate in the soil of the valley land (Lungas). Extractable acidity in Tripura soil is more in upland as compared to lowland soil.

In general, soils of Tripura are classified into two categories – upland & lowland. General fertility of the soil of the state is medium. The soil varies in reaction from very strong to strong acidic with medium organic matter content and low availability of phosphorus and potash contents. The pH varies from 4.85 to 5.80. Soil texture varies from sandy clay loam to clay loam. The organic carbon content is medium.

Given the pressure of increasing population, the topography of the state and changes in agricultural pattern, the agricultural department has been carrying out several programmes to ensure food security for its people.

A Brief History of Agricultural Development

At the time of the merger of Tripura with the Indian Union, Animal Husbandry and Fishery wings were also functioning as part of the Department of Agriculture. In April 1959, the work relating to development of Animal Husbandry was transferred by creating a separate department. Later, the work of Fisheries

was also transferred from the Department of Agriculture to the newly-created Fisheries Department in 1977.

The Agriculture Directorate had been looking after horticultural programmes since May 31, 1985. For effective implementation of the schemes relating to horticulture and soil conservation, a separate directorate was created as "Directorate of Horticulture and Soil Conservation" under the Department of Agriculture which started functioning from June 1, 1985. These were not cosmetic changes. They were warranted by administrative efficiency.

It is worthwhile to point out that agricultural activity in Tripura, in spite of location hindrance and communication bottlenecks is not only diversified but also remarkable in lots of other perspectives. The farmers of Tripura, notwithstanding their economic handicap, used new technology for practising in their small pieces of land for bigger harvest. The development of agriculture is welcome not only for achieving self-sufficiency in foodgrains but also for all-round development of economy of the state. The state has a rice-based cropping system in the hills as well as in the plains with 27 per cent of geographical area under cultivation having 0.97 ha. as average size of holding and 176 per cent cropping intensity.

Rice in Tripura

Rice-based cropping system

The cropping system of Tripura is essentially rice-based. Tripura has some unique features, which proves predominance of rice in its agricultural production scenario.

The features of rice predominance are:

- Concentration of agriculture in low land
- Predominance of small holdings (0.97 ha. average)
- Large-scale transfer of nutrients from uplands to lowlands
- Imbalanced use of chemical fertilisers and or use of only nitrogenous fertilisers
- Irrigation in low and medium land only
- Minimum use of improved farm machineries
- Marginal and small holdings constitute 90 per cent of farming community but operate only 63 per cent of total operational area
- Balance 10 per cent of farming community (big farmers) operates 37 per cent area.

The development of agriculture is welcome not only for achieving self-sufficiency in foodgrains but also for all-round development of economy of the state.

Tripura has been striving hard to attain food self-sufficiency and food security. Adoption of modern seed-fertiliser-irrigation technology, popularly known as HYV technology, has more than doubled the production of foodgrains during the last three decades.

Rice in Tripura is grown in three seasons – Aus, Aman (winter) and Boro (summer). Apart from these, many parts of Tripura follow shifting agriculture or Jhum.

Appendix 1.1 and 1.2 give details on the production of rice and other crops in Tripura in recent years.

Profitability of rice growing for farmers has declined due to increasing prices of inputs and a relatively stable producer price for rice.

Tripura has been striving hard to attain food self-sufficiency and food security. Appendix 1.3 has time series data of productivity trends in rice and pulses in the state from 1955-2002. Adoption of modern seed-fertiliser-irrigation technology, popularly known as HYV technology, has more than doubled the production of foodgrains during the last three decades. However, the yield growth of rice has levelled out. Yield response to modern inputs like chemical fertilisers and to water has declined. Soil and environmental degradation is accelerating. Profitability of rice growing for farmers has declined due to increasing prices of inputs and a relatively stable producer price for rice. It transpires from the above that operational holding of Tripura is small and the economy of rice cultivation is always under severe pressure.

The first high-yielding variety introduced in the state was TN-1 (Taichung Native -1) in the year 1967. Since then, change of variety was a continuous process. At present, under paddy cultivation, more than 95 per cent of area is occupied by high-yielding variety. The adoption of varietals technology is a proven method for boosting productivity.

Table 2.1: Rice – Area, production and yield

All-India				Tripura			
Area - Million Hectares				Area - Thousand Hectares			
Production - Million Tonnes				Production - Thousand Tonnes			
Yield - kg./ha.				Yield - kg./ha.			
Year	Area	Production	Yield	Year	Area	Production	Yield
1999-00	45.16	89.68	1986	1999-00	232.16	505.69	2178
2000-01	44.71	84.98	1901	2000-01	243.09	547.53	2252
2001-02	44.90	93.34	2079	2001-02	246.76	587.36	2380
2002-03	41.18	71.82	1744	2002-03	255.95	587.83	2297
2003-04	42.59	88.53	2077	2003-04	257.45	616.83	2396
2004-05	41.91	83.13	1984	2004-05	256.08	602.22	2352
2005-06	43.66	91.79	2102	2005-06	253.07	602.95	2383
2006-07*	43.70	91.05	2084	2006-07*	250.98	612.48	2440

** Advance estimates as on 04.04.2007*

Note: The yield rates given above have been worked out on the basis of production & area figures taken in '000 units.

Perspective Plan for Self-Sufficiency in Foodgrains by 2010

Table 2.2 indicates there has been a fall in cropping area and production in the state. With a view to set right this trend and increase rice production and attain self-sufficiency in foodgrains, the Government of Tripura constituted a committee comprising Agriculture and Allied Departments to prepare a *"Perspective Plan for Self-Sufficiency in Foodgrains by 2010"*.

Table 2.2: Food deficiency in Tripura

CROP		1996-1997	1997-1998	1998-1999	1999-2000	2000-2001
Rice – Aus	A	53.95	52.71	53.24	27.41	40.26
	P	102.89	98.90	97.97	50.37	78.70
Rice – Aman (Winter)	A	140.01	138.40	138.89	136.28	137.22
	P	308.63	316.53	298.11	319.2	312.032
Rice – Jhum	A	8.55	9.91	10.00	10.73	8.38
	P	4.30	6.00	5.80	5.46	6.10
Rice – Boro (Summer)	A	56.43	56.76	53.35	57.73	55.30
	P	129.00	114.50	89.55	130.65	63.80
Total Rice	A	258.94	257.78	255.48	232.15	241.17
	P	544.82	535.83	491.43	505.68	547.53

Area [A] in '000 ha.; Production [P] in '000 MT

The report of the Task Force in respect of the Perspective Plan shows the net area as 9000 ha. and 1,40,00 ha. for local and HYV hybrid rice area whereas the gross area under rice is given as 9000 ha. and 2,90,00 ha. respectively i.e. total 2,99,000 ha. Since 2000-2001 and 2003-2004 the achievement is 2,57,450 ha. Thus an area of 41,550 ha. is yet to be achieved though the target for rice in terminal year was fixed as 3,09,000 ha. which has been revised as 2,79,000 ha. Another 21,550 ha. has to be covered. The gross area is determined at 2,79,000 ha. – 14,000 local, 2,50,000 HYV, 5,000 hybrid and 10,000 ha. in Jhum, a reduction of 20,000 ha. than the earlier gross area.

The gross area in the year prior to implementation of the Perspective Plan was 2,32,160 ha. (Kharif 1,74,425 ha., Rabi 57,735 ha.) In 2003-04 it was 2,57,450 ha. (Kharif 1,96,970 ha. an increase of 13 per cent, Rabi 60,480 ha. an increase of 4.7 per cent) (plus) 10.9 per cent which has to reach 2,79,000 ha. in 2009-2010.

In the pre-plan period (1950-51) the area under rice was 1,58,250 ha. and production was only 1,35,000 M.T. The productivity was roughly 853 kg./ha. Now after a lapse of 54 years productivity is 2,396 kg./ha. – an increase of 181 per cent as a result of technological achievement and increase of 62.7 per cent area under rice (area 2,57,450 ha., production 6,16,820 M.T.).

In West Tripura, rice area increased in 1999-2000 by only 1.8 per cent that too on Aus 26 per cent, Aman 2 per cent, Jhum 3 per cent but Rabi rice area decreased by 2.6 per cent. The area is likely to decrease further in future.

Variation Across Districts

The distribution across the four districts – Dhalai, North, South and West Tripura were varied and are discussed below in terms of area, productivity and coverage of hybrid area.

In Dhalai, the rice area increased by 27 per cent but the area under Rabi rice decreased by 2.9 per cent over 1,170 ha. in 1999-2000 – Aus 77 per cent, Aman 12 per cent and Jhum 6.3 per cent which is not encouraging as the Kharif rice area has some limitation.

In North Tripura, the rice area marginally increased by 12 per cent but the Rabi rice decreased by 2.5 per cent over 1,225 ha. in 1999-2000. The maximum increase was found on Jhum (132.6 per cent) i.e. 1,550 ha. to 3,605 ha. in 2003-2004 covering some greener areas. Aus and Aman saw an increase of 15 per cent and 4 per cent respectively, which is the same as Dhalai.

In West Tripura, rice area increased in 1999-2000 by only 1.8 per cent that too on Aus 26 per cent, Aman 2 per cent, Jhum 3 per cent but Rabi rice area decreased by 2.6 per cent. The area is likely to decrease further in future.

In South Tripura, the rice area increased by 17 per cent in 1999-2000. Rabi rice increased by 16.8 per cent which is linked to increase of irrigation potentiality and Kharif rice Aus 25 per cent, Aman 12 per cent and Jhum 90 per cent over the reference year.

Productivity

In Dhalai, the Kharif rice yield increased to 1,975 kg./ha. against 1,633 kg. in 1999-2000 – an increase of 21 per cent. Rabi rice yield decreased from 2,278 kg./ha. in 1999-2000 to 1720 kg./ha. i.e. (-) 24.5 per cent.

In North Tripura, the Kharif rice yield increased to 2,177 kg. against 1,977 kg. in 1999-2000 – an increase of 10 per cent. Rabi rice plummeted from 2,286 kg. to 1,842 kg./ha. – a steep downfall of 19.4 per cent probably due to less area in hybrid paddy having good yield potential.

In West Tripura, the Kharif rice yield increased to 2,530 kg./ha. from 2,361 kg. in 1999-2000 i.e. a seven per cent increase. The yield in Rabi also showed an increase from 2,238 kg. to 2,470 kg./ha. i.e. a 10 per cent increase due to more coverage in hybrid and improved HYV seed replacement etc.

In South Tripura, the Kharif rice productivity rose to 2458 kg. from 2,212 kg. in 1999-2000 – an increase of 11 per cent. In Rabi rice too it was 2,574 kg. against 2,298 kg. due to same reasons as in West Tripura.

Table 2.3: Coverage of hybrid area, production & yield (Rabi) districts ha./M.T./kg.

Year		Dhalai	North	West	South	State
1999-2000	A	80	55	NIL	40	175
	P	230	185	NIL	120	535
	Y	2875	3364	NIL	3000	3057
2003-2004	A	16	39	255	290	600
	P	45	102	855	1238	2240
	Y	2812	2615	3353	4269	3733
Per cent increase/ decrease in 2003-04 over 1999-2000	A	-80%	-29%		625%	243%
	P	-80%	-45%		932%	319%
	Y	-2%	-22%		42%	22%

Cost of Rice Cultivation and Net Return

The cost of cultivation of Kharif HYV rice fixed in 2001 was Rs. 20,685. The yield (average) is 2,522 kg./ha. and as per harvest price the rate of paddy is Rs. 7 per kg. i.e. Rs. 17,564 per ha. It has no net return except by using own labour. The cost of cultivation of Rabi rice is Rs. 21,588 and average yield comes to 2,535 kg./ha. i.e. 2,535 X 7 comes to Rs. 17,745 which is derived from paddy only.

Relationship between Water and Cultivation of Rice

Rice is being grown in Tripura in three seasons, two seasons under rain-fed conditions and another season under controlled system. (Rain-fed – Aus and Aman, Irrigated – Boro). Tripura receives 2,200-2,500 mm rainfall per annum, with the maximum rainfall covering four months i.e. June, July, August and September. Paddy area during Aus and Aman is nearly 1.50 lakh ha. The irrigated area is nearly 60,000 ha. mostly based on the river lift irrigation project. But due to under-utilisation of irrigation project, total area cannot be brought under cultivation during Boro season. It also could not be recycled or harvested in an appropriate manner for crop production. In other words, water use efficient technologies have to be adopted or WUE (water use efficiency) has to be increased.

Rice is being grown in Tripura in three seasons, two seasons under rain-fed conditions and another season under controlled system. Due to under-utilisation of irrigation project, total area cannot be brought under cultivation during Boro season.

Table 2.4: Potential created for irrigation (ha.)

Year	Potential Created	Per cent Irrigation Potential Created to Net Cropped Area
2000-01	59951	21%
2001-02	67278	24%
2002-03	74570	27%
2003-04	77722	28%
2004-05	81833	29%
2005-06	86793	32%
2006-07	90853	36%

Opportunities for Rice Cultivation

There is scope in rice cultivation as farmers are having higher adoption aptitude through which modern technology can be exploited to the fullest extent. Rice being the principal crop and staple food of the state, needs attention for increase of production and productivity. It is suggested to develop measures through which economic as well as agronomic efficiency of the rice-based cropping system will be sustainable. It is also necessary to develop some low-cost, gender-friendly agro machineries and implements under Tripura conditions.

Under these circumstances, the needs of Tripura agriculture, especially related to rice, include:

- Substantial and sustainable increase in rice yield, and the release of surplus land for production of higher value crops;
- Reduction in costs of production and rise in profitability of rice production;
- Reduced need for high-cost modern inputs like fertiliser, irrigation water and insecticides;
- Promotion of environment-friendly sustainable agriculture.

Appendix 1.1: Production of rice and other crops in Tripura (2001-02 to 2005-06)

Variety-wise Area, Production & Yield of Major Crops from 2001-02 to 2005-06 Area (A) in '000 ha., Production (P) in '000 MT & Yield (Y) in kg./bales/ha.											
Crops		**1997-98**	**1998-99**	**1999-00**	**2000-01**	**2001-02**	**2002-03**	**2003-04**	**2004-05**	**2005-06**	**2006-07 (Provisional)**
Aus (Local)	A	8.82	7.86	5.10	6.63	5.79	5.86	4.10	3.20	2.58	1.96
	P	12.32	10.61	7.10	9.82	8.30	7.95	5.50	4.02	3.53	3.04
	Y	1396.26	1349.87	1392.16	1481.15	1434.75	1355.96	1341.46	1256.65	1368.99	1557.03
Aus (HYV)	A	43.89	45.38	22.32	33.64	25.90	30.51	32.58	28.69	27.24	23.23
	P	86.50	87.36	43.27	68.85	53.07	60.28	71.14	53.06	53.94	49.94
	Y	1970.72	1924.97	1939.05	2046.97	2049.03	1975.75	2183.39	1849.25	1980.25	2150.31
Aus (Total)	A	52.71	53.24	27.42	40.27	31.69	36.37	36.68	31.89	29.82	25.18
	P	98.81	97.97	50.37	78.67	61.37	68.23	76.64	57.07	57.47	52.99
	Y	1874.60	1840.06	1837.32	1953.81	1936.88	1875.84	2089.29	1789.87	1927.36	2104.25
Aman (Local)	A	17.29	19.09	13.18	11.57	10.18	8.55	7.00	6.48	5.28	4.82
	P	28.20	30.35	19.95	18.09	15.71	13.40	10.46	9.51	9.53	7.56
	Y	1630.71	1589.99	1514.23	1563.53	1543.22	1567.25	1495.07	1468.05	1803.83	1570.92
Aman (HYV)	A	121.11	119.81	123.10	125.57	132.47	135.41	137.95	139.13	140.13	141.33
	P	288.34	267.77	299.25	298.21	337.89	340.40	365.20	371.60	381.17	375.08
	Y	2380.77	2235.05	2430.95	2374.85	2550.69	2513.85	2647.30	2670.81	2720.13	2654.00
Aman (Hybrid)	A	Not introduced			0.08	0.28	0.11	0.00	0.10	0.10	0.11
	P				0.40	0.77	0.29	0.01	0.36	0.37	0.34
	Y				5000.00	2723.40	2698.11	2333.33	3466.02	3833.33	3177.57
Aman (Total)	A	138.40	138.89	136.28	137.22	142.93	144.07	144.95	145.72	145.51	146.25
	P	316.53	298.12	319.20	316.70	354.37	354.09	375.67	381.47	391.06	382.99
	Y	2287.07	2146.41	2342.32	2307.97	2479.28	2457.80	2591.69	2617.90	2687.61	2618.72
Jhum	A	9.92	10.00	10.74	8.38	12.83	15.51	15.34	17.13	15.92	15.67
	P	6.00	5.80	5.47	6.10	11.63	14.74	14.09	15.49	15.85	15.51
	Y	605.14	580.00	509.08	727.92	906.47	950.35	918.19	904.23	995.92	990.23

(Contd...)

(Contd...)

Crops		1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07 (Provisional)
Total Kharif Rice	A	201.03	202.13	174.43	185.87	187.45	195.95	196.97	194.73	191.24	187.10
	P	421.34	401.88	375.04	401.47	427.37	437.06	466.39	454.02	464.39	451.49
	Y	2095.96	1988.23	2150.12	2160.01	2279.94	2230.46	2367.80	2331.61	2428.28	2413.12
Boro (Local)	A	1.71	2.16	1.57	0.51	0.87	0.45	0.36	0.62	0.33	0.36
	P	2.54	2.77	2.38	0.79	1.33	0.72	0.53	0.92	0.56	0.55
	Y	1485.38	1285.38	1512.74	1549.02	1531.79	1600.00	1478.87	1480.77	1677.71	1513.89
Boro (HYV)	A	55.06	51.20	55.99	56.07	57.76	59.13	59.53	59.77	60.46	61.88
	P	111.96	86.78	127.74	143.31	156.55	148.77	147.68	144.60	135.06	151.73
	Y	2033.60	1694.86	2281.48	2555.91	2710.59	2515.98	2480.97	2419.11	2233.80	2452.00
Boro (Hybrid)	A	Not introduced		0.18	0.64	0.70	0.42	0.60	0.96	1.03	2.44
	P			0.54	1.96	2.12	1.28	2.24	2.68	2.95	8.81
	Y			3057.14	3062.50	3043.17	3054.76	3733.33	2800.42	2850.92	3607.70
Boro (Total)	A	56.77	53.36	57.74	57.22	59.32	60.00	60.48	61.35	61.83	64.68
	P	114.50	89.55	130.65	146.06	159.99	150.77	150.45	148.20	138.56	161.08
	Y	2017.09	1678.32	2262.93	2552.60	2697.29	2512.88	2487.52	2415.51	2241.13	2490.41
Total (Local)	A	37.74	39.10	30.58	27.09	29.66	30.37	26.79	27.42	24.11	22.80
	P	49.05	49.53	34.89	34.80	36.97	36.81	30.57	29.93	29.47	26.67
	Y	1299.85	1266.62	1140.94	1284.61	1246.29	1211.93	1141.02	1091.61	1222.21	1169.76
Total (HYV)	A	220.06	216.39	201.41	215.28	216.13	225.05	230.06	227.60	227.83	226.43
	P	486.79	441.91	470.26	510.37	547.51	549.45	584.02	569.25	570.17	576.75
	Y	2212.13	2042.20	2334.90	2370.78	2533.30	2441.46	2538.57	2501.14	2502.61	2547.13
Total (Hybrid)	A	Not introduced		0.18	0.72	0.98	0.53	0.60	1.06	1.13	2.55
	P			0.54	2.36	2.88	1.57	2.25	3.04	3.31	9.15
	Y			3057.14	3277.78	2950.87	2982.89	3726.37	2865.09	2934.46	3589.64
Total Rice	A	257.79	255.49	232.16	243.09	246.76	255.95	257.45	256.08	253.07	251.78
	P	535.84	491.43	505.69	547.53	587.36	587.83	616.83	602.22	602.95	612.57
	Y	2078.59	1923.50	2178.17	2252.42	2380.26	2296.66	2395.92	2351.71	2382.56	2432.97

Crops		1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07 (Provisional)
Maize	A	2.23	2.32	1.25	1.58	2.08	2.31	2.24	2.79	2.15	2.45
	P	1.98	1.73	1.00	1.58	2.08	2.16	2.15	2.97	2.10	2.42
	Y	887.89	745.69	800.00	1000.00	1000.00	934.92	959.82	1063.44	976.74	987.76
Wheat	A	2.31	1.11	1.25	1.06	1.22	1.15	0.90	0.94	1.75	0.98
	P	4.40	2.10	2.40	2.23	2.45	2.30	1.81	1.92	3.18	1.82
	Y	1904.76	1891.89	1920.00	2103.77	2008.20	2000.00	2022.35	2038.14	1818.86	1849.59
Kharif Pulses including Arhar	A	4.26	3.26	3.79	6.88	4.55	4.75	4.67	4.57	5.00	5.18
	P	2.50	1.90	2.34	4.15	2.93	3.10	2.93	2.94	3.19	3.20
	Y	586.85	582.82	617.41	603.20	642.86	652.63	628.08	643.62	637.20	618.50
Rabi Pulses	A	4.07	3.40	3.40	4.20	3.85	3.67	3.31	3.50	3.65	3.20
	P	2.04	1.79	2.02	2.78	2.31	2.15	2.14	2.22	2.72	2.06
	Y	501.23	526.47	594.12	661.43	600.00	585.83	647.50	632.86	746.30	642.95
Total Pulses	A	8.33	6.66	7.19	11.08	8.40	8.42	7.97	8.07	8.65	8.38
	P	4.54	3.69	4.36	6.93	5.24	5.25	5.07	5.16	5.91	5.26
	Y	545.02	554.05	606.40	625.27	623.21	623.52	636.14	638.95	683.24	627.85
Total Foodgrains	A	270.66	265.58	241.85	256.81	258.46	267.82	268.56	267.88	265.62	263.59
	P	546.76	498.95	513.45	558.27	597.12	597.53	625.86	612.27	614.14	622.07
	Y	2020.10	1878.74	2122.99	2173.90	2310.29	2231.07	2330.47	2285.58	2312.13	2359.97
Kharif Oilseeds	A	4.03	3.59	2.85	2.88	2.23	2.38	1.97	2.02	2.14	2.49
	P	3.00	2.34	1.60	1.81	1.27	1.57	1.17	1.17	1.37	1.48
	Y	744.42	651.81	561.40	628.47	571.24	659.66	591.28	580.61	637.25	595.66
Rabi Oilseeds	A	5.42	4.00	3.29	3.38	3.03	2.40	2.06	1.92	2.04	1.90
	P	4.38	3.21	2.51	2.70	2.59	2.07	1.59	1.53	1.55	1.60
	Y	808.12	803.50	762.92	798.82	852.34	862.50	771.84	795.51	757.71	842.47
Total Oilseeds	A	9.45	7.59	6.14	6.26	5.26	4.78	4.03	3.94	4.19	4.39
	P	7.38	5.55	4.11	4.51	3.86	3.64	2.76	2.70	2.91	3.08
	Y	780.95	731.71	669.38	720.45	733.41	761.51	683.53	685.20	696.06	702.46

(Contd...)

(Contd...)

Crops		1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07 (Provisional)
Jute	A	1.37	1.26	0.86	1.40	1.32	1.40	1.33	0.98	0.69	0.45
	P	13.00	10.00	6.75	12.51	11.90	12.60	10.87	7.75	5.41	3.73
	Y	9.49	7.94	7.89	8.94	9.02	9.00	8.17	7.92	7.90	8.25
Mesta	A	2.77	2.18	1.50	1.39	1.66	1.65	1.44	1.25	1.17	1.06
	P	24.00	15.25	11.20	11.12	13.50	13.50	11.15	9.65	8.52	7.80
	Y	8.68	7.01	7.47	8.00	8.16	8.18	7.77	7.72	7.28	7.33
Jute & Mesta	A	4.14	3.44	2.36	2.79	2.98	3.05	2.77	2.23	1.86	1.52
	P	37.00	25.25	17.95	23.63	25.40	26.10	22.02	17.40	13.93	11.53
	Y	8.95	7.35	7.62	8.47	8.54	8.56	7.96	7.81	7.51	7.60
Cotton	A	0.86	0.75	0.87	0.91	1.29	1.25	1.22	1.05	1.14	1.15
	P	1.15	0.85	1.02	1.34	1.90	1.60	1.69	1.56	1.60	1.60
	Y	1.34	1.13	1.18	1.47	1.48	1.28	1.38	1.49	1.40	1.39
Sugarcane	A	1.07	1.00	1.02	1.04	1.02	1.05	1.12	1.03	0.87	0.89
	P	58.00	51.30	51.30	54.10	52.70	54.60	47.51	50.41	43.33	41.20
	Y	54205.61	51300.00	50541.87	52019.23	51666.67	52000.00	42419.64	48944.66	49581.24	46448.70
Potato	A	5.94	5.12	5.55	5.59	5.37	5.74	5.67	5.28	5.42	5.39
	P	100.90	88.00	100.00	105.87	106.28	112.07	89.57	93.47	67.63	92.97
	Y	17000.00	17187.50	18018.02	18939.18	19791.43	19541.41	15810.24	17703.03	12478.41	17248.61

Appendix 1.2: Productivity of rice and other crops in Tripura (1997-98 to 2002-03)

Area (A) in '000 ha., Production (P) in '000 MT & Yield (Y) in kg./bales)/ha.

Crops		1997-98	1998-99	1999-00	2000-01	2001-02	2002-03
Rice	A	257.79	255.49	232.16	243.09	246.76	255.95
	P	535.84	491.43	505.69	547.37	587.37	587.83
	Y	2079	1924	2178	2380	2380	2297
Maize	A	2.23	2.32	1.25	1.58	2.08	2.31
	P	1.98	1.73	1.00	1.58	2.08	2.16
	Y	887.89	745.69	800.00	1000.00	1000.00	934.92
Wheat	A	2.31	1.11	1.25	1.06	1.22	1.15
	P	4.40	2.10	2.40	2.23	2.45	2.30
	Y	1905	1892	1920	2104	2008	2000
Pulses	A	9.36	7.46	6.47	10.02	8.40	8.42
	P	5.60	4.21	3.69	6.96	5.24	5.25
	Y	598	564	570	695	623	624
Total foodgrains	A	270.66	265.58	241.85	256.81	258.46	267.82
	P	546.76	498.95	513.45	558.27	597.12	597.53
	Y	2020.10	1878.74	2122.99	2173.90	2310.29	2231.07
Kharif Oilseeds	A	4.03	3.59	2.85	2.88	2.23	2.38
	P	3.00	2.34	1.60	1.81	1.27	1.57
	Y	744.42	651.81	561.40	628.47	571.24	659.66
Rabi Oilseeds	A	5.42	4.00	3.29	3.38	3.03	2.40
	P	4.38	3.21	2.51	2.70	2.59	2.07
	Y	808.12	803.50	762.92	798.82	852.34	862.50
Total Oilseeds	A	9.45	7.59	6.14	6.26	5.26	4.78
	P	7.38	5.55	4.11	4.51	3.86	3.64
	Y	780.95	731.71	669.38	720.45	733.41	761.51
Jute	A	1.37	1.26	0.86	1.40	1.32	1.40
	P	13.00	10.00	6.75	12.51	11.90	12.60
	Y	9.49	7.94	7.89	8.94	9.02	9.00
Mesta	A	2.77	2.18	1.50	1.39	1.66	1.65
	P	24.00	15.25	11.20	11.12	13.50	13.50
	Y	8.68	7.01	7.47	8.00	8.16	8.18
Jute & Mesta	A	4.14	3.44	2.36	2.79	2.98	3.05
	P	37.00	25.25	17.95	23.63	25.40	26.10
	Y	8.95	7.35	7.62	8.47	8.54	8.56
Cotton	A	0.86	0.75	0.87	0.91	1.29	1.25
	P	1.15	0.85	1.02	1.34	1.90	1.60
	Y	1.34	1.13	1.18	1.47	1.48	1.28
Sugarcane	A	1.07	1.00	1.02	1.04	102	1.05
	P	58.00	51.30	51.30	54.10	52.70	54.60
	Y	54206	51300	50542	52019	51667	52000

** Source : Agricultural Statistics at a Glance 2001 published by GoI.*

Appendix 1.3 Trends in rice production (1955-2002)

Year	A	P	Y	Year	A	P	Y
	Rice			Pulses			
1955	164.62	137.67	836	1955	0.88	0.36	409
1956	164.3	151.57	923	1956	0.98	0.44	449
1957	146.5	121.6	830	1957	0.98	0.43	439
1958	163.41	133.21	815	1958	1.71	0.54	462
1959	172.4	155.72	903	1959	1.29	0.56	434
1960	170.37	158.48	930	1960	1.38	0.62	449
1961	174.83	169.68	971	1961	1.61	0.67	416
1962	180.29	173.48	962	1962	1.66	0.73	440
1963	113.73	173.94	1529	1963	1.76	0.82	466
1964	242.81	201.55	830	1964	1.85	0.84	454
1965	246.04	204	829	1965	2.46	1.26	512
1966	250.1	202.63	810	1966	3.1	1.33	429
1967	251.51	207.5	825	1967	3.18	1.32	415
1968	264.12	219	829	1968	3.07	1.18	384
1969	266.4	234.68	881	1969	3.15	1.24	394
1970	268.06	256.1	955	1970	3.29	1.3	395
1971	277	270.84	978	1971	3.34	1.34	401
1972	181.78	183.29	650	1972	2.75	0.92	335
1973	298.8	362	1212	1973	3.19	1.19	373
1974	298.87	326	1091	1974	3.2	1.22	381
1975	300.15	366.56	1221	1975	4.66	1.06	227
1976	305.08	340.9	1117	1976	4.93	1.85	375
1977	302.36	363.24	1201	1977	4.87	2	411
1978	298.51	368.36	1234	1978	4.67	1.98	424
1979	254.47	301	1183	1979	5.04	2.03	403
1980	287.62	390	1356	1980	5.58	2.27	407
1981	295.54	350.04	1184	1981	4.9	1.93	394
1982	294.88	419.65	1323	1982	5.56	2.41	433
1983	285.67	378.6	1325	1983	5.81	2.54	437
1984	266.01	373.01	1402	1984	5.67	2.41	425
1985	278.14	367.48	1321	1985	5.67	2.52	444
1986	256.94	388.23	1511	1986	5.8	2.59	447
1987	271.11	433.19	1598	1987	7.95	3.82	481
1988	278.33	457.47	1644	1988	8.18	4.39	537
1989	250.22	459.02	1834	1989	10.93	6.04	553
1990	274	501.3	1830	1990	10.93	6.18	565
1991	257.1	474.54	1846	1991	10.94	6.21	568
1992	241.57	438.12	1814	1992	11.65	6.45	554
1993	257.53	492.21	1911	1993	11.45	6.48	566
1994	255.93	413.9	1617	1994	10	5.7	570

Year	A	P	Y	Year	A	P	Y
	Rice			Pulses			
1995	231.53	465.55	2011	1995	8.3	4.72	569
1996	258.97	544.82	2104	1996	9.86	6.04	613
1997	257.79	535.84	2079	1997	9.36	5.6	598
1998	255.49	491.43	1924	1998	7.46	4.21	564
1999	232.16	505.69	2178	1999	6.47	3.69	570
2000	243.09	547.53	2252	2000	10.02	6.96	695
2001	246.76	587.37	2380	2001	8.4	5.24	623
2002	255.95	587.83	2297	2002	8.42	5.25	624

Chapter 3

SRI IN TRIPURA

The System of Rice Intensification (SRI) offers an interesting alternative to improve rice productivity. It is a system of practices that can bring about improvements in total factors of productivity of land, capital, water and labour simultaneously.

There are three options for increasing the productivity of rice. One of the alternative technologies to attain a breakthrough and increase in rice yields has been the use of hybrid seeds. However, this technology is heavily dependent on high-cost modern inputs and has the associated problems of soil and environmental degradation. Another alternative is to explore the potential of biotechnology for evolving new higher-yielding rice varieties by overcoming the complex problems of disease and pest incidence, increasing tolerance to biotic and abiotic stresses, and also improving rice quality. This technology too is heavily dependent upon costly modern inputs with additional apprehensions about possible health and environmental hazards.

The System of Rice Intensification (SRI) offers an interesting alternative to improve rice productivity. It is a system of practices that can bring about improvements in total factors of productivity of land, capital, water and labour simultaneously. This system developed in Madagascar in the 1980s has, since 1999, been tried out successfully in 25 countries across the world providing farmers with increased options. SRI is a system of growing rice that involves principles that are at times radically different from traditional ways of growing rice. It involves single seedling transplantation of young seedlings with care instead of the conventional method of transplanting multiple and mature seedlings from the nursery. SRI spaces rice plants more widely and does not depend on continuous flooding of rice fields, uses lesser seed and chemical inputs, and promotes soil biotic activities in, on and around plant roots, enhanced through liberal applications of compost and weeding with a rotating hoe that aerates the soil. These changed practices with lower inputs counter-intuitively lead to improved productivity with yields of 7-8 tonnes/hectare (t/ha.), about double the present world average of 3.8 t/ha.*

The SRI story in Tripura is an interesting example of local adaptation of a global practice involving several technological and institutional innovations. The power of ideas and how they could spread even in remote regions is best typified by SRI in Tripura.

* Uphoff, N. 2007. 'Agroecological Alternatives: Capitalising on Genetic Potentials. *Journal of Development Studies.* 43:1, 218-236.

Though a small state (10,491 sq km) with a cropped area of 2,80,000 ha., the achievement with regard to SRI is considerable and provides hope and lessons to offer for the rest of the country. An estimated 14,000 ha. of rice in 2006-07 is under SRI that is nearly 8 per cent of the total land area under paddy. The plan objective for 2007-08 is 30,000 ha.

An Innovation takes Root in Remote Tripura

The achievement of Tripura has been due to the work of a dynamic agricultural officer, Baharul Majumder, who was responsible for introducing SRI and systematically working towards overcoming its technical hitches and glitches before arguing the case with his peers and creating a positive environment for SRI. With the help of the state government officials and their political back-up, Tripura has been able to provide institutional support to its farmers in enabling them to make the transition. It is the combination of the social entrepreneurial skills and sincere efforts of Baharul and the policy support of the state government that is responsible for this transition.

With the help of the state government officials and their political back-up, Tripura has been able to provide institutional support to its farmers.

The story of SRI in Tripura dates back to 1999 when Baharul Majumder first heard of SRI from people in Calcutta. He was recuperating from an angioplasty operation and was trying to get in touch with some of his friends. Subrata Rana, a Cornell alumnus, was one of them. Rana played a role similar to Subodh Kumar Gupta and Smita Rawat, also Cornell alumni, who gave information and contacts to PRADAN in Purulia about SRI. Rana had earlier shared some articles with Prof. Ashis Chakravorty, who passed them to Baharul.

The Story of a Crusader

Baharul Majumder, Senior Agronomist, was the pioneer to whom the credit goes for introducing SRI in Tripura. It all started in 1999 when the Government of Tripura assigned a task to the Department of Agriculture to prepare a plan to reduce the burden of importing large quantities of foodgrains from outside the state in every year. Subsequently, an inter departmental task force/committee was constituted to study and prepare a plan on the basis of the ground realities of the problem and considering the available natural resources, financial resources and technologies.

Shri Sunirmal Sen Chowdhury, Ex-Advisor and Additional Secretary-cum-Director of Agriculture, Government of Tripura, constituted a Task Force to identify technologies to be adopted in crop production. Baharul Majumder was a key member of the Task Force. From day one of the process of preparation of the "Perspective Plan for Self Sufficiency in Food Grain by 2010" his mind was hungry for new technologies to fulfill the dream of the farming community of the state.

The implementation of the Perspective Plan started from the crop year 2000. After initial increase in the Seed Replacement Rate, adoption of new HYV, consumption of NPK, increase of area under irrigation and farm mechanisation etc., the progress started to plateau after three years. An attempt to break the yield barrier in rice through introduction and popularisation of hybrid paddy was also attempted but no major breakthrough was possible.

At around that time Majumder initiated an experiment on a technology which was treated as untouchable and considered useless. But after three years of adaptive research we found it to be the most modern scientific method of rice cultivation of the world. The farmers of Tripura, a tiny state of India, have proved it in their fields. This was SRI.

Majumder had with him a paper on SRI written by Dr. Norman Uphoff from the Cornell International Institute for Food Agriculture and Development (CIIFAD), USA. Initial trials were conducted at the State Agriculture Research Station (SARS), Department of Agriculture, Government of Tripura, where an evaluation was made of the performance by different spacing, age of seedling, and seed rate per hectare. The result was not at all encouraging. The following season the trials were repeated with greater care in all the field operations like raising of nursery bed, uprooting of seedling and method of transplanting as depicted in Uphoff's paper. The missing links were in the following aspects:

a) Nursery bed preparation and management
b) Uprooting of seedling
c) Time period between uprooting and transplanting
d) Depth of planting
e) Water management
f) Weeding in appropriate time

It was observed that all these were directly related to the basic principle of SRI, which gives synergistic effect for doubling the yield. Results from the third season trials were unbelievable. Majumder was under tremendous pressure from his co-workers and field workers to submit a proposal to the department to recommend its adoption in farmers' field.

Majumder continued research/trial programme in other departmental farms for multi-locational evaluation for 2.5 years/5 seasons covering both Kharif and Rabi. He then looked for farmers' plots for demonstrations. A progressive farmer, Shri Abu Sarkar agreed to take it up. He harvested yield of 7.12 tonnes of paddy per hectare (Variety-IR-64; year-2002-2003 Boro). Later, popularisation of SRI in Tripura was made possible by the farmers of Tripura, officials and field level functionaries of the Department of Agriculture, all members of the three-tier PRI (Panchayati Raj Institutions) and all other supporters of agriculture technology in the state.

On his return to Tripura, Baharul decided to try out SRI based on the information he had. He first tried out single seedling and young age seedlings (10 days, 15 days and 20 days). His initial attempts to speak to farmers and agricultural officers were met with great scepticism. He did not lose hope. In fact, he became more determined. He then decided to try things out by himself in East Charakbai/Baikhora in South Tripura district, an area where he had worked. Simultaneously he was trying to reach Dr. Norman Uphoff at Cornell. A friend from the Fisheries Department had known and worked with Uphoff in Bangladesh and gave him the contact. Uphoff, when contacted, gave Baharul a lot of information and asked him to get in touch with Dr. Alapati Satyanarayana who was doing SRI work in Andhra Pradesh. Baharul received valuable inputs from Uphoff and Satyanarayana and often asked for their practical advice and experience from the SRI fields in Tripura. By 2002, SRI was being practised by 22 farmers in first time use. This brought a smile on the face of Baharul.

Initial Experiments with SRI in Tripura

Initial trials: Experience with SRI performance in various countries showed the high potential of SRI to improve rice productivity and profitability, along with other benefits. That is why trials and experiments were initiated to determine the suitability of SRI for large-scale adoption in Tripura.

Experience with SRI performance in various countries showed the high potential of SRI to improve rice productivity and profitability, along with other benefits.

Initial trials in the state started in 1999 during the *Boro* season (Dec-Jan sowing) under an irrigated environment in government farms, and continued up to 2003-04 in both *Aman* (*Kharif* – June sowing) and *Boro* (*Rabi* - Winter) seasons under the auspices of the Agronomy Division of the State Agricultural Research Station (SARS), Department of Agriculture, Government of Tripura. The results of these initial trials were encouraging. The results on research plots led SARS to start demonstration trials in farmers' fields during 2001 *Boro* season, which continued upto 2004-05 covering both seasons.

Demonstration in Farmers' Fields: Based on the results of SRI demo-cum-trials, the department initiated a large-scale demo programme in farmers' fields during 2005-06 with a target of 16,000 ha. Out of the targeted area of 16,000 ha., 14,876 ha. was achieved which covered more than 74,000 farmers of the state. The department provided support to farmers at Rs. 4,500 per ha. in the farmers' fields for popularisation of SRI.

Figure 3.1: Trends in rice production 1955-2002

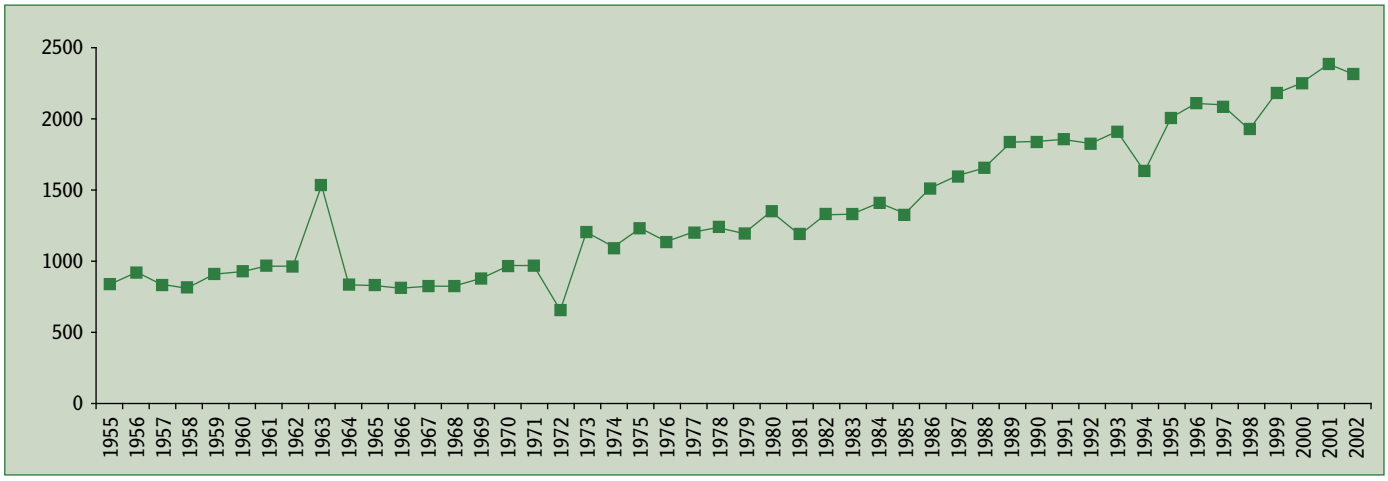

Table 3.1: Rice yield rate in Tripura

Crop Season	2002-03	2003-04	2004-05	2005-06	2006-07 (Provisional)
Kharif	2230.46	2367.8	2331.61	2428.28	2413.12
Rabi	2296.66	2395.92	2351.71	2382.56	2432.97
Average Yield Rate (kg/ha.)	2263.56	2381.86	2341.66	2405.42	2423.05

The target of demonstration in farmers' fields for the crop year 2007-08 is 30,000 ha. The Government of Tripura is now providing Rs. 5,000 per ha. for conducting demonstrations on SRI (in cash and inputs) for popularisation and adoption according to the basic principles of SRI.

Table 3.2: Economics of SRI vs. conventional method

Parameter		Unit	Conventional Method	SRI	ICM
Seed Rate		kg.	50	5	15
		Rate (Rs./kg.)	15.00	15.00	15.00
		Total Cost (Rs.)	750.00	75.00	225.00
Seedling per hill		Nos.	3-4	1	2
Seedling age		days	21-30	8-12	10-15
Spacing		sq. cm.	15X15	25X25	20X20
		sq. cm.	20X15	30X30	20X20
NPK Requirement		kg./ha.	80:40:40 (Kharif)	20:10:10 (Kharif)	40:20:20 (Kharif)
			100:50:50 (Rabi)	25:12:12 (Rabi)	50:25:25 (Rabi)
In terms of Fertiliser **(Kharif)**	Urea	kg.	174	44	88
	SSP		250	63	125
	MOP		65	17	34
	FYM		10000	10000	10000
In terms of Fertiliser **(Rabi)**	Urea	kg.	217	54	109
	SSP		312	75	156
	MOP		83	20	42
	FYM		10000	10000	10000
Rate per Kg	Urea	Rs./kg.	5.25	5.25	5.25
	SSP		5.00	5.00	5.00
	MOP		6.49	6.49	6.49
	FYM		0.30	0.30	0.30
Total Fund involvement for Fertiliser (Kharif)	Urea	Rs.	913.50	231.00	462.00
	SSP		1250.00	315.00	625.00
	MOP		421.85	110.33	220.66
	FYM		3000.00	3000.00	3000.00
	Total		5585.35	3656.33	4307.66

Parameter		Unit	Conventional Method	SRI	ICM
Total Fund involvement for Fertiliser **(Rabi)**	Urea	Rs.	1139.25	283.50	572.25
	SSP		1560.00	375.00	780.00
	MOP		538.67	129.80	272.58
	FYM		3000.00	3000.00	3000.00
	Total		6237.92	3788.30	4624.83
Water Requirement	Kharif	mm	1800	900	1400
	Rabi	mm	2000	1000	1600
No. of irrigation to be given		Nos.	7	3	5
Rate per irrigation per hectare		Rs.	300.00	300.00	300.00
Total requirement for irrigation		Rs.	2100.00	900.00	1500.00
Labour requirement		Nos. days	125	115	120
Rate per Labour		Rs.	63.00	63.00	63.00
Total requirement for Labour		Rs.	7875.00	7245.00	7560.00
PPC (Lump sum)		Rs./ha.	500.00	500.00	500.00
Tillage Operation		Rs./ha.	2500.00	2500.00	2500.00
Grand Total Cost of Cultivation			**19962.92**	**15008.30**	**16909.83**
			20000.00	**15000.00**	**17000.00**
Average Yield (M.T./ha.)		M.T.	5.0	7.5	6.5
Market Value		Rs./M.T.	7000.00	7000.00	7000.00
Gross return		Rs./ha.	35000.00	52500.00	45500.00
Net return		Rs./ha.	15000.00	37500.00	28500.00
Benefit-Cost Ratio			1.75	3.50	2.68

Peoples'/Farmers' Participation: The role of the representatives of the three-tier Panchayati Raj Institution (PRI) system of the state was significant. Without their active participation, it would not have been possible to extend the area under SRI to such a large extent within so short a period. The most important aspect revealed from the SRI trials in Tripura is the highly positive attitude of the farmers towards the method. It has been reported from all areas that even those farmers who were not directly involved with the SRI became interested in adopting the methods at least partially once they saw SRI plants growing in fields like their own. They modified their practices by going in for early transplantation, line transplanting, wider spacing, using single or at most two seedlings per hill, and using more organic fertilisers and less pesticides.

The most important aspect revealed from the SRI trials in Tripura is the highly positive attitude of the farmers towards the method.

The Tripura Chief Minister Mr. Manik Sarkar in his speech at the National Development Council meeting held in New Delhi on May 29, 2007 said, "Adoption of the System of Rice Intensification technology for paddy cultivation has increased productivity of rice from 2.5 t/ha. to about 3.5 t/ha."

The Commissioner and Secretary of Agriculture and the Director of Agriculture, Tripura, were proactive in accepting the technology as a great tool to increase the production of rice, so as to attain self-sufficiency in foodgrains by 2010, a government objective.

Government Support: The Hon'ble Chief Minister and Hon'ble Minister for Agriculture for Tripura are very supportive of this programme. Policy support at the level of Council of Ministers was one of the major breakthroughs for popularisation of SRI in Tripura. The Commissioner and Secretary of Agriculture and the Director of Agriculture, Tripura, were proactive in accepting the technology as a great tool to increase the production of rice, so as to attain self-sufficiency in foodgrains by 2010, a government objective. The government is reviewing the progress of work on a quarterly basis, showing great interest in its implementation. Extension personnel of the Department of Agriculture are also showing a positive attitude and have been helping farmers to disseminate SRI practices. The department has now included SRI methods in its training programmes for extension personnel.

Two striking features of SRI in Tripura are the scale of operations with large stretches of contiguous SRI plots of 30-50 ha. and the strong policy and field support of the Department of Agriculture so much so that SRI in Tripura is not promoted by NGOs unlike in other states.

Technology Support: Dr. Norman Uphoff, Cornell University, was always supportive of the programme. Research and development information from around the world on SRI was provided by him on a constant basis which helped to refine the package of practices suitable to the agro-climatic requirement. Dr. Uphoff's constant support has generated confidence which has been translated into success on the farmers' fields.

Table 3.3: Consolidated statistics regarding number of SRI farmers

Year	Demo. in Farmers' Field (in nos.)	Total Area & Area Per Unit Demo
2001-02	1 farmer	0.4 ha.
2002-03	44 farmers	176 ha. @ 0.40 ha.
2003-04	176 farmers	70.40 ha.@ 0.40 ha.
2004-05	220 farmers	88.00 ha.@ 0.40 ha.
2005-06	440 farmers	176 ha.@ 0.40 ha.
2006-07	73,390 farmers	14,678 ha. @ 0.20 ha.
2007-08 (Up to Aug'07)	80, 400 farmers	16,080 ha. @ 0.20 ha.

Another 13,920 ha. will be covered during Boro (irrigated winter crop) which will involve 69,600 farmers, i.e. in total 1, 50,000 farmers will be covered during 2007-08 crop year as per target. It covers all the districts of the state considering land suitability.

Table 3.4: Farmers and SRI practice

Agronomic Comparisons: SRI Trials vs. Farmers' Practice *Rabi (Boro)* - Winter Season, 2001-02 to 2004-05					
	2001-02	2002-03	2003-04	2004-05	Average
SRI Practice					
Tillers per hill	43	58	52	58	52.75
Effective tillers	28	39	32	37	34.00
Length of panicle (cm)	21	22	20	22	21.25
Weight of 1000 grains (g)	22	23	24	23	23.00
Per cent unfilled grains	12	11	13	10	11.50
Farmers' Practice					
Tillers per hill	17	21	16	18	18.00
Effective tillers	09	12	08	07	9.00
Length of panicle (cm)	17	18	16	20	18.00
Weight of 1000 grains (g)	21	21	26	20	22.00
Per cent unfilled grains	23	15	19	25	20.50

Agronomic Comparison: SRI Trials and Farmers' Practice *Kharif (Aman)* Rainy Season (2001-02 to 2004-05)					
	2000-01	2001-02	2002-03	2003-04	Average
SRI Practice					
Tillers per hill	37	45	41	43	41.50
Effective tillers	26	33	29	31	29.75
Length of panicle (cm)	21	21	22	23	21.75
Weight of 1000 grains (g)	23	23	22	24	23.00
Per cent unfilled grains	13	10	13	11	11.75
Farmers' Practice					
Tillers per hill	16	21	17	20	18.50
Effective tillers	08	11	10	11	10.00
Length of panicle (cm)	18	18	18	19	18.25
Weight of 1000 grains (g)	19	20	20	21	20.00
Per cent unfilled grains	17	14	16	19	16.50

The slogan used in Tripura went something like this: 'Beej kam, saar kam, jal kam, aushadh kam, kharcha kam, phalan bishi, aay bishi'. The slogan is similar to the main theme of 'more from less' in SRI and indicates lesser inputs in seed, fertiliser, pesticides, water and costs, with increased output and incomes.

Success Stories of Farmers

In Dudhpatil in E Nuagaon, Jirania block village, breeder seeds of the Satabdi variety were being used and farmers expressed satisfaction with SRI. Forty-four farmers had agreed to take up SRI in the village. They mentioned the existence of an informal group of farmers already involved in managing water through lift irrigation scheme, support from the department, and the visit to the demonstration plot. Dinesh Debnath was the first farmer to take up SRI in 2005. There was also a government incentive for SRI that amounted to a total of Rs. 4,500 per ha. Of this, most was in kind and Rs. 500 in cash – Rs. 400 was for procuring organic matter for composting and Rs. 100 for nursery management. The department supplied azotobacter and recommended doses of fertilisers and pesticides, as required. The discussions later revealed that democratic decentralisation through the Panchayati Raj system was an important factor in the success of SRI. These officials were the best motivators for the farmers.

Karanjit Choudhury

Karanjit Choudhury, a farmer, tried SRI in 2.2 ha. He had done transplantation in a week with the help of 14 labourers. He heard about SRI first through a panchayat meeting and had received training from the Department of Agriculture. He also saw the demonstration plot. To him SRI would increase yield and reduce cost of cultivation. His average productivity was 4.5 to 5 t/ha., and he expected SRI yields to be closer to 7.2 to 7.5 t/ha. The agricultural officer estimated an even higher yield.

Prabhat Baishnab: A sharecropper

He tried out SRI in 2 kanis or 0.8 acres own and 0.5 acres sharecropping. He felt SRI involved less fertilisers and inputs. He heard about SRI through local village agricultural officer and had also seen other plots of relatives in South Tripura district. He then decided to have SRI in all his 1.3 ha. He has tried short duration and medium duration paddy (MTU 7029) in his plot.

There is a government incentive for SRI that amounts to a total of Rs. 4500 per ha. Of this, most is in kind and Rs. 500 in cash – Rs. 400 for procuring organic matter for composting and Rs. 100 for nursery management. The democratic decentralisation through the Panchayati Raj system was an important factor in the success of SRI.

The experience gained through research plots and demonstration trials for SRI in the farmers' fields of Tripura in different districts and agri-subdivisions of the state shows an encouraging picture. Agronomic findings show, in most cases, more tillers per hill, longer panicles, more grain, and fewer unfilled grains. Grain quality was also found to be better. Yield increases in general appear to be less spectacular than in some other Asian countries, but have ranged up to 34 per cent over farmers' practices. Costs of production were found to be consistently less in all the farmers' fields covering four districts; but in many areas these could be reduced even more by better management of labour and irrigation facilities and by use of rotary weeder.

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Limitations of SRI

In spite of the largely favourable results achieved by SRI trials, there were certain limitations of the trials. During this short period, certain practices could not be followed properly, such as application of organic manure and bio-fertilisers to improve soil fertility, alternate drying and wetting or proper water management for reducing irrigation cost and adequate weeding for better soil aeration.

In most cases, farmers could not apply organic manure in desired quantities due to lack of availability. Proper water management in most of the SRI plots was not possible due to the general practice of flood irrigation. Farmers faced problems to start irrigation projects (DTW, RLI, etc.) on time, which can be addressed through a community approach with farmers' participation. In some areas, transplantation was somewhat delayed due to cold temperature, and often the reduced number of seedlings, depth of transplanting, and age of seedling were other factors. Proper weeding also was not done in many cases, thinking that this would save labour cost and not appreciating the potential gain in output from this.

Chapter 4

SRI IN TRIPURA: TOWARDS SELF-SUFFICIENCY IN RICE

Tripura has, by its own experiences, shown the way for the country and the world that devising strategies for rapid adoption of SRI by farmers is possible at this scale.

Tripura state has made significant progress in popularising SRI. The first trial started in 1999, but the recent work undertaken by the State Agriculture Department during last three years has made SRI as a mainstream practice. Currently around 15,000 ha. are under SRI. The state has a specific target to bring 40,000 ha. under SRI by the end of 2007-08. This is almost 12 per cent of the total area of rice cultivated in the state. Tripura has, by its own experience, shown the way for the country and the world that devising strategies for rapid adoption of SRI by farmers is possible at this scale.

Tripura has three specific challenges in order to meet its long standing aspiration to produce its own foodgrains – a) sustaining the gains that it has already made in large scale adoption, b) setting a target of about 1,00,000 ha., i.e. 40 per cent of the total area of rice cultivated to switch to SRI, and c) designing a specific programme and mobilising required financial and human resources to meet its targets.

This chapter discusses these challenges and some of the opportunities to meet its ambitious targets. It has a great opportunity to become the first state in India to declare that it is producing rice in a sustainable way with less water, less seed and less chemical inputs which is benefiting people and ecosystems. Tripura can do it and there are many external partners ready to work with it to meet this challenge.

The State Government of Tripura has set a target for expanding the area under SRI to 30,000 ha. in 2007-08; 50,000 ha. in 2008-09 and 75,000 ha. in 2008-09. In order to achieve these targets, it is estimated that about Rs. 80 crore is needed at an estimated cost of Rs. 5,000 per ha. These are tentative estimates. Most of this amount is going to the farmers and will contribute to improved conditions. It is also important that this additional investment should result in improved production with less demand on scarce water resources. In order to justify these additional investments, the following points have to be debated for clarity and sustainability of this scheme. Five questions mentioned below need to be discussed and debated for designing an effective strategy and programme to sustain and improve the adoption of SRI in Tripura.

Is this additional investment in SRI resulting in improving the food security of state of Tripura?

As reported in the paper, by adopting SRI, farmers are improving production by 2.5 tonnes over conventional method (5 t/ha. for conventional and 7.5 t/ha. for SRI). Taking average of 2 t/ha. improvement, the total production increase will be 60,000 tonnes in 2007-08. This improvement has to be reflected in the net production in the state. That is the first indicator to know that the state as a whole benefited from this investment.

What is the rate of return on this investment?

The report has mentioned that the farmers, by adopting SRI, are getting about Rs. 17,000/ha. more than the farmers who are sticking to the conventional method. It looks pretty clear with data presented in the report that the farmers who are adopting are gaining significantly (about 50 per cent more than the conventional method). By investing Rs. 15 crore the state can improve rice production by at least Rs. 42 crore. It is almost 180 per cent more than it invested. This is remarkable for any public spending. In one year the state is getting back all its investments and making profit by reducing its dependency on foodgrains. Otherwise the state has to import more foodgrains. This is the second indicator to justify the additional investment.

Can Tripura afford to support 1,00,000 ha. of SRI farming with the same level of investment?

Tripura has to adopt at least 40 per cent of its rice cultivated area or 1,00,000 ha. for SRI by 2010 to make a big impact on its production, improving the water productivity. Will the state be able to mobilise the resources required? To get to that level the state needs to spend about Rs. 50 crore/year. This is about 70 per cent of the current expenditure on agriculture. In order to convince farmers, the state might have to run the programme for at least 10 years (by phasing out support for individual farmer in five years). This means a farmer can get support for five years, but the state will take up 1,00,000 ha. per year for the next 10 years, so that almost every one in the

state will get an option to adopt SRI. This will cost about Rs. 500 crore. A small state like Tripura needs to get continued support from the Union Government. This support might have to increase for encouraging Tripura to experiment with its policies. This way the state will avoid expensive irrigation projects and avoid water wastage. This will also improve the productivity of the farmers and improve the production by at least 2,00,000 tonnes.

Currently Tripura produces 6,12,000 tonnes of rice by cultivating 2,50,000 ha. The average yield of the state is almost stagnant around 2.5 t/ha. Tripura needs about a million tonnes by 2015. It has very little possibility of expanding the rice area, or making major investments to expand irrigation. SRI can help in that process. Farmers have demonstrated that by adopting SRI, they can produce up to 7.5 t/ha. (paddy). By adopting SRI in 1,00,000 ha., with a target average yield of 6 t/ha. which is lower than what is demonstrated, the state could produce 6,00,000 tonnes. By investing moderately in the other 1,50,000 ha. to improve productivity, SRI can easily push production by more than a million tonnes in the next five years. For that the state needs a major programme with possible investment of Rs. 500 crore of which half will go to farmer support and rest for institutional building. This amount is not much considering the returns to the state.

Why do the farmers need support when they are already getting more production?

The cost of cultivation in Tripura is around Rs. 20,685 and at an average production of 2,522 kg/ha. (this is milled rice) with market price of Rs. 10,000 the farmers are expected to get about 25,000 ha. if there is no crop failure. Basically farmers by cultivating rice, are getting their wages back, that too at low rates. So rice cultivation in Tripura and perhaps other states too should be viewed as self-employment. The investment in SRI should be looked upon as improved skill training to produce more with less water and use inputs which are beneficial to the nation and the environment. So without additional support, it is rather difficult to persuade farmers, particularly small and marginal ones who partly depend on wages earned outside of rice cultivation, to adopt SRI. Tripura experience is the best example that by providing additional support, which is reasonable, it is possible to persuade farmers, with little investment in extension, to switch to SRI to produce more foodgrains. So the additional support is absolutely essential for rapid spread of SRI not only in Tripura but in all parts of India. The support, perhaps, should continue for five years or so and after that the farmers will learn that it is in their own interest to continue the practice. The support to farmers will also lead to improvement in their lives.

What is the benefit of SRI in water saving and how will that help ecosystems?

This is the least researched and understood aspect of SRI in Tripura and other parts of India as well. It is a fact that SRI needs less water. Quantification of reduced water requirements by SRI is not studied and reported. A proper research programme to monitor and document the findings is needed. By promoting 30,000 ha. of area under SRI, Tripura has saved about 180 million cubic meters of water (assuming that the production increase is 60,000 tonnes and each tonnes of rice requires 3,000 cu.m. of water). This is a very rough calculation. It is essential to scientifically document this water

saving part of SRI. Providing irrigation is very expensive and it is getting even more expensive. Some states are spending up to Rs. 5,00,000 capital costs to provide irrigation to one ha. without calculating the maintenance costs, ecological costs, rate of interest etc. Irrigation is very expensive, so water productivity improvements directly reduce the burden on increasing costs of irrigation and associated ecological costs.

Tripura has about 60,000 ha. of irrigated area mostly under lift irrigation and river flow. The state is not able to utilise this potential due to various problems. By adopting SRI under these irrigation schemes, the state can improve its productivity. It is possible to install water meters under these irrigation schemes first to know the water savings under SRI and then introducing policies to allocate water. This way the state can utilise its full potential and avoid additional irrigation schemes in future.

Conclusion

Tripura, a small state with a very innovative approach, has shown the way to the nation in improving the productivity of rice cultivation. This is only the beginning and it has a long way to go. The state may design an ambitious programme to make its entire rice production into sustainable rice cultivation by adopting SRI, organic method and reducing energy requirements to achieve its ambition of becoming a foodgrain self-sufficient state. Tripura can easily achieve the target of producing 1.3 million tonnes of paddy (0.9 tonnes of milled rice) in next eight years by 2015. For this the state has to design an innovative programme building on the initial success of SRI. The programme might need about Rs. 500 crore spanning a decade with an annual requirement of Rs. 50 crore. This programme can have specific targets of improving the productivity, reducing the chemical inputs and converting the entire rice production to a ecologically and socially friendly system. This is possible and Tripura has made a beginning. It can offer a lot to India's future direction by forging partnerships between state government agencies, central agencies, research institutions, farmers and civil society. We all need to work towards that partnership in order to make a nation wide impact in producing more rice with less water.

Tripura, a small state with a very innovative approach, has shown the way to the nation in improving the productivity of rice cultivation. This is only the beginning and it has a long way to go.

SRI ACTIVITIES IN TRIPURA

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