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A REVIEW OF RESULTS OF THE NATIONAL COORDINATED CROPPING SYSTEMS RESEACH PROGRAMME IN BANGLADESH

PART - I

SITE DESCRIPTION, COMPONENT TECHNOLOGY STUDIES AND CROPPING PATTERN TESTING

1980 - 1984

AGRICULTURAL RESEARCH PROJECT, PHASE II (USAID)
AGRICULTURAL RESEARCH PROJECT, (IDA-828-BD)
EXTENSION AND RESEARCH PROJECT II (IDA-1215-BD)

BANGLADESH AGRICULTURAL RESEARCH COUNCIL
June 1985

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Film

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NATIONAL COORDINATED CROPPING SYSTEMS RESEARCH PROJECT
IN BANGLADESH

CONTENTS

		Page No.
ACKNOWLEDGEMENT	...	i
FOREWORD	...	1
SUMMARY AND CONCLUSIONS	...	2
INTRODUCTION	...	7
METHODOLOGY	...	8
1. Site Selection	...	8
2. Site Description	...	8
3. Design and Test of Improved Cropping Systems.		9
RESULTS	...	10
I. BANGLADESH AGRICULTURAL RESEARCH INSTITUTE (BARI)		11
Hathazari Site (Chittagong District)	...	12
A. Benchmark Survey - Site Description	...	12
B. Component Technology Studies	...	15
C. Cropping Pattern Testing	...	23
Jessore Site (Jessore District)	...	39
A. Benchmark Survey - Site Description	...	39
B. Component Technology Studies	...	42
C. Cropping Pattern Testing	...	49
II. BANGLADESH AGRICULTURAL UNIVERSITY (BAU)	...	60(a)
Trishal Site	...	61
A. Benchmark Survey - Site Description	...	61
B. Component Technology Studies	...	64
C. Cropping Pattern Testing	...	86
III. BANGLADESH JUTE RESEARCH INSTITUTE (BJRI)	...	93(a)

C O N T E N T S

Manikganj and Kishorganj Site ... 94

A. Benchmark Survey - Site Description (Manikganj) 94

AA. Benchmark Survey - Site Description (Kishorganj) 96

B. Component Technology Studies (Manikganj & Kishorganj) 98

C. Cropping Pattern Testing ... 120

1. Manikganj (Kalampur) ... 120

2. Kishorganj (Vashkar Khilla) ... 131

IV. SUGARCANE RESEARCH AND TRAINING INSTITUTES 138(a)

Ishurdi Site ... 139

A. Benchmark Survey - Site Description ... 139

B. Component Technology Studies and Cropping Pattern Testing ... 141

C. ON-STATION EXPERIMENTS ... 144

V. BANGLADESH WATER DEVELOPMENT BOARD ... 157(a)

Thakurgaon Site ... 158

A. Benchmark Survey - Site Description ... 158

B. Component Technology Studies ... 160

C. Cropping Pattern Testing ... 171

ANNEX-1: Some Charactaristics of CSR sites in Bangladesh ... 174

ANNEX-2: References ... 175

ANNEX-3: Staff list - National Coordinated Cropping Systems Programme ... 178

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The support and the cooperation of all Persons and Institutions mentioned above is acknowledged.

FOREWORD

The present report summarises the results of Cropping Systems Research obtained by the various institutes participating in the National Coordinated Cropping Systems Programme during the years 1980-1984.

Most of the results reported in the following pages were obtained from research carried out in farmers' fields, with the farmers as active participants in the research process. The farmers were the focus of the research work, and multi-disciplinary teams have been involved in the research process with the overall activities based on the farming systems research approach.

In four years of research covered by this report, three of the five phases common in a cropping systems research plan, namely, diagnosis, design and testing, have been completed. There are evidances of a good potential for increasing production of the small farmers in Bangladesh by introducing simple changes in existing technologies.

The studies carried out by the various institutes confirmed the need for constant testing, adjustment and modification of the technology generated at the experimental stations, and the importance of involving the farmers in all the different phases of the research.

As a coordinating agency, BARC expresses its satisfaction with the efforts the institutes have made towards obtaining a better understanding of the problems faced by Bangladeshi farmers, as with the efforts to identify possible solution.

EKRAMUL AHSAN
Chairman-in-charge,
B A R C.

SUMMARY AND CONCLUSIONS

INTRODUCTION

The National Coordinated Cropping Systems Programme (NCCSR) was organized by the Bangladesh Agricultural Research Council (BARC) in 1979, with the participation of the Bangladesh Rice Research Institute (BRRI), Bangladesh Agricultural Research Institute (BARI), Bangladesh Jute Research Institute (BJRI), Bangladesh Agricultural University (BAU), Bangladesh Water Development Board (BWDB), Sugarcane Research and Training Institute (SRTI) and Mennonite Central Committee (MCC).

The programme was oriented towards (1) testing, adjusting and modifying existing agricultural technology in the country with farmers' participation; (2) conducting research on a cropping pattern basis to evaluate the interaction between different crops; (3) combining the agronomic and socio-economic components to get a better understanding of existing farming practices; and (4) developing systems for technology transfer through a better linkage between research and extension.

The participating institution had overall responsibility for implementing the programmes assisted by the Crops and Agricultural Economics and Social Science divisions of BARC.

With the exception of the programmes implemented by BRRI and MCC, research carried out at the institutes has been coordinated, monitored and funded by BARC as a project under its Contract Research Programme which is funded by the World Bank and USAID.

What follows is a summary of the results of Cropping Systems Research obtained by the participating institutes since 1980. The review includes results reported to BARC up to 1st February, 1985. The results obtained by BRRI and MCC are not included in this review since they elaborated their own annual reports. The authors give full recognition to all the participating institutions, their Principal Investigators, Scientific Officers and Field Assistants who participated in the implementation of the Programmes, data collection and elaboration of the reports.

METHODOLOGY

a) Site Selection:

The research was carried out in seven sites : Hathazari (Chittagong), Bagherpara (Jessore), Trishal (Mymensingh), Kalampur (Manikganj), Vashkarkilla (Kishorganj), Shahpur (Ishurdi) and Thakurgaon (Dinajpur). The sites were selected to meet the following criteria : (a) representative of large agroclimatic areas of the country to assure the applicability of results obtained on them to other areas with similar environment; (b) high potential for crop intensification; (c) priority in national or regional development plans; and (d) easy accessibility to assure efficient supervision and participation of supporting multidisciplinary research teams located in different institutes and/or stations.

b) Benchmark Surveys:

Benchmark Surveys were carried out with the participation of socio-economic research teams, during the first year of the project (1980-81). These studies provided information about environmental factors (climate, land types), economic resources (availability of land, labour, cash, power, equipment and materials) and socio-economic conditions (product prices, marketing cost, and customs) reflecting preferences for certain food or management practices. The information collected through the Benchmark Survey was utilized for the site description. This information describes the location, social infrastructure, farm size and tenancy, agroclimatic conditions (rainfall, temperature, evaporation, day length), soils, major cropping patterns, labour supply, livestock, inputs use and source, crop production and use and constraints to crop production. The agronomic and socio-economic studies planned for the years 1981-1984 were mostly based on the findings of the Benchmark Surveys

c) Test of Existing and Improved Cropping Systems:

Yearly research programmes were designed by the Cropping Systems Research staff with the support of task forces appointed by each participant institute.

During the first year (1980-81) the research programmes at the different sites included some component technology studies which were implemented at the same time the Benchmark Survey was carried out. The component technology studies continued and included the evaluation of the performance of promising varieties of rice, wheat, mustard, potato and other crops grown by the farmers. The rice varieties BR-1, BR-3, BR-9, BR-10, BR-11, Pajam, Nizershail, Chinal, Hashikalmi, Purbachi, Chandina, Hasa, Gumbir, Jagali, Kashiabini and others were observed under farmers' and improved agronomic practices. Varieties of wheat evaluated included Sonalika, BAW-28, BAW-12, Jupateco, Pavon-76, Balaka, Ananda, Inia-66 and Kanchan. Mustard varieties evaluated were SS-72, SS-75 and Tori-7. Other component technology studies included crop response to fertilizer application, comparison of different seed rates and planting methods.

After the first year, the main activity at the Cropping Systems Research sites consisted of evaluating agronomic and economic performances of the existing and alternative cropping patterns. This activity is generally referred to as Cropping Pattern Testing. About 60 cropping patterns were tested by the participating institutes. The cropping patterns were evaluated in different land types that, together with rainfall, are the major determinants for their selection. The existing cropping patterns in the project areas are referred to as farmers' cropping patterns (F). Priority was given to evaluate the performance of these existing patterns with the technology commonly used by the farmers. At the same time, some changes, aimed at improved performance, were introduced into the existing patterns. These were referred to as farmers' improved cropping patterns (FI). In some cases a new

crop, proved to be suitable for the area, was introduced in the project area, or an additional crop was planted on land that usually remained fallow. These patterns were studied as an alternative to the existing or common patterns in the area and were referred to as alternative cropping patterns (FA). Each cropping pattern is usually evaluated with the collaboration of five farmers (replications) on each land type. The plot size was from $500m^2$-$1000m^2$. This relatively large area was chosen to get an accurate figure about the labour utilized and the best estimate of the cost of production. The agronomic and economic performance of each pattern tested has been tabulated in this review with the following information: land types, varieties of each crop, planting dates (range), seed rates, fertilizer, field duration, yield/ha, yields (kg/ha/day), cost of cultivation, gross returns, net returns and benefit cost ratios. The discussion of the performance of the cropping patterns was mainly based on the yields obtained in the different crops. The economics of each cropping pattern or crops in the cropping pattern have not been discussed in the review, because constant changes in the cost of labour and inputs have made those data out of date.

RESULTS:

The results obtained by the participant institutes reflect well the basic objective of a Cropping Systems Research programme which is " to test, adjust and modify the technology available in the country directly in the farmers' fields and with farmers' participation". The participant institutes gave emphasis on studying systems more relavant to their specific mandate. However, the specialized institutes, such as BJRI and SRTI had the opportunity to become acquainted not only with jute or sugarcane but with other crops of the systems operated by the farmers. This circumstance has facilitated the work of the institutes with the farmers, who usually appreciated better assistance to their whole systems, rather than individual crops or commodities.

The results obtained indicate that there is a high potential to increase the production of the cropping patterns and/or individual crops in the pattern by introducing simple changes in the practices used by the farmers. The main scope for increasing production lies in replacing local varieties by improved ones, with proper fertilization.

The use of fertilizer is a key factor in increased production. The farmers find it difficult to use the recommended rates for HYVs, but they have fully identified the systems that give them maximum productivity with the resources they have on hand. The best example is the use of the rice variety Pajam. Many farmers prefer this variety to any of the HYVs released by BRRI, when they find that they can not provide the recommended technology for the latter. They know that Pajam responds to low rates of N and its yield is stable when alternate wet and dry periods occur.

The institution participating in the NCCSR programme designed " technological packages " based on the results of agricultural research available in the country. As in the case of fertilizer, these " technological packages " are not always within the reach of the farmers.

The initial research plans were sometimes modified, but it was not possible to introduce changes which demanded additional funds. This situation gave rise tc the lack of information about performance of the cropping systems under different " technological packages ". However, this information will be obtained throughout the multilocation testing phase of the programme. Below are general conclusions drawn from the results of four years of research in cropping systems in the five participant institutes.

CONCLUSIONS

1) The results indicate that there is a high potential to increase production of the common cropping patterns practiced by the farmers of Bangladesh by introducing simple changes in the agronomic practices followed by the farmers.

2) The major scope for increasing production lies in replacing the local or existing varieties by improved or high yielding varieties and by modifying some agronomic practices such as rates of fertilizer, seed rates, age of seedlings and planting dates.

3) Land types, rainfall and irrigation are the major determinants of the cropping patterns but the production of the patterns depends on other factors, like soils and management practices.

4) There are innumeruble cropping patterns in existance often with a bias for rice production. In areas where irrigation is available and irrigation schedules are reliable, the farmers prefer the cropping pattern Rice (boro) - Rice (t.aman).

5) In rainfed areas, where the residual moisture is high after harvesting rice (t.aman), the main cropping patterns are of the rype Rice (direct seeded aus) - Rice (t.aman) - Rabi Crops (including mustard, potato and pulses). The yields of the rabi crops in this pattern are generally low because of late planting. In rainfed highlands and rainfed medium lowlands, the most common cropping patterns are Rice (aus) - Rice (t.aman) - Fallow, or Rice (aus) - Fallow - Mustard, or Jute - Fallow - Mustard. Late planting of mustard considerably decreases its yields, Farmers usually plant this crop when the land remains fallow after harvesting rice (aus) or jute.

6) The potential to expand alternative cropping patterns in the rural areas is limited. Crops like maize and mungbean can be planted instead of aus rice in late March or early April, but the farmers' acceptance is limited because of the risk of drought or excessive moisture. In addition maize is not well accepted as a food crop and its marketing is limited.

7) The most suitable crop varieties for improving production of different cropping patterns are Rice (aus): BR-1 (direct seeded or transplanted); Rice (t.aman)_ BR-11, Pajam, Nizershail; Rice (boro): Purbachi, Pajam; Jute, CV-33, D-154; Wheat, Inia-66, Balaka, Sonalika; Potato: Cardinal; Mustard: SS-75, Tori-7.

8) Yields of HYV rice above 3.5 t/ha can be expected if they are fertilized with 80-60-40 kg/ha NPK, and other recommended agronomic practices are followed. The varieties Pajam and Purbachi yield from 2.5 to 3.5 t/ha, using lower fertilizer rates, like 60-40-40 or 40-20-0 kgs/ha NPK.

9) The addition of Zn and S generally causes an increase of 500-800 kg/ha over the yield obtained when only NPK at the rate mentioned above is applied. However, the cost of Zn is too high to make blanket recommendations for Zn and S applications.

10) There is indication that the production of land cultivated with sugarcane can be increased by intercropping winter crops like potato, mustard, lentils, chickpeas, radish, onions and spinach. These systems require further evaluations in the sugarcane-growing areas.

11) Some of the cropping patterns tested by the participant organizations have been identified as suitable for extrapolation to other areas. These cropping patterns will be tested with the participation of extension personnel. Some of the cropping patterns recommended for multilocation testing areas given ~~in Annex 1.~~

INTRODUCTION

Bangladesh is an agricultural country, whose vast majority of people depend directly upon their own farm production for survival. The country's agriculture is complex, labour-intensive and has a low technological and resource base. Most farmers follow cropping patterns that involve sequence cropping, mixed-cropping and relay-cropping.

Agro-ecological conditions are complex in most parts of Bangladesh. Although several land type classifications exist, the following are commonly used: highland (flood free), medium highland (flooding from 35cm to 60cm), medium lowland (flooding from 60cm to 100cm) and bottom lowland (permanently under water). In any village, at least three major land types exist, which determine different cropping patterns and make land use very complicated.

Cropping patterns in Bangladesh are mainly determined by land type, depth and duration of seasonal flooding and residual soil moisture as determined by the rates of percolation. Since a number of alternative crops would be suitable for each agro-ecological situation, the farmers base their decisions on socio-economic factors, such as the net returns and availability of agricultural inputs. Single commodity-based agricultural research has not been enough successful in Bangladesh, because of the complexities outlined above.

Cropping systems research using a systematic approach, with the farmers as active participants, was initiated in 1974 by the Bangladesh Rice Research Institute. Later a National Coordinated Cropping Systems Programme was organised by Bangladesh Agricultural Research Council (BARC) with the participation of several institutes dealing with agricultural research. The programme is oriented towards: (1) testing, adjusting and modifying the existing agricultural technology with farmers' participation; (2) conducting research on a cropping pattern basis to evaluate the interactions between different crops; (3) combining the agronomic and socio-economic research components to get a better understanding of existing farming practices; and (4) developing systems for technology transfer through a better linkage between research and extension.

The following organizations/institutes took part in cropping systems research as members of the Coordinated Programme:

Bangladesh Rice Research Institute	(BRRI)
Bangladesh Agricultural Research Institute	(BARI)
Bangladesh Jute Research Institute	(BJRI)
Bangladesh Agricultural University	(BAU)
Bangladesh Water Development Board	(BWDB)
Sugarcane Research and Training Institute	(SRTI)
Mennonite Central Committee	(MCC)

BARC has played a central role in the organisation and coordination of the National Programme. There is a National Committee, composed of institute programme leaders, economists, specialist members and extension personnel, to provide technical and policy guidance to the cropping systems research teams.

The seven participant institutions worked in 16 project areas, located in nine different districts of Bangladesh, which covered several environments representative of other large areas of the country. The main characteristics of some of the sites are given in Annex 1.

This report compiles and summaries the results of four years of research in the sites where the project research activities were funded through BARC. The BRRI and MCC have published their results separately. It is intended that the information in this report can be useful either as a feed back from the farmers to the researchers in the experimental stations and as a guide line for extension workers.

METHODOLOGY

The cropping systems research activities focused on the description and classification of the environment, on the design of improved cropping systems and their testing on individual farms, and on methods for the formulation of production programmes.

The following phases of cropping systems research have been implemented during the year 1980-1984.

1. Site Selection:

Each participant institution selected one or two areas for cropping systems research that met the following criteria:

a) Representative of large agroclimatic areas of the country to assure the applicability of results obtained on them to other areas with similar environment;

b) High potential for crop intensification;

c) Priority in National or Regional Development Plans;

d) Easy accessibility to assure efficient supervision and participation of supporting multidesciplinary research teams located in different research institutes and/or research stations.

2. Site Description:

The first activity of the cropping systems research teams was to describe the existing socio-agroecological conditions of each selected site. This activity was carried out by all the institutions during the

first year of the project (1980-81), through bench mark surveys. These studies provided information about agro-ecological factors (climate and land types), economic resources (availability of land, labour, cash, power equipment and materials), and socio-economic conditions (product prices, marketing costs, and customs reflecting preferences for certain food or management practices). The environmental description of the sites continued throughout the research process and in some cases the activities of the entire farms were monitored to get a better understanding of the farmers' conditions

3. Design and Test of Improved Cropping Systems:

The yearly research programmes were designed by the cropping systems staff with support of the task force appointed by each participant institute. The research programme at a site included: (a) Component Technology Studies; (b) Cropping Pattern Testing.

a) Component Technology Studies

Although the major research activity at each Cropping Systems Research site is to test existing and alternative cropping patterns the site research team must also ensure that the management specified for the crops in the pattern is iptimal. As the research team identifies cropping pattern and the component technology studies, it also identifies subject in which there is a lack of information and which need to be studied at the site. Component technology research is conditioned to the cropping patterns selecte

The research must address the whole pattern rather than the individual crops. Variable such as varieties, tillage methods and rates of fertilizer are included as component technology studies. The objectives is to identify alternative management practices (variety, fertilizer, seed rate) for the technology selected to test the cropping pattern.

b) Cropping Pattern Testing

This activity is defined as the agronomic and economic evaluation of existing and new cropping patterns in the area. Five farmers are selected to evaluate a cropping pattern in each of the main land types on the site. The area of each plot is approximately $1000m^2$. At the end of the agricultural year, that is, when the cropping pattern is completed, the agronomic and economic performance of the different patterns under evaluation are compared

The existing cropping patterns in the area are referred to as Farmers' Cropping Patterns (F). The first step is to evaluate the performance of these existing patterns with the farmers' technology Some changes, aimed at improved performance, are introduced into the existing pattern. These are called Farmers' Improved Cropping Patterns (FI). The changes or improvements may be replacement of a local variety by a HYV, higher fertilizer rates, adjusted seed rates, etc.

In some cases, a new crop, proved to be suitable for the area, is introduced in the project areas, or an additional crop is planted on land that usually remains fallow. These are new cropping patterns, which are studied with the farmer as an alternative to existing patterns. New cropping patterns, if suitable for farmers' conditions, are referred to as Alternative Cropping Patterns (FA).

RESULTS

Because of the large number of agro-socioeconomic studies carried out by the different institutes participating in the National Coordinated Cropping Systems Programme, the review of the results will be published in three separate reports. Part-I is the review of the results of the Benchmark Surveys, Component Technology Studies and the agro-economic evaluation of Cropping Systems (Cropping Pattern Testing), obtained by BARI in two CSR sites (Hathazari and Jessore), BAU in one site (Trishal), BJRI in two sites (Manikganj and Kishoreganj), SRTI in one site (Ishurdi) and BWDB in one site (Thakurgaon). All the institutes initiated CSR activities in July 1980. The results obtained in each CSR site are presented separately. The Benchmark Survey was implemented during the first year of the project (1980-81). A summary of the information obtained through those studies is included for each site and serves as the site's description. Only the results obtained in those CSR sites initiated in 1980 are included in this part.

Part-II of the review will be published as "Guidelines for Multilocation Testing". This report lists the cropping patterns and the technology identified as suitable to be extrapolated to different areas of Bangladesh with social and agroecological conditions similar to the CSR sites. The Guidelines were prepared for use by researchers and extensionists responsible for technology transfer programmes.

The socio-economic studies carried out in the different CSR sites have been coordinated by the Agricultural Economics and Social Science Division of BARC. Several reports have been prepared based on the findings in the sites operated by BARI, BJRI and MCC. The results of these studies will be reviewed and compiled in Part-III of this series of reports.

BANGLADESH AGRICULTURAL RESEARCH INSTITUTE

HATHAZARI SITE

A. BENCHMARK SURVEY - SITE DESCRIPTION

a) Location:

The site is located about 42 kilometres north of Chittagong city on the Nazirhat-Chittagong highway. There are seven villages in the project area, namely Alampur, Chandrapur, Mirerkhil, Mirzapur, Charia, Dalui and Enayetpur.

b) Social Infrastructure:

The total population of these seven villages is 46,000. The male population is 45% of the total. There are 8,800 households, 14 primary schools, four night schools, three high schools, and three high madrashas in the project area. The level of education is higher than the country average.

Generally, the farmers are engaged in several other occupations in addition to agriculture. The average size of family, as calculated from the total population and the number of households, is 5.2

c) Farm size and Tenancy:

The area under cultivation is approximately 2360 ha. Average farm size is 0.27 ha. However, only 17% of the total households own land, a large proportion of the farmers being tenants. Small and medium farmers also cultivate land belonging to large farm families on a share cropping basis.

d) Agro-climatic conditions:

Rainfall:

The average annual rainfall is 2865 mm. The average number of rainy days/year is 106. The rainfall occures mainly from June to September. Minimum rainfall is observed from November to March.

Temperature:

Mean annual maximum temperature is 28.7°C. The mean minimum temperature is 21.4°C. Higher temperatures are observed during April and May. The coldest months are December and January.

Day Length:

The day length in the project area is longest in June (13.6 hours) and shortest in December (10.7 hours). Although the days are longer in June, it is cloudy during most of the day. The most hours of sunshine occur in November (9.3 hours).

Soils:

There are detailed soil surveys of the area. Soils have been grouped in several physiographic units: (1) Old Chittagong Coastal Tidal Flood Plain; (2) Minor River Flood Plains; (3) Piedmont Alluvial Plains and Valleys; and (4) Hills with unconsolidated sediments. The soil textures vary from silt loam to silty clay loam in the first three listed physiographic units, where the project area is located.

e) Land Types:

There are two distinct land types in the area, lowland and highland. Streams from the nearby hills flow through the project area all year round. Highlands adjacent to the streams receive water throughout the year and are cultivated with boro rice and rabi crops. Little water is available for lowland crops with residual moisture.

f) Cropping Patterns:

The predominant cropping patterns are:

Rice (b. aus) - Rice (t. aman) - Fallow
Rice (b. aus) - Rice (t. aman) - Rice (boro)
Rice (b. aus) - Rice (t. aman) - Cowpea
Rice (b. aus) - Rice (t. aman) - Mustard
Fallow - Rice (t. aman) - Fallow
Fallow - Rice (t. aman) - Boro

g) Labour Supply:

Because of the high cropping intensity (277%), labour requirements are high. Bullocks are used for land preparation but other operations are done by human labour. Most of the labour requirements are met by the farmer and his family, although larger farmers employ permanent agricultural labour. During peak periods, family labour is supplemented by hired labour.

Wages range from Tk. 10 to 15. The peak demand for labour is in July and August when aus rice is harvested and aman rice is transplanted. In November and December, shortages can occur because of transplanting of boro rice and planting of rabi crops.

h) Livestock:

About eight per cent of the farmers have bullocks for land operations and a large proportion own cows (83%). The average number of bullocks is 1.52, 2.40 and 3.12 for small, medium and large farmers, respectively.

i) Input Use and Sources:

Most of the farmers use their own seeds with a few large farmers collecting rice and potato seed from Bangladesh Agricultural Development Corporation. Chemical fertilizers are used to some extent by all farmers. Supplies are purchased from local dealers. Maximum use of fertilizers occurs in the early kharif season. Insecticides are also used by most farmers.

A large number of farmers use credit from different sources. Most use irrigation in the rabi season for rice (boro), potato and vegetables.

j) Crop Production and Use:

About 20 different crops are produced in the area. Ninety-three per cent of the farmers produce rice and 80% grow cowpea, vegetables, mungbean and potato. Other crops such as wheat, maize and mustard are also grown, in a limited way. Crops such as local varieties of boro rice, jute, tobacco, cotton, lentils and kheshari were once grown but the farmers' interest in them has declined.

Farmers produce crops for consumption as well as for marketing. About 79% of the farmers purchase pulses and 82% potato. Although vegetables are produced by 94% of the farmers, additional supplies must be purchased in the market. Chilli is grown by a large number of farmers while interest in wheat cultivation, a crop not grown in the area, is increasing.

k) Constraints to Crop Production:

The farmers identify the following as the main constraints to better crop production:

* Yields of HYV rice are less than expected and production costs high;

* Improved seeds of wheat, maize, potato and mustard are not available.

* Yields of local varieties of rice are very low;
* Lack of irrigation;
* Low market prices for crops like jute, potato and lentil;
* Lack of technical knowledge about new crops;
* Severe insect attacks in potato, cowpeas and mungbean, the three common crops in the project area.

B. COMPONENT TECHNOLOGY STUDIES

A considerable number of component technology studies were carried out at the Cropping Systems Research Project area and the Hathazari Regional Research Station during the years 1981-1984. The results are summarized as follows:

a) Performance of promising varieties of wheat:

Nine varieties of wheat, BAW-28, Sonalika, BAW-12, Jupateco, Pavon-76, Balaka, BAW-18, Ananda and Kanchan were studied and their performances compared under partially irrigated land. The highest yields were observed in the varieties Kanchan, Ananda, Balaka and Sonalika (Table-1). The potential to grow wheat in the rainfed area is very limited because the soil residual moisture is extremely low.

b) The effect of planting methods on the yield of cowpea:

The efficient use of soil residual moisture is important to establish a crop after harvesting rice (t.aman). Five methods of planting cowpea were compared to observed their effects on the crop performance. The yields obtained with the three methods studied in 1981-1982 did not differ significantly (Table-2). In 1983-1984 the yields were considerably lower than those observed in 1981-1982, possibly due to less soil residual moisture in the last year. Considering the averages, the highest yields were observed when the cowpea was planted after one ploughing (.62 t/ha), but they did not differ from the yields in the farmers' check (.55 t/ha). The potential for increasing production of cowpea is limited. Varieties adopted for rainfed conditions are needed.

c) Comparison of the performance of two varieties of potato:

Varieties Patrones and Cardinal were compared under irrigated conditions. The average yield of Cardinal was 24.0 t/ha. The other variety, Patrones, yielded 19.5 t/ha (Table-3). The potential for growing potato is excellent, but the low marketing price limits its acceptance by the farmers.

d) Performance of local and improved varieties of rice in the early kharif season (aus):

Seven varieties of rice, Chinal, Hashikalmi, Purbachi, Chandina, Dular, BR-8 and BR-9 were tested and their yields compared. A uniform dose of 60 kg/ha N, 40 kg/ha P_2O5 and 20 kg/ha K_2O was applied. There were two applications of nitrogen, 20 days after sowing and at panicle initiation. Although the differences in yields were not statistically significant, Purbachi produced about three times as much (2.84 t/ha) as BR-8 (0.96 t/ha) and 82% more than the local variety Chinal (1.58 t/ha). The crop duration of the improved varieties Chandina (105 days), BR-8 (123 days) and BR-9 (123 days) was substantially longer than that of Purbachi (85 days), Chinal (77 days) (Table-4).

e) Performance of different varieties of rice during the late kharif season (t.aman):

Six varieties of rice, Pajam, BR-4, BR-10, BR-11, Chakkal and BR-3 were tested during the kharif season 1982 and 1983. A uniform dose of fertilizer (80-60-40 kg/ha NPK) was applied. The variety BR-11 yielded significantly higher than the rest of the varieties in the year 1983-1984 (Table-5). The average yield of two years also shows that the highest yield was for the variety BR-11 (3.79 t/ha). The crop duration (DAT) of the local variety Chakkal (144 days) was subtantially longer than that of Pajam (97 days), BR-4 (106 days), BR-10 (106 days), BR-11 (101 days).

f) Performance of different crop species:

Four crop species, cowpea, sweet potato, groundnut (3 varieties), lentil and field peas were planted after harvesting rice in the late kharif season. The higher yields were observed in three of the species already cultivated by the farmers, cowpea (.69 t/ha), sweet potato (21.36 t/ha) and groundnut (.93 t/ha) (Table-6). The lentil and field peas crops were lost.

g) Response of rice (variety BR-11, t.aman) to Zinc and Sulphur applications:

This experiment was carried in the Hathazari Regional Research Station in a highland area. The variety BR-11 was used and all the plants were fertilized with a dose of 80-60-40 kg/ha NPK. The higher yields were observed when 20 kg/ha of sulphur and 6 kg/ha of Zn were applied (Table-7). However, these yields were not significantly higher than the yields observed when only 20 kg/ha of S were applied, indicating that the application of Zn did not cause significant increase in yields in the soils of Hathazari Regional Station.

h) Response of rice (variety BR-11) to P and K application:

This experiment was also conducted at Hathazari Regional Research Station under rainfed highland conditions. The experiment was designed to test the residual effect of P and K on the praceeding crops. The results of the experiment did not indicate a definite response of rice to P or K individually, but the higher yield (4.77 t/ha) was observed when both elements were applied (Table-8).

i) Response of cowpea to the application of P,K,Zn and S.:

The addition of phosphorus, potash, zn and sulphur did not cause significant increase in yields as indicated by this experiment carried out in the Hathazari Regional Research Station (Table-9).

TABLE: 1 : Performance of the promising varieties of wheat at Hathazari Cropping Systems Site (Component Technology Studies 1980-1984)

Variety	Grain Yield (t/ha)			
	1981-82	1982-83	1983-84	Average
BAW - 28	0.67	1.82 a		1.24
Sonalika	0.91	1.62 ab	1.80 a	1.44
BAW - 12	1.15			
Japateco	0.63	1.33 c		0.98
Pavon - 76	0.76	1.21 bc	1.50 a	1.16
Balaka		1.09 c	1.62 a	1.65
BAW - 18		1.03 c		
Ananda			1.66 a	1.66
Kanchan			2.10 a	2.10

TABLE: 2 : The effect of planting methods on the yield of cowpea. (Component Technology Studies Hathazari Cropping Systems Site, 1981-1984).

Treatments *	Grain Yield (t/ha)		
	Year		
	1981-82	1983-84	Average
Single furrow	0.77	0.30	.53
One ploughing	0.62		
Relay		0.17	
Dibbling		0.22	
FArmers check	0.63	0.46	.55

* Treatment were not the same in different years.

TABLE: 3 : Comparison of the performance of two varieties of potato in Hathazari Cropping Systems Site (Component Technology Studies 1981-1982).

Varieties	Tuber yields (t/ha)	
Cardinal	24.0	a
Patrones	19.5	b

TABLE: 4 : Performance of local and improved varieties of rice (Component Technology Studies, Hathazari RARS 1981-1982).

Varieties	Yield (t/ha)		Crop duration (days)	Per day production (kg/ha)
Hashikalmi	1.58	N.S.	77	20.52
Purbachi	2.84		85	33.41
Chandina	2.27		105	21.62
Dular	1.29		85	15.18
BR 8	0.96		123	7.20
BR 9	2.05		123	16.67
Chinal	0.62		77	8.27

N.S. No significant difference between two treatments.

TABLE: 5 : Performance of different varieties of rice during the late kharif season (t.aman). (Component Technology Studies, Hathazari Cropping Systems Site, 1982-84).

Varieties	Days after transplanting	Yield (t/ha)			
		1982-83	1983-84		Average
Pajam	97	2.83	2.72	b*	2.77
BR - 4	106	2.65	3.00	b	2.87
BR - 10	106	3.24	3.36	b	3.30
BR - 11	101	3.24	4.34	a	3.79
Chakkal	144	2.00	2.76	b	2.38
BR - 3	-	-	3.54	ab	-

* Duncan multiple test.

TABLE: 6 : Performance of different crop species. (Component Technology Studies, Hathazari Cropping Systems Site, 1982-1983).

Crop Species	Field duration	Yield (t/ha)
Cowpea	107	0.69
Sweet Potato	107	21.36
Groundnut (var. DM 1)	136	0.43
Groundnut (var. D 1)	136	1.30
Groundnut (local variety)	136	0.93
Lentil	-	-
Field pea	-	-

TABLE: 7: Response of rice (variety BR-11, t.aman) to Zinc and Sulphur applications.(Component Technology Studies Hathazari Cropping Systems Site, RARS, 1983-1984).

Treatments * S - Zn (Kg/ha)	Grain Yield (t/ha)
20 - 6	4.77 a
20 - 0	4.62 ab
0 - 6	4.51 bc
0 - 0	4.33 c

* All treatments received a blank application of 80-60-40 kg/ha NPK.

TABLE: 8: Response of rice (variety BR-11, t.aman) to P and K applications.(Component Technology Studies. Hathazari Cropping Systems Site, RARS, 1983-1984).

Treatments Kgs/ha N - P_2O5 - K_2O	Grain Yield (t/ha)
80 - 60 - 40	4.33 a
80 - 60 - 0	4.29 ab
80 - 0 - 40	4.09 ab
80 - 30 - 40	4.20 ab
80 - 0 - 0	3.75 b

TABLE: 9: Response of cowpea to P.K. Zn and S applications. (Hathazari Cropping Systems Site, 1983-1984).

Treatments Kgs/ha N - P_2O5 - K_2O - S - Zn	Grain Yield (t/ha)
15 - 30 - 20 - 20 - 0	.43
15 - 60 - 20 - 20 - 0	.43
15 - 60 - 20 - 40 - 0	.42
15 - 60 - 20 - 0 - 0	.40
15 - 60 - 20 - 0 - 6	.42
15 - 60 - 20 - 0 - 6	.41
CV (%)	7.0

C. CROPPING PATTERN TESTING

The main activity in a Cropping System Research Project area is to evaluate the performance of the existing cropping pattern (F) under the practices utilized by the farmers and compare with either the performance of the same cropping patterns utilizing improved agronomic practices (FI), or with the performance of alternative cropping patterns (FA).

Nine cropping patterns were evaluated at Hathazari during 1981-84. Three were in rainfed medium lowlands, one in rainfed highlands and five in partially irrigated highlands. A summary of the agronomic and economic performances of the cropping patterns evaluated is given in tables 1 to 8. The performances of the cropping patterns evaluated in each land type are discussed separately.

RAINFED MEDIUM LOWLANDS:

This land type is not usually flooded. Rain water stands on the land up to a maximum of 60cms level during the monsoon season. This land type covers about 50% of the total project area.

a) Rice(b.aus) - Rice(t.aman) - Cowpea. (Table-10)

This is a cropping pattern common in the project area. The farmers plant the local rice variety Chinal (direct seeding, broadcast) in the early kharif and the variety Pajam (transplanted) in the late kharif. Some of the farmers plant Cowpea in the rabi season if there is sufficient residual soil moisture. The yield of all 3 crops in this pattern can be increased with improved management practices on the local varieties. The farmers' practices (F) can be modified by (1) decreasing the seed rate of the rice variety Chinal, from 150 to 100 kgs/ha, (2) adjusting the fertilizer rate for the local variety of rice Chinal in the early kharif (aus) and of variety Pajam in the late kharif (3) fertilizing cowpea during the rabi season.

Although there are variations from year to year, the mean results of the 3 years indicated that the production of all three crops in the pattern increased (and consequently the overall production of the pattern) with the changes in agronomic practices mentioned above. The yield of the variety Chinal increased by 25% (from 1.97 to 2.48 t/ha), the yield of the rice variety Pajam increased by 25% (2.18 to 2.79 ton/kg) and the yields of cowpea by 13% (from 0.59 to 0.67 ton/kg).

The increase in production in this pattern by using improved practices is limited. The extensionists should be careful in recommending the technology tested in this cropping pattern. A better scope for increasing production lies in changing the local varieties of rice by improved ones, as will be discussed in the following cropping pattern.

b) Rice(b.aus) - Rice(t.aman) - Mustard. (Table-11)

This cropping pattern is similar to the one discussed above. The farmers grow the local rice variety Chinal (direct seeded), in the early kharif (aus), and the variety Pajam in the late kharif as t.aman. Mustard (var. Tori-7) is planted in the winter season when the rice (t.aman) is harvested early and the soil residual moisture is adequate. The production of this pattern may be increased by:

i) Replacing the local variety Chinal by the improved varieties Chandina or Purbachi.

ii) Transplanting an improved variety Purbachi or Chandina in the early kharif, instead of direct seeding a local variety

iii) Adjusting the seed rate for the rice seed bed to 50 kg/ha.

iv) Fertilizing the rice varieties with 80-60-40 kgs/ha NPK.

With the use of the technology mentioned above the mean yields of the improved rice varieties (Purbachi, 3.59 t/ha and Chandina, 3.07 t/ha) was 50% higher than the mean yield of the local variety Chinal (1.76 t/ha).

The yield of the local variety of mustard was increased from 0.36 to 0.46 t/ha (27%) in the year 1981-82. The performance of mustard will depend on the planting date and soil residual moisture.

Conclusion:

The production of rice grain in this pattern can be increased by replacing the local rice variety Chinal with the varieties Chandina or Purbachi.

There is no good scope for increasing mustard production over the farmers' yields, in this land type.

c) Rice(b.aus) - Rice(t.aman) - Fallow. (Table-12)

This is the existing predominant cropping pattern for the rainfed medium lowlands. The farmers plant the local rice variety Chinal (direct seeded, broadcast) in the early kharif and the variety Pajam in the late kharif (t.aman). The lands are left fallow during the winter season if residual moisture is not sufficient to grow other crops like mustard or cowpea.

There is a high potential to increase the total production of this pattern by:

(a) Transplanting the improved rice variety Chandina instead of direct seeding (broadcast) the local variety Chinal in the early kharif(aus).

(b) Replacing the variety Pajam by the HYV BR-11 in the late kharif (t.aman).

(c) Fertilizing the improved rice varieties Chandina and BR-11 with 80-60-40 kg/ha NPK.

With improved agronomic practices, the yield of the variety Chandina (3.85 t/ha) was 103% higher than the local variety Chinal (1.89 t/ha). The yield of variety BR-11 (3.57 t/ha) was 41% higher than the variety Pajam (2.52 t/ha).

Conclusion:

The rice production in the cropping pattern Rice(b.aus) - Rice (t.aman) - Fallow grown in the rainfed medium lowlands can be increased up to 70% if the local variety Chinal is replaced by the HYV, Chandina in the early kharif season, and if the variety Pajam is replaced by the HYV BR-11 in the late kharif. In all cases the seed rate for the rice nursery must be adjusted to 50 kgs/ha and the fertilizer rate, (80-60-40 kg/ha NPK) be used.

RAINFED HIGHLANDS:

This land type covers 35% of the total cultivated land of the project area. Only one cropping pattern was evaluated in this land type. The results are summarised below.

a) Rice(b.aus) - Rice(t.aman) - Fallow. (Table-13)

This is the predominant pattern in the rainfed highlands. About 28% of the farmers in the project area practice this pattern. The farmers plant the local variety Chinal in the early kharif and Pajam, Nizershail or Bini in the late kharif. They use low fertilizer rates and the yields are low. This cropping pattern was evaluated for two years (1982-84) and the summary of the result is given in table-13. The production of the pattern may be substantially increased by:

(a) Replacing the local variety Chinal by the variety Purbachi in the early kharif season.

(b) Increasing the fertilizer rate used by the farmers to 80-60-40 kg/ha NPK, in both early and late kharif seasons (aus and t.aman).

(c) Replacing the varieties Pajam or Nizershail by the variety BR-11 in the late kharif season (t.aman).

(d) Transplanting the improved varieties in May or early June, when water is enough for puddling the soil rather than direct seeding the local varieties in late March or April.

(e) Reducing the turn around time between harvesting the rice planted in early kharif (aus) and transplanting the rice in late kharif (t.aman).

(f) Using 45 day-old rice seedlings.

With the improved practices the mean yield of the improve variety for early kharif, Purbachi (3.15 t/ha) was 52% higher than the mean yields of the local variety Chinal (2.06 t/ha). In the late kharif the mean yield of the variety BR-11 (3.32 t/ha) was 40% higher than the mean yield of varieties Pajam and Nizershail (2.36 t/ha). This increase in yield assures a higher net return to the farmers.

Conclusion:

The potential to increase the total production of the pattern rice (b.aus) - rice(t.aman) by changing the farmers' practices is high. The combined yields of rice of the early and late kharif seasons can be increased with the use of improved varieties of rice and medium fertilizer rates. The improved pattern FI, Rice(t.aus, variety Purbachi) - Rice (t.aman, variety BR-11) will give better benefits to the farmers.

PARTIALLY IRRIGATED HIGHLANDS:

This land type covers about 20% of the total cultivated area of the CSR site. The water does not stand during the rainy season but there are facilities for partial irrigation using water from streams originating in the hills. Five Cropping Patterns were evaluated in this land type during the years 1982-1984.

a) Rice(b.aus) - Rice(t.aman) - Chillies. (F) (Table-14)

The agronomic and economic performance of this pattern with the farmers (F) and improved practices (FI) are presented in table-14. The farmers plant the local rice variety Chinal in the early kharif, the variety Pajam in the late kharif and a local variety of Chillies in the rabi season. The production of the pattern can be increased by (a) using fertilizer rates of 60-40-20 kg/ha NPK, for the variety Chinal (b.aus) (b) replacing the variety PAJAM for the variety BR-11 (c) fertilizing the variety BR-11 with 80-60-40 kg/ha NPK, (d) adjusting the seed rate of the seedbed to 50 kg/ha and (e) increasing the fertilizer rates used by the farmers in the chilli crop.

With the practices outlined above the mean yields of the variety Chinal (b.aus) can be increased by 18% (1.87 to 2.21 t/ha). The mean yields of the variety BR-11 (3.83 t/ha) were 38% higher than the yields of the variety Pajam (2.77 t/ha) and the yields of Chilli were increased 17% (92 to 1.08 t/ha) by the use of fertilizer.

Conclusion:

Although the yields of the three crops in the cropping pattern can be increased by using some agronomic practices different to the ones used by the farmers, only the increase in yield obtained in the late kharif, by replacing the variety Pajam for the variety BR-11 with proper fertilization can be considered significant. Increase in yields less than 30-40% usually are not considered by the farmers.

b) Rice(b.aus) - Rice(t.aman) - Potato. (F)
Maize - Rice(t.aman) - Potato. (FA) (Table-15)

The agronomic and economic performance of these patterns are presented in table-15. The potential of maize to replace the rice crop during the early kharif was explored by evaluating this pattern. In addition, in the alternative cropping pattern (FA), the improved rice variety BR-11, and Cardinal variety of potato, were included instead of the local varieties in the farmers' pattern (F). Using the improved practices the mean yield of the variety BR-11 (4.06 t/ha) was 128% higher than the yield of Pajam (1.78 t/ha). The yield of the potato variety Cardinal (28.71 t/ha) was 191% more than the yield of the local variety (9.71 t/ha). The average yield of maize (var. Sadaf) in two years was 4.06 t/ha, more than double the yield of rice (aus). The net returns from maize (Tk.8,514) obtained in the year 1983-84 were 3 times more than the net returns from rice (Tk.2,287) in the same year.

Conclusion:

There is a high potential to increase the production in the partially irrigated land types by replacing the existing cropping pattern Rice(b.aus) - Rice(t.aman) - Potato, by the alternative pattern Maize (var. Sadaf) - Rice(t.aman, var. BR-11) - Potato (var. Cardinal) and adjusting seed and fertilizer rates. However, the limited marketing conditions for maize and potato and the high cost involved in potato production may reduce the adoption of this pattern by the majority of the farmers. The potato grower can benefit by adopting the whole pattern. Planting of maize will aloow early transplanting of rice in the late kharif. This early planting allows to make a more efficient use of rainfall water and higher yields of rice can be obtained.

c) Rice(b.aus) - Rice(t.aman) - Fallow. (F)
Rice(t.aus) - Rice(t.aman) - Wheat. (FA) (Table-16)

Part of the partially irrigated highlands are laft fallow for about 170 days after harvesting rice(t.aman). Wheat was evaluated as a third crop, aiming to increase the land use. The performance of the alternative cropping pattern Rice(t.aus) - Rice(t.aman) - Wheat (FA) was compared with the performance of the farmers' existing pattern (F). In the alternative pattern (FA), the variety Purbachi was transplanted and the

farmers' fertilizer rate adjusted in the early kharif, and the local variety Nizershail replaced by the improved variety BR-11 in the late kharif. The wheat variety Sonalika was planted in the rabi season. The improved practices increased the production of all the crops in the alternative pattern: (a) The transplanting and fertilizer use in the variety Purbachi increased the yields by 13% (3.03 to 3.43 t/ha), (b) The mean yield of the variety BR-11 (4.19 t/ha) was 56% more than the variety Nizershail (2.65 t/ha), (c) The mean yield of the extra crop, wheat, was 1.29 t/ha.

Conclusion:

In the partially irrigated highland of Hathazari or other areas with similar agroecological conditions, wheat can be planted as a third crop, in areas which usually remain fallow, after Rice(aus) and Rice(t.aman).

The variety BR-11 with 80-60-40 kg/ha NPK, can be transplanted instead of the local variety Nizershail.

The increase in yield by transplanting the variety of rice Purbachi instead of direct seeding, is not that high as to encourage the farmers to change their practices.

d) Rice(b.aus) - Rice(t.aman) - Groundnut. (Table-17)

The performance of this existing pattern was studied under farmers' practices (F), and under improved practices. The improved practices consisted of (a) replacing the local varieties of rice and groundnut for improved varieties (b) adjusting the fertilizer and seed rates, (c) transplanting the rice variety Purbachi in the early kharif instead of direct seeding the local variety Chinal. The pattern was evaluated for two years. The performance of both the farmers' (F), and the (FI) pattern are given in table-17.

The yield of each of the improved varieties tested in the improved pattern (FI), were substantially higher than the yields commonly obtained by the farmers. The yield of the variety Purbachi (3.00 t/ha) was 65% more than the local variety Chinal (1.81 t/ha). The yield of the variety BR-11 (3.63%) was 44% higher than the variety Pajam (2.51 t/ha). The groundnut variety D.1 yielded 30% more than the local variety (local, 0.86 t/ha - D., 1.11 t/ha).

Conclusion:

There is a high potential to increase the production of this cropping pattern in the partially irrigated highlands like the ones in Hathazari. The production of all three crops in the farmers' pattern can be increased by 30% or more, by changing the local varieties to improved ones and adjusting the fertilizer rates. The inclusion of groundnut as a winter crop may improve the soil conditions.

e) Rice(b.aus) - Rice(t.aman) - Potato. (F)
Rice(t.aus) - Rice(t.aman) - Potato - Mungbean. (FA) (Table-18)

During the year 1983-84, the farmers' cropping pattern (F), was compared with the farmers' alternative cropping pattern (FA). The last pattern include four crops, and it is suitable only for those areas where supplemental irrigation can be assured. Mungbean can be grown when potato is timely planted. The residual effect of fertilizer applied to potato may benefit the mungbean crop. The performance of these patterns is presented in table-18. The study of this pattern confirmed that the available improved varieties of rice offer a high potential for increasing the production of some of the cropping patterns grown by the farmers. The performance of the alternative pattern has to be evaluated further.

TABLE: 10 : Agronomic and Economic performance of the Cropping Pattern Rice (B.Aus) - Rice (T.Aman) - Cowpea evaluated under Farmer's (F) and improved practices(FI) in rainfed medium lowland landtypes of Hathazari CSR site, 1981 - 1984.

INFORMATION									
Land Type		Rainfed Medium Lowland							
Cropping Pattern		(F) Rice (b.aus) - Rice (t.aman) - Cowpea				(FI) Rice (b.aus) - Rice (t.aman) - Cowpea			
		1981-1982	1982-1983	1983-1984	Means	1981-1982	1982-1983	1983-1984	Means
Varieties *	C1	Chinal	Chinal	Chinal		Chinal	Chinal	Chinal	
	C2	Pajam	Pajam	Pajam		Pajam	Pajam	Pajam	
	C3	Local	Local	Local		Local	Local	Local	
Planting date (Range)	C1	-	May 5-15	May 11-28		-	May 5-15	May 11-28	
	C2	-	Aug 21-27	Aug 12-25		-	Aug 21-27	Aug 12-25	
	C3	-	Dec 9-15	Dec 9-24		-	Dec 9-15	Dec 9-24	
Seed rate	C1	150	134	119	134	100	100	100	100
	C2	62	86	60	69	50	50	50	50
	C3	24	28	25	26	22	25	25	25
NPK (kg/ha)	C1	21 - 0 - 0	16 - 0 - 0	25 - 0 - 0	21 - 0 - 0	60-40-20	60-40-20	60-40-20	60-40-20
	C2	55 -30 - 0	42 -15 - 0	50 -16 - 7	50 -20 - 0	60-40-20	60-40-20	60-40-20	60-40-20
	C3	0 - 0 - 0	0 - 0 - 0	0 - 0 - 0	0 - 0 - 0	0 - 0 - 0	30-20-20	30-20-20	30-20-20
Field duration (days)	C1	-	88	74	81	-	87	74	80
	C2	-	99	103	101	-	98	104	101
	C3	-	111	137	124	-	111	117	114
Yield (t/ha)	C1	1.40	2.70	1.79	1.97	1.74	3.10	1.86	2.48
	C2	1.75	2.20	2.58	2.18	2.49	2.80	2.78	2.79
	C3	0.73	0.70	0.35	0.59	0.73	0.90	0.45	.675
Yield (kg/ha/day)	C1	-	31	24	27	-	35	25	30
	C2	-	22	25	23	-	29	27	28
	C3	-	5.5	2.5	4.0	-	7.7	3.2	5.5
Cost of Cultivation	C1	-	2,456	3,357		-	2,834	4,135	-
	C2	-	3,486	4,548		-	3,501	5,608	-
	C3	-	1,366	1,388		-	1,744	2,036	-
Gross return (tk/ha)	C1	-	9,913	7,178		-	11,079	7,459	
	C2	-	8,750	11,739		-	11,348	12,649	-
	C3	-	3,799	2,450		-	4,548	3,150	-
Net return (tk/ha)	C1	-	7,457	3,821		-	8,245	3,324	-
	C2	-	5,264	6,991		-	7,847	7,041	-
	C3	-	2.433	1,062		-	2,714	1,114	-
Benefit Cost ratio	C1	-	4.04	2.14		-	3.91	1.80	-
	C2	-	2.51	2.47		-	3.24	2.26	-
	C3	-	2.78	1.77		-	2.48	1.55	-

* C1= Rice (B.Aus) C2= Rice (T.Aman) C3= Cowpea.

TABLE: 11 : Agronomic and Economic evaluation of the Cropping Pattern Rice (B.Aus) - Rice (T.Aman) - Mustard evaluated under Farmers existing practices(F) and with improved agronomic practices(FI), in the rainfed medium lowlands landtype of Hathazari Cropping System Site, BARI 1981 - 1983.

INFORMATION							
Land Type		Rainfed Medium Lowland					
Cropping Pattern		(F) Rice (b.aus) - Rice (t.aman) - Mustard			(FI) Rice (t.aus) - Rice (t.aman) - Mustard		
Year		1981 - 82	1982 - 83	Mean	1981 - 82	1982 - 83	Mean
Varieties	C1	Chinal	Chinal		Purbachi	Chandina	
	C2	Pajam	Pajam		BR 11	BR 11	
	C3	Tori 7	Tori 7		Tori 7	Tori 7	
Planting dates (Range)	C1	-	May 7-27		-	June 16-21	
	C2	-	Aug 26 Sep 2		-	Jul 28 Sept 7	
	C3	-	*		-	-	
Seed rate(kg/ha)	C1	62	62	62	50	50	50
	C2	62	86	74	50	50	50
	C3	18	-	18	12	-	12
NPK (kg/ha)	C1	29-0-0	27-0-0	28-0-0	80-60-40	80-60-40	80-60-40
	C2	55-30-0	46-13-0	50-17-0	80-60-40	80-60-40	80-60-40
	C3	67-50-0	-	-	80-60-30	-	-
Field duration (days)	C1	-	88	88	-	75	75
	C2	-	105	105	-	103	103
	C3	-	-	-	-	-	-
Yield (t/ha)	C1	1.62	1.41	1.76	3.59	3.07	3.33
	C2	3.24	2.63	2.93	3.93	3.80	3.86
	C3	0.36	-	0.36	0.46	-	0.46
Yield(kg/ha/day)	C1	-	22	-	-	41	41
	C2	-	25	-	-	35	35
	C3	-	-	-	-	-	-
Cost of cultivation(tk/ha)	C1	-	-	-	-	-	-
	C2	-	-	-	-	-	-
	C3	-	-	-	-	-	-
Gross return (tk/ha)	C1	-	6,895	-	-	11,068	-
	C2	-	10,534	-	-	15,036	-
	C3	-	-	-	-	-	-
Net return (tk/ha)	C1	-	4,268	-	-	7,016	-
	C2	-	7,110	-	-	10,879	-
	C3	-	-	-	-	-	-
Benefit Cost ratio	C1	-	2.64	-	-	2.73	-
	C2	-	3.08	-	-	3.62	-
	C3	-	-	-	-	-	

C1= Rice (B.Aus) C2= Rice (T.Aman) C3= Mustard.

* Crop was not planted because of late harvesting of the rice.

TABLE: 12: Agronomic and Economic performance of the existing cropping pattern Rice (b.aus) - Rice (t.aman) - Fallow evaluated under farmer products (F) and with improved agronomic practices (FI) in the rainfed medium lowland landtypes of Hathazari Cropping Systems Research Site, 1982 - 1983.

INFORMATION			
Land Type		Rainfed Medium Lowland	
Cropping Pattern		(F) Rice (b.aus) - Rice (t.aman) - Fallow	(FI) Rice (t.aus) - Rice (t.aman) - Fallow
Year		1982 - 1983	1982 - 1983
Varieties	* C1	Chinal (b. aus)	Chandina (t. aus)
	C2	Pajam (t.aman)	BR 11 (t.aman)
	C3	-	-
Planting dates (Range)	C1	May 2 - 25	June 14 - 17
	C2	August 19 - 26	August 31 - September 7
	C3	-	-
Seed rate(kg/ha)	C1	143	50
	C2	74	50
	C3	-	-
NPK (kg/ha)	C1	25 - 0 - 0	80 - 60 - 40
	C2	41 - 9 - 0	80 - 60 - 40
	C3	-	-
Field duration (days)	C1	85	90
	C2	105	108
	C3	-	-
Yield (t/ha)	C1	1.89	3.85
	C2	2.52	3.57
	C3	-	-
Yield (kg/ha/day)	C1	22	48
	C2	24	33
	C3	-	-
Cost of cultivation (Tk/ha)	C1	2,752	4,064
	C2	3,632	4,489
	C3	-	-
Gross return (Tk/ha)	C1	6,841	13,906
	C2	9,767	14,153
	C3	-	-
Net return (Tk/ha)	C1	4,089	9,842
	C2	6,130	9,664
	C3	-	-
Benefit cost ratio	C1	2.49	3.42
	C2	2.68	3.14
	C3	-	-

* C1= Rice (B.Aus) C2= Rice (T.Aman) C3= Fallow

TABLE: 13: Agronomic and Economic performance of the cropping pattern Rice (b.aus) - Rice (t.aman)- Fallow evaluated under farmers' existing practices (F) and with improved agronomic practices (FI) in the rainfed highlands of Hathazari Cropping Systems Site, BARI, 1982-84.

INFORMATION							
Land Type		Rainfed Highland					
Cropping Pattern		(F) Rice (b.aus) - Rice (t.aman) - Fallow			(FI) Rice (t.aus) - Rice (t.aman) - Fallow		
Year		1982 - 1983	1983 - 1984	Mean	1982 - 1983	1983 - 1984	Mean
Varieties	* C1	Chinal	Chinal		Purbachi	Purbachi	
	C2	Nizershail	Nizershail		BR 11	BR 11	
	C3	-	-	-	-	-	-
Planting dates (Range)	C1	May 18 - Jun 2	April 25 May 14		May 13 - 30	June 10 - 17	
	C2	August 28 - 30	August 8 - 27		August 12 - 31	September 8-11	
	C3	-	-	-	-	-	-
Seed rate(kg/ha)	C1	135	146 (DS)	140	50	50	50
	C2	63	60	63	50	50	50
	C3	-	9 - 0 - 0	- -	- -		
NPK (kg/ha)	C1	33 - 22 - 7	36 - 9 - 9	37 - 15 - 8	80 - 40 - 40	80 - 60 - 40	80 - 50 - 40
	C2	43 - 12 - 0	-	-	80 - 60 - 40	80 - 60 - 40	80 - 60 - 40
	C3	-	-	-	-	-	-
Field duration (days)	C1	80	87	81	89	78	82
	C2	97	88	92	107	95	101
	C3	-	-	-	-	-	-
Yield (t/ha)	C1	1.99	2.14	2.06	3.09	3.21	3.15
	C2	2.43	2.30	2.36	4.25	3.20	3.32
	C3	-	-	-	-	-	-
Yield(kg/ha/day)	C1	25	26	25.5	35	41	38
	C2	25	26	25.5	40	33	36
	C3	-	-	-	-	-	-
Cost of cultivation (Tk/ha)	C1	4,583	2,648	-	5,908	3,912	-
	C2	4,434	3,500	-	5,566	4,019	-
	C3	-	-	-	-	-	-
Gross return (Tk/ha)	C1	7,980	7,778	-	12,391	11,595	-
	C2	11,057	8,940	-	18,190	12,355	-
	C3	-	-	-	-	-	-
Net return (Tk/ha)	C1	3,397	5,131	-	6,483	7,683	-
	C2	6,623	5,440	-	12,624	8,336	-
	C3	-	-	-	-	-	-
Benefit cost ratio	C1	1.74	2.98	-	2.10	2.96	-
	C2	2.49	2.55	-	3.27	3.05	-
	C3	-	-	-	-	-	-

* C1 = Rice (B.Aus) C2 = Rice (T.Aman) C3 = Fallow.

TABLE: 14: Agronomic and Economic performance of the existing cropping pattern Rice (b.aus) - Rice (t.aman) - Chillies, evaluated under farmers (F) and under improved agronomic practices (FI). Hathazari Cropping Systems Research Site, BARI, 1981 - 1984.

INFORMATION									
Land Type		Partially Irrigated Highland							
Cropping Pattern		F) Rice (b.aus) - Rice (t.aman) - Chillies				FI) Rice (t.aus) - Rice (t.aman) - Chillies			
Year		1981 - 82	1982 - 83	1983 - 84	Mean	1981 - 82	1982 - 83	1983 - 84	Mean
Varieties	C1	Chinal	Chinal	Chinal		Chinal	Chinal	Chinal	
	C2	Pajam	Pajam	Pajam		BR 11	BR 11	BR 11	
	C3	Local	Local	Local		Local	Local	Local	
Planting Dates (Range)	C1		Mar 9-29	May5-June1			Mar. 10-21	May16-June1	
	C2		Aug.17-Sept1	Aug. 3-25			Aug18-Sept1	Aug. 3-25	
	C3		Dec.20-30	Dec15-Jan.1			Dec.20-30	Dec19-Jan.3	
Seed Rate(kg/ha)	C1	150	127	134	137	100	100	100	100
	C2	62	82	67	70	50	50	50	50
	C3	188,350 Pl	187,000 Pl	203,700 Pl	193,000 Pl	144,900 Pl	125,000 Pl	125,000 Pl	131,600 Pl
NPK (kg/ha)	C1	29-0-0	20-0-0	20-0-0	23-0-0	60-40-20	30-40-20	60-40-20	50-40-20
	C2	30-40-0	49-34-0	26-0-0	35-25-0	80-60-40	80-60-40	80-60-40	80-60-40
	C3	82-97-57	60-32-9	60-40-0	67-56-22	80-60-40	80-60-40	80-60-40	80-60-40
Field duration (days)	C1		86	70	78		82	71	76
	C2		101	107	104	143	107	113	121
	C3		119	139	129	111	119	139	123
Yield (t/ha)	C1	1.62	1.89	1.90	1.89	1.87	2.67	2.09	2.21
	C2	2.98	2.65	2.80	2.77	3.61	3.85	4.05	3.83
	C3	1.01	1.13	0.72	0.92	1.05	1.25	0.94	1.08
Yield (kg/ha/day)	C1		22	27	25		33	29	31
	C2		26	26	26		35	36	35
	C3		10	5	7.5		11	7	9
Cost of cultivation (Tk/ha)	C1		2,418	3,540			3,165	3,871	
	C2		4,045	4,349			4,103	5,339	
	C3		7,324	6,875			6,773	1,250	
Gross return (Tk/ha)	C1		6,927	7,619			9,369	8,381	
	C2		10,298	12,740			15,238	17,334	
	C3		16,965	19,440			18,735	25,380	
Net return (Tk/ha)	C1		4,509	4,079			6,204	4,510	
	C2		6,253	8,391			11,135	11,295	
	C3		9,661	12,565			11,962	18,130	
Benefit cost ratio	C1		2.95	2.15			3.28	2.17	
	C2		2.55	2.93			3.71	3.13	
	C3		2.32	2.83			2.77	3.50	

* C1= Rice (b or t aus) C2= Rice (t.aman) C3= Chillies.

TABLE: 15: Agronomic and Economic performance of an existing cropping pattern evaluated with farmers' technology (F) compared to the performance of an alternative cropping pattern evaluated with improved practices (FA): Hathazari Cropping Systems Research Site, BARI, 1981 - 1984.

INFORMATION									
Land Type		Partially Irrigated Highland							
Cropping Pattern		F) Rice (b.aus) - Rice (t.aman) - Potato				FA) Maize - Rice (t.aman) - Potato			
Year		1981 - 82	1982 - 83	1983 - 84	Mean	1981 - 82	1982 - 83	1983 - 84	Mean
Varieties	C1	Chinal	Chinal	Chinal		Sadaf	Sadaf	Sadaf	
	C2	Pajam	Pajam	Pajam		BR 11	BR 11	BR 11	
	C3	Local	Local	Local		Cardinal	Cardinal	Cardinal	
Planting Dates (Range)	C1		Ap-24 May23	May24,Jun30			Mar.26,Ap.11	Mar.29,Ap.8	
	C2		Aug.22,Sep11	Aug. 10-22			Jul.30,Aug19	Jul31-Aug25	
	C3		Dec. 24-30	Dec.12Jan-7			Mar24-Dec13	Dec. 12-19	
Seed Rate(kg/ha)	C1	150	141	129	140	20	30	20	23
	C2	62	77	60	68	50	50	50	50
	C3	1112	360	190	554	1500	1500	1300	1430
NPK (kg/ha)	C1	29-0-0	5-0-0	40-0-0	25-0-0	100-60-40	100-60-40	100-40-40	100-53-40
	C2	50-30-0	45-18-0	58-37-18	50-28-6	80-60-40	80-60-40	80-60-40	80-60-40
	C3	90-105-40	54-40-32	90-66-42	78-70-38	120-100-120	120-100-120	120-100-120	120-100-120
Field duration (days)	C1	95	81	78	85	99	88	93	93
	C2	-	107	104	105	140	105	109	118
	C3	-	89	83	86	82	76	85	81
Yield (t/ha)	C1	1.62	2.07	1.65	1.78	51.200 cobs	4.13	4.00	4.06
	C2	3.16	2.23	2.37	2.59	4.31	4.38	4.38	4.34
	C3	10.73	7.95	10.46	9.71	24.02	31.50	29.23	28.25
Yield(kg/ha/day)	C1		26	21	23		47	43	45
	C2		21	23	22		42	40	41
	C3		89	126	107		414	344	379
Cost of cultivation (Tk/ha)	C1		2,554	4,329			5,96[illegible]	7,486	
	C2		3,573	4,840			4,158	5,548	
	C3		8,208	11,018			20,668	23,460	
Gross return (Tk/ha)	C1		7,465	6,616			21,109	16,000	
	C2		8,922	10,783			17,329	18,746	
	C3		17,888	31,380			55,123	78,921	
Net return (Tk/ha)	C1		4,911	2,287			15,146	8,514	
	C2		5,349	5,944			13,171	12,898	
	C3		9,682	20,362			34,455	55,461	
Benefit cost ratio									

TABLE: 16: Agronomic and Economic performance of the existing Cropping Pattern (F) Rice (b.aus) - Rice (t.aman) - Fallow, compared with the performance of the alternative cropping pattern (FA) Rice (t.aus) - Rice (t.aman) - Wheat. Hathazari Cropping Systems Research Site, BARI, 1981 - 1984.

INFORMATION									
Land Type		Partially Irrigated Highland							
Cropping Pattern		(F) Rice (b.aus) - Rice (t.aman) - Fallow				(FA) Rice (t.aus) - Rice (t.aman) - Wheat			
Year		1981 - 82	1982 - 83	1983 - 84	Mean	1981 - 82	1982 - 83	1983 - 84	Mean
Varieties	C1	Purbachi	Purbachi	Purbachi		Purbachi	Purbachi	Purbachi	
	C2	Nizershail	Naizershail	Naizershail		BR 11	BR 11	BR 11	
	C3	-	-	-		Sonalika	Sonalika	Sonalika	
Planting Dates (Range)	C1		May14-Jun14	May 4-23			May14-Jun14	May 6-31	
	C2		Aug14-Sept14	Aug 22-30			Aug18-Sept13	Aug 12-30	
	C3						Dec17-Dec30	Dec 11-24	
Seed Rate(kg/ha)	C1	62	56	62	60	50	50	50	50
	C2	62	84	65	70	50	50	50	50
	C3	-	-	-	-	146	125	120	130
NPK (kg/ha)	C1	71-46-35	89-39-14	51-30-12	70-30-20	80-60-40	80-60-40	80-40-30	80-53-36
	C2	40-30- 0	67-47- 0	32-19- 7	46-32- 2	80-60-40	80-60-40	80-40-20	80-53-33
	C3					80-60-40	80-60-40	80-60-40	80-60-40
Field duration (days)	C1		79	83	54		79	83	81
	C2		97	105	67		102	112	107
	C3		-	-	-		89	93	91
Yield (t/ha)	C1	3.52	3.16	2.40	3.03	3.80	3.70	2.79	3.43
	C2	2.93	2.46	2.57	2.65	4.01	3.75	4.82	4.19
	C3	-	-	-	-	0.86	1.62	2.25	1.29
Yield (kg/ha/day)	C1	-	40	29	34	-	47	34	40
	C2	-	25	24	24	-	37	43	40
	C3	-	-	-	-	-	18	24	21
Cost of cultivation (Tk/ha)	C1	-	-	5,146	-	-	-	5,588	-
	C2	-	-	5,431	-	-	-	6,192	
	C3	-	-	-	-	-	-	5,571	-
Gross return (Tk/ha)	C1	-	11,400	9,624	-	-	13,321	11,188	
	C2	-	9,869	11,784	-	-	14,850	20,630	-
	C3	-	-	-	-	-	6,068	9,562	-
Net return (Tk/ha)	C1	-	7,455	4,478	-	-	9,507	5,600	-
	C2	-	6,354	6,353	-	-	11,171	14,438	-
	C3	-	-	-	-	-	1,288	3,991	-
Benefit cost ratio	C1	-	2.89	1.87	-	-	3.49	2.00	-
	C2	-	2.81	2.17	-	-	4.04	3.33	-
	C3	-	-	-	-	-	1.27	1.22	-

TABLE: 17: Agronomic and Economic performance of the existing cropping pattern Rice (b.aus) - Rice (t.aman) - Groundnut evaluated under farmers' (F) and improved agronomic practices (FI).
Hathazari Cropping Systems Research Site, BARI, 1982 - 1984.

INFORMATION							
Land Type		Partially Irrigated Highland					
Cropping Pattern		(F) Rice (b.aus) - Rice (t.aman) - Groundnut			(FI) Rice (t.aus) - Rice (t.aman) - Groundnut		
Year		1982 - 1983	1983 - 1984	Mean	1982 - 1983	1983 - 1984	Mean
Varieties	C1	Chinal	Chinal		Purbachi	Purbachi	
	C2	Local(Pajam)	Pajam		BR 11	BR 11	
	C3	Local	Local		D - 1	D - 1	
Planting Dates (Range)	C1	May 5 - 15	May21-June 5		June 14-20	May 25-28	
	C2	Aug.20-Sept.6	Aug.16-Sept.3		September 5-8	Aug.16-Sept.3	
	C3	January 1-10	Jan.12-Jan.20		January 1-2	January 11-20	
Seed Rate(kg/ha)	C1	138	135	137	50	50	50
	C2	78	62	70	50	50	50
	C3	120	115	117	100	100	100
NPK (kg/ha)	C1	6-0-0	33-22-7	20-11-35	80-60-40	80-40-30	80-50-35
	C2	46-29-0	56-25-7	51-27-35	80-60-40	80-60-40	80-60-40
	C3	-	0-0-0	-	30-30-20	15-30-20	22-30-20
Field duration (days)	C1	80	77	79	77	76	76
	C2	97	106	101	106	109	107
	C3	136	130	133	136	132	135
Yield (t/ha)	C1	1.95	1.68	1.81	3.13	2.87	3.00
	C2	2.58	2.45	2.51	3.14	4.12	3.63
	C3	0.93	0.80	0.86	1.30	0.92	1.11
Yield(kg/ha/day)	C1	24	22	23	41	38	39
	C2	27	23	25	30	38	34
	C3	7	6	6.5	10	7	8
Cost of cultivation (Tk/ha)	C1	2,422	3,843		3,716	5,496	
	C2	3,393	4,498		4,185	5,608	
	C3	6,963	6,688		7,133	6,490	
Gross return (Tk/ha)	C1	7,029	6,737		11,306	11,509	
	C2	9,991	11,148		12,423	17,634	
	C3	9,300	9,600		13,000	11,040	
Net return (Tk/ha)	C1	4,607	2,895		7,590	6,013	
	C2	6,598	6,650		8,238	12,026	
	C3	2,337	2,912		5,867	4,550	
Benefit cost ratio	C1	2.90	1.75		3.04	2.09	
	C2	2.94	2.48		2.97	3.14	
	C3	1.34	1.43		1.82	1.70	

TABLE: 18: Agronomic and Economic performance of the existing cropping pattern (F) and of the alternative cropping pattern (FA) Rice (t.aman) - Rice (t.aus) - Potato - Mungbean. Hathazari Cropping Systems Research Site, BARI, 1983-84.

INFORMATION			
Land Type		Partially Irrigated Highland	
Cropping Pattern		(F) Rice (b.aus) - Rice (t.aman) - Potato	(FA) Rice (t.aus)-Rice (t.aman)-Potato-Mungbean
Year		1983 - 1984	1983 - 1984
Varieties	C1	Chinal	Purbachi
	C2	Pajam	BR 11
	C3	Local	Cardinal - C4 Mubarac
Planting Dates (Range)	C1	May-20, June-7	May-20, June-7
	C2	August 18-30	August-10, September-5,
	C3	December 6-16	December 9-21, C4 February-28,March-7
Seed Rate(kg/ha)	C1	125	50
	C2	62	50
	C3	189	1500 C4 25
NPK (kg/ha)	C1	22 - 0 - 0	60 - 40 - 20
	C2	42 - 27 - 20	80 - 40 - 40
	C3	67 - 33 - 31	120 -100 -120 C4 0-0-0
Field duration (days)	C1	77	86
	C2	88	105
	C3	89	78 C4 60
Yield (t/ha)	C1	1.75	3.43
	C2	2.96	3.33
	C3	11.83	28.04 C4 0.31
Yield (kg/ha/day)	C1	23	40
	C2	34	32
	C3	133	359 C4 50
Cost of cultivation (Tk/ha)	C1	3,957	5,323
	C2	6,647	6,946
	C3	10,995	25,512 C4 1;366
Gross return (Tk/ha)	C1	2,018	13,754
	C2	13,469	14,252
	C3	35,490	75,708 C4 3,720
Net return (Tk/ha)	C1	3,061	8,431
	C2	6,822	7,306
	C3	24,495	50,196 C4 2,354
Benefit cost ratio	C1	1.77	2.58
	C2	2.03	2.05
	C3	3.23	2.97 C4 2.77

JESSORE SITE

A. BENCHMARK SURVEY - SITE DESCRIPTION

a) Location:

The site is located about 16 kilometres northeast of Jessore on both sides of the Jessore - Narail highway. Eight villages under Bagherpara Thana are part of the project area. These villages are Darajhat, Balarampur, Syed Mamudpur, Budhapur, Rustompur, Debinagar, Dadpur and Parkul.

b) Social Infrastructure:

Total population in the eight villages is 4,440, 51% of whom are male. There are 432 households. The level of education is much higher than the national average. The farmers are engaged in various other jobs in addition to agriculture. The average size of family is 8.9.

c) Farm Size and Tenancy:

Total cultivatable area is 634 hectares with farm size at averaging 1.47 ha. However, the land is not evenly distributed. 15% of the households are landless, 69% have less than 1.0 ha, while 15% have more than 2.0 hectares. About 49% of the small farmers are sharecroppers. Only 10% of this group leases out any land.

d) Agroclimatic conditions:

Rainfall:

Total annual rainfall is 1765 mm. The average number of rainy days in a year is 102. Rainfall is heaviest from June to September, with only five per cent of the annual total falling between November and March. Rainfall is highly variable from year to year.

Temperature:

The average maximum temperature is 31.1°C and the minimum 20.3°C. Maximum temperatures occur in April and May, minimum temperatures in January.

Evaporation:

Total yearly evaporation is 1,183 mm. Mean monthly evaporation is highest in April (153.4 mm) and lowest in January (61.2 mm).

Day Length:

Days are longer in June (13.6 hours) and shorter in December (10.7 hours).

Soils:

The soils in the project area belong to the old Ganges meander flood plain physiographic unit. The topography, is nearly level to gently undulating, broad ridges. Soils are silty loam and sandy loam and are considered to have a high production potential.

e) Major Cropping Patterns:

	% Farmers Practicing
Rice (b. aus) - Rice (t. aman) - Fallow	71
Rice (b. aus) - Fallow - Mustard + Lentil	33
Rice (b. aus) - Fallow - Mungbean	30
Rice (b. aus) - Fallow - Lentil	29
Rice (b. aus) - Fallow - Mustard	21
Jute - Fallow - Mustard + Lentil	20
Jute - Fallow - Mustard	19
Rice (b. aus) - Fallow - Potato	15
Rice (b. aus) - Fallow - Gram	13
Rice (b. aus) - Fallow - Onion + Garlic	11

f) Labour Supply:

Labour requirements in the project area are high because of the high cropping intensity and the extensive use of human labour. Some farmers hire labour permanently. During peak periods, family labour is supplemented by hired labourers.

g) Livestock:

There is no shortage of animal power at the site, the average numbers of bullocks owned by small, medium and large farmers being 1.14, 2.06 and 3.54 respectively. Average numbers of milk cows for the same three groups are 0.59, 1.00 and 1.92.

h) Input Use and Source:

Most farmers use their own seed or obtain supplies from the local market.

Fertilizers, purchased from local dealers or other farmers, are used by most of the farmers. In general, fertilizer use is high, average 133.5 kg per hectare. Small and medium farmers use more fertilizer in the early kharif season, while large farmers use it more in the late kharif.

Fifty per cent of the farmers use insecticide purchased from local dealers. The availability of sprayers is limited.

Sixty-four per cent of farmers interviewed use credit for crop production, 66% from banks and 34% from money lenders.

Only a few farmers at the site have access to irrigation from low lift pumps located in Syed Mamudpur and Balarampur villages.

i) Crop Production and Use:

The use of local varieties is predominant in the project area. Ninety-six per cent of farmers plant local varieties of aus rice in the early kharif season and 86% aman varieties in the late kharif. Only 24% of the farmers plant HYV rice. A high proportion (30%) cite high production costs as a major constraint. Most farmers have no interest in planting crops like maize, sweet potato, cotton, tobacco, sugarcane or peanuts. On the other hand, many are interested in jute, mustard, lentil, mungbean and vegetables.

The farmers produce crops for both for market and home consumption. Seventy per cent purchase wheat and rice, indicating that the area is highly deficit in production of these grains. One third purchase mustard, potato and vegetables, the rest being self-sufficient in these crops.

j) Constraints to Crop Production:

Farmers identify the main constraints to higher crop production as:

* the high cost of producing HYV rice, with yields lower than expected;
* lack of irrigation facilities for all crops;
* lack of technical knowledge of new crops such as maize;
* high cost of production and low prices for crops such as jute and potato;
* lack of improved varieties of mustard and pulses to replace low-yielding local varieties.

B. COMPONENT TECHNOLOGY STUDIES

a) Performance of promising varieties of wheat. (Table-19)

Eleven varieties of wheat, Balaka, Pavon, Sonalika, Doel, Jupateco, Inia, BAW-18, BAW-28, Barkat, Akbar and Ananda were tested and their yield compared. The performance of the varieties varied from year to year (table-19). In 1981-82 the higher yields were observed in the varieties Balaka (2.20 t/ha) Doel (2.04 t/ha) and Sonalika (2.03 t/ha). In 1982-83 the highest yield was observed again in the variety Balaka (1.34 t/ha). In the year 1983-84 the newly released variety Akbar yielded more (1.91 t/ha) than the rest of the varieties. The result indicated that there are several varieties that can replace Sonalika, the variety commonly used by the farmers.

b) Response of mustard to different rates of NPK and to the addition of sulphur. (Table-20)

The addition of NPK and of each element alone caused significant increase in the yield of mustard. The addition of S did not increase the yield of the crop. The maximum yield (1.42 t/ha) was obtained with the combination 80-60-30+12.5 kg/ha NPKS. The yield of the check plot (0-0-0 kg/ha NPK) was only o.63 t/ha (table-20). The difference in yields are not statistically signiiicant, but an economic evaluation indicates that the highest net benefit (Tk/ha) was obtained with the NPK combination 80-60-30+12.5 kg/ha NPKS. (Table-20).

c) Response of mustard to the application of sulphur and zinc. (Table-21)

The addition of sulphur and zn to mustard increased the yield of the crop but was not statistically significant. (Table-21).

d) Performance of mustard, chickpea and lentil as sole crops and in mixed cropping. (Table-22)

The yields per unit area of all three crops were substantially lower when they were grown in mixed cropping. Lentil yielded 0.90 t/ha as a sole crop and 0.50 t/ha when mixed cropped with mustard (Table-22). The LER (land equivalent ratio) of the mixed cropping Mustard + Chickpea is 1.3 and of the mixed cropping Mustard + Lentil is 1.14.

e) Performance of mustard, chickpea and lentil as sole crops and in mixed cropping at different seed rates. (Table-23)

Land equivalent ratio (LER) higher than 1.0 were observed when mustard was grown in mixed cropping with lentil or chickpeas (table-23). The highest yield and LER were observed when mustard and chickpeas were mixed cropped in a 50-50% seed rate (6 kg/ha mustard, 20 kg/ha chickpea). The seed rates for the sole crops were 12 kg/ha for mustard and 40 kg/ha for chickpea and lentils.

f) Performance of promising varieties of mustard. (Table-24)

Four varieties of mustard, SS-75, Tori-7, Rai-5, TS-72 were compared with the local variety Kazla. The variety SS-75 performed better than the others (Table-24). The average yields of two years for the variety SS-75 was .75 t/ha, three more than the yields of the local variety Kazla (.34 t/ha).

g) Performance of three improved varieties of rice in the late. kharif (t.aman). (Table-25)

Pajam is sometimes considered an improved local variety and has been widely adopted by farmers in the project area and by Bangladeshi farmers in general. The performance of this variety was compared with two HYV's, BR-4 and BR-11. The yields of the HYV were substantially higher than the yield of Pajam (1.30 t/ha) (Table-25).

h) Performance of local and improved varieties of rice in the early kharif (b.aus). (Table-26)

This study was conducted at the Regional Agricultural Research Station, Jessore. Three local varieties of rice, Hashikalmi, Dular and Gumbir were compared with three improved varieties. Purbachi, BR-9 and BR-8. All plots were fertilised with 80-60-40 kg/ha NPK. All P and K and 50% of the N were applied at the time of final land preparation. The rest of the N was split into two applications, 20 DAS and at panicle initiation. The yields of the three local varieties were significantly higher than the improved varieties. The yields observed for the different varieties were: Gumbir 2.50 t/ha, Dular 2.10 t/ha, Hashikalmi 1.80 t/ha, Purbachi 0.86 t/ha, BR-8 0.94 t/ha, and BR-9 0.80 t/ha (Table-26).

i) Response of potato to the application of different potash rates. (Table-27)

The maximum yield of potato (18.10 t/ha) was obtained when 120 kgs/ha potash were applied together with 120 kg/ha N and 80 kgs/ha P_2O_5. At high rates of potash application, the yield of potato decreased, even when the N and P fertilizer dose was higher (Table-27).

TABLE: 19: Performance of promising varieties of wheat, in Jessore Cropping Systems Research Site, (Component Technology Studies) 1981 - 1984.

Varieties	1981-82		1982-83	1983-84	Average
	Crop Duration	Yield (t/ha)	Yield (t/ha)	Yield (t/ha)	(t/ha)
Balaka	98	2.20	1.34 b	1.64	1.73
Pavon	104	1.59			1.59
Sonalika	92	2.03	1.22 b	1.37	1.54
Doel	98	2.04			2.04
Jupateco	101	1.84			1.84
Inia	98	1.84			1.84
BAW 18			1.40 ab		
BAW 28			1.76		
Barkat				1.76	
Akbar				1.91	
Ananda				1.72	

TABLE: 20: Response of mustard to Zinc and sulphur application (Component Technology Studies; Jessore Cropping Systems Research Site), 1981 - 1982.

Treatments N-P-K (kg/ha)	Grain Yield (t/ha)		Net Benefit (Taka)
0 - 0 - 0	0.63	N.S.*	5080
80 - 0 - 0	1.01		7423
80 - 60 - 0	1.14		8132
80-60-30	1.33		9535
80 - 60 - 30 + 12.S8	1.42		10256
120 - 60 - 30	1.34		9315
80 - 30 - 30	1.32		9642

* N.S. = No significant difference between two treatments.

TABLE: 21: Response of mustard to application of Sulphur and Zinc (Component Technology Studies at Jessore Cropping Systems Research Site), 1983 - 1984.

Treatments * Sulphur	Zinc	Grain Yield (t/ha)
30	6	.75
30	0	.74
0	6	.66
0	0	.50

* A blank application of 60-40-2- kg/ha NPK was made.

TABLE: 22: Performance of mustard, chickpea and lentil as sole crops and in mixed-cropping(Component Technology Studies; Jessore Cropping Systems Research Site, 1981 - 1982.

Treatments	Grain yield (t/ha) Crop-1	Crop-2	Total yield (t/ha)	LER
Mustard (Sole crop)	0.52	-	0.52	-
Chickpea (Sole crop)	0.78	-	0.78	-
Lentil (Sole crop)	0.94	-	0.94	-
Mustard + Chickpea	0.41	0.41	0.82	1.31
Mustard + Lentil	0.40	0.51	0.91	1.14

TABLE: 23: Performance of mustard, chickpeas and lentil in mixed-cropping at different seed rates - (Component Technology Studies; Jessore Cropping Systems Research Site, 1983 - 1984.

Treatments Seed Rates - %			Yield(tons/ha)				
Chickpea	Mustard	Lentil	Chickpea	Mustard	Lentil	Total	LER
50	50	0	.41	.43	-	.84	1.67
60	40	0	.38	.39	-	.79	1.54
40	60	0	.28	.49	-	.78	1.52
0	50	50	-	.35	.38	.73	1.20
100	0	0	.48	-	-	.48	1.0
0	100	0	-	.53	-	.53	1.0
0	0	100	-	-	.72	.72	1.0

TABLE: 24: Performance of promising varieties of mustard at Jessore Cropping Systems Research Site,(Component Technology Studies) 1981 - 1984.

Varieties	Field Duration (days)	Grain yield(tons/ha) 1981 - 1982		1983 - 1984		Average (t/ha)
SS-75	93	0.94	a	0.57	a	.75
Tori-7	77	0.44	b	0.34	c	.39
Rai -5	93	0.45	b	0.50		.47
TS -72	89	0.40	b	0.43		.41
Kazla	77	0.28	b	0.41		.34

TABLE: 25: Performance of three improved varieties of rice in the late Kharif season (Component Technology Studies), Jessore Cropping Systems Research Site, 1981 - 1982.

Varieties	Grain yield (t/ha)	
BR - 4	2.12	N.S. *
BR - 11	1.82	
Pajam	1.30	

CV 30.39

* N.S. = No significant difference.

TABLE: 26: Performance of local and improved rice varieties in the early kharif (b.aus) season. (Component Technology Studies) Jessore Cropping Systems Research Site, 1981 - 1982.

Varieties	Grain yield (t/ha)		Crop duration (days)
Gumbir	2.48	a	112
Dular	2.12	a	108
Hashikalmi	1.83	ab	104
Purbachi	0.86	b	119
BR - 8	0.94	b	135
BR - 9	0.80	b	124

CV 18.42

TABLE: 27: Response of potato to the application of different potash rates. (Component Technology Studies), Jessore Cropping Systems Research Site, 1983 - 1984.

Treatments N	- P_2O5	- K_2O	Yield (t/ha of tubers)	
120	80	80	14.22	bc
120	80	60	16.91	ab
120	80	120	18.10	a
120	80	240	16.98	ab
120	80	360	17.03	ab
120	80	480	14.16	bc
120	80	600	11.71	c
180	150	600	11.88	c

C. CROPPING PATTERN TESTING

A total of 7 cropping patterns were evaluated in Jessore (Bhagerpara) cropping systems site, during the years 1981-84. The patterns were studied in different land types. One was located in rainfed highlands, one in irrigated highlands, three in rainfed medium highlands and two in irrigated medium highlands.

RAINFED HIGHLANDS:

The highlands cover about 20% of the total area of the project. In this land type the farmers usually plant direct seeded rice (broadcast aus) and leave the land fallow after harvesting the rice until October when they plant mustard. The predominant cropping pattern grown in this land type is discussed next.

a) Rice(b.aus) - Fallow - Mustard. (Table-28)

The performance of this pattern under farmers' practices (F), and with improved agronomic practices (FI), was studied for two years. The information of the agronomic and economic performances is given in table-28. The yield of the local variety of rice Gumbir increased from 1.59 t/ha to 2.26 t/ha (42% increase) by using 60-40-20 kg/ha NPK instead of 21-6-35 kg/ha NPK, which is the mean doses used by the farmers. The mean yields of mustard were also increased from 0.26 t/ha to 0.46 t/ha by using fertilizer.

Conclusion:

In the cropping pattern Rice(b.aus) - Fallow - Mustard grown in the rainfed highlands, the yield of the local variety of rice Gumbir can be increased by 42% with the use of fertilizer (60-40-20 kg/ha NPK) and reduction of the seed rate. The yield of mustard in the rabi season can be increased, replacing the local variety Tori-7, by the improved variety SS-75.

IRRIGATED HIGHLANDS:

a) Maize - Mungbean - Mustard. (FA) (Table-29)

The cropping pattern listed above is an alternative for the rainfed highlands when irrigation can be supplied. The maize variety Sadaf was planted in the early kharif instead of rice(aus); Mungbean (var. 7706) was planted after harvesting the green cobs of maize, and mustard (var. SS-75) was grown in the rabi season. The performance of this pattern was compared with the performance of the pattern Rice(aus) Fallow - Mustard, which is grown under rainfed conditions in the same land type.

The results indicated that there is a good potential to replace the rice crop by maize in the early kharif and to add a mungbean as second crop. The gross and net returns observed in the year 1983-84 was substantially higher in the alternative pattern (Table-29) than in the farmers' cropping pattern. The results also confirmed that the yield of the variety of mustard SS-75 (0.52 t/ha) is higher than the local variety Tori-7 (0.26 t/ha).

Conclusion:

The cropping pattern Maize (var. Sadaf) - Mungbean (var. 7706) - Mustard (var. SS-75) is a promising alternative to the pattern Rice(aus, var. Gumbir) - Fallow - Mustard (var. 7706). The adoption of the alternative pattern may be limited by the marketing problems of green cobs of maize. Furthermore, the variety of mungbean is showing high susceptibility to virus deseases.

RAINFED MEDIUM HIGHLANDS:

This land type covers about 20% of the total cultivated land in the project area. Three cropping patterns were evaluated in this land type.

a) Rice(b.aus) - Rice(t.aman) - Fallow. (Table-30)

This is the predominant cropping pattern in the rainfed medium highlands of the project area. It is planted in about 70% of the area. The farmers use local varieties of rice in both early and late kharif seasons. The performance of the cropping pattern was evaluated under farmers' practices (F) and improved agronomic practices (FI). The results (Table-30) indicate that (a) the production of the local varieties of rice, Hashikalmi and Nizershail commonly planted by the farmers can be increased by the using of fertilizer (60-40-20 kg/ha NPK) and (b) the rice variety BR-4 is suitable for the late kharif season.

The mean yields of the variety Hashikalmi with improved practices, (3.15 t/ha) were 52% higher than the yields with farmers' practices (2.10 t/ha). In the year 1982-83 the yield of the rice variety BR-4 (3.12 t/ha) was 38% higher than the variety Nizershail (2.25 t/ha).

Conclusion:

The production of the cropping pattern Rice(b.aus) - Rice(t.aman) Fallow in the rainfed medium highlands of Jessore site or areas with similar agroecological conditions, can be increased by about 40%, by fertilizing the local varieties of rice Hashikalmi or Nizershail and replacing the local variety Nizershail by the variety BR-11 in the late kharif season.

b) Jute - Fallow - Mustard + Chickpea/Lentil. (F) (Table-31)

This cropping pattern is planted in about 20% of the rainfed medium lowlands of the project area. The farmers plant a local variety of jute in the early kharif, and they usually do not use fertilizer. The land is left fallow after harvesting jute and mustard. Mixed cropped of chickpea or lentils are planted in the rabi season.

The agronomic performance of this pattern under farmers (F), and improved agronomic practices (FI), is given in table-31. The yields of the improved jute varieties 0-4, or JR-0632 and of the local variety Babytossa can be increased by using the fertilizer rate 40-10-20 kg/ha NPK. The average yield of the varieties of jute under farmers' practices (F) was 2.26 tons/ha, and 3.05 t/ha under the improved agronomic practices. The increase in yield of jute with the improved practices was 35%. The mean yields of the mixed cropping also increased with the improved practices. The average yield of the local variety of mustard increased by 72% (from .11 to .38 t/ha) with the use of fertilizer. The yield of the crops grown in mixed cropping with mustard decreased slightly, possibly due to a competition for light caused by a more vigorous growth of the mustard.

Conclusion:

The production of jute and mustard in the existing cropping pattern Jute - Fallow - Mustard+Lentil/Chickpea can be considerably increased with the use of fertilizer (40-10-20 kg/ha NPK). The yield of lentil and chickpeas mixed cropped with mustard is affected when the mixed crop is fertilized. This is possibly due to a better growth of the mustard which causes a competition for light and/or soil residual moisture.

c) Rice(b.aus) - Rice(t.aman) - Chickpea. (F)
Maize - Rice(t.aman) - Chickpea. (FA) (Table-32)

The alternative cropping pattern Maize - Rice(t.aman) - Chickpea was evaluated during the year 1981-82. The maize crop failed because of the excessive rainfall shortly after germination. The chickpea was lost in the rabi season because of a low residual moisture. Since water can be retained temporarily in the medium lowlands and the maize crop is seriously affected by the excess of moisture, this pattern is not suitable for this land type. The major scope for increasing the production of the pattern lies in replacing local varieties of rice by HYV during the late kharif season.

The results of the last two years indicated that the rice varieties BR-4 and BR-11 are suitable to replace the local variety of rice in the late kharif season. The mean yield of the improved varieties (2.87 t/ha) was 60% higher than the yield of local varieties (1.79 t/ha) (Table-32). The mean yield of the local varieties planted

in the early kharif also increased from 1.79 to 2.69 t/ha with the use of fertilizer. The yield of the improved chickpea variety Sabur 4, in the last year (1.33 t/ha) was considerably higher than the mean yield of the local varieties (0.58 t/ha) observed in the years 1982-1984.

Conclusion:

There is a high potential to increase the yield of the cropping pattern Rice(b.aus) - Rice(t.aman) - Chickpea by (a) improving the management practices of the local varieties of rice in the early kharif season (b) replacing the local varieties of rice by the improved varieties BR-4 or BR-11 with improved management practices in the late kharif and (c) by replacing the local varieties of chickpea by the improved variety Sabur 4.

Maize is not a good alternative crop for the medium lowland types, since it can be affected by excessive moisture if high rainfall occurs shortly after germination.

IRRIGATED MEDIUM HIGHLANDS:

a) Rice(b.aus) - Rice(t.aman) - Potato. (Table-33)

This is a predominant cropping pattern in the irrigated medium highlands. The farmers plant local varieties of rice (generally the variety Gumbir in the early kharif, and Nizershail in the late kharif) and potato in the rabi season. In most cases they use some fertilizer in all the crops of the pattern. The production in this pattern can be increased by (a) increasing the fertilizer rates generally used by the farmers in the local rice varieties in the early kharif or late kharif (b) replacing the local varieties of rice by the improved variety BR-11 in the late kharif (c) changing the local varieties of potato by the improved variety Cardinal in the rabi season (d) increasing the fertilizer rates in the late kharif and rabi seasons. Mean yield of the local varieties of rice in the early kharif (b.aus) grown with farmers' practices was 1.58 t/ha and with improved practices 2.14 t/ha. This is an increase of 35%. In the late kharif (t.aman) the yield of the local varieties, cultivated with farmers' practices was 2.04 t/ha and with improved practices 2.38 t/ha (mean of two years). The improved variety BR-11 yielded 3.46 t/ha in the year 1983-84. The mean yield of the improved potato variety Cardinal (18.50 t/ha) grown with improved practices was 50% higher than the local varieties (12.33 t/ha).

Conclusion:

The total production of the cropping pattern Rice(b.aus, local varieties) - Rice(t.aman, local varieties) - Potato (local varieties) in the irrigated highlands of Bhagerpara or areas with similar

agroecological conditions can be increased by (a) increasing the fertilizer rates used by the farmers for the local varieties during the early kharif (b.aus), (b) changing the local varieties of rice by improved varieties and using improved agronomic practices during the late kharif (c) replacing the local variety of potato by the improved variety Cardinal using improved agronomic practices.

The increase in yields of the local varieties of rice during the late kharif, obtained by increasing the fertilizer rate used by the farmers is not significant (16%). (The experience indicates that the farmers do not change their practices if they do not get 30% or more increase in yield by adopting a given technology).

b) Rice(b.aus) - Rice(t.aman) - Wheat. (F) (Table-34)

This is an existing cropping pattern in the area. The farmers plant local variety of rice (Gumbir) in the early kharif. Some of them have adopted the rice variety BR-4 for the late kharif and the wheat variety Balaka for the rabi season. The performance of this pattern cultivated with farmers' practices (F) and with improved practices (FI) was evaluated in the year 1982-84. The performance of the cropping pattern with local varieties of rice in both early and kharif season and farmers' practices, was compared with the performance of the same pattern using the rice variety BR-11 and the recently released wheat variety Kanchan. The results of the year 1982-83 indicated that with fertilizer, in the early kharif the yield of the local rice variety Gumbir increased from 1.87 t/ha (without fertilizer) to 2.39 t/ha (with 60-40-20 kg/ha NPK). The yield of the variety BR-11 (2.39 t/ha) was 37% higher than the yield of the variety BR-4 (1.74 t/ha in the late kharif. The yield of wheat increased from 0.41 t/ha to 1.13 t/ha with the use of improved practices. This is an increase of 175%. In the year 1983-84, the mean yield of the local rice variety increased 50% (from 1.28 t/ha to 1.93 t/ha) by adjusting the fertilizer rate used by the farmers in the early kharif. The yield of the variety BR-11 (3.22 t/ha) was 33% higher than the yield of the local variety (2.42 t/ha). The yield of the wheat variety Kanchan (1.77 t/ha) cultivated with improved practices was 39% higher than the yield of the variety Sonalika (1.27 t/ha) cultivated with farmers' practices.

Conclusion:

There is a good scope for increasing the production of the cropping pattern Rice(b.aus) - Rice(t.aman) - Wheat in the rainfed medium highlands of Bhagerpara by (a) increasin- the fertilizer rate used by farmers in the local rice varieties during the early kharif (b.aus), (b) replacing the local varieties of rice and the improved variety BR-4, by the variety BR-11 and using improved practices and (c) replacing the variety of wheat Sonalika by the variety Kanchan.

TABLE: 28: Agronomic and Economic performances of an existing cropping pattern evaluated under farmers' practices (F) and improved (FI) agronomic technology. Jessore Cropping Systems Research Site, 1981 - 1983.

INFORMATION							
Land Type		Rainfed Highland					
Cropping Pattern		(F) Rice (b.aus) - Fallow - Mustard			(FI) Rice (b.aus) - Fallow - Mustard		
Year		1981 - 1982	1982 - 1983	Mean	1981 - 1982	1982 - 1983	Mean
Varieties	C1	Local(Gumbir)	Local (Gumbir)		Local(Gumbir)	Local(Gumbir)	
	C2						
	C3	Tori 7	Tori 7		SS 75	SS 75	
Planting Date (Range)	C1		April-18-May-18			April-20-May-20	
	C2						
	C3		October 25-31			October 25-31	
Seed Rate(kg/ha)	C1	180	100	140	100	100	100
	C2						
	C3	12	12	12	12	12	12
NPK (kg/ha)	C1	42 - 0 - 0	0 - 13 - 7	21 - 6 - 35	60 - 40 - 20	60 - 40 - 20	60 - 40 - 20
	C2						
	C3	0 - 0 - 0	0 - 0 - 0	0 - 0 - 0	50 - 60 - 30	60 - 60 - 30	55 - 60 - 30
Field duration (days)	C1		111	111		111	111
	C2						
	C3	92	87	92	82	105	88
Yield (t/ha)	C1	2.10	1.08	1.59	2.66	1.87	2.26
	C2						
	C3	0.28	0.24	0.26	0.40	0.52	0.46
Yield(kg/ha/day)	C1		9.7			16.8	
	C2						
	C3		2.8			4.9	
Cost of cultivation (Tk/ha)	C1						
	C2						
	C3						
Gross return (Tk/ha)	C1		3,969			6,872	
	C2						
	C3		1,959			4,236	
Net return (Tk/ha)	C1		530			3,194	
	C2						
	C3		625			1,724	
Benefit cost ratio	C1		1.14			1.87	
	C2						
	C3		1.47			1.69	

TABLE; 29: Agronomic and Economic performances of an existing cropping pattern(F) in highland rainfed landtypes and of alternative cropping pattern(FA) for highlands when irrigation is available.
Jessore Cropping Systems Research Site, BARI, 1981 - 1983.

INFORMATION							
Land Type		Rainfed Highland			Irrigated Highland		
Cropping Pattern		F) Rice (B.Aus) - Fallow - Mustard.			FA) Maize - Mungbean - Mustard.		
Year		1981 - 1982	1982 - 1983	Mean	1981 - 1982	1982 - 1983	Mean
Varieties	C1	Local(Gumbir)	Local(gumbir)		Sadaf	Sadaf	
	C2				7706	7706	
	C3	Tori - 7	Tori - 7		SS-75	SS-75	
Planting Dates (Range)	C1		April-18,May-18		April-22,May-13	February - 28	
	C2				Aug-17,Sept-9	June - 22	
	C3		October 25 - 31		October 25-31	November 4-18	
Seed Rate(kg/ha)	C1	180	100	140	30	30	30
	C2				30	30	30
	C3	12	12	12	12	12	12
NPK (kg/ha)	C1	42 - 0 - 0	0 - 13 - 7	21 - 6 - 35	100 - 60 - 40	100 - 60 - 40	100 - 60 - 40
	C2				30 - 30 - 20	30 - 30 - 20	30 - 30 - 20
	C3	0 - 0 - 0	0 - 0 - 0	0 - 0 - 0	80 - 60 - 30	60 - 60 - 30	80 - 60 - 30
Field duration (days)	C1		111	111	80	94	87
	C2				66	67	66
	C3	92	87	92	97	98	97
Yield (t/ha)	C1	2.10	1.08	1.59	38,777 g.cobs	54,222 g.cobs	46,500
	C2				0.76	0.75	0.75
	C3	0.28	0.24	0.26	0.47	0.57	0.52
Yield(kg/ha/day)	C1		9.7		485 g.cobs	577 g.cobs	500
	C2				11.51	11.20	11.35
	C3		2.8		4.24	5.80	5.02
Cost of cultivation (Tk/ha)	C1				2,518	3,540	
	C2				1,991	3,030	
	C3				2,940	4,073	
Gross return(Tk/ha)	C1		3,969		15,511	17,136	
	C2				6,626	6,428	
	C3		1,959		3,859	7,954	
Net return(Tk/ha)	C1		5,30		12,993	23,596	
	C2				4,635	3,398	
	C3		6,25		919	3,881	
Benefit cost ratio	C1		1.14		6.16	7.67	
	C2				3.32	2.12	
	C3		1.47		1.31	1.95	

TABLE: 30: Agronomic and Economic performances of existing cropping patterns evaluated under farmers(F) and improved (FI) agronomic practices. Jessore Cropping Systems Research Site, BARI, 1981 - 1983.

INFORMATION							
Land Type		Rainfed Medium Highlands					
Cropping Pattern		F) Rice(b.aus) - Rice(t.aman) - Fallow			FI) Rice(b.aus) - Rice(t.aman) - Fallow		
Year		1981 - 1982	1982 - 1983	Mean	1981 - 1982	1982 - 1983	Mean
Varieties	C1	Hashikalmi	Hashikalmi		Hashikalmi	Hashikalmi	
	C2	Nizershail	Nizershail		Nizershail	BR-4	
	C3						
Planting Dates (Range)	C1		April 23-26			April 22-26	
	C2		August 7-10			August 5-10	
	C3						
Seed Rate(kg/ha)	C1	120	100		100	100	
	C2	92	67		50	50	
	C3						
NPK (kg/ha)	C1	23 - 21 - 3	0 - 0 - 0		60 - 40 - 20	60 - 40 - 20	
	C2	25 - 0 - 0	30 - 9 - 6		60 - 40 - 20	80 - 60 - 40	
	C3						
Field duration (days)	C1		101		95	101	
	C2		113		130	103	
	C3						
Yield (t/ha)	C1	1.88	2.31	2.10	2.82	3.48	
	C2	1.30	2.25	1.78	1.94	3.12	
	C3						
Yield (kg/ha/day)	C1		22.87			34.48	
	C2		19.91			30.29	
	C3						
Cost of cultivation (Tk/ha)	C1						
	C2						
	C3						
Gross return (Tk/ha)	C1		8,346			12,573	
	C2		8,733			12,109	
	C3						
Net return(Tk/ha)	C1		4,074			8,842	
	C2		5,940			9,023	
	C3						
Benefit cost ratio	C1						
	C2						
	C3						

TABLE: 31: Agronomic and Economic performances of existing cropping pattern farmers (F) and improved (FI) agronomic practices. Jessore Cropping Systems Research Site, BARI, 1981 - 1984.

INFORMATION							
Land Type		Rainfed Medium Highlands					
Cropping Pattern		F) Jute - Fallow - Mustard + Chickpea or Lentil.			FI) Jute - Fallow - Mustard + Chickpea or Lentil.		
Year		1981 - 1982	1982 - 1983	1983 - 1984	1981 - 1982	1982 - 1983	1983 - 1984
Varieties	C1	Local	0-4	JR-0632	(Babytossa)	JR-0632	0-4/JR-0632
	C2						
	C3	Local+Local **	Local+Local *	Local+Local **	Local	Local+Local *	Local+Local **
Planting Dates (Range)	C1		April 23-30	April-30,May-1		April 23-30	April-30,May-1
	C2						
	C3		November 1-7	November 10-20		November 1-7	November 10-19
Seed Rate(kg/ha)	C1	8	9	7.5	8	8	7.5
	C2						
	C3	8+20	12+14	8.5+21	7+22	12+14	8.5+25
NPK (kg/ha)	C1	0 - 0 - 0	12 - 16 - 0	10 - 6 - 10	40 - 10 - 20	40 - 10 - 20	40 - 10 - 20
	C2						
	C3	0 - 98 - 0			30 - 60 - 30	30 - 60 - 30	30 - 60 - 30
Field duration (days)	C1		129	128	128	129	125
	C2						
	C3		74+142	80+116	83	74+142	76+109
Yield (t/ha)	C1	2.68	2.29	1.81	3.05 ✓	3.86	2.24
	C2						
	C3	0.30 + 0.38	.20 + .83	0.15 + 0.38	0.48 + 0.54	.42 + .43	0.25 + 0.43
Yield(kg/ha/day)	C1		17.75	14.5		29.9	17.9
	C2						
	C3		2.75 + 5.87	1.9 + 3.3		5.6 + 3.1	3.29 + 3.94
Cost of cultivation (Tk/ha)	C1						
	C2						
	C3						
Gross return (Tk/ha)	C1		5,599	10,660		14,478	13,993
	C2						
	C3		6,435	4,469		5,723	6,162
Net return(Tk/ha)	C1		2,384	7,434		9,437	10,214
	C2						
	C3		4,516	2,812		3,467	3,817
Benefit cost ratio	C1		1.74	3.30		2.87	3.70
	C2						
	C3		3.35	2.70		3.54	2.63

* Mustard + Chickpea
** Mustard + Lentil.

TABLE: 32: Agronomic and Economic performances of an existing cropping pattern(F) alternative cropping pattern(FA) and the existing cropping pattern with improved agronomic technologies (FI). Jessore Cropping Systems Research Site, B A R I, 1981 - 1984.

INFORMATION									
Land Type		Rainfed Medium Highlands							
Cropping Pattern		F) Rice (b.aus) - Rice (t.aman) - Chickpea				FA) Maize - Rice(t.aman) - Chickpea FI) Rice(b.aus) - Rice(t.aman) - Chickpea			
Year		1981-1982	1982-1983	1983-1984	Mean	1981-1982	1982-1983	1983-1984	Mean **
Varieties	C1		Hasa (L)	Local		Sadaf *	Hasa (L)	Local	
	C2		Local	Kartikshail		BR-11	BR-4	BR-11	
	C3		Local	Local		Local	Local	Sabur-4	
Planting Dates (Range)	C1		April 21-23	April30May9			April 21-23	April30May9	
	C2		August 6-10	Aug.10Sept5			August 6-10	Aug.10Sept.5	
	C3		Nov. 23-30	December-3			Nov. 23-30	December-3	
Seed Rate(kg/ha)	C1		100	100	100	20 *	100.	100	100
	C2		50	50	50	50	50	50	50
	C3		50	40	45	30	40	40	40
NPK (kg/ha)	C1		20 - 6 - 20	23-20-0	21-13-10	100-60-40	60-40-20	60-40-20	60-40-20
	C2		33 -16 - 5	24-5 -0	28-10-3	80-60-40	80-60-40	80-60-40	80-60-40
	C3		0 - 0 - 0	0 - 0 - 0	0 - 0 - 0	20-30-20	20-50-20	15- 0- 0	17-25-10
Field duration (days)	C1		103	104	103	Lost	103	103	103
	C2		105	101	103	131	105	130	117
	C3		126	124	125	Lost	126	124	125
Yield (t/ha)	C1		2.29	1.30	1.79		3.41	1.98	2.69
	C2		2.06	2.55	2.30	2.31	2.47	3.27	2.87
	C3		0.33	0.83	0.58	Lost	0.32	1.33	0.82
Yield (kg/ha/day)	C1		21.8	12.5	17.1	-	32.5	19.2	25.8
	C2		20.0	25.2	22.7	-	24.0	25.0	24.5
	C3		2.6	6.7	4.6	-	2.6	10.7	6.6
Cost of Cultivation (Tk/ha)	C1		4,113						
	C2		2,591						
	C3		1,804						
Gross return(Tk/ha)	C1		8,288	5,054			12,341	7,813	
	C2		8,921	11,803			10,696	14,865	
	C3		1,868	5,134			1,839	8,216	
Net return(Tk.ha)	C1		4,175				8,198		
	C2		6,330				650		
	C3		84				760		
Benefit cost ratio	C1			1.63				1.68	
	C2			4.96				3.93	
	C3			4.55				5.57	

* Maize
** For years 1982-1984 only.

TABLE: 33: Agronomic and Economic performances of an existing cropping pattern evaluated with farmers'(F) and improved (FI) agronomic practices. Jessore Cropping Systems Research Site, BARI, 1981-1984.

INFORMATION									
Land Type		Irrigated Medium Highlands							
Cropping Pattern		F) Rice(b.aus) - Rice(t.aman) - Potato				FI) Rice(b.aus) - Rice(t.aman) - Potato			
Year		1981-1982	1982-1983	1983-1984	Mean	1981-1982	1982-1983	1983-1984	Mean
Varieties	C1	Local	Gumbir	Local		Local	Gumbir	Local	
	C2	Local	Local	Local		Local	Local	BR-11	
	C3	Local	Local	Local		Cardinal	Cardinal	Cardinal	
Planting Dates (Range)	C1		April 14-20	March 24-31			April 16-20	March 23-31	
	C2		August 7-17	Jlu-25Aug-4			August 7-17	Jul-25Aug-4	
	C3		Dec. 20-31	Dec. 2-20			Dec. 20-31	Dec. 14-18	
Seed Rate(kg/ha)	C1	180	160	147	162	100	160	100	120
	C2	90	170	50	103	50	50	50	50
	C3	1900	1800	1500	1733	1500	1800	1500	1600
NPK (kg/ha)	C1	11-8-0	0-0-0	33-15-13	14-7-4	60-40-20	60-40-20	60-40-20	60-40-20
	C2	33-14-6	25-0-0	44-26-6	34-13-4	60-40-20	60-40-20	80-60-40	66-46-26
	C3	76-69-64	54-61-68	72-82-57	67-71-63	120-100-120	120-100-120	120-80-120	120-90-120
Field duration (days)	C1		104	115	109		104	115	109
	C2		98	113	105		98	110	104
	C3		90	90	90		90	93	91
Yield (t/ha)	C1	1.85	1.68	1.21	1.58	2.48	2.22	1.73	2.14
	C2	2.05	1.63	2.44	2.04	2.51	2.26	3.46	2.74
	C3	10.75	11.40	12.73	11.60	12.33	22.60	20.67	18.50
Yield(kg/ha/day)	C1		16.1	10.5	13.3		20.3	15.0	17.6
	C2		16.6	21.6	19.1		23.0	31.0	27.0
	C3		126.3	141.4	133.8		251.1	222	236
Cost of cultivation (Tk/ha)	C1								
	C2								
	C3								
Gross return(Tk/ha)	C1		6,071	5,568			8,022	7,825	
	C2		7,140	11,175			9,900	15,541	
	C3		15,364	30,679			30,579	49,814	
Net return(Tk/ha)	C1		3,165	2,528			4,208	4,353	
	C2		4,102	7,539			6,802	10,482	
	C3		6,649	14,756			21,692	32,823	
Benefit cost ratio	C1		2.40	1.83			2.10	2.25	
	C2		2.68	3.07			2.68	3.07	
	C3		3.33	1.93			3.44	2.93	

TABLE: 34: Agronomic and Economic performances of an existing cropping pattern evaluated with farmers' (F) and improved (FI) agronomic practices.
Jessore Cropping Systems Research Site, BARI, 1981 - 1984.

INFORMATION									
Land Type		Irrigated Medium Highlands							
Cropping Pattern		F) Rice(b.aus) - Rice(t.aman) - Wheat				FI) Rice(b.aus) - Rice(t.aman) - Wheat			
Year		1981-1982	1982-1983	1983-1984	Mean	1981-1982	1982-1983	1983-1984	Mean
Varieties	C1		Gumbir(L)	Local			Gumbir	Local	
	C2		BR - 4	Sonálika			BR - 11	BR - 11	
	C3		Balaka	Sonalika			Balaka	Kanchan	
Planting Dates (Range)	C1		April 20-24	Mar.27May10			April 20-27	Mar.27-May1	
	C2		August 17	Jul25-Sep25			August 17	May26-Aug27	
	C3		Nov.24-30	Nov17-Dec31			Dec.25-31	December12-31	
Seed Rate(kg/ha)	C1		100	163	131		100	100	100
	C2		50	50	50		50	50	50
	C3		120	158	149		120	120	120
NPK (kg/ha)	C1		0-0-0	34-0-0	17-0-0		60-40-20	60-40-20	60-40-20
	C2		48-10-0	55-36-19	51-23-9		80-60-40	80-40-40	80-50-40
	C3		0-14-3	24-25-5	12-19-4		80-60-40	80-40-40	80-50-40
Field duration (days)	C1		107	106	106		107	106	106
	C2		106	105	105		106	102	104
	C3		114	100	107		114	102	108
Yield (t/ha)	C1		1.87	1.28	1.57		2.39	1.93	2.16
	C2		1.74	2.42	2.08		2.39	3.22	2.80
	C3		0.41	1.25	0.83		1.13	1.77	1.45
Yield (kg/ha/day)	C1		18	12	15		22	18	20
	C2		16	23	19		22	31	26
	C3		4	12	8		10	17	13
Cost of cultivation (Tk/ha)	C1		3,040	3,252			4,275	4,477	
	C2		2,701	4,803			3,887	4,658	
	C3		2,823	4,594			3,828	5,453	
Gross return (Tk/ha)	C1		8,142	5,077			10,692	7,682	
	C2		7,633	10,338			10,540	13,795	
	C3		1,855	5,776			5,075	7,960	
Net return(Tk/ha)	C1		5,102	1,825			6,687	3,205	
	C2		4,932	5,535			6,523	9,137	
	C3		958	1,182			1,240	2,507	
Benefit cost ratio	C1		2.68	1.56			2.67	1.72	
	C2		0.66	1.26			1.32	1.46	

BANGLADESH AGRICULTURAL UNIVERSITY

TRISHAL THANA SITE

A. BENCHMARK SURVEY - SITE DESCRIPTION

a) Location:

The project area includes eight villages of Trishal Thana, Mymensingh District. The area is situated by the side of Mymensingh Trishal road about 8 to 13 kilometers from the Bangladesh Agricultural University.

b) Social Infrastructure:

The total population of the project area is 14,988 of whom 36% are working males and 24% working females. Children under 10 years of age represent 33% of the total population. Effective family labour is 1.68 persons per farms. Family size varies from village to village from 6.3 to 9.3 persons per family. The average family size is 7.73. Average literacy rate is 41%.

c) Farm Size and Tenancy:

Farmers are categorised as: a) landless, with less than 0.2 ha (12%), b) small farmers, with 0.2 to 0.6 ha (30%), c) medium farmers with 0.6 to 1.20 ha (27%) and d) large farmers with more than 1.20 ha (31%).

In the project area 87% of the farmers cultivate their own land, 35% of the farmers lease in land and 19% lease out their land. The average cultivated land per farm is 1.07 ha, the highest being 5.6 ha. The average number of plots per farm is 7.88.

d) Agroclimatic Conditions:

Rainfall:

The average rainfall in the project area is 2230mm per year. The lowest rainfall occurs in January (11.6mm) and the highest in July (399.8mm). There is a dry period from November to March (11.6 - 46.5mm) and a wet period from April to October (1720 to 3990mm).

Temperature:

The temperature of the project area varies from 11.6°C to 35°C. The cold season is from November to March (minimum temperature 18.2°C) and the hot season from April to September. The maximum temperature occurs in April (33.8°C). Mean annual minimum is 20.5°C.

Evapotranspiration:

The total year mean evapotranspiration is 1.109mm, most of which from March to May.

Soils:

The soils in the project villages are non-calcareous dark grey flood plain soils falling under the old, Brahmaputra flood plain physiographic unit. Soils are medium to strongly acid when dry, but neutral in reduced conditions. Top soil is often lighter than sub-soils. The texture is closely related to relief position. Ridge soils are commonly silty loams or silty clay loams. Basin soils are silty clay loam or silty clay.

e) Land Types:

Flood free highlands, rainfed and tubewell irrigated bunded plots.

f) Cropping Patterns:

The predominant in the irrigated area:

Rice (t.aus) - Rice (t.aman) - Rice (boro)
Rice (t.aus) - Rice (t.aman) - Fallow.

In the rainfed area the main existing cropping patterns are:

Jute - Rice (t.aman) - Fallow
Rice (t.aus) - Rice (t.aman) - Fallow
Rice (t.aus) - Rice (t.aman) - Wheat
Jute - Rice (t.aman) - Vegetables or Pulses

g) Labour Supply:

The effective family labour in the area varies between 1.23 and 2.43. On average it is 1.68 per farm. The hired permanent labour is 0.36/farm.

h) Livestock:

In the project area 80% of the farms have bullocks for draught power. The average number is 1.5 per farm. The number of milk cows and young stock is 0.6 and 1.2 per farm respectively.

i) Input Use and Source:

In the project area, 80% of the farms use modern seeds but the total cropped area with improved seed is still small. About 98% of the farmers use chemical fertiliser and in some villages all farmers use this input but at lower rates than those recommended.

Approximately 41% and 51% of the farmers use only urea for rice in the aus and t.aman seasons respectively. Only 16% of the farmers use urea and triple superphosphate in both aus and aman rice. About 36% of the farmers use urea., Triple superphosphate and muriate of potash for aus rice and about 22% use all three fertilisers for t.aman rice.

About 65% of the farmers used insecticides to protect their crops, but timing and dosages seem to be inappropriate.

There are four deep tubewells in the project area, one in each of four villages. About 27% of the farms use irrigation water. The total command area associated with all the wells is 100 ha.

Credit is used by approximately 55% of the farms. Credit sources are relatives, friends, the Bangladesh Krishi Bank, Cooperatives IRDP, moneylenders, landlords and others.

j) Major crops in the project area are rice, jute and wheat. Other crops grown are pulses, mustard, potato, chillies and various kinds of vegetables. Jute is second in importance to rice in the production area. Farmers use modern varieties of rice and wheat, but the total cropped area is small compared to that planted to local varieties. The yields per unit area are low.

k) Constraints to Crop Production:

Low productivity is mainly due to poor management in respect to variety selection, planting methods, plant population, fertilisation, weeding, soil and water management, pest control. These constraints are of course common to most agricultural areas of Bangladesh.

B. COMPONENT TECHNOLOGY STUDIES

Most of the component technology studies in the Cropping Systems Research site operated by BAU were carried out in the year 1981-82. A few studies were carried out in 1982-83, different to the ones established in the first year. The results are discussed below:

a) Rice:

The evaluation of some rice varieties during the late kharif season in 1981 showed no significant difference in yields although the variety BR-11 yielded higher than the varieties BR-10, BR-11 and Nizershail (Table-35). The yield of BR-4 was the lowest due to late transplanting. Field duration was shortest in the farmers' variety. Nizershail also had a short field duration. From the agronomic point of view BR-11 has the potential as a late transplanted crop in the system.

In the boro season, Purbachi had the shortest field duration (Table-36). Purbachi, IR-8, BR-3, BR-9 and BAU-63 did not vary significantly either in grain or straw yield (Table-36). Farmers prefer Purbachi to other varieties because it has the shortest field duration.

The aus rice BR-1, BR-3 and BR-9 gave significantly higher grain and straw yields than BR-6 and Purbachi (Table-37). The latter two varieties had shorter field duration. The variety BR-9 matured 10 days earlier than BR-3.

In the rainfed area at Uzan Boilor, varieties BR-1, BR-3, BR-6, BR-9 and Purbachi were tried as direct seeded line sown aus crops (Table-38). Results indicate that varieties did not differ significantly in yield. Field duration was highest in BR-3, followed by BR-9. Performance of Purbachi as a short duration variety was excellent. The varieties BR-3 and BR-9 had a longer field duration. Overall performance of all varieties was good since the crops received a sufficient supply of rain water.

b) Wheat:

This was a relatively new crop for the rainfed area and had good potential. Wheat was not cultivated in the irrigated area. A plan to introduce this crop in the irrigated area was not successfull because of farmers' preference for rice (boro).

Varieties Sonalika, Balaka and Inia-66 were planted under rainfed conditions after Pajam rice was harvested. Planting was delayed due to heavy rainfall on 10 December, 1981. Overall performance of the varieties was not as good as expected due to late planting and absence of rainfall during the vegetative period. Balaka gave the highest yield, followed by Sonalika (Table-39). Balaka seems to be superior to the other varieties. In 1982-83 the same varieties and 2 additional ones were planted with normal land preparation. The yields doubled more than the ones observed in the first year.

c) Mustard:

Farmers grow mustard on a very limited scale becuase most of the land is occupied by t.aman rice in October when mustard must be planted.

The varieties TS-72, M-12, Rai-5, SS-75 and local farmers' variety were tested in the rainfed area after Pajam rice was harvested. The performance of the crop was very poor due to late sowing and heavy rainfall on 10 December, 1981. The varieties did not differ in respect to grain yield, except in the farmers' variety (Table-40).

d) Jute:

Varieties D-154, CVE-3, CVL-1 and CC-45 were grown on the BAU farm. They did not differ significantly in yields of fibre but did in stick (Table-41). The highest yield of fibre was observed in D-154 and of stick in CVE-3. In 1982-83, the performance of these jute varieties were similar. The improved varieties yielded significantly higher than the local variety.

e) Fertilizer:

BAU's Benchmark Survey revealed that the main constraint on fertilizer use is lack of cash. In order to determine the maximum yield obtainable with low levels of fertilizer, some N, P and K trials were established. Experiments were also conducted in farmers' fields and the BAU farm to observe the response of rice to applications of zinc and sulphur.

Fertilizer doses in rice (BR-1 aus), at the rate of 45-35-45 kg/ha NPK, gave similar yields to those obtained with higher fertilizer rates (Table-42). The addition of K had no significant effect on the yield at the higher rates of NP.

The response of rice, (BR-4 t.aman) to different levels of fertilizer in the irrigated area was not statistically significant, but the maximum yield was obtained at highest NPK application (Table-43).

The results discussed above indicate that in the early kharif season, when water can be a limiting factor for the rice crop, the application of 45-35-45 kg/ha NPK produced better economic results since the value of the fertilizer will be less and the yields will be similar to the ones obtained with higher fertilizer rates. In the late kharif, when there is generally enough water for good crop development, higher dosages of NPK produced maximum yields. The difference in the varieties used (BR-1 in early kharif, BR-4 in late kharif) also explain the differences in the response to fertilizer.

f) Zinc and Sulphur trials in rice:

Zinc fertilizer experiments in rice, aus variety BR-1, indicated that zinc had a significant effect on the yield of rice when applied at rates of 8 kg/ha (Table-44). Increasing the rate from eight to

12 kg/ha did not produce any significant increase in yield. It is therefore suggested to apply 8 kg/ha Zn for maximum return under irrigated conditions.

Two trials at the BAU farm on zinc and sulphur fertilizers revealed that under submerged and moist conditions, application of zinc and sulphur significantly increased the yield of BR-4 rice (Table-45,46). Application of zinc and sulphur fertilizer in combination did not increase the yields significantly.

Similar experiments to those discussed above were carried out in the irrigated area of the CSRS Kanhar, on aman and boro rice (Table-47,48). Zinc oxide (Zn^{o}) was excluded from the experiments. The results indicate that application of zinc or sulphur was not necessary at the project area.

g) Spacing and age of seedling in rice:

Two separate experiments were conducted to study the effect of row to row distance of transplanted aman and boro rice (Table-49,50). In both experiments 25 cm x 12 cm and 20 cm x 12 cm spacing gave the highest yield. But in the case of transplanted aman, the farmers' method of transplanting at random gave similar yields to the spacing mentioned above.

In transplanted aman rice age of seedling and the number of seedlings per hill are two important factors influencing field duration and the crop yield. A study was conducted at the BAU farm with 40-day-old, 60-day-old and 80-day-old seedlings and 2, 4 and 8 seedlings per hill, on BR-4 rice. The crop was transplanted late. It was found that the age of the seedlings did not have a significant effect on grain yield. The field duration of the crop decreased with increasing age of seedling.

Eight-day-old seedlings matured 21 and 11 days earlier than 40-day-old and 60-day-old seedlings respectively. Two seedlings per hill gave the highest yield (Tables-51,52).

In 1982-83, three different ages of seedling 35,55, and 75 days were tested and the yield of rice compared. There was no significant difference in yields among the different ages of seedling (Table-51). When 75-day -old seedlings were utilized, the rice matured one week earlier than when the seedlings were 35 or 55 days old.

i) Land preparation:

The yield of rice was observed with three different land preparation methods; no ploughing transplanting rice (t.aman) after harvesting rice (aus); transplanting after one ploughing and transplanting after three ploughings and one laddering. The highest yield (5.12 t/ha) was observed when the land was ploughed three times and laddered once (Table-53).

j) Relay Cropping:

The yield of gram as a relayed crop in rice (t.aman) fields one week before harvesting was similar to the yield when it was planted one week after harvesting rice (without land preparation) or when planted after normal land preparation (Table-54). The yield of gram did not differ significantly when it was relayed at seed rates of 30, 35, 40 or 45 kgs/ha.

TABLE: 35: Agronomic performance of some varieties of rice in late kharif season (aman) at BAU CSRS, Trishal Thana Irrigated Area Kanhar, 1981 - 1982.

Varieties	Yield (t/ha)		Field duration (days)
	Grain	Straw	
BR - 4	2.31 c	2.83 c	115
BR - 10	3.25 ab	4.17 a	100
BR - 11	4.49 a	4.32 a	110
Pajam	2.57 bc	3.47 b	103
Nizershail	2.95 ab	3.88 ab	96
Farmers' variety	2.69 bc	3.56 b	88

TECHNOLOGY:

1. Replications - 5
2. Plant Spacing - 25cm x 12cm
3. Fertilizer - 85-55-45 (N, P_2O_5, K_2O kg/ha)
4. Age of seedlings - 35 days
5. Irrigation - one at panicle initiation
6. Plant protection - one application of Diazinon @1.5 kg/ha
7. Weedings - 2 handweedings
8. Date of transplanting - 18. 8. 1981

TABLE: 36: Agronomic performance of some rice varieties in the winter season (boro) at BAU CSRS, Irrigated Area Kanhar, 1981.

Varieties	Yield(t/ha)	
	Grain	Straw
Purbachi	2.99	8.58
IR - 8	3.03	6.77
BR - 3	3.20	7.46
BR - 9	2.93	7.24
BAU - 63	3.68	9.14

TECHNOLOGY:

1. Spacing - 25cm x 12cm
2. Fertilizer - 105-8-45 (N, P_2O_5, K_2O kg/ha)
3. Age of seedling - 35 days
4. Water Management - constant 2-5cm water depth
   Water supply stopped at later stage of growth (3 weeks before harvesting
5. Plant protection - 2 applications Diazinon @1.5 kg/ha
6. Interculture operation - 2 handweedlings
7. Date of transplanting - 27. 2. 1982
8. Replications - 5

TABLE: 37: Agronomic performance of some rice varieties during the early kharif (aus) at BAU CSRS, Irrigated Area Kanhar, 1982.

Varieties	Yield(t/ha)		Field duration (days)
	Grain	Straw	
BR - 1	3.36 a	4.52	95
BR - 3	3.91 a	5.09	103
BR - 6	2.97 b	3.46	80
BR - 9	3.83 b	4.76	93
Purbachi	2.94 b	3.37	78

TECHNOLOGY:

1. Spacing - 25cm x 12cm
2. Fertilizer - 85-55-45 (N, P_2O_5, K_2O kg/ha)
3. Age of seedlings - 45 days
4. Water Management - rainfed bunded plots
5. Plant protection - 1 spray with Diazinon @1.5 kg/ha
6. Interculture operation - 2 handweedings
7. Date of transplanting - 15. 5. 1982
8. Replications - 5

TABLE: 38: Agronomic performance of some rice varieties (aus during the early kharif season at BAU CSRS, Rainfed Area Uzan Boilor, 1982.

Varieties	Yield(t/ha)		Field duration (days)
	Grain	Straw	
BR - 1	4.55	4.86	120
BR - 3	4.67	5.56	133
BR - 6	4.09	4.43	105
BR - 9	4.73	4.95	120
Purbachi	4.59	4.81	104

TECHNOLOGY:

1. Spacing - 25cm row to row, direct seeded
2. Fertilizer - 85-55-46 (N, P_2O_5, K_2O kg/ha)
3. Water Management - rainfed bunded plots
4. Plant protection - 2 applications (sprayers) Diazinon @ 1.5 kg/ha
5. Interculture operation - 3 handweedings
6. Date of transplanting - 19. 4. 1982
7. Replications - 5

TABLE: 39: Agronomic performance of some promising varieties of wheat at BAU CSRS, Rainfed Area Uzan Boilor, 1981 - 1983.

Varieties	Year 1981-1982 Field duration	Year 1981-1982 Yield(t/ha)	Year 1982-1983 Yield(t/ha)
Sonalika	92	1.56 b	3.40
Balaka	97	1.68 a	3.40
Inia - 66	95	1.46 c	3.57
Pavon			3.22
Tanon			3.71

TECHNOLOGY:

1. Spacing - 20cm x 7cm
2. Fertilizer - 105-70-45 (N, P_2O_5, K_2O kg/ha)
3. Water Management - rainfed (residual soil moisture)
4. Plant protection - 1 spray Malathion
5. Interculture operation - 1 handweeding
6. Date of sowing - 19. 12. 1982
7. Replications - 5

TABLE: 40: Agronomic performance of some improved varieties of mustard at BAU CSRS, Rainfed Area Uzan Boilor, 1981 - 1982.

Varieties	Grain Yield (t/ha)	Field duration (days)
TS - 72	4.52 a	80
M - 12	4.47 a	87
Rai - 5	4.60 a	85
SS - 75	4.50 a	93
Farmers' variety	3.25 b	80

TECHNOLOGY:

1. Spacing - 20cm x 5cm
2. Fertilizer - 85-60-45 (N, P_2O_5, K_2O kg/ha)
3. Water Management - residual soil moisture
4. Plant protection - 2 sprays with Malathion
5. Interculture operation - 1 handweeding
6. Date of transplanting - 20. 11. 1981
7. Replications - 5

TABLE: 41: Agronomic performance of some jute varieties at BAU Experimental Farm, 1982.

Varieties	Yield(t/ha)			
	1981-1982		1981-1982	
	Fibre	Stick	Fibre	Stick
D - 154	2.76	4.86 b	2.10 a	4.20 a
CVE - 3	2.32	6.24 a	2.80 a	5.80 a
CVL - 1	2.58	4.78 b	2.60 a	5.30 a
CC - 45	2.52	4.98 b		
Local			1.30 b	2.60 b

TECHNOLOGY:

1. Spacing - 22cm x 7cm
2. Fertilizer - 50-13-20 (N, P_2O_5, K_2O kg/ha)
3. Plant protection - 1 spray
4. Interculture operation - 2 handweedlings
5. Date of sowing - 24. 4. 1982
6. Replications - 5

TABLE: 42: Agronomic performance of rice (aus), variety BR-1 at different NPK levels at BAU CSRS, Irrigated Area Kanhar, 1982.

Treatment N	P	K (kg/ha)	Yields (t/ha) Grain	Straw
45	35	0	3.92 b	4.74
45	35	45	4.17 a	4.86
65	45	0	4.10 a	4.83
65	45	45	4.18 a	4.98
85	70	0	4.12 a	4.97
85	70	45	4.13 a	4.94

TECHNOLOGY:

1. Spacing - 25cm x 12cm
2. Fertilizer - as per treatment
3. Age of seedlings - 45 days
4. Water Management - rainfed
5. Plant protection - 1 spray with Diazinon @ 1.5 kg/ha
6. Interculture operation - handweedings
7. Replications - 5

TABLE: 43: Agronomic performance of rice (aman) variety BR-4 at different NPK levels at BAU CSRS, Irrigated Area Kanhar, 1982.

Treatment N	P	K (kg/ha)	Yields (t/ha) Grain	Straw
45	35	0	4.24	5.91
45	35	45	4.49	6.14
65	45	0	3.98	6.03
65	45	45	4.22	5.96
85	55	0	4.41	6.20
85	55	45	5.38	6.39

TECHNOLOGY:

1. Spacing - 25cm x 12cm
2. Fertilizer - as per treatment
3. Age of seedlings - 45 days
4. Water Management - rain water
5. Plant protection - 1 spray with Diazinon @1.5 kg/ha
6. Interculture operation - 2 handweedings
7. Date of transplanting - 4. 8. 1981
8. Date of harvesting - 25. 11. 1981
9. Replications - 5

TABLE: 44: Agronomic performance of rice (aus) variety BR-1 at different zinc levels at BAU CSRS, Irrigated Area Kanhar, 1982.

Treatment Zn SO_4 (kg/ha)	Yields (t/ha) Grain	Straw
0	4.00 b	5.09 b
6	4.17 ab	5.32 ab
8	4.67 a	5.35 ab
10	4.42 ab	5.62 a
12	4.31 ab	5.24 b
14	3.91 b	5.20 b

TECHNOLOGY:

1. Spacing - 25cm x 12cm
2. Fertilizer - 85-55-45 (N, P_2O_5, K_2O kg/ha)
3. Age of seedlings - 40 days
4. Water Management - rain water
5. Plant protection - 1 spray Diazinon, @ 1.5 kg/ha
6. Interculture operation - 2 handweedings
7. Date of transplanting - 20. 5. 1981
8. Date of harvesting - 23. 8. 1981
9. Replications - 5

TABLE: 45: Agronomic performance of rice (t.aman) variety BR-4, with zinc and sulphur fertilizers under flooded conditions at BAU Experimental Farm, 1982.

Fertilizer	Yields (t/ha) Grain	Straw
Check	6.84 b	9.62 b
ZnO	8.51 a	10.17 b
$ZnSO_4$	8.62 a	10.13 b
Gypsum	8.46 a	90.45 b
Zn + Gypsum	8.94 a	10.81 ab
$ZnSO_4$ + Gypsum	8.96 a	11.27 a

TECHNOLOGY:

1. Spacing - 25cm x 12cm
2. Fertilizer - 85-55-45 (N, P_2O_5, kg/ha, Zn 5 kg/ha, S 30 kg/ha)
3. Age of seedlings - 45 days
4. Water Management - constant submerged conditions
5. Plant protection - 1 spraying with Diazinon @1.5 kg/ha
6. Interculture operation - 2 handweedings
7. Date of transplanting - 15. 6. 1981
8. Date of harvesting - 27. 10. 1981
9. Replications - 5

TABLE: 46: Agronomic performance of rice (t.aman) variety BR-4, with zinc and sulphur and application under moist conditions at BAU Experimental Farm, 1982.

Fertilizer	Yields (t/ha) Grain	Straw
Control	6.91 c	7.11 b
ZnO + 0	7.77 a	7.26 b
$ZnSO_4$ + 0	7.37 ab	7.57 ab
0 + Gypsum	7.49 ab	8.43 a
Zno + Gypsum	7.19 bc	8.73 a
$ZnSO_4$ + Gypsum	7.60 ab	9.10 a

TECHNOLOGY:

1. Spacing - 25cm x 12cm
2. Fertilizer - 85-55-35 (N, P_2K_2O kg/ha, Zn 5 kg/ha, S 30 kg/ha)
3. Age of seedlings - 45 days
4. Water Management - rain water - moist condition
5. Plant protection - 1 spray Diazinon @ 1.5 kg/ha
6. Interculture operation - 2 handweedings
7. Date of transplanting - 15. 6. 1981
8. Replications -

TABLE: 47: Agronomic performance of rice (t.aman) variety BR-4, with zinc and sulphur and fertilizers at BAU CSRS, Irrigated Area Kanhar, 1981.

Fertilizer	Yields (t/ha) Grain	Straw
Control	4.30 a	6.18 a
$ZnSO_4$	3.86 c	6.02 b
Gypsum	4.04 b	6.23 a
$ZnSO_4$ + Gypsum	4.54 d	6.15 ab

TECHNOLOGY:

1. Spacing - 25cm x 12cm
2. Fertilizer - 85-55-45 (N, P_2O_5, K_2O kg/ha, Zn 5 kg/ha, S 30 kg/ha)
3. Age of seedlings - 45 days
4. Water Management - rain water moist and submerged
5. Plant protection - 1 spray with Diazinon @1.5 kg/ha
6. Interculture operation - 2 handweedings
7. Date of transplanting - 27. 7. 1981
8. Date of harvesting - 24. 11. 1981
9. Replications - 5

TABLE: 48: Agronomic performance of rice (boro) variety Purbachi, with zinc and sulphur fertilizers at BAU CSRS, Irrigated Area Kanhar, 1982.

Fertilizer	Yields(t/ha) Grain	Straw
Control	4.78 a	9.61 a
$ZnSO_4$	4.65 ab	9.03 ab
Gypsum	4.78 a	9.37 a
$ZnSO_4$ + Gypsum	4.14 b	8.01 b

TECHNOLOGY:

1. Spacing - 25cm x 12cm
2. Fertilizer - 105-55-45 (N, P_2O_5, K_2O kg/ha)
3. Age of seedlings - 45 days
4. Water Management - moist to submerged
5. Plant protection - one spray with Diazinon @1.5 kg/ha
6. Interculture operation - 2 handweedings
7. Date of transplanting - 3. 2. 1981
8. Date of harvesting - 7. 5. 1981

TABLE: 49: Agronomic performance of rice (t.aman) variety BR-4 at different hill spacings at BAU CSRS, Irrigated Area Kanhar, 1982.

Spacing Rows x hill (cm)	Yields (t/ha) Grain	Straw
30 x 12	3.98 b	5.34 b
25 x 12	5.20 a	6.23 a
20 x 12	4.60 a	6.32 a
Farmers' spacing	4.51 ab	5.61 ab

TECHNOLOGY:

1. Spacing - as per treatment
2. Fertilizer - 85-55-45 (N, P_2O_5, K_2O kg/ha)
3. Age of seedlings - 45 days
4. Water Management - rain water, moist and submerged
5. Plant protection - 1 spraying with Diazinon @1.5 kg/ha
6. Interculture operation - one handweeding
7. Date of transplanting - 29. 7. 1981
8. Date of harvesting - 25. 11. 1981
9. Replications - 5

TABLE: 50: Agronomic performance of rice (boro) variety Purbachi, at different hill spacing at BAU CSRS, Irrigated Area Kanhar, 1982.

Spacing Rows x hill (cm)	Yields(t/ha) Grain	Straw
30 x 12	4.51 b	6.88 c
25 x 12	5.59 a	8.22 a
20 x 12	4.91 ab	8.10 a
Farmers' spacing	4.18 b	7.07 b

TECHNOLOGY:

1. Spacing - as per treatment
2. Fertilizer - 105-55-45 (N, P_2O_5, K_2O kg/ha)
3. Age of seedlings - 35 days
4. Water Management - moist to submerged
5. Plant protection - 1 spraying with Diazinon @1.5 kg/ha
6. Interculture operation - 2 handweedings
7. Date of transplanting - 4. 2. 1982
8. Date of harvesting - 8. 5. 1982
9. Replications - 5

TABLE: 51: The effect of the age of seedlings on yield of rice (t.aman) variety BR-4, at BAU Experimental Farm, 1982-84.

Age of Seedlings		Yield (t/ha)		
1982-1983	1983-1984	1982-1983		1983-1984
		Grain	Straw	Grain
40		4.19	7.26	
60		5.26	6.58	
80		4.81	6.09	
	35			4.77
	55			4.59
	75			4.76

TABLE: 52: Effect of the number of seedling per hill on the yield of rice(t.aman) variety BR-4 at BAU Experimental Farm, 1982.

Numbers of Seedlings (days)	Yields (t/ha) Grain	Straw	Field duration (days)
2	5.54 a	6.22	110
4	5.14 b	6.15	108
6	4.83 c	7.33	106
8	4.58 d	6.86	104

TECHNOLOGY:

1. Spacing - 25cm x 12cm
2. Fertilizer - 85-55-45 (N, P_2O_5, K_2O kg/ha)
3. Age of seedlings - 30 days as per treatment
4. Water Management - rain water, moist to submerged
5. Plant protection - 1 spraying with Diazinon @1.5 kg/ha
6. Interculture operation - 2 handweedings
7. Date of transplanting - 20. 8. 1981
8. Replications - 3
9. Design - split plot.

TABLE: 53: Agronomic performance of the rice variety BR-4 with different land preparation methods. Component Technology Studies, BAU Farm, 1982-1983.

Treatment	Yields (t/ha) Grain	Straw
No ploughing	4.31 b	10.64
One ploughing	4.71 a	
Three ploughing + one laddering	5.12 a	

TABLE: 54: Yield of gram variety Sabur-4 with different planting systems. Component Technology Studies, BAU Farm, 1982 - 1983.

Treatment	Yield (t/ha)
Relayed (one week before harvesting the rice)	0.76
Planted without ploughing one week after harvesting rice	0.70
Planted after normal land preparation	0.82

C. CROPPING PATTERN TESTING

Cropping pattern testing studies in Trishal Thana were carried out in irrigated and rainfed highlands. Irrigation was provided from a deep tubewell operated by a farmers' cooperative. Most of the agronomic and economic evaluations of the cropping patterns (cropping pattern testing) were carried out in 1982-83. Only the results obtained in two cropping patterns were reported in the year 1983-84. The results under each water management conditions are presented separately.

RAINFED HIGHLANDS:

In this area the farmers select their cropping patterns according to the time and amount of rainfall. As a result, the area devoted to a given cropping pattern varies from year to year. In the years 1980-82, the farmers planted 26 different cropping patterns but 90% of the patterns included transplanted rice in the early kharif (t.aman). About 43% of the farmers used local varieties of rice (Hashibini), 22% the variety Pajam and the rest plant the improved varieties BR-11 or BR-4. About half of the existing cropping patterns include jute as the crop for the early kharif. In this land type three of the existing predominant cropping patterns (F) grown with the farmers' agronomic practices were compared with alternative cropping patterns (FA) in which wheat was introduced as a third crop and improved varieties of rice were used instead of the local varieties. The results are presented next.

a) Rice(D.S. Aus) - Rice(T.Aman) - Fallow. (F)
Rice(D.S. Aus) - Rice(T.Aman) - Wheat. (FA) (Table-55)

The most common cropping pattern in the rainfed highlands of the project area is Rice(D.S. Aus) - Rice(T.Aman) - Fallow. The farmers plant the local rice variety Hashikalmi in the early kharif and Hashibini in the late kharif. They leave their lands fallow during the rabi season. The studies carried out indicated that the land use can be intensified by planting wheat as a third crop and that production of rice can be increased by changing the local varieties for improved ones with appropriate agronomic practices. The agronomic and economic performance of the existing (F) and alternative (FA) cropping patterns was tested with a group of farmers using the rice variety BR-10 in the late kharif (FA-1), and another group using the variety BR-11 (FA-2). The rest of the agronomic practices as the same for both groups of farmers.

The results showed that with improved practices, the average yields of the variety BR-1 (4.38 t/ha) were 234% higher than the yields of the local variety Hashikalmi (1.31 t/ha) in the early kharif. The average yields of the varieties BR-10 and BR-11 (5.12 t/ha) in the late kharif were 173% higher than the local variety Hashikalmi (1.87 t/ha). Extra 3.87 t/ha of wheat were produced in the rabi season. The average field

duration of the improved varieties of rice in the early kharif (137 days) is substantially longer than the one of the local variety (75) but in the late kharif the improved varieties were susbtantially earlier than the local varieties (101 days Vs. 154 days). The addition of S in teh early kharif and Zn in the late kharif is needed to obtain higher grain yields.

Conclusion:

There is a high potential for increasing the production of the cropping pattern Rice(D.S. Aus) - Rice(T.Aman) - Fallow by (a) replacing the local variety of rice Hashikalmi by the improved varieties BR-1 in the early kharif and the local variety Hsahibini by BR-10 or BR-11 in the late kharif, (b) adjusting the rice seed rates and hill spacing, (c) fertilizing rice with the rates 85-55-60+30 kg/ha NPK-S, in the early kharif and 85-55-60+5 kg/ha NPK+Zn in the late kharif and (d) by planting wheat with fertilizer (90-65-60 kg/ha NPK) in the rabi season.

b) Rice(D.S. Aus) - Rice)T.Aman) - Khesari. (F)
Rice(D.S. Aus) - Rice(T.Aman) - Lentil. (FA) (Table-56)

In the existing cropping pattern (F) the farmers plant the local variety of rice Hashikalmi in the early kharif and Hashibini in the late kharif. They usually plant Khesari as a relay crop before harvesting the rice (t.aman). The performance of this pattern was compared with an alternative pattern (FA) which included the change of the crop Khesari by Lentils in the rabi season, and the use of improved varieties of rice with improved technologies. The agronomic and economic performance of these two patterns is presented in table-56. In the early kharif season the yield of the variety BR-1 (4.83 t/ha) was 268% higher than the local variety Hashikalmi (1.31 t/ha). The yield of the variety BR-11 (5.10 t/ha) was 172% higher than the local variety Hashibini (1.87 t/ha) in the late kharif. The yield of lentils (0.61 t/ha) in the alternative pattern were lower than the yields of Khesari (1.31 t/ha) in the existing pattern.

Conclusion:

Production of grain of rice can be increased in the cropping pattern Rice(b.aus) - Rice(t.aman) - Khesari by changing the local varieties Hashikalmi and Hashibini by the improved varieties BR-1 or BR-11 respectives with fertilizer rates of 85-55-50+30 kg/ha NPK+S, in the early kharif and 85-50-50-5 kg/ha NPK+Zn for the late kharif.

For better yields of rice Zinc (Zn) should be used in the late kharif and Sulphur (S) in the early kharif.

Khesari is a better crop than Lentils in the rabi season as indicated by its performance in these studies.

c) Jute - Rice(T,Aman) - Fallow. (F)
Rice(D.S. Aus) - Rice(T.Aman) - Potato. (FA-1)
Jute - Rice(T.Aman) - Wheat. (FA-2) (Table-57)

The cropping pattern Jute - Rice(t,aman) - Fallow is the second in importance in te- rainfed highlands of teh project area. The performance of this pattern was compared with an alternative cropping pattern which included potato or wheat as a third crop in the rabi season, As in the other cropping patterns discussed above, the local variety of rice was replaced by improved ones. The performance of the existing (F) and alternative cropping patterns is summarized in table-57. The gross return of rice (aus) variety BR-1 (Tk.25,465) were higher than the returns from the local variety of jute (Tk.7,239) and the improved variety of jute CV-3 (Tk.14,563). The yields of the variety BR-1 (4.85 t/ha), Pajam (5.39 t/ha) and BR-11 (5.38 t/ha) were substantially higher than the yields of the local variety Hashikalmi (1.87 t/ha). The gross returns from potato (Tk.27,046) were considerably higher than the gross return from wheat (Tk.14,563).

Conclusion:

The production of the rainfed highlands in which the cropping pattern Jute - Rice(b.aus) - Fallow is cultivated, can be increased by (a) growing potato or wheat as a third crop in the rabi season, (b) using the improved variety BR-1 in the early kharif, (c) using the improved varieties BR-11 or Pajam in the late kharif, (d) adjusting the seed rates, planting methods and fertilizer use and (e) changing the local variety of jute by the improved variety CV-3.

IRRIGATED HIGHLANDS:

This land type is representative of areas in the Mymensingh District provided with deep tubewells. The farmers' preference is to grow two crops of rice. The plan to introduce cropping patterns with three crops was not successfull because of unreliable irrigation schedules, a general farmers' preference for rice (boro), and difficulties for land preparation after harvesting the rice (t.aman). The results of the studies in this land type follow.

a) Rice(T.Aman) - Rice(Boro) - Fallow. (F)
Rice(T.Aman) - Rice(Boro) - Fallow. (FI)
Rice(T.Aman) - Rice(Boro) - Green Manure. (FA-1)
Rice(T.Aus) - Rice(T.Aman) - Mustard. (FA-2)
Rice(T.Aus) - Rice(T.Aman) - Fallow. (FA-3) (Table-58)

The performance of the existing predominant pattern (F) was compared with that of the same pattern but with improved agronomic practices (FI) and with the one of three laternative patterns (FA-1, FA-2 and FA-3). In two of these, a third crop was added to the existing pattern and in the other the systems Rice (aus) and Rice (t.aman) is compared with the F existing pattern. The information about the performance of all these patterns is given in table-58. As in the rainfed

areas, the production of the existing cropping patterns can be increased by adopting improved agronomic practices. The rice variety Pajam can be replaced by the varieties BR-11 in the FI pattern or by BR-4, BR-10 or BR1 in the alternative patterns (FA-1,2,3). The local variety Jagali can be replaced by the varieties Purbachi in the rabi season. In the alternative cropping patterns observed, the green manure was lost because of high rainfall. The yield of mustard (0.46 t/ha) was acceptable but the added cost of production and risk involved by unreliable irrigation schedule limits the potential of this crop.

In the late kharif season the yields of the variety BR-11 (5.23 t/ha) and BR-4 (5.51 t/ha) were higher than the yield of the variety Pajam (3.75 t/ha). In the rabi season the yield of the variety Purbachi (5.07 t/ha) was substantially higher than that of the local variety Jagali (2.43 t/ha). In the alternative cropping patterns Rice(t.aus) - Rice(t.aman) - Mustard, and Rice(t.aus) - Rice(t.aman) - Fallow the yield of the varieties BR-10 (4.35 t/ha) and BR-1 (4.24 t/ha) were higher than the yield of the variety Pajam (3.75 t/ha) transplanted in the late kharif (t.aman).

Conclusion:

Farmers' preference for a rice crop transplanted late in the rabi season (February), limits the scope for intensifying the use of irrigated highlands in the location studied (Trishal Thana), since the system does not allow a timely planting of a rabi crop.

The potential for increasing the yields of the existing cropping pattern Rice(t.aman) - Rice(boro) - Fallow is very high. The varieties BR-11 and BR-4 when fertilized with 85-50-60 kg/ha NPK and 30 kg/ha sulphur yielded about 25% more than the variety Pajam, in the late kharif. The varieties BR-10 and BR-1 are of short duration and are suitable for a cropping pattern with three crops, like Rice(t.aus) - Rice(t.aman) - Mustard or Rice(t.aus) - Rice(t.aman) - Fallow.

TABLE: 55: Agronomic and economic performance of farmers'(F), farmers' improved(FI) and farmers' alternative(FA). Cropping Patterns in rainfed highland types of Trishal Thana C.S.R. Site, B A U. 1982 - 1983.

INFORMATION					
Land Type		Rainfed Highland			
Cropping Pattern		F)Rice - Rice - Fallow	FA) Rice(D.S.Aus) - Rice(T.Aman) - Wheat FA-1	FA-2	
Year		1982 - 1983	1982 - 1983	1982 - 1983	Average (FA-1 and FA-2)
Varieties	C1	Hashikalmi	BR - 1	BR -1	
	C2	Hashabinni	BR - 10	BR -11	
	C3	-	INIA - 66	INI A - 66	
Planting Dates (Range)	C1	March 25 - April 25	April 10 - 15	April 9 - 15	
	C2	July 1 - 31	August 12 - 14	August 24 - 26	
	C3	-	March 25 - April 25	December 9 - 25	
Seed Rate(kg/ha)	C1	90	50	50	50
	C2	50	50 (25 x 12)	50 (25 x 12)	50 (25 x 12)
	C3	-	200 (b)	200 (b)	
NPK (kg/ha)	C1	-	85-55-60+30S	85-55-60+30S	85-55-60+30S
	C2	-	85-55-60+5Zn	85-55-60+5Zn	85-55-60+5Zn
	C3	-	90 - 65 - 60	90 - 65 - 60	90 - 65 - 60
Field duration (days)	C1	75	138	137	137
	C2	154	106	99	101
	C3	-	105	109	107
Yield (t/ha)	C1	1.31	3.86	4.91	4.38
	C2	1.87	4.84	5.40	5.12
	C3	-	3.57	4.17	3.87
Yield(kg/ha/day)	C1	17	28	36	32
	C2	12	46	55	50
	C3	-	34	38	36
Cost of cultivation (Tk/ha)	C1				
	C2				
	C3				
Gross return (Tk/ha)	C1	6,858	16,658	25,570	
	C2	8,165	23,422	26,511	
	C3		9,365	11,009	
Net return (Tk/ha)	C1	2,958	8,385	16,732	
	C2	3,865	16,539	19,628	
	C3		3,626	5,270	
Benefit cost ratio	C1	1.76	2.01	2.89	
	C2	1.90	3.40	3.85	
	C3		1.63	1.91	

TABLE: 56: Agronomic and economic performance of farmers'(F), farmers' improved(FI) and farmers' alternative(FA). Cropping Patterns in rainfed highland types of Trishal Thana C.S.R. Site, B A U. 1982 - 1983.

INFORMATION			
Land Type		Rainfed Highland	
Cropping Pattern		F) Rice(D.S.Aus) - Rice(T.Aman) - Khesari.	FA) Rice(D.S.Aus) - Rice(T.Aman) - Lentil.
Year		1982 - 1983	1982 - 1983
Varieties	C1	Hashkalmi	BR - 1
	C2	Hashabinni	BR - 11
	C3	Local	Pabna (L)
Planting Dates (Range)	C1	March 25 - April 25	April 7 - 14
	C2	July 1 - 31	August 14 - 17
	C3	November 1 - 25	December 1 - 4
Seed Rate(kg/ha)	C1	90 (D.S.)	50 (D.S.)
	C2	50 (Ir)	50 (25 x 12)
	C3	60	25
NPK (kg/ha)	C1	-	85-55-60+30S
	C2	-	85-55-60+5Zn
	C3	-	15 - 22 - 17
Field duration (days)	C1	75	136
	C2	154	108
	C3	129	98
Yield (t/ha)	C1	1.31	4.83
	C2	1.87	5.10
	C3	1.31	0.61
Yield(kg/ha/day)	C1	17.4	36.0
	C2	12.1	47.0
	C3	10.1	6.2
Cost of cultivation (Tk/ha)	C1	3,900	8,958
	C2	4,300	8,286
	C3	1,300	2,442
Gross return (Tk/ha)	C1	6,858	25,330
	C2	8,165	24,166
	C3	5,225	3,787
Net return (Tk/ha)	C1	2,958	16,372
	C2	3,865	15,880
	C3	3,925	1,345
Benefit cost ratio	C1	1.76	2.82
	C2	1.90	2.91
	C3	4.02	1.55

b = broadcast.

TABLE: 57: Agronomic and economic performance of farmers'(F), farmers' improved(FI) and farmers' alternative(FA). Cropping patterns in rainfed hihgland types of Trishal Thana, CSR site, B A U. 1982 - 1983.

INFORMATION				
Land Type		Rainfed Highland		
Cropping Pattern		F) Jute - Rice(t.aman) - Fallow	Rice(aus)-Rice(t.aman)-Potato FA-1	Jute - Rice(t.aman) - Wheat FA-2
Year		1982 - 1983	1982 - 1983	1982 - 1983
Varieties	C1	Local	BR - 1	CV - 3
	C2	Kashiabinni	Pajam	BR - 11
	C3	-	Potato	INIA - 66
Planting Dates (Range)	C1	March 10 - April 10	April 8 - 17	April 6 - 12
	C2	July 1 - 31	July 14 - 17	August 11 - 12
	C3	-	November 29 - 30	December 9 - 12
Seed Rate(kg/ha)	C1	12	50 (D.S.)	10 (22 x 7)
	C2	50 (Ir)	50 (25 x 12)	50 (22 x 12)
	C3	-	(55 x 25)	200 - 0
NPK (kg/ha)	C1	-	85-55-60+Zn5	45 - 11 - 35
	C2	-	85-55-60+30S	85-55-60+30S
	C3	-	120 - 66 - 170	90 - 65 - 60
Field duration (days)	C1	132	139	137
	C2	154	113	110
	C3	-	97	103
Yield (t/ha)	C1	1.34	4.85	2.43
	C2	1.87	5.39	5.38
	C3	-	18.03	3.99
Yield(kg/ha/day)	C1	10	35	18.0
	C2	12	48	45.0
	C3	-	186	41.0
Cost of cultivation (Tk/ha)	C1			
	C2			
	C3			
Gross return (Tk/ha)	C1	7,239	25,465	14,563
	C2	8,165	28,429	25,916
	C3	-	27,046	14,563
Net return (Tk/ha)	C1	2,214	16,506	7,022
	C2	3,865	20,562	17,629
	C3	-	11,071	4,728
Benefit cost ratio				

TABLE: 58: Agronomic and economic performance of farmers' (F), farmers' improved (FI) and farmers' alternative (FA). Cropping Patterns in Irrigated Highland types in Trishal Thana C.S.R. Site. B A U. 1982 - 1983

Information		C R O P P I N G P A T T E R N S				
Land Type		Irrigated Highland				
Cropping pattern types		F	FI	FA-1	FA-2	FA-3
Crops in the pattern	C1	Rice (t.aman)	Rice (t.aman)	Rice (t.aman)	Rice (t.aus)	Rice (t.aus)
	C2	Rice (boro)	Rice (boro)	Rice (boro)	Rice (t.aman)	Rice (t.aman)
	C3	Fallow	Fallow	Sesbenia	Fallow	Mustard
Variety	C1	Pajam	BR - 11	BR - 4	BR - 10	BR - 1
	C2	Jagali	Purbachi	Purbachi	BR - 11	BR - 11
	C3	-	-	-		Rai - 5
Planting date (Range)	C1	July 1 - 31	August 11-13	July 19-22	February 21-24	February 19-21
	C2	Feb.15 - Mar.28	February 17-19	February 17-19	July 31 - Aug.3	August 13-16
	C3	-	-	April - 10	-	-
Seed Rate(kgs/ha Hill spacing cm)	C1	50 (Ir)	50 (25 x 12)	50 (25 x 12)	50 (25 x 12)	50 (25 x 12)
	C2	50 (Ir)	50 (25 x 12)	50 (25 x 12)	50 (25 x 12)	50 (25 x 12)
	C3	-	-	5	-	12
NPK-S-Zn (kgs/ha)	C1	55 - 20 - 0	85-55-60 - 30S	85-55-60 30S	85-55-60 30S	85-55-60 30S
	C2	40 - 0 - 0	85-55-60 - 5Zn	85-55-60 5Zn	85-55-60 5Zn	48-40-40 -5Zn
	C3	-	-	-	-	45 - 33 - 17
Field duration(days)	C1	115	106	113	109	110
	C2	92	90	90	114	114
	C3	-	-	-	-	102
Yield (t/ha)	C1	3.75	5.23	5.51	4.35	4.24
	C2	2.43	5.07	4.60	5.31	4.85
	C3	-	-	-	-	0.46
Yield (kgs/ha/day)	C1	33	49	49	40	39
	C2	26	56	51	47	43
	C3	-	-	-	-	6
Gross Return	C1	14,984	19,944	27,589	18,754	24,891
	C2	12,130	21,835	19,836	26,559	24,203
	C3	-	-	-	-	2,894
Net Return	C1	9,763	12,457	19,446	9,386	14,609
	C2	7,239	13,187	11,188	18,976	17,216
	C3	-	-	-	-	804
Benefit cost ratio mean of the pattern	C1	2.87	2.78	3.38	3.50	
	C2	2.48	2.52	2.29	2.00	
	C3	-	-	-	-	

BANGLADESH JUTE RESEARCH INSTITUTE

MANIKGANJ AND KISHORGANJ SITE

A. THE BENCHMARK SURVEY - SITE DESCRIPTION (MANIKGANJ SITE)

a) Location:

The Manikganj project area is located on the Gangetic alluvial tract which represents the riverine lands of the Gangetic plains. The project area includes the villages Chandoir, Panjankhara, Ali Nagar, Bathuli, Balitha, Kisirnagar, Kalampur and Bhalum. The villages are located around the BJRI Central Research Farm at Jagir about 48 km from Dhaka on the Dhaka-Manikganj road.

b) Social Infrastructure:

Nearly 50 per cent of the total population is engaged in full-time farming. Twenty-three per cent maintain their livelihood by small businesses, 20% are day labourers on other farms. Others are engaged in non-farm activities such as rickshaw pulling, fishing, etc. Family size is on average 7.9. The literacy rate is 26% which is above the national average of 20%. One third of the farmers are members of cooperatives. The site has good road links with Dhaka city.

c) Farm Size and Tenancy:

Average size of farms is 0.4 ha. Forty-two per cent of the total households are classified as small farms having less than one hectare. Sixteen per cent of the farms have more that 2 ha of land. About 48% of the small farmers cultivate land by share cropping agreements.

d) Agroclimatic Conditions:

Rainfall:

The average rainfall in the project area is 1702mm. There are five months with more than 200 mm fainfall.

Temperature:

Mean annual maximum and minimum temperatures are 30.2°C and 21.0°C respectively.

Evapotranspiration:

The total annual evapotranspiration is 1,170 mm, most of it occuring from March to May.

Soils:

The soil texture ranges from clay loam to loam. The pH is neutral or slightly alkaline.

e) Land Type:

Land types in the area can be classified as highland rainfed, highland partially irrigated, medium land rainfed, lowland partially irrigated.

f) Cropping Patterns:

Jute - Fallow - Wheat

Jute - Rice (t.aman) - Fallow

Jute - Rice (t.aman) - Pulses

Rice (aus) - Rice (t.aman) - Mustard

Rice (aus) + Rice (b.aman) - Vegetables

The component crops are all local varieties.

g) Labour Supply:

Most of the labour requirements are fulfilled by the farm family. During peak demand periods family labour is supplemented by casual hired labour. The wage rate ranges from Tk 15 to Tk 25/-.

h) Livestock:

The average number of bullocks is 1.0, 1.8 and 3.6 for small, medium and large farmers respectively. Average number of milk cows is 0.60, 1.30 and 2.00 for the three groups of farmers.

i) Input Use and Source:

Most of the farmers use their own seeds while a small proportion rely on the local market. Improved jute seed is sometimes collected by farmers from BJRI. Fertilizer is used by some farmers and is obtained from local markets. Fifty per cent of farmers use insecticides. Twenty-six per cent use credit obtained from the Bangladesh Krishi Bank or money lenders. Some areas have irrigation facilities during the dry months which they use mainly for cultivating boro rice.

j) Major Crops in the Projects Area:

Jute, aus and b.aman rice, wheat, mustard, tobacco, pulses and vegetables are important crops in the project area.

k) Constraints to Crop Production:

* Scarcity of water;
* Lack of improved seeds:
* High price and scarcity of fertilizer and insecticides;
* Lack of credit;
* Drought; and
* Flood.

AA. THE BENCHMARK SURVEY - SITE DESCRIPTION (KISHORGANJ SITE)

a) Location:

Kishoreganj is located on the Brahmaputra alluvial tract where the best quality of jute ("Jat" type) is grown. The area is inundated and replenished every year by fresh deposits of silt. Eleven villages, Zosodal, Pakundia, Ayla (Karimganj), Nandial, Rahidabad, Boulai, Biddanpur, Vaskarkilla, Zafrabad, Marca and Khudir Jangal are in the site. They are located around Kishoreganj town at distances varying from three to sixteen kilometers

b) Social Infrastructure:

The family size averages 6.60 persons. Thirty-eight per cent of the total population is engaged in full-time farming. Twelve per cent maintain their livelihood by operating small businesses and 29% depend on wage labour. The remainder maintain their livelihood by providing small services, fishing, rickshaw pulling, etc. The literacy rate is 27%. Net annual income per family is US $71.00. A third of the farmers are members of cooperatives. Markets are available near each village of the site.

c) Farm Size and Tenancy:

Average farm size is 0.5 ha (range 0 - 4.86 ha). Fifty-five per cent of the farmers cultivate their own land exclusively, while seven per cent rent out a portion of their land for cultivation by others and 27% rent some land in addition to their own.

d) Agroclimatic Condition:

Rainfall	: Average annual rainfall is 2433 mm.
Temperature	: Mean maximum 30.1°C, minimum 20.5°C.
Evapotranspiration	: 1109 mm.
Soils	: Acidic. Texture varies from sandy loam to clay loam.

e) Land Type:

Five different land types can be distinguished: Highland rainfed, highland partially irrigated, medium land irrigated, lowland rainfed, and lowland partially irrigated.

f) Cropping Patterns:

The predominant cropping patterns are:

Jute - Rice (t.aman) - Fallow
Rice (aus) - Rice (t.aman) - Fallow
Rice (aus) - Rice (t.aman) - Rabi Crops
Jute - Fallow - Rabi Crops

g) Labour Supply:

Adult males and children constitute the potential family labour force on the farm. About 46% of agricultural labour comes from the farm family.

h) Livestock:

There is an acute shortage of draft animal power on the site with only .6 animals per household. Milk cow per household is 0.90. Young stock and goats per household are 0.77 and 0.68 respectively.

i) Input Use and Source:

About 86% of the farmers use their own seed for rice production. Only three per cent use HYV rice. For jute cultivation 60% of the farmers use local market seed and only 16% farmers use BJRI's improved seed. About 52% and 55% farmers use fertilizer and insecticide respectively. 21% of the farmers obtain credit from Krishi Bank, Commercial Bank or relatives.

j) Major Crops in the Project Area:

Rice, Jute, Wheat, Lentil, Potato, Sweet Potato, Mustard, Garlic, Chilli and Eggplant.

k) Constraints to Crop Production:

Major constraints to crop production are:

* Unavailability of improved seeds;
* High price and unavailability of fertilizer and insecticides;
* Lack of irrigation and drainage facilities;
* Shortage of draft animal power.

B. COMPONENT TECHNOLOGY STUDIES (MANIKGANJ AND KISHORGANJ SITE)

Years 1980 - 1982.

The following are the results of component technology studies on jute-based cropping systems carried out at experimental stations and farmers' fields during the year 1981-1982:

a) The fesibility of intercropping jute with millet, rice, and sesame in alternate single rows:

This study was undertaken to see whether jute can be intercropped with rice, millet and sesame so that farmers can get food and a fibre crop.

Results indicate that intercropping decreased considerably the yields of jute. The land equivalent ratio (LER) of the intercropping systems was only slightly larger than 1 (Table-59).

b) Agronomic performance of jute in different cropping patterns:

The experiment was conducted to study the effect of millet intercropping on jute and its influence on the subsequent cropping. Pure-stand jute was better in terms of productivity than the intercropping of jute and millet (Table-60).

c) Performance of olitorius jute on medium lowlands:

Attempts were made to grow olitorius on medium lowland which is usually planted to capsularis. It was found that olitorius could be successfully grown on medium high and medium lowland. Late planting of both capsularis and olitorius considerably decreased yield, (Table-61).

d) Performance of capsularis varieties planted in line and broadcast methods of sowing:

The study was conducted to find out the yield of different recommended capsularis varieties planted in rows or sown broadcast. The study was conducted on farmers' fields at Kishorganj and Manikganj. CC-45, CVE-3, CVL-1, D-154 and local capsularis varieties were considered for the study.

The result indicated that the line-sowing method and improved seed produced higher yield than the broadcasting method and farmers' seed (Table-62).

e) Performance of recommended and local olitorius varieties at Kishorganj and Manikganj:

The study was aimed at comparing the yield performance and economic profitability of local olitorius varieties and the improved

variety O 4 at Kishorganj and Manikganj.

Variety O 4 produced a higher yield than the local varieties at both Kishorganj and Manikganj. It was also observed that local varieties at Kishorganj gave better yields than those at Manikganj (Table-63).

f) Effect of placement of fertilizer on the growth and yield of Jute:

This experiment was conducted at the Central Research Farm, Jagir, Manikganj to assess the efficiency of band fertilizer application on the yield of jute. Result indicated that band application 5cm below the seed is the most efficient method of applying fertilizer (Table-64).

g) Effect of the date of initiation of weed control on the yield of jute:

This experiment was conducted at the Central Research Farm, Jagir, to study the effect of the date of initiation of weed control on the yield of jute. The highest yield of fibre (4.10 t/ha) was observed when weed control started 20 days after emergence (Table-65).

h) Determination of optimum plant density for higher yield of capsularis jute:

This experiment was conducted to find out the optimum spacing for capsularis jute. The experiment was conducted at the Central Research Farm, Jagir, in 1981 crop season. Row spacing of 15cm x 15cm and 15cm x 8cm gave higher fibre yield than the recommended 30cm x 5cm, and other spacing patterns of 15cm and 23cm between rows seed to be better than 30cm (Table-66).

The following are evaluations of individual crop performances carried out at Manikganj and Kishorganj cropping systems sites:

Early Kharif:

Rice (aus): The aus + b.aman mixed rice crop systems occupied the major area of medium high and medium lowlands at Manikganj Cropping Systems Site. Only two plots in the project area were under a sole local aus variety Parangi. The yield of local aus was 1.46 t/ha. Several local and HYV varieties were cultivated in the Kishorganj cropping systems research site. The local varieties were Agali and Moslem. HYVs cultivated during the aus season were Chandina, Mala and Biplob. Average yield of local varieties was 1.84 t/ha. The yield of HYV of rice in the early kharif (aus) was 2.75 t/ha (Table-67).

Jute: Forty-one plots were planted to capsularis jute and 12 plots to olitorius jute at Manikganj cropping systems research site. Mean yield for capsularis was 1.79 t/ha and 1.63 t/ha for olitorius (Table-68).

In Kishorganj cropping systems research site 76 plots were planted with jute, 50 of these to capsularis and 26 to olitorius. Mean yield for capsularis was 1.85 t/ha and for olitorius 2.55 t/ha (Table-68).

Late Kharif:

Rice (t.aman): Most of the plots in the late kharif (t.aman) season were occupied by b.aman in the early kharif (aus+b.aman). Six plots in the research site were planted with local t.aman and had a mean yield of 1.94 t/ha at Manikganj.

Local varieties occupied most of the rice plots (t.aman). Grain yield average was 2.11 t/ha in Kishorganj. The predominant variety cultivated in the area was Pajam. Others were Killoi, Nizershail, Maloti and Chowali. The average yield of Pajam was 2.10 t/ha (Table-69). HYVs of t.aman were cultivated in 29 plots at Kishorganj. The dominant variety was BR-4 which had a yield of 2.69 t/ha. The other HYV varieties were BR-3, BR-10 and BR-11. The mean yield of HYV from 29 plots was 2.92 t/ha.

Rabi Crops:

Potato: Potato is important in a cropping pattern with jute as a component. In Manikganj cropping systems research site, potato was one of the dominant crops in the cropping season 1981-1982. The variety Cardinal performed better than the local on this site, with an average yield of about 9.23 t/ha (Table-70).

In the Kishorganj cropping systems research site, Patrones yielded about 7.67 t/ha. The yields of Cardinal and local varieties were 6.69 t/ha and 5.35 t/ha, respectively. As the yield of all the varieties in general has been extremely appears that there was something wrong somewhere.

Speices: Onion and garlic were the principal spices grown at the Kishorganj and Manikganj cropping systems sites. In the cropping systems monitoring block at Manikganj three plots of onion only were planted with a yield of 2.10 t/ha (Table-71).

Yields of onion and garlic at Kishorganj cropping systems site were 1.18 t/ha and 1.20 t/ha respectively. Onion and garlic are two dominant crops grown in the river belt or in the low lying areas of Kishorganj. The yields have been too poor to diserve careful examination.

Pulses: The yield of some pulses from samples taken in farmers' fields in Manikganj and Kishorganj are given in Table-72. The average yield of lentil was 0.10 t/ha in Manikganj and 0.73 t/ha in Kishorganj. The low yields of gram and mungbean were due to very low plant population.

Chilli: The cropping pattern involving jute and chilli is predominant in the river belt or medium highland and in the medium lowland areas at Kishorganj. Varieties Balijuri and Nayajuri performed very well compared with other local varieties. Yields of Balijuri and Nayajuri were 3.57 t/ha and 3.35 t/ha respectively (Table-73).

Mustard: Mustard is the principal oil-seed crop grown at Manikganj and Kishorganj cropping systems research sites. A large number of plots in both locations were occupied by mustard (Table-74). Farmers' variety performed best compared with other varieties such as Tori-1, Rai-5 and TS-72.

Aus + b.aman (mixed crop): Aus + b.aman mixed crop occupied a large number of plots at Manikganj cropping systems research site. In the mixed cropping pattern aus and b.aman are planted in March/April. The aus crop is harvested during July and August, while the b.aman crop remains standing in the field. B.aman is harvested during October to November to make the land available for rabi crops. The average yield of aus + b.aman mixed crop obtained from 42 plots was 2.62 t/ha (Table-75).

Other crops and cropping patterns: Sugarcane, sweet potato, wheat/mustard mixed crop, kalimotor/sunflower mixed crop, cabbage and sunflower occupied some plots of the Manikganj cropping systems research site (Table-76). Cabbage was the most productive crop, having a yield of about 35.56 t/ha. The yield of sweet potato was 7.39 t/ha.

Years 1982 - 1984:

The following are the results of some other component technology studies carried out in the years 1982-1984, in both sites, Kalampur and Kishorganj.

a) Variety trials of jute:

Several varieties of jute were tested in different land types. In the highland of Kalampur the varieties O-4 and OVT yielded significantly more than the local variety of olitorious. In medium highlands the yield of all the improved varieties tested was higher than the yield of the local varieties. In the medium highlands only one of the improved varieties tested yielded significantly higher than the local capsularis (Table-77). The yields of the same varieties were lower in Kishorganj.

b) Response of jute (var. CC-45) to the application of different rates of N, P and K:

In these experiments the yields of jute with nine different fertilizer rates were studied in two different land types. The maximum yields were observed in both land types when 45 kg/ha N, 10 kg/ha P_2O_5 and 20 kgs/ha of K_2O were applied (Table-78).

c) Performance of local and improved varieties of rice in the early and late kharif season:

These experiments were conducted in Kishorganj. The farmers in this area plant local varieties in the early kharif season. The yield of the variety BR-3 (4.23 t/ha) was significantly higher than the yield of the local varieties (Table-79). In the late kharif season the rice variety Pajam yielded more than the local varieties Birroi and Killoi and the improved variety Purbachi.

d) Wheat variety trials:

Four promising varieties of wheat, Inia-66, Jupateco, Pavon and Tanon were planted and their yield compared with the one of the variety Sonalika, which is commonly planted by the farmers. The higher yields were observed in the variety Sonalika (Table-80)

e) Mustard variety trials:

In this experiment the performances of the mustard varieties TS-72, Rai-5, Tori-7 and Australian, were compared with the performance of SS-75 was significantly higher than the yield of the other varieties (Table-81).

f) The effect of two agronomic practices in the yield of potato:

The yields of potato fields in which water hyacinth was used as a mulch, was higher than the ones of that were only earthened up (Table-82).

TABLE: 59: Agronomic performance of inter-cropping of jute with millet, rice (aus) and sesame, 1981-1982 (on-station).

Treatments	Yield (t/ha) Fibre/grain	Stick/straw	LER
Pure-stand jute (D-154)	1.53	4.11	-
Pure-stand millet (local)	0.84	2.53	-
Pure-stand Aus (local)	1.22	3.17	-
Jute + Millet	0.91 + 0.38	2.47 + 1.17	1.04
Jute + Aus	0.86 + 0.58	2.98 + 1.68	1.03

TABLE: 60: Agronomic performance of jute in different cropping patterns Manikganj 1981 - 1982 (on-station).

Crop - 1	Crop - 2	Yield (t/ha) Crop - 1 Fibre/grain	Crop - 1 Stick/Straw	Crop - 2 Grain	Crop - 2 Straw
Jute (D-154)	T.aman (Nizershail)	1.25	3.25	0.79	1.72
Millet (Local)	T.aman (Nizershail)	0.81	2.52	0.58	1.23
Jute + Millet	T.aman	0.58 + 0.55	1.67 + 1.81	0.64	1.44

TABLE: 61: Performance of jute olitorius on medium lowlands, 1981.

Planting Dates	Yield (t/ha) Varieties D - 154	O 4
	Olitorius	Capsularis
Mid - April	2.57	2.81
Late - April	2.53	2.41

TABLE: 62: Agronomic performance of capsularis varieties with different planting methods, component technology studies in farmers' fields, 1981.

Location and variety	Planting method: Line sowing: No. of rep/ fields	Line sowing: Plant height (metre)	Line sowing: Base diameter (mm)	Line sowing: Yield of fibre (t/ha)	Broadcast sowing: Plant height (metre)	Broadcast sowing: Base diameter (mm)	Broadcast sowing: Yield of fibre (t/ha)
Kishoreganj:							
CC 45	16	3.32	21.31	2.67	3.09	21.03	2.44
CVE 3	16	3.24	20.83	2.63	3.03	20.64	2.36
D 154	16	3.34	22.29	2.99	3.28	21.78	2.85
CVL 1	16	3.38	22.31	2.90	3.31	21.88	2.62
Local cap	16	3.04	18.80	2.49	2.82	18.54	2.23
Total/mean	80	3.26	21.11	2.74	3.11	20.77	2.50
Manikganj:							
CC 45	7	3.62	20.99	2.55	3.35	19.19	2.16
CVE 3	7	3.60	20.28	2.48	3.35	19.64	2.20
D 154	7	3.69	21.61	2.51	3.49	19.78	2.26
CVL 1	7	3.70	22.02	2.56	3.51	19.95	2.36
Local cap	7	3.36	18.77	2.20	3.45	17.48	2.02
Total/mean	35	3.59	20.73	2.46	3.43	19.21	2.20

TABLE: 63: Agronomic performance of two varieties of jute in Kishorganj and Manikganj Cropping Systems Area (farmers' fields) 1981.

	No. of field/ Rep.	Fibre yield (t)
Kishorganj:		
0 4	18	2.95
Local olit	18	2.84
Manikganj:		
0 4	10	2.84
Local olit	10	2.49

TABLE: 64: Effect of placement of fertiliser on the yield of jute (D 154) Manikganj, 1981 (on-station).

Treatments	Yield(t/ha) O 4	CVL 1
1. Broadcast application of fertiliser	1.68	2.47
2. Band application fertiliser with seeds	1.58	2.47
3. Band application 5cm below seeds	1.82	2.73
4. Band application 5cm to both sides and 5cm below seeds	1.87	2.47

TABLE: 65 : The effect of date of initiation of weed control on the yield of jute, Manikganj, 1981.

Treatments	Plant population (000/ha)	Fibre yield (t/ha)
1. Weed control started 10 DAE**	386	3.99
2. " " " 20 "	396	4.10
3. " " " 30 "	361	3.74
4. " " " 40 "	335	3.26
5. " " " 50 "	348	3.30
6. No weed control	323	2.83
7. Regular weeding (3 hand weedings)	334	3.77

**DAE - days after emergence

TABLE: 66: Effect of row spacing on yield of jute, Manikganj, 1981 (on-station).

Row spacing cm	Yield of fibre (t/ha)
1. 23 x 5	2.19
2. 15 x 8	2.25
3. 10 x 11	2.26
4. 30 x 5	1.57
5. 15 x 10	2.12
6. 13 x 12	2.20
7. 23 x 8	2.19
8. 13 x 14	2.19
9. 30 x 8	2.25
10. 15 x 10	1.99
11. 15 x 15	2.32

TABLE: 67: Yield of rice (aus) in Manikganj and Kishoreganj Cropping Systems Project Area, 1981.

Location and variety	No. of fields/obs	Mean yield (t/ha)
Manikganj:		
Local	2	1.46
HYV	-	-
Kishoreganj:		
Local	61	1.84
HYV	47	2.75

TABLE: 68: Yield of jute in Manikganj and Kishoreganj Cropping Systems Project Area, 1981.

Location and variety	No. of Fields/obs	Mean yield (t/ha)
Manikganj:		
Capsularis	41	1.79 a
Olitorius	12	1.63 a
Kishoreganj:		
Capsularis	50	1.85 b
Olitorius	26	2.55 a
Total	129	Mean 1.95

TABLE: 69: Yield of rice (t.aman) in Manikganj and Kishoreganj Cropping Systems Research Sites, 1981.

Location and variety	No. of fields/obs		Mean yield (t/ha)
Manikganj:			
Local	6		1.94
Kishoreganj:			
Local	157		2.11
HYV	29		2.92
Total	192	Mean	2.23

TABLE: 70: Yield of potato varieties at Manikganj and Kishoreganj Cropping Systems Research Sites, 1981-82.

Location and variety	No. of fields/obs		Mean yield (t/ha)
Manikganj:			
Local	2		11.31
Cardinal	1		9.23
Kishoreganj:			
Cardinal	4		6.96
Patrones	4		7.67
Local	3		5.35
Total	19	Mean	7.01

TABLE: 71: Yield of spices in Manikganj and Kishoreganj Cropping Systems Sites, 1981-82.

Location and crop	No. of fields/obs	Mean yield (t/ha)
Manikganj:		
Onion	3	2.10
Kishoreganj:		
Onion	5	1.18
Garlic	3	1.20

TABLE: 72: Yield of pulses in Manikganj and Kishoreganj Cropping Systems Sites, 1981-82.

Location and crop	No. of fields/obs	Mean yield (t/ha)
Manikganj:		
Lentil	5	0.10
Khesari	4	0.88
Kishoreganj:		
Lentil	2	0.73
Gram	1	0.15
Mungbean	1	0.46

TABLE: 73: Yield of several varieties of chilli in Kishoreganj Cropping Systems Research Site, 1981-82.

Variety	No. of fields/obs	Mean yield (t/ha)
Balijuri	15	3.57
Nadaria	2	1.13
Nayajuri	3	3.35
Local chilli	4	0.87
Total/mean	24	2.89

TABLE: 74: Yield of mustard varieties in Manikganj and Kishoreganj Cropping Systems Sites, 1981-82.

Location and variety	No. of fields/obs		Mean yield (t/ha)
Manikganj:			
Farmers' variety	45		0.74 a
Total/mean	45		0.74
Kishoreganj:			
TS 72	5		0.45 a
Tori 7	4		0.33 bc
Rai 5	4		0.29 c
Farmers' variety	22		0.52 a
Total/mean	35		0.46
Total	80	Mean	0.40

TABLE: 75: Yield of Aus/b. aman mixed crop at Manikganj Cropping Systems Research Site, 1981-82.

Variety	No. of fields/obs	Mean yield (t/ha)
Aus/b. aman (local) mixed crop	42	2.62

TABLE: 76: Yield of other crops in Manikganj Cropping Systems Site, 1981-82.

Crops	No. of fields/obs	Mean yield (t/ha)
Sugarcane	1	3.06
Sweet Potato	1	7.39
Wheat + Mustard (mixed crops)	1	0.35 + 1.38
Kalimotor + Sunflower (mixed crops)	1	0.52 + 0.31

TABLE: 77: Performance of jute varieties in different land types of Kalampur,(Manikganj and Kishorganj Cropping Systems Research Sites, BJRI, 1983-1984.

Sites	Yield tons/ha			
	Highlands	Medium Highland		Medium Lowland	
	Kalampur	Kalampur-Kishorganj		Kalampur-Kishorganj	
O - 4	3.21 *	3.00 **	2.35 **		
OVT - 3	3.10 **	N.T	2.97 **		
Local olitorius	2.22 **	N.T			1.32
CVL - 1		2.86 **			1.16
CC - 45		2.68 **	1.56 *		
CV3 - 3		2.57 **		2.74	
Local Capsularis		2.38 **		2.49	
D - 154		2.64 **	2.03 *	2.20	
O - 9897		2.64 **		2.91 *	
Dhabhabey		2.47 **			
Chailali				3.00 *	

* Significant at 5% level

** Significant at 1% level.

TABLE: 78: Response of jute to the application of different rates of N.P and K in two land types. Kalampur Cropping Systems Site, BJRI, 1983-1984.

Treatments N - P - K (kgs/ha)	Yield(t/ha) Medium Highland*	Medium Lowland	Mean
0 - 0 - 0	1.40	1.85	1.62
45 - 0 - 0	1.69	2.41	2.05
0 - 10 - 0	1.67	2.18	2.43
0 - 0 - 20	1.65	2.17	1.92
45 - 10 - 0	2.03 **	2.38 *	2.18
0 - 10 - 20	1.90 *	2.44 *	2.17
45 - 0 - 20	1.99 *	2.52 **	2.25
45 - 10 - 20	3.20 **	2.77 **	3.00

* Significant at 5% level

** Significant at 1% level.

TABLE: 79: Performance of some local and improved varieties of rice in two land types of Kishorganj Cropping Systems Site, BJRI, 1983-1984.

Varieties	Yield (t/ha)			
	Medium Highland		Highland	
	Early Kharif	Late Kharif	Early Kharif	Late Kharif
Kashibini (Local)	1.97 *		1.98 NS	
Mala (Local)	1.77		2.19 NS	
Lema (Local)	1.81		2.10 NS	
Agali (Local)	1.45		N. P.	
BR - 3	4.23 **		N. P.	
Pajam		2.57 *		2.81
Purbachi		1.99		2.38
Birroi		2.00		2.10
Killoi		2.21 *		

N.P. = Not Planted

* = Significant at 5% level

** = Significant at 1% level

All varieties cultivated with same agronomic practices used for the cropping patter testing (See section-C)

TABLE: 80: Yield of promising varieties of wheat in Kalampur Cropping Systems Site, BJRI, 1982-1983.

Varieties	Yield (t/ha)
Inia - 66	1.99 NS
Jupateco	1.87 **
Pavon	1.51 **
Tanon	1.92 **
Sonalika	2.17

TABLE: 81: Yield of promising varieties of mustard in Kalampur Cropping Systems Research Site, BJRI, 1982-1983.

Varieties	Yield (t/ha)
TS - 72	.49
Rai - 5	.43
Tori - 7	.57
Australian	.41
SS - 75	.91

TABLE: 82: Yields of potato under two different agronomic practices.

Agronomic Practices	Yield (t/ha)
1-Mulching with water hyacinth	21.18
2-Eartherned	16.82

C. CROPPING PATTERN TESTING: AT MANIKGANJ (KALAMPUR) SITE

Most of the cropping pattern studies in the two sites operated by the BJRI were carried out from 1982 to 1984. Because of the modifications in the research programs the results in each site are discussed separately.

Year 1982 - 1983.

In this year, eight cropping patterns were evaluated in three (3) different land types. Two (2) were evaluated in rainfed medium highlands, three (3) in rainfed highlands and three (3) in the medium lowlands. The results obtained are summarized as follows.

RAINFED MEDIUM HIGHLANDS: - (Table-83)

The predominant cropping patterns grown by the farmers in this land type are Jute - Fallow - Wheat and Jute - Rice(t.aman) - Wheat. These cropping patterns cover about 14% of the total cultivated lands of the project area. The farmers usually plant the local variety of jute Capsularis, and the improved variety of wheat, Sonalika. The production of the cropping patterns in this land type can be increased by replacing the local variety of jute by the improved varieties CVE-1 or CVE-3. The yield of jute variety CVE-1 (2.47 t/ha) was 38% higher than the local variety of Olitorious jute (1.78 t/ha) when improved management practices were utilized. The yield of the jute variety CVE-3 (1.76 t/ha) was similar to the variety CVE-1. The yield of the wheat variety Sonalika with improved management practices was only slightly higher than the yield of wheat with improved management practices

The yields of rice(t.aman) in the cropping pattern jute - rice - wheat, were not substantially increased when the local variety of rice (3.05 t/ha) was replaced by the improved variety BR-10 (3.67 t/ha)

RAINFED HIGHLANDS: - (Table-84)

The three (3) cropping patterns evaluated in this land type were: Jute - Fallow - Potato, Jute - Fallow - Sweet Potato and Jute - Fallow - Cabbage. The yield of jute in all the patterns increased when the local variety Capsularis was replaced by the improved jute varieties O-4, or CVE-1. The yields of the improved potato variety Cardinal increased from 12.13 ton/ha to 15.0 t/ha with higher Nitrogen fertilizer and adjustment of the seed rate.

In this land type, the crops sweet potato and cabbage are also planted in the winter season. The performance of the cropping patterns including these two crops is presented in table-84).

RAINFED MEDIUM LOWLANDS: (Table-85)

This land type covers about 30% of the total cultivated area of the CSR site. The three (3) predominant cropping patterns are Rice(aus+aman)-Fallow, Jute - Fallow - Mustard and Rice(aus+aman) - Mustard. Rice and Jute are almost equal in importance on the project area in the early kharif season. The farmers' preference for one crop from the other is generally determined by the market price of each crop.

There are not available improved varieties of rice to replace the local varieties in the system Rice(aus+aman). The farmers plant a mix of local varieties Kalamanik and Asaya. The use of fertilizer in these local varieties resulted in a small increase in yield (from 1.73 to 1.90 t/ha). The mustard variety SS-75 had a higher yield than the local variety.

TABLE: 83: Agronomic and economic performance of Farmers'(F), Farmers' improved (FI) and Farmers' alternative (FA). Cropping Pattern in different lands types of Kalampur C.S.R. Site, B J R I, 1982 - 1983.

Land Type		RAINFED MEDIUM HIGHLANDS			
Pattern Management		F	FI	F	Fi
Cropping in the pattern	C1	Jute	Jute	Jute	Jute
	C2	Fallow	Fallow	Rice(t.aman)	Rice(t.aman)
	C3	Wheat	Wheat	Wheat	Wheat
Varieties	C1	Local (Cap)	CVL-1	Local (Cap)	CVE-3
	C2			Local	BR-10
	C3	Sonalika	Sonalika	Sonalika	Sonalika
Planting Dates (Range)	C1	March 14-31	March 14-27	March 23-27	March 23-27
	C2	-	-	August 6-24	August 6-24
	C3	November 17-19	November 11-17	December 8-9	December 8-9
Seed Rate(kg/ha)	C1	9	16	18	16
	C2	-	-	50	50
	C3	92	93	92	92
NPK (kg/ha)	C1	17 - 20 - 17	45 - 13 - 22	14 - 8 - 14	45 - 13 - 22
	C2	- -	- -	55 - 35 - 35	93 - 64 - 44
	C3	70 - 40 - 28	23 - 40 - 34	40 - 53 - 28	45 - 41 - 34
Field Duration (days)	C1	144	144	131	131
	C2	-	-	113	113
	C3	117	115	100	100
Yield (t/ha)	C1	1.78	2.47	1.76	2.49
	C2	-	-	3.05	3.67
	C3	1.84	2.28	1.82	2.05
Yield (kg/ha/day)	C1	12.4	17.1	13.4	19.0
	C2	-	-	27.0	32.5
	C3	15.7	19.-	18.2	20.5
Total Variable cost	C1	5,730	5,971	6,341	6,496
	C2	-	-	5,590	6,582
	C3	4,824	4,686	4,458	4,205
Gross Benefit(Tk/ha)	C1	8,324	12,589	18,265	11,658
	C2	-	-	14,974	17,763
	C3	6,652	8,588	6,583	7,294
Gross Margin(Tk/ha)	C1	2,594	6,618	1,924	4,990
	C2	-	-	3,313	11,182
	C3	1,823	3,902	1,807	3,189
Benefit Cost Ratio	C1	1.41	1.98	1.82	2.13
	C2				
	C3				

TABLE: 84: Agronomic and economic performance of Farmers'(F), Farmers'improved(FI) and Farmers' alternative(FA). Cropping Pattern in different lands types of Kalampur C.S.R. Site, B J R I, 1982 - 1983.

Land Type		RAINFED HIGHLANDS			
Pattern Management		F	FI	F	FI
Cropping in the pattern	C1	Jute	Jute	Jute	Jute
	C2	Fallow	Fallow	-	-
	C3	Potato	Sweet potato	Potato	Cabbage
Varieties	C1	Local (cap)	0-4	CVL-1	0-4
	C2	-	-	-	-
	C3	Cardinal	Local	Cardinal	K.Y. Cross
Planting Dates (Range)	C1	March 30 - Apr.1	March 24-27	March 30 - Apr.1	April 15-27
	C2	-	-	-	-
	C3	Nov.24 - Dec.16	October 19	December 10-19	Oct.16 - Nov.5
Seed Rate(kg/ha)	C1	15.6	16	13	10
	C2	-	-	-	-
	C3	1790	(31,250 cutting)	1870	N.A.
NPK (kg/ha)	C1	20 - 9 - 13	45 - 13 - 22	45 - 13 - 22	45 - 13 - 22
	C2	-	-	-	-
	C3	90 - 140 - 144	43 - 44 - 54	146 - 96 - 195	85 - 23 - 30
Field Duration (days)	C1	120	123	119	138
	C2	-	-	-	-
	C3	85	152	77	92
Yield (t/ha)	C1	1.78	2.30	2.00	1.92
	C2	-	-	-	-
	C3	12.13	10.40	15.00	(25,763 c.b)*
Yield (kg/ha/day)	C1	14.8	18.7	16.9	13.9
	C2	-	-	-	-
	C3	14.2	68.4	194.5	(280 c.b)
Total Variable cost	C1	5,511	6,720	5,131	5,022
	C2	-	-	-	-
	C3	13,441	6,443	14,783	8,105
Gross Benefit(Tk/ha)	C1	8,103	12,925	9,638	11,340
	C2	-	-	-	-
	C3	29,259	8,344	40,125	20,688
Gross Margin(Tk/ha)	C1	2,592	6,204	4,507	6,317
	C2	-	-	-	-
	C3	15,818	1,899	27,811	12,583
Benefit Cost Ratio	C1	1.97	1.61	2.50	
	C2				
	C3				

* Cabbage heads

TABLE: 85 : Agronomic and economic performance of Farmers'(F), Farmers' improved(FI), and Farmers' alternative(FA). Cropping Patterns in different lands types of Kalampur C.S.R. Site, B J R I, 1982 - 1983.

Land Type		RAINFED MEDIUM LOWLANDS		
Pattern Management		F	F	FI
Cropping in the pattern	C1	Rice(Aus+Aman).	Rice((Aus+Aman)	Jute
	C2	-	-	-
	C3	Fallow	Mustard	Mustard
Varieties	C1	Kalamanik	Kalamanik	CVL-1
	C2	+ Apsaya	L + Apsaya	-
	C3	-	Local	SS-75
Planting Dates (Range)	C1	March 25 - April 4	March 26 - April 25	April 12 - 18
	C2	-	-	-
	C3	-	November 4 - 15	November 8 - 15
Seed Rate(kg/ha)	C1	10 Kalamanik	10 (Aus)	12
	C2	55 Apsaya	51 (Banana)	-
	C3	-	14	12
NPK (kg/ha)	C1	0	20 - 0 - 0	45 - 13 - 22
	C2	-	-	-
	C3	-	30 - 40 - 28	20 - 54 - 26
Field Duration (days)	C1	88 (aus)	96 (aus)	126
	C2	189 (aman)	180 (aman)	-
	C3	-	66	87
Yield (t/ha)	C1	1.72 (aus+aman)	1.90 (aus+aman)	1.90
	C2	-	-	-
	C3	-	0.76	0.91
Yield (kg/ha/day)	C1	N.A.	N.A.	15.0
	C2	-	-	-
	C3	-	11.51	18.4
Total Variable cost	C1	4,007	4,180	5,894
	C2	(aus + aman)	-	-
	C3	-	2,419	3,218
Gross Benefit(Tk/ha)	C1	9,674	10,863	9,685
	C2	-	-	-
	C3	-	5,404	4,746
Gross Margin(Tk/ha)	C1	5,667	6,682	3,791
	C2	-	-	-
	C3	-	2,984	1,528
Benefit Cost Ratio	C1	2.42	2.46	1.58
	C2			
	C3			

Year 1983 - 1984.

A total of eight (8) cropping patterns were evaluated this year. The results in the three different land types are discussed below.

RAINFED MEDIUM HIGHLANDS: - (Table-86)

Two cropping patterns were evaluated in this land type: Jute - Rice(t.aman) - Potato and Jute - Rice(t.aman) - Wheat. The first pattern was observed both under farmers (F) and improved management practices (FI). The second pattern was observed only under improved practices.

The yield of all three crops in the cropping pattern; Jute - Rice(t.aman) - Potato, can be increased by, a) changing the local varieties with improved ones, b) using larger doses of N, P and K and c) adjusting the seed rate of the potato.

The yield of the jute variety CVE-1 (2.28 t/ha) was 18% higher than the yield of the local variety Capsularis (1.93 t/ha). The yield of the rice variety BR-10 (3.33 t/ha) was 74% higher than the yield of the local variety Apsaya. Yield of the potato variety Cardinal increased from 13.9 to 18.1 t/ha, when the fertilizer rate used by the farmers was increased.

In the cropping pattern Jute - Rice(t.aman) - Wheat, the yields were 2.6 t/ha of the jute variety D154, 3.26 t/ha of the rice variety BR-10 and 1.54 t/ha of wheat variety Sonalika, using improved mangement practices, mainly, balanced fertilizer doses.

RAINFED HIGHLANDS: - (Table-87)

Four cropping patterns are usually grown by the farmers in this land type: Jute - Fallow - Cabbage, Jute - Fallow - Potato, Jute - Fallow - Sweet Potato and Jute - Fallow - Lentil. The agronomic performance of these cropping patterns grown under farmers' practices (F) was compared with the performance using improved agronomic practices. The results of these observations are presented in table-87.

In all four patterns the yield of jute was considerably higher when the improved variety O-4 was used instead of the local variety Olitorious. The yield of the potato grown under farmers' practices (16.8 t/ha) was similar to the yield obtained with the practices considered as improved (16.4 t/ha), indicating that the farmers' practices to grow potato are adequate. The production of lentil slightly increased with the improved cultural practices. Yield of sweet potato increased from 7.30 to 10.43 t/ha when improved practices were used. The total number of cabbage heads harvested was larger with the improved technology. The economic analysis indicated that the cropping pattern Jute - Fallow - Cabbage was the most profitable.

RAINFED MEDIUM LOWLANDS: - (Table-88)

The performance of the two most common cropping patterns, Rice(aus+b.aman) - Fallow - Mustard and Jute - Fallow - Mustard was studied in this land type. As stated above, there is no suitable improved technology to replace the farmers' technology in the system Rice(aus + aman). The only scope for increasing production in this pattern is by replacing the local varieties of jute and mustard with improved ones and using higher doses of fertilizer nitrogen, phosphorus and potash.

TABLE: 86: Agronomic and economic performance of cropping patterns evaluated with Farmers'(F) and improved management practices(FI) in Rainfed Medium Highlands, Kalampur C.S.R. Site, B J R I, 1982 - 1984.

Land Type		RAINFED MEDIUM HIGHLANDS		
Pattern Management		F	FI	FI
Crops in the pattern	C1	Jute	Jute	Jute
	C2	Rice (t.aman)	Rice (t.aman)	Rice (t.aman)
	C3	Potato	Potato	Wheat
Varieties	C1	Capsularis (L)	CVL-1	D-154
	C2	Apsaya (Local)	BR-10	BR-10
	C3	Cardinal	Cardinal	Sonalika
Planting Dates (Range)	C1	April - 1	March - 31	March-30, April-7
	C2	August - 18	August - 19	August - 16
	C3	December - 16	December - 17	December - 12
Seed Rate(kg/ha)	C1	13.0	9.0	9
	C2	65.0	50.0	33
	C3	16.10	1870.0	93
NPK (kg/ha)	C1	35 - 0 - 0	46 - 10 - 27	46 - 10 - 27
	C2	52 - 0 - 0	75 - 54 - 39	75 - 54 - 39
	C3	60 - 29 - 53	112 - 77 - 149	80 - 60 - 39
Field Duration (days)	C1	126	128	131
	C2	115	115	117
	C3	73	77	107
Yield (t/ha)	C1	1.93	2.28	2.60
	C2	1.91	3.33	3.26
	C3	13.9	18.10	1.54
Yield (kg/ha/day)	C1	15.3	17.8	19.8
	C2	16.6	28.9	27.8
	C3	19.0	254.9	14.4
Total Variable cost	C1	5,540	6,090	6,064
	C2	5,830	6,722	6,749
	C3	15,866	19,253	5,282
Gross Benefit(Tk/ha)	C1	13,327	14,828	17,465
	C2	12,352	19,741	20,565
	C3	37,211	48,410	19,529
Gross Margin(Tk/ha)	C1	7,787	8,738	11,401
	C2	6,522	13,019	13,816
	C3	21,345	29,157	5,247
Benefit Cost Ratio	C1	2.41	2.43	2.88
	C2	2.12	2.94	3.05
	C3	2.35	2.51	1.99

TABLE: 87: Agronomic and economic performance of three cropping patterns under Farmers'(F) and improved management practices(FI) evaluated in Rainfed Highlands. Kalampur C.S.R. Site, 1983-1984.

Land Type		RAINFED HIGHLANDS			
Pattern Management		F	FI	F	FI
Crops in the pattern	C1	Jute	Jute	Jute	Jute
	C2	Fallow	Fallow	Fallow	Fallow
	C3	Cabbage	Cabbage	Potato	Potato
Varieties	C1	Olitorious	0-4	0-4/CVL-1	0-4
	C2	-	-	-	-
	C3	Local	Atlas 70	Patronese	Cardinal
Planting Dates (Range)	C1	April-23	April-22	April-19	April-18
	C2	-	-	-	-
	C3	November-29	November-30	December-14	December-5
Seed Rate(kg/ha)	C1	11.5	6.0	11.5	9.3
	C2	-	-	-	-
	C3	28,820 *	25,000 *	1,500	1,990
NPK (kg/ha)	C1	30 - 5 - 7	105 - 22 - 45	17 - 3 - 3.5	46 - 10 - 27
	C2	-	-	-	-
	C3	175 - 49 - 29	160 - 40 - 40	130 - 80 - 160	120 - 80 - 160
Field Duration (days)	C1	114	115	121	138
	C2	-	-	-	-
	C3	100	103	82	80
Yield (t/ha)	C1	1.73	2.43	2.22	3.10
	C2	-	-	-	-
	C3	23,829 H	24,467 H	16.8	22.5
Yield (kg/ha/day)	C1	15.1	21.1	18.3	22.5
	C2	-	-	-	-
	C3	238 H	237 H	204.0	20.5
Total Variable cost	C1	5,569	6,042	5,642	6,072
	C2	-	-	-	-
	C3	9,855	8,951	16,862	20,300
Gross Benefit(Tk/ha)	C1	13,819	20,825	17,024	24,080
	C2	-	-	-	-
	C3	29,774	32,052	45,088	43,936
Gross Margin(Tk/ha)	C1	8,250	14,782	11,400	18,008
	C2	-	-	-	-
	C3	19,919	23,101	28,226	23,636
Benefit Cost Ratio	C1	2.48	3.45	3.02	3.97
	C2	-	-	-	-
	C3	3.02	3.58	2.67	2.16

* Not Seedlings

TABLE: 87: (Contd.)

Land Type		RAINFED HIGHLANDS			
Pattern Management		F	FI	F	FI
Crops in the pattern	C1	Jute	Jute	Jute	Jute
	C2	Fallow	Fallow	Fallow	Fallow
	C3	Lentil	Lentil	Sweet Potato	Sweet Potato
Varieties	C1	Olitorious	0-4	Olitorious (L)	0-4
	C2	-	-	-	-
	C3	Local	Local	Local	Local
Planting Dates (Range)	C1	April-30	April-22	March 17-25	November-1
	C2	-	-	-	-
	C3	November-13	November-23	April-17,May-2	November-1
Seed Rate(kg/ha)	C1	10.6	9.0	12.6	6.0
	C2	-	-	-	-
	C3	2.2	3.3	3880	4,000
NPK (kg/ha)	C1	7 - 0 - 0	45 - 10 - 28	40 - 11 - 0	47 - 10 - 28
	C2	-	-	-	-
	C3	0 - 0 - 0	75 - 42 - 34	6 - 6 - 6	47 - 46 - 51
Field Duration (days)	C1	112	136	123	125
	C2	-	-	-	-
	C3	110	107	134	134
Yield (t/ha)	C1	1.91	2.84	1.78	2.74
	C2	-	-	-	-
	C3	0.98	1.08	7.30	10.43
Yield (kg/ha/day)	C1	17.0	20.8	14.4	21.9
	C2	-	-	-	-
	C3	8.9	10.0	54.4	77.8
Total Variable cost	C1	5,275	6,042	5,682	6,042
	C2	-	-	-	-
	C3	2,194	3,277	2,784	4,073
Gross Benefit(Tk/ha)	C1	15,477	24,537	14,325	23,496
	C2	-	-	-	-
	C3	8,403	9,260	7,811	11,214
Gross Margin(Tk/ha)	C1	10,202	18,495	8,643	17,456
	C2	-	-	-	-
	C3	6,204	5,983	5,029	7,141
Benefit Cost Ratio	C1	2.93	4.06	2.52	3.89
	C2	-	-	-	-
	C3	3.83	3.83	2.81	2.75

TABLE: 88: Agronomic and economic performance of cropping patterns evaluated under Farmers'(F) and improved management practices(FI) in Rainfed Medium Lowlands, Kalampur , C.S.R. Site, B J R I, 1983 - 1984.

Land Type		RAINFED MEDIUM LOWLANDS		
Pattern Management		F	F	FI
Cropping in the pattern	C1	Rice(aus+b.aman)	Jute	Jute
	C2	-	-	-
	C3	Mustard	Mustard	Mustard
Varieties	C1	Kalamanik	Capsularis (Local)	CVE-3
	C2	Apsaya	-	-
	C3	Local	Local	SS-75
Planting Dates (Range)	C1	March 27, April 4,	April 12 - 21	April 12- 29
	C2	-	-	-
	C3	November 18-25	November 19-25	November 19-25
Seed Rate(kg/ha)	C1	80 + 35	13.0	6.0
	C2	-	-	-
	C3	5.8	10.3	9.3
NPK (kg/ha)	C1	0 - 0 - 0	25 - 6 - 6	24 - 24 - 27
	C2	16 - 0 - 0	-	-
	C3	15 - 28 - 24	24 - 0 - 13	20 - 0 - 30
Field Duration (days)	C1	232	114	114
	C2	-	-	-
	C3	62	78	92
Yield (t/ha)	C1	1.54 + 2.10	1.01	2.76
	C2	-	-	-
	C3	0.97	0.85	1.29
Yield (kg/ha/day)	C1	15.6	8.8	24.0
	C2	-	-	-
	C3	15.6	10.9	14.0
Total Variable cost	C1	1,708	5,584	6,036
	C2	2,220	-	-
	C3	2,488	2,253	2,693
Gross Benefit(Tk/ha)	C1	9,691	6,847	18,449
	C2	14,407	-	-
	C3	10,185	8,480	13,825
Gross Margin(Tk/ha)	C1	7,983	1,263	12,413
	C2	10,187	-	-
	C3	7,697	6,227	11,132
Benefit Cost Ratio	C1	5.67	1.23	3.04
	C2	5.59	-	-
	C3	4.09	3.76	5.13

C1 - C2 = Rice (aus) + Rice (t.aman)

CC. CROPPING PATTERN TESTING: AT KISHORGANJ(VASHKAR KHILLA) SITE

Year 1982 - 1983.

During this year a total of ten cropping patterns were evaluated in three different land types. The results were as follows:

RAINFED MEDIUM HIGHLANDS: - (Table-89)

The performance of seven cropping patterns were evaluated in this land type. Two patterns were tested under farmers management practices (F) and five under improved management practices (FI).

The farmers in the area plant the jute variety D-154 and the rice variety Pajam in the double cropped lands. The yields in the pattern Jute - Rice(t.aman) - Fallow can be increased by a) replacing the jute variety D-154 with the variety CVE-1 and the rice variety Pajam by BR-11 and b) using fertilizer rates higher than the ones used by the farmers.

The yield of the rice variety BR-11 (3.04 t/ha) in the cropping pattern Rice(aus) - Rice(t.aman) - Fallow, was similar to the yield of the local variety Khirloi (2.85 t/ha) when grown under farmers' practices.

In the triple cropped lands the performance of the rice varieties BR-11 and BR-10 was satisfactory. In the cropping pattern Jute - Rice(t.aman) - Wheat the variety BR-4 yielded 3.9 t/ha. In the cropping pattern Jute - Rice(t.aman) - Lentil the yield of the variety BR-10 was 4.05 t/ha. These yields are considerably higher than the yields of the variety Pajam and of the other local rice varieties.

RAINFED MEDIUM LOWLANDS: - (Table-90)

Only one cropping pattern Jute - Fallow - Garlic was evaluated under farmers' practices in this land type. The information about its agronomic and economic performance is presented in table-90. The yields of both jute and garlic were low.

RAINFED HIGHLANDS: - (Table-90)

Two of the existing cropping patterns Jute - Fallow - Brinjal, and Jute - Fallow - Potato were observed under improved management practices. The yield of potato (5.0 t/ha) was very low because of the low soil moisture. The yield of brinjal was satisfactory. The net returns from this crop was higher than the net return from potato.

TABLE: 89 : Agronomic and economic performance of farmers'(F), farmers' improved(FI) and farmers' alternative(FA). Cropping Patterns Tested in Rainfed Medium Highlands of Vaskarkhilla C.S.R. Site, B J R I, 1982-1983.

Land Type		RAINFED MEDIUM HIGHLANDS						
Pattern Management		F	FI	FI	F	F	FI	FI
Crops in the pattern	C1	Jute	Jute	Jute	Rice(aus)	Rice(aus)	Jute	Jute
	C2	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)
	C3	Fallow	Fallow	Fallow	Fallow	Fallow	Wheat	Lentil
Varieties	C1	D-154	CVE-1	CVE-1	Mala	Lama	D-154	CVE-1
	C2	Pajam	BR-11	Pajam	BR-11	Khirlloi	BR-4	BR-10
	C3	-	-	-	-	-	Sonalika	Sonalika
Planting Dates (Range)	C1	Mar 3-20	Mar 21-27	Mar23-Aug5	Mar29-May6	March13-25	March22-30	March24-28
	C2	Aug.6-27	Aug.22-27	Aug.18-28	Aug.8-23	Aug.14-20	Aug.12-29	Aug.20-27
	C3	-	-	-	-	-	Nov.12-15	Nov.26-29
Seed Rate(kg/ha)	C1	8	13	9	N.A.	N.A.	8	7
	C2	50.70	50	50	N.A.	N.A.	50	50
	C3	-	-	-	-	-	137	27
NPK (kg/ha)	C1	18-0-0	45-11-22	45-11-22	13-0-0	18-0-0	45-11-22	45-11-22
	C2	19-0-0	48-36-24	20-0-0	25-18-0	18-0-0	58-43-26	74-54-39
	C3	-	-	-	-	-	22-23-12	4-0-0
Field Duration (days)	C1	139	143	135	116	131	135	134
	C2	109	96	98	112	112	112	92
	C3	-	-	-	-	-	95	69
Yield (t/ha)	C1	1.64	1.85	1.71	2.40	1.76	2.45	1.79
	C2	3.14	3.50	2.72	3.04	2.85	3.90	4.05
	C3	-	-	-	-	-	1.19	0.54
Yield (kg/ha/day)	C1	11.8	12.9	12.7	20.7	13.4	18.1	13.3
	C2	28.8	36.4	27.7	27.1	25.4	34.8	44.0
	C3	-	-	-	-	-	12.5	7.8
* Total Variable cost	C1	4,973	5,699	5,695	5,251	N.A.	5,114	6,185
	C2	4,011	5,213	3,395	5,201	N.A.	4,149	4,518
	C3	-	-	-	-	-	4,310	2,302
Gross Benefit(Tk/ha)	C1	8,687	8,942	9,403	10,703	N.A.	12,494	10,042
	C2	14,770	15,017	10,500	14,696	N.A.	15,764	17,520
	C3	-	-	-	-	-	4,375	5,170
Gross Margin(Tk/ha)	C1	3,710	3,244	3,707	5,451	N.A.	6,380	3,857
	C2	10,958	9,799	7,105	9,495	N.A.	11,615	13,002
	C3	-	-	-	-	-	05	868
Benefit Cost Ratio								

TABLE: 90: Agronomic and economic performance of one cropping pattern evaluated under farmers' agronomic practices(F) and of two cropping patterns evaluated with improved management practices in highland types.

Land Type		MEDIUM LOWLAND.	MEDIUM HIGHLANDS	
Pattern Management		F	FI	FI
Crops in the pattern	C1	Jute	Jute	Jute
	C2	Fallow	Fallow	Fallow
	C3	Garlic	Brinjal	Potato
Varieties	C1	Cap. Local	0 - 4	0 - 4
	C2	-	-	-
	C3	Local	Local	Cardinal
Planting Dates (Range)	C1	Feb. 25 - May 21	April 10 '83	April 19 '83
	C2	-	-	-
	C3	Nov. 29 - Dec 14	December 12 '83	December 12 '83
Seed Rate(kg/ha)	C1	7	6	4
	C2	-	-	-
	C3	250	(34,500)*	2,300
NPK (kg/ha)	C1	0 - 0 - 0	45 - 11 - 11	45 - 11 - 11
	C2	-	-	-
	C3	0 - 0 - 0	50 - 37 - 13	60 - 68 - 81
Field Duration (days)	C1	144	144	134
	C2	-	-	-
	C3	84	55	86
Yield (t/ha)	C1	1.20	1.79	2.46
	C2	-	-	-
	C3	2.03	17.74	5.00
Yield (kg/ha/day)	C1	8.33	12.4	18.3
	C2	-	-	-
	C3	24.16	322	58.0
Total Variable cost	C1	4,109	5,214	6,136
	C2	-	-	-
	C3	6,997	4,960	8,035
Gross Benefit(Tk/ha)	C1	5,165	11,782	12,059
	C2	-	-	-
	C3	18,256	38,842	22,656
Gross Margin(Tk/ha)	C1	1,056	6,568	5,923
	C2	-	-	-
	C3	11,259	33,882	14,621
Benefit Cost Ratio				

* Seedlings.

Year 1983 - 1984.

RAINFED MEDIUM HIGHLANDS: - (Table-91)

In this year five existing cropping patterns were evaluated under farmers' (F) and improved agronomic practices (FI). In addition, the performance of two of the existing patterns was studied under the farmers' practices. The performance of these patterns is presented in table-91.

In the cropping pattern Jute - Rice(t.aus) - Potato the yield of the jute variety D-154 (1.83 t/ha) grown with the farmers' technology was slightl less than the yield of the variety CVE-1 (2.01 t/ha) cultivated with improved practices. The yield of the rice variety BR-4 (3.38 t/ha) in the improved pattern was 19% higher than the yield of the rice variety Pajam (2.38 t/ha) cultivated with farmers' practices. Overall production in this cropping pattern did not increase substantially with the use of the improved practices

The production of the three crops in the cropping pattern Jute - Rice (t.aman) - Lentil increased with the use of improved management practices. The rice variety BR-4 yielded 770 kg/ha more than the local rice variety Kiloi. The yield of lentils w-th improved practices and farmers' practices were similar. The yield of the jute variety D-154 (1.95 t/ha) was 34% higher than the yield of the local variety (1.45 t/ha).

As in the case of the cropping pattern discussed above, the yields of all three crops in the cropping patterns, Jute - Rice(t.aman) - Khesari and Jute - Rice(t.aman) - Wheat increased with the improved management practices. However, the use of the improved practices required a higher cash investment that the farmers could not always afford. Furthermore, in some cases the increase in yields were not as high as the farmers wanted in order to accept the risk.

The economic performance of the cropping patterns, Jute - Rice(t.aman) - Fallow and Rice (local aus) - Rice(t.aman) - Fallow was studied only under the agronomic practices used by the farmers. These studies will serve as the basis to design some improved agronomic practices to be tested in the future.

RAINFED HIGHLANDS: - (Table-92)

Only the cropping pattern Jute - Fallow - Potato was studied in this land type. The yield of the improved jute variety O-4 was 300 kg/ha higher than the local variety (2.34 t/ha). The economic analysis of this pattern indicated that its profitability was similar to either farmers' improved practices.

RAINFED MEDIUM LOWLANDS: - (Table-93)

Two cropping patterns were studied in this land type, Jute - Fallow - Wheat and Jute - Fallow - Garlic. The overall production was higher with the improved practices but the increase in yield of the different crops was not substantial, and it is unlikely the farmers will be attracted by the practices evaluated.

TABLE: 91: Agronomic and economic performance of three cropping patterns evaluated under farmers'(F) and improved(FI) management practices, Vaskarkhilla C.S.R. Site, B J R I, 1983 - 1984.

INFORMATION		RAINFED MEDIUM HIGHLAND					
Land Type							
Pattern Management		F	FI	F	FI	F	FI
Cropping in the pattern	C1	Jute	Jute	Jute	Jute	Jute	Jute
	C2	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)
	C3	Potato	Potato	Lentil	Lentil	Khesari	Khesari
Varieties	C1	D-154	CVE-1	Local	D-154	Local	CVE-1
	C2	Pajam	BR-4	Killoi (L)	BR-4	Beroi (L)	BR-4
	C3	Local	Cardinal	Local	Local	Local	Local
Planting Dates (Range)	C1	March 11-15	March 24-28	March 10-20	April 2-11	Feb 25,Mar 25	Mar-26,Apr-11
	C2	August 7-11	August 11-21	August 2-15	August 16-22	August 1-26	August 12-26
	C3	Dec. 10-14	Dec. 12-22	Dec. 12-15	Dec. 12-22	Nov.2-12	Nov. 9-12
Seed Rate(kg/ha)	C1	104	10	10	9	11.0	10
	C2	26	28	26	27	25.0	27
	C3	860	1940	25	23	52.0	47
NPK (kg/ha)	C1	0 - 0 - 0	29-61-13	6 - 0 - 0	30-6-15	10 - 0 - 0	30-7-14
	C2	21 - 0 - 0	46-30-26	18 - 0 - 0	97-64-39	22 - 0 - 0	56-40-43
	C3	0 - 0 - 0	67-22-50	11-11-4	21-34-17	0 - 0 - 0	0 - 0 - 0
Field Duration (days)	C1	147	127	132	121	149	126
	C2	142	115	121	111	116	110
	C3	88	82	87	92	124	129
Yield (t/ha)	C1	1.83	2.01	1.47	1.95	1.48	1.99
	C2	2.83	3.38	2.84	3.61	2.45	3.54
	C3	6.12	5.21	0.57	0.66	0.71	0.84
Yield (kg/ha/day)	C1	12.4	15.8	11.1	16.1	10.0	15.0
	C2	19.9	29.3	23.4	32.5	21.1	32.0
	C3	69.5	63.5	6.5	7.1	5.7	6.5
Total Variable cost	C1	5,827	6,177	5,769	6,334	5,711	7,244
	C2	5,285	5,936	5,257	6,909	5,304	6,291
	C3	9,629	18,427	2,854	2,899	940	930
Gross Benefit(Tk/ha)	C1	11,298	12,382	8,364	12,497	9,108	12,218
	C2	17,398	18,308	16,216	19,032	14,662	19,033
	C3	16,395	13,958	3,665	4,244	3,120	3,691
Gross Margin(Tk/ha)	C1	5,471	6,205	3,595	6,163	3,397	4,974
	C2	12,113	12,372	10,959	12,123	9,368	12,742
	C3	6,766	-4,469	811	1m345	2,180	2,761
Benefit Cost Ratio	C1	1.94	2.00	1.62	1.97	1.59	1.69
	C2	3.29	3.08	3.08	2.75	2.76	3.03
	C3	1.70	0.76	1.28	1.46	3.32	3.97

TABLE: 91 : (Contd.)

Land Type		RAINFED MEDIUM HIGHLAND					
Pattern Management		F	FI	F	FI	F	FI
Cropping in the pattern	C1	Jute	Jute	Jute	Jute	Jute	Rice(local aus)
	C2	Fallow	Fallow	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)
	C3	Chilli	Chilli	Wheat	Wheat	Fallow	Fallow
Varieties	C1	Local	CC-45	Loc.Capsularis	D-154	Capsularis (L)	Local
	C2	-	-	Pajam	BR-4	Beroi/Killoi	Pajam
	C3	Local	Local	Wheat	Wheat	-	-
Planting Dates (Range)	C1	April 6-17	Mar.29-Apr.18	March 18-21	Mar.29.-Apr.7	March - 20	March - 9
	C2	-	-	July 25-27	August 28-30	Aufust-25	August-15
	C3	Nov-6,Dec-4	Nov.4-19	Dec. 12-16	Dec. 11-21	-	-
Seed Rate(kg/ha)	C1	10	8	13	10	8	56
	C2	-	-	47	60	22	32
	C3	32	32	137	160	-	-
NPK (kg/ha)	C1	0-0-0	45-16-8	17-9-7	25-9-14	46-0-0	23-0-0
	C2	-	-	19-17-0	37-38-44	0-0-0	17-0-0
	C3	48-9-0	48-25-19	17-0-0	60-49-40	-	-
Field Duration (days)	C1	87	79	122	128	113	116
	C2	-	-	122	98	102	102
	C3	180	130	109	92	-	-
Yield (t/ha)	C1	1.86	2.58	1.77	2.26	1.69	1.89
	C2	-	-	2.49	3.03	2.11	2.12
	C3	1.31	1.64	1.08	1.80	-	-
Yield (kg/ha/day)	C1	21.3	32	14.5	17.6	14.9	10.2
	C2	-	-	20.4	30.9	20.6	20.7
	C3	7.2	12.1	9.9	19.6	-	-
Total Variable cost	C1	5,724	6,711	6,163	6,215	6,394	4,934
	C2	-	-	5,555	6,290	5,150	5,290
	C3	6,593	6,235	5,394	3,919	-	-
Gross Benefit(Tk/ha)	C1	11,443	16,056	11,119	14,110	10,777	9,091
	C2	-	-	14,006	16,592	10,992	10,844
	C3	21,057	26,361	8,339	12,884	-	-
Gross Margin(Tk/ha)	C1	5,719	9,345	4,956	7,995	4,383	4,757
	C2	-	-	8,451	10,302	5,842	5,554
	C3	14,464	20,126	2,945	9,265	-	-
Benefit Cost Ratio	C1	2.00	2.39	1.80	2.27	7.69	1.84
	C2	-	-	2.52	2.64	2.13	2.05
	C3	3.19	4.23	1.55	3.56	-	-

TABLE: 92 : Agronomic and economic performance of cropping patterns evaluated under farmers'(F) and improved management practices(FI) in Rainfed Highlands type - Vaskarkhilla, B J R I, 1983-1984.

Land Type		RAINFED HIGHLANDS	
Pattern Management		F	FI
Cropping in the pattern	C1	Jute	Jute
	C2	Fallow	Fallow
	C3	Potato	Potato
Varieties	C1	Local	0-4
	C2	-	-
	C3	Local	Cardinal
Planting Dates (Range)	C1	April 10-19	April - 4
	C2	-	-
	C3	November 13-17	December-5
Seed Rate(kg/ha)	C1	9	10
	C2	-	-
	C3	920	1290
NPK (kg/ha)	C1	6.0 tons FYM	48-15-23
	C2	-	-
	C3	2.5 tons FYM	90-130-80
Field Duration (days)	C1	148	132
	C2	-	-
	C3	101	78
Yield (t/ha)	C1	2.34	2.74
	C2	-	-
	C3	5.90	5.75
Yield (kg/ha/day)	C1	15.8	20.7
	C2	-	-
	C3	58.4	73.7
Total Variable cost	C1	5,878	6,365
	C2	-	-
	C3	10,050	14,453
Gross Benefit(Tk/ha)	C1	17,700	20,545
	C2	-	-
	C3	15,806	15,404
Gross Margin(Tk/ha)	C1	11,822	14,180
	C2	-	-
	C3	5,776	950
Benefit Cost Ratio	C1	3.01	3.23
	C2	-	-
	C3	1.57	1.07

TABLE: 93: Agronomic and economic performance of two cropping patterns evaluated under farmers'(F) and improved management practices(FI) in Medium Highlands types of Vaskarkhilla C.S.R. Site, B J R I, 1983-1984.

INFORMATION					
Land Type		RAINFED MEDIUM LOWLANDS			
Pattern Management		F	FI	F	FI
Cropping in the pattern	C1	Jute	Jute	Jute	Jute
	C2	Fallow	Fallow	Fallow	Fallow
	C3	Wheat	Wheat	Garlic	Garlic
Varieties	C1	Local	CVE-3	Local	CVE-3
	C2	-	-	-	-
	C3	Sonalika	Sonalika	Local	Local
Planting Dates (Range)	C1	March 12-6	March-3, April-6	March 2-10	March 2-10
	C2	-	-	-	-
	C3	Nov-28, Dec-1	Nov-29, Dec-1	December 4-9	December 4-8
Seed Rate(kg/ha)	C1	12	105	11	9
	C2	-	-	-	-
	C3	110	112	92	92
NPK (kg/ha)	C1	5 - 0 - 0	21 - 6 - 9	10 - 0 - 0	27 - 7 - 16
	C2	-	-	-	-
	C3	30 - 48 - 33	67 - 55 - 33	0 - 0 - 0	25 - 40 - 16
Field Duration (days)	C1	132	120	131	138
	C2	-	-	-	-
	C3	108	107	92	101
Yield (t/ha)	C1	1.76	2.04	1.55	2.28
	C2	-	-	-	-
	C3	1.76	1.85	3.24	4.22
Yield (kg/ha/day)	C1	13.3	17.0	11.8	16
	C2	-	-	-	-
	C3	16.3	17.3	35	41.7
Total Variable cost	C1	5,982	6,307	6,019	6,407
	C2	-	-	-	-
	C3	5,446	5,892	3,838	4,581
Gross Benefit(Tk/ha)	C1	10,713	12,714	9,963	13,993
	C2	-	-	-	-
	C3	12,969	14,004	27,793	36,199
Gross Margin(Tk/ha)	C1	4,731	4,607	3,944	7,586
	C2	-	-	-	-
	C3	7,523	8,112	23,955	31,618
Benefit Cost Ratio	C1	1.79	2.02	1.66	2.18
	C2	-	-	-	-
	C3	2.38	2.38	7.24	7.90

SUGARCANE RESEARCH AND TRAINING INSTITUTE

138 A

ISHURDI SITE

A. BENCHMARK SURVEY - SITE DESCRIPTION

The Benchmark Survey at the project area was started in October 1980. The findings are summarised below:

a) Location:

The project area comprises five villages, namely Musidpur, Diarbagoil, Charruppur, Shahpur and Mohadebpur of Ishurdi Thana in Pabna District. The area lies beside the Ishurdi - Kushtia Road, about five km from the Sugarcane Research and Training Institute.

b) Social Infrastructure:

Out of the total population, 33% are adult male, 27% adult female and 40% are children. Average family size varies from 9 to 18 members. On an average, 23% of the family members are working as family labourers. The level of literacy varies from 89% at Munsidpur to 47% at Diarbagoil.

c) Farm Size and Tenancy:

Land holdings vary; 33.9 per cent having less than 1.0 ha, 21.5 per cent between 1.0 and 2.0 ha, 21.5 per cent with 2 to 4 ha, 15.4 per cent with 4 to 8 ha and 7.7 per cent above 8 ha.

d) Agroclimatic Conditions:

Rainfall	-	1700 mm (4 years average)
Temperature	-	Maximum 31.4°C, Minimum 21.0°C
Humidity	-	82%

Soils in the project area fall under the Ganges River Flood plain soiltypes. They are slightly to moderately alkaline with pH 7.00 to 8.5. The soils are heavy, soft clay and get sticky when wet. When dry they become hard land compact with wide cracks at the surface. The soil is low in organic matter and nitrogen but rich in potassium. The availability of phophorus is low due to a high content of calcium and calcium carbonate.

e) Land Type:

Flood free highland rainfed.

f) Cropping Patterns:

Rice (aus)	-	Fallow	-	Vegetables
Rice (aus)	-	Fallow	-	Lentil
Rice (aus)	-	Fallow	-	Mustard
Rice (aus)	-	Onion(bulb)	-	Vegetable
Rice (aus)	-	Onion(bulb)	-	Sugarcane
Rice (aus)	-	Fallow	-	Sugarcane
Jute	-	Fallow	-	Mustard
Jute	-	Fallow	-	Lentil
Tumeric	-	Vegetables.		

g) Labour Supply:

On an average, 23% of family members made up the effective labour force on their farms.

h) Livestock:

Sufficient bullock power is available with an average of 2.83 animals per farm. This is from 4.89 at Munsidpur to 1.57 at Charruppur. One third of farmers rented animals while 15 per cent shared animals.

i) Input Use and Sources:

Crops seeds are obtained from various sources. The market provides 20% of farmers with rice seed, 23% with pulse seed, 17% with oilseeds and 18% with wheat seeds. Two per cent and 8% of farmers purchased seed of pulses and wheat from research institutions. About 40% receive seeds of sugarcane from sugar mills and 2% from other farmers. Forty-three per cent use no insecticide on their land and 20% no fertilizer. Fertilizers are bought from the market (25%), dealers (66%) or sugar mills (94%).

Only 31% of farmers irrigate their land by deep tubewell.

j) Major Crops:

Major crops grown in the project area are rice (b.aus), sugarcanr, jute, lentil, mustard, brinjal, chilli, onion and vegetables.

k) Constraints to Crop Production:

The main constraints to crop production are:

* Uneven distribution of rainfall;
* Lack of any arrangement for supplying seeds of good varieties of vegetables or other crops;
* Unreliable supply of fertilizer;
* Insufficient knowledge of crop production technology.

Performance of sugarcane intercropping systems:

The evaluation of three different cropping systems with sugarcane as the main component crop was initiated in November, 1980. Systems to be evaluated are:

System A : Sugarcane intercropped with lentils, gram, peanuts, coriander, spinach, onion and mustard. Sugarcane pure stand was used as a control.

System B : Sugarcane + Mustard
Mustard - Sugarcane
Sugarcane Fallow

System C : Sugarcane + Potato
Potato - Sugarcane
Sugarcane Fallow

Planting and harvesting dates for the different systems are approximate.

The yields of the intercrops in Systems A are presented in Table-94. The yields of lentil, gram and peanuts as intercrops were very low, possiyly due to late sowing and the effects of heavy rainfall early in the season. The yields of mustard, coriander and spinach are satisfactory. It seems that sugarcane will not be affected by competition from the intercrops.

The yields of mustard as a monocrop were higher than in association with sugarcane (Table-94). However, in the mustard sugarcane system the planting date of sugarcane was delayed, so yields suffered because of poor germination and low tillering. No marked difference was observed in yield between sugarcane grown as monocrop and sugarcane intercropped with mustard.

In cropping system C, higher yields of potato were obtained when it was intercropped with sugarcane (Table-95). It is possible that the potato crop utilised some of the fertilizer applied to the sugarcane. Sugarcane planted after harvesting potato is inferior with respect to germination, tillering and growth to cane planted initially as a monocrop or intercrop.

B. COMPONENT TECHNOLOGY STUDIES AND CROPPING PATTERN TESTING.

The SRTI's research in cropping systems has been oriented to studying how sugarcane performs when intercropped with winter crops. Sugarcane takes about 15 months from planting to harvesting. There are approximately 162,000 hectares of it under cultivation. Since its initial growth rate is slow land use can be intensified by intercropping winter crops. The Institute has been giving emphasis to these types of studies and the results

obtained are encouraging. In most intercroppings the sugarcane yield is decreased but the products of the winter crop compensate for for this. Improving human diet through production of pulses is possibly the major potential offered by these new systems.

The research with farmers' participation was conducted at Sahpur Cropping Systems Research Site during the period 1980-83. In this site three different systems were studied. The system-1 followed the patterns Rice(aus) - Sugarcane + Rabi crops or Rice(aus) - Rabi crop - Sugarcane. The system-2 followed the patterns Jute - Sugarcane + Rabi crops or Jute - Rabi crops - Sugarcane. In the system-3 the performance of several crops, (mainly vegetables) in intercropping with early planted sugarcane was evaluated.

In the System-1 seven treatments were studied (Table-94). The crops were established in plots which have been cultivated with rice in the early kharif(aus). The farmers usually grow the local variety Hajali which is sown broadcast in April and harvested at the end of July. The farmers in the area use very little chemical fertilizer, particularly for the aus crop. Cowdung or compost is sometimes applied during land preparation. There are no systematic efforts to control pests and diseases in the aus crop. These poor cultivation practices resulted in low yields averaging 1.58 t/ha, and an average net return of Tk.2,171/ha.

After the rice (aus) was harvested the land remained fallow for 45-50 days before ploughing was started for the sugarcane and/or rabi crops. The land was well prepared. Three-budded sugarcane setts were planted in rows one metre apart. Potato, mustard and lentil were sown at the same time between the two rows of sugarcane. The recommended fertilizers were applied as basal doses at planting and top dressed in the growing stage. Varieties used were: sugarcane - CO 1158; mustard - SS 75; potato - Cardinal; and local lentil. Each of the rabi crops yielded better as a solecrop.

Planting sugarcane after the three rabi crops (treatments 4,5, and 6) had a very adverse effect on these yields. Sugarcane planted after potato produced a comparatively higher yield than when planted after mustard or lentil. The land equivalent ratio (LER) was higher than 1 in the three intercrops studied and two of the intercrops gave profits over the monocrop of sugarcane (Table-95).

The yield and yield-contributing attributes of sugarcane in these same combinations of intercrops are presented in table-96. Sugarcane intercropped with potato produced significantly higher yields than when intercropped with mustard or lentil. Sugarcane gave a similar yield when planted in pure stand, or when intercropped with potato.

A significantly higher percentage of germination and larger number of tillers and millable sugarcane were also observed in the intercrop with potato.

The system-2 consisted of five treatments (Table-98) established after harvesting jute. Olitorius jute was sown in the first fortnight of April and harvested early in September. Standard cultural practices were followed.

The average yield was 1.12 t/ha, the average production cost Tk.2,689/ha and the net profit per hectare was Tk.319 (Table-97).

After the jute harvest, the land was prepared for cultivation of the rabi crops. Sugarcane was planted first, in the last week of October, which is the ideal time to obtain maximum yield and economic benefit. The mustard and lentil were sown two to three days afterwards, on the same date as the solecrop of sugarcane.

In the intercropping system the sugarcane was planted in furrows one metre apart, with one line of mustard or lentil sown on ridges between the sugarcane rows. Pure stands of mustard and lentil were sown in lines 22cm and 15cm apart respectively. The yields of mustard lentil and sugarcane were higher when grown as a monocrops than when intercropped with sugarcane The LER for the intercroppings was higher than 1 and the intercroppings gave profits over the sugarcane in pure stand.

As in the case of system-1, the yields of sugarcane planted after lentil or mustard were considerably lower than the ones of sugarcane planted early (Table-98). The germination percentages, number of tillers, millable cane and yield per hectare of sugarcane are presented in table-99. Significantly higher germination, more tillers, millable cane and yield were obtained in the sugarcane in pure stand. Next best was sugarcane plus lentil, then sugarcane plus mustard. Planting sugarcane after harvesting either of the rabi crops resulted in low germination, poor tillering, millable cane and yield. The lowest yield of all was obtained when sugarcane was planted after harvesting mustard.

In system-3 five winter crops were individually intercropped with sugarcane: radish, spinach, onion, gram and mustard. A pure stand of sugarcane was used as the control. Planting was carried out following crop of local aus rice, which was sown broadcast in the first week of April. Standard cultivation practices were followed. No chemical fertilizer was applied to the aus crop. It was harvested by the last week of July. The average yield was 1.38 t/ha with a net profit of Tk.1,495/ha. This is based on a price for paddy of Tk.2,680/t and labour at the rate of Tk.12 per eight hour day (Table-100).

The farmers prepared the land for the rabi crops after the aus was harvested. Sugarcane was planted by the first week of November. Planting was in ploughed furrows following the end-to-end method of seed placement. The recommended doses of fertilizer were applied.

One row of radish, gram or mustard, was sown on the ridges, and two rows of spincch or three rows of onion seedlings were transplanted between the sugarcane rows. Additional fertilizer was applied for the intercrops. The agronomci performance of the intercrops is presented in table-101. The highest yield of sugarcane was obtained from the pure stand. Next highest yield was obtained from the intercrop with onion. Yield and yield-contributing

factors of sugarcane as affected by the intercrops are presented in table-102. Sugarcane + Mustard resulted in the lowest percentage of germination and less tillers and millable cane. A significantly higher rate of germination, millable cane and tillers was obtained by growing the sugarcane as solecrop.

C. ON-STATION EXPERIMENTS

The objective of the experiments was to determine which potato and mustard varieties are most suitable for intercropping with sugarcane. Three varieties of potato (Cardinal, Multa and Kupri Sinduri) and three of mustard (Rai-5, Tori-7 and SS-75) were planted as intercrops with sugarcane in last week of October in the years 1981-1982 and 1982-1983.

The sugarcane was planted in one metre rows by the end-to-end method of seed placement. The recommended dose of fertilizer was applied and normal cultural practices followed.

One line of potato was planted on the ridges with an additional application of fertilizer. The yields of potato were generally very low but the variety Cardinal gave the highest yield in the intercropping systems, producing nearly twice as much as the other two varieties (Table-103).

One line of mustard was sown on each ridge in the last week of October. Additional fertilizer was applied for mustard and standard cultivation practices followed for both crops. The Tori-7 matured about 10 days early than the other varieties (harvested 7 February 1982 compared to 17 February). SS-75 and Rai-5 yielded nearly twice that of Tori-7 (Table-104). The intercropping of sugarcane with the mustard variety Tori-7 and SS-75 resulted in the higher yields of sugarcane, possibly due to a lower shading effect and the early-maturing nature of these varieties.

The mustard variety SS-75 seems the more suitable for this system since its yield in intercrop is high and it reduces the yield of sugarcane less than the other varieties tested.

Conclusions:

On the basis of research results obtained in SRTI Cropping Systems Research Site and the Research Station during the years 1980-1983 the following conclusions can be drawn.

- The yields of sugarcane and winter crops in intercroppings are higher in a system Jute - Sugarcane + Rabi crops than in the system Rice - Sugarcane + Rabi crops.

- The yields of sugarcane are higher when it is planted early (October) than when it is planted late (March-April).

- Early planting (October) of sugarcane permits to intercrop winter crops like potato, mustard and several vegetables.

- The yields of sugarcane are generally reduced when it is intercropped with rabi crops. The yield reduction changes with the different crops.

- Intercropping of potato and mustard with sugarcane in the systems Rice - Sugarcane + Rabi crops or Jute - Sugarcane + Rabi crops, gave higher economic benefits than the systems rice or jute+winter crops or than sugarcane as a solecrop.

- The yields of sugarcane when intercropped with potato are similar to the yields of sugarcane as solecrop. Apparently the fertilizer applied to potato is not efficiently used leaving a high residual effect to sugarcane.

- The mustard variety SS-75 produced the higher yields when intercropped with sugarcane, but the yields of the last crop were reduced more than when the mustard variety Rai-5 or Tori-7 are planted.

- Intercropping sugarcane with onion, spinach or radish showed a good potential for increasing farmers' economic benefits.

- The intercropping of sugarcane with winter crops required high cash investment (mainly fertilizer). Partial irrigation is advisable to increase fertilizer use efficiences by the rabi crops.

TABLE: 94: Agronomic and economic performance of rice(aus) in the systems rice - sugarcane+rabi crops or rice - rabi crops - sugarcane (system 1). Sahpur Cropping Systems Research Site, SRI, 1981 - 1983.

Rice (aus) Variety	Dates - 1981 Sowing	- Harvesting	Yield (t/ha)	Value (t/ha (1))	Production Cost (Tk/ha (2))	Net Return (Tk)
Hajali	5 April	18 July	1.84	4931	2143	2788
Hajali	4 April	16 July	1.65	4422	1913	2905
Murisbati	8 April	26 July	1.47	3939	1775	2164
Hajali	7 April	23 July	1.65	4422	1763	2659
Murisbati	7 April	24 July	1.30	3484	2750	734
Mean			1.58	4240	2069	2171

(1) Price of paddy = Tk. 2680/t

(2) Labour rate = Tk. 12/eight hour day.

TABLE: 95: Agronomic and economic performance of sugarcane intercropping systems established after aus rice (System-1). Sahpur Cropping Systems Research Site, Ishurdi, 1981 - 1983.

Treatments	Crops Yield(t/ha)						LER	Profit or Loss over monocrop of Sugarcane
	Intercrop			Sugarcane				
	1981-82	1982-83	Mean	1981-82	1982-83	Mean	Mean	
Sugarcane + Potato	6.35	4.35	5.35	67.9	66.6	61.2	1.83	7.128
Sugarcane + Mustard	0.76	0.84	0.80	54.5	63.1	58.8	1.77	2.073
Sugarcane + Lentil	0.35	0.59	0.47	55.7	62.1	58.9	1.58	-1.886
Mustard - Sugarcane	0.88	0.96	0.92	34.0	45.2	40.1	-	- 551
Lentil - Sugarcane	0.62	0.73	0.68	37.8	45.1	41.4	-	-4,601
Potato - Sugarcane	7.26	4.91	6.08	41.5	48.3	44.9	-	-6.797
Sugarcane (early planted in pure stand)	-	-	-	68.2	69.3	68.8		

TABLE: 96: Yield and yield-contributing attributes of sugarcane as affected by the intercrops (System 1). Sahpur Cropping Systems Research Site, Ishurdi, 1981-1983.

Treatments	Germination %	Tillers ('000')	Millable cane ('000')	Cane yield (t/ha)	Sucrose Content
Cane (Pure stand)	53.92d	159.42c	82.59d	68.19d	10.38
Cane + Potato	50.51d	163.89c	74.35c	67.87d	9.95
Cane + Mustard	44.66c	138.21b	67.86b	54.46c	10.20
Cane + Lentil	44.03c	141.94b	68.48b	51.30bc	9.83
Cane after potato	42.67c	114.22a	52.63a	41.55ab	9.95
Cane after mustard	35.44a	116.29a	53.42a	33.95a	10.14
Cane after lentil	37.66ab	117.52a	55.99a	37.78a	10.06

TABLE: 97: Agronomic and economic performance of Jute in the system Jute - Sugarcane + Rabi crops (System 2). Sahpur Cropping Systems Research Site, S.R.I. 1980 - 1983.

Dates - 1981 Sowing - Harvesting	Yield (t/ha)/1	Value (Tk/ha)	Production cost (Tk/ha)/2	Net Return (Tk)
7 April - 7 September	0.99	2671	2470	+201
12 April - 3 September	1.24	3346	2790	+556
14 April - 6 September	1.30	3507	2971	+536
8 April - 3 September	0.93	2509	2523	- 14
Mean	1.12	3008	2689	+319

1/ Fibre price = Tk.2698/t, Stick price = Tk. 322/t.

2/ Production cost includes land preparation; weeding, thinning and mulching; manure; seed; harvesting, carrying and extraction; and drying, storage and transportation.

TABLE: 98: Agronomic and economic performance of sugarcane intercropping systems established after jute (System-2). Sahpur Cropping Systems Research Site, S.R.I. 1981-1983.

Treatments	Crop Yields(t/ha)						LER	Profit or Loss over monocrop of Sugarcane
	Intercrops			Sugarcane				
	1981-82	1982-83	Mean	1981-82	1982-83	Mean	Mean	
Sugarcane + Mustard	0.79	0.78	0.79	76.1	56.4	66.2	1.59	2,135
Sugarcane + Lentil	0.37	0.40	0.39	78.9	61.6	70.2	1.61	844
Mustard* - Sugarcane	1.07	1.15	1.11	66.7	41.0	53.8	-	-1,748.1
Lentil* _ Sugarcane	0.51	0.62	0.57	66.8	43.1	54.9	-	-5,299
Sugarcane (early planted in pure stand)	-	-	-	83.6	66.8	75.2	-	-

* Mustard and Lentils in treatments 3 and 4 are the monocrops.

TABLE: 99: Yield and yield-contributing attributes of sugarcane as affected by the intercrops (System-2). Sahpur Cropping Systems Research Site, S.R.I., 1981 - 1983.

Treatment	Germination %	Tillers ('000')	Millable cane ('000')	Cane yield (t/ha)	Sucrose content
Cane (Pure stand)	51.42c	158.23c	96.64b	83.60c	10.37
Cane + Mustard	44.98b	141.66b	92.14ab	78.10b	10.07
Cane + Lentil	41.59b	151.51c	95.60b	78.91bc	9.58
Cane after Mustard	36.34a	127.79a	80.50a	66.70a	10.18
Cane after Lentil	33.94a	135.91ab	80.68a	66.84a	10.06

TABLE: 100: Agronomic performance of rice(aus) in a systems Rice(aus) - Sugarcane + Rabi crops. (System-3). Sahpur Cropping Systems Research Site, Ishurdi, 1980-1983.

Aus Variety	Dates - 1981 Sowing	Harvesting	Yield (t/ha)	Value (Tk/ha (1))	Production cost(Tk/ha)/2	Net Return (Tk)
Marichbati	7 April	25 July	1.65	4422	2100	+2322
Hajali	4 April	17 July	1.38	3698	1950	+1748
Marichbati	8 April	26 July	1.11	2975	3250	- 276
Hajali	6 April	22 July	1.38	3698	1512	+2186
M e a n		1.38	3698	2203	+1495	

1/ Price of paddy = Tk. 2680/t.

2/ Labour rate = Tk. 12/eight-hour day.

TABLE: 101: Agronomic and economic performance of sugarcane* and winter crops in intercropping systems (System-3). Sahpur Cropping Systems Research Site, 1981 - 1983.

Treatments	Yields (t/ha)						Profit or loss over sugarcane monocrop (Tk/ha)
	Intercrops			Sugarcane			
	1981-82	1982-83	Mean	1981-82	1982-83	Mean	
Sugarcane + Radish	10.8	11.4	11.1	68.7	61.7	85.2	4397
Sugarcane + Spinach	2.5	5.3	3.9	67.4	68.1	67.7	5600
Sugarcane + Onion	-	3.9	1.9	70.9	71.7	71.3	6298
Sugarcane + Gram	0.52	0.5	0.5	66.7	66.1	66.4	228
Sugarcane + Mustard	0.7	0.5	0.6	71.0	66.2	68.6	1226
Sugarcane + Solecrop				73.9	72.1	73.0	-

* Sugarcane planted in October. (early planting)

TABLE: 102: Yield and yield-contributing attributes of sugarcane as affected by the intercrops (System 3). Sahpur Cropping Systems Research Site, 1981-1983.

Treatments	Germination %	Tillers ('000')	Millable cane ('000')	Cane yield (t/ha)
Cane (Pure stand)	53.93c	157.88d	93.38d	73.90d
Cane + Radish	46.99b	150.78bc	79.39b	68.75bc
Cane + Spinach	45.92b	144.91ab	83.23bc	68.77bc
Cane + Onion	50.01bc	156.07cd	87.09c	72.47d
Cane + Gram	50.01bc	150.93bc	79.78b	65.42ab
Cane + Mustard	38.97a	139.50a	72.79a	61.45a

TABLE: 103: Performance of different potato varieties when intercropped with sugarcane. Research Station, S.R.I., 1981 - 1983.

Treatment	Yield (t/ha)						Profit or loss over sugarcane in pure stand (Tk/ha)
	Sugarcane			Potato (Intercrop)			
	1981-82	1982-83	Mean	1981-82	1982-83	Mean	
Sugarcane + Cardinal	70.9	99.8		6.48	9.40	7.94	14,963
Sugarcane + Multa	70.5	109.0		3.76	4.52	4.14	8,577
Sugarcane + Kufri Sinduri	71.5	92.4		3.50	5.24	4.37	6,246
Sugarcane Pure Stand	64.3	90.8		-	-	-	-

TABLE: 104: Performance of different mustard varieties when intercropped with sugarcane. Research Station, S.R.I. 1981 - 1983.

Treatments	Sugarcane			Mustard (Intercrop)			Profit or Loss over sugarcane in pure stand (Tk/ha)
	1981-82	1982-83	Mean	1981-82	1982-83	Mean	
Sugarcane + Rai 5	66.8	85.8	76.3	0.99	1.07	1.03	1,927
Sugarcane + Tori 7	75.8	84.8	80.3	0.54	0.81	0.68	1,950
Sugarcane + SS 75	71.4	89.0	80.2	0.99	1.03	1.01	3,347
Sugarcane pure stand	74.4	97.3	85.0	-	-	-	-

ANNEX: 1 - Agronomic practices for sugarcane and rabi crops planted as monocrops or in intercrops. Cropping Systems Research Site, 1981 - 1983.

Crops	Variety	Date of Planting	Seed Rate/ Spacing	Fertilizer Mono	Fertilizer Inter	Method of Application
Sugarcane	CO-1158	Oct. 25-30	5.25 t/ha (1 meter between rows)	136-142-119	136-142-119	
Rice	*	April25-30	92 kg/ha (broadcast)	42-44-28	-	All at sowir time.
Potato	Cardinal or Kupri Sinduri	Oct. 25-30	0.98 t/ha (22" bet lines) (One row between 2 rows sugarcane)	159-94110	95-63-48	All at sowir time
Mustard	SS-75	Oct. 25-30	6 kg (9" bet lines) (One rwo between 2 rows sugarcane)	63-66-34	21-22-14	All NPK at sowing time
Lentil	Local	Oct. 25-30	20 kg/ha (6" bet lines) (One row between 2 rows sugarcane)	32-72-17	11-22-11	All NPK and sowing tin
Radish	Mino Early	Oct28-Nov3	1.0 SrS. (One row between 2 rows sugarcane)	-	-	All NPK at seeding as per sugarcane recommendation.
Spinach	Local	Oct28-Nov3	1.5 SrS (One rwo between 2 rows sugarcane)	-	-	All NPK at seeding as applied to sugarcane.
Onion	Local	Sept.15-30	4 Maunds (2 lines between 2 rows sugarcane)	-	-	All NPK at planting as per sugarcane recommendation
Gram	Local	Nov. 25-30	4 SrS (One line between 2 rows sugarcane)	-	-	All NPK at seeding as per sugarcane.

BANGLADESH WATER DEVELOPMENT BOARD

157
A

THAKURGAON SITE

The Cropping Systems Research Site selected at Thakurgaon is representative of the irrigated area of the northern region of Bangladesh. During the first year (1980-1981) baseline information about the project area was collected to get a better understanding of farmer practices. In March 1981, component technology studies were initiated on both experimental station plots and in farmers' fields. The predominant cropping patterns have been determined and evaluation begun in the Experimental Station.

A. THE BENCHMARK SURVEY - SITE DESCRIPTION

Because of lack of trained staff a systematic and technical Benchmark Survey was not conducted. The following information was obtained from informal interviews with farmers, experienced persons in the project area, and secondary sources.

a) Location:

The project area is located about 16 kilometres from Thakurgaon in the village of Suk-Akcha which forms part of the Thakurgaon Tubewell project area.

b) Social Infrastructure:

The average family size in the area ranges from 6.0 to 7.3 members. From 60 to 80 per cent of the population are illiterate and the rest have only primary education. All farm families in Kachubari and Munshihat derive their income from agriculture. In the other villages, 10% to 15% of the family members have off-farm employment.

c) Farm Size and Tenancy:

The area of cultivable land owned by farmers ranges from 1.2 to 2.2 ha. The number of plots owned per family ranges from 10 to 35.

d) Agroclimatic Conditions:

Rainfall:

Total annual rainfall in 1980 was 2,120mm. The pattern indicates that there is enough rainfall from May to October to have two rainfed rice crops in the area. A triple crop system may also be considered on some land types with residual moisture.

Temperature:

The highest maximum temperature, 33°C, occurs in April. The average minimum is 29°C. Temperature rises late in Thakurgaon, favouring the growth of late-planted wheat in the area.

Evapotranspiration:

There was no available data on evapotranspiration in the project area. However, the district data are recorded as 805mm, 925mm for the years 1977-1978 and 1979 respectively.

Soils:

The soils in the selected sites vary from sandy loam to loam, and sandy clay loam to clay loam. The pH ranges from 5.0 to 6.0 in the plough layer and from 6.0 to 7.0 in the subsoil. The organic matter content of soil ranges from 1.5 to 2.5%.

d) Land Types:

The whole of the project area is located in flood free highlands with tubewell irrigation.

f) Cropping Patterns:

Predominant cropping patterns in the area are:

Fallow - Rice(LIV aman) - Wheat (35% of the total area)
Rice(t.aman LIV) - Rice(t.aman HYV) - Wheat (24% of the area)
Jute - Rice(LIV t.aman) - Wheat (21% of the area).

g) Labour Supply:

Farming is the sole occupation of more than 80% of the family members in the area. Only six percent of family members work as day labourers, a factor which may limit adoption of farming systems which need hired labour.

h) Livestock:

The average number of draught animals per family is 2.4. Sixtyseven per cent of the farmers interviewed had a milk cow and 10-15 per cent have young stock.

i) Input Use Source:

The management practices followed by the farmers at Kachubari are similar. The average rate of fertilizer use for high yielding varieties of rice is 50-60-40 kg/ha NPK and 12-12-0 kg/ha NPK for local varieties.

During the rabi season, those farmers in Kachubari who grow wheat use Sonalika, Jupateco and Pavon. Sonalika is the most popular, but Pavon produces the highest yield (3.0 t/ha). Farmers use more fertilizer on wheat than on rice. Average rates are 50-60-40 kg/ha NPK for Sonalika, 80-80-50 kg/ha NPK for Jupateco and 70-70-50 kg/ha for Pavon.

In Suk-Akcha farmers who planted HYV rice (a limited number at present) used more fertilizer for BR-4 than BR-3. Very low rates of fertilizer are used with local varieties.

In Mushihat a rice variety (originated at the Philippines but not clearly identified) was grown on 50% of the project area during 1980-81 Varieties BR-3 and BR-4 are relatively new here. Improved varieties of Wheat (Sonalika and Pavon) are commonly planted but their yields are only of 1.6 and 1.7 t/ha respectively.

Fertilizer and improved seeds are generally readily available in the project area, supplied by a BADC dealer and TCCA Ltd.

j) Crop Production and Use:

Major crops grown are rice, wheat, jute, sugarcane, kaon, mustard and potato. Marketing facilities present a major constraint to farmers. Tobacco production, previously high in the area, has decreased because of similar problems. Potato and vegetable productions offer a good potential but storage facilities are limited. The area planted to sugarcane is increasing becuase of marketing incentives offered by sugar factories.

k) Constraints to Crop Production:

Factors which limit crop production in the Thakurgaon area are stil not clearly defined. The limited use of improved varieties of rice and of fertilizer is of course one limitation. The effect of planting dates, appropriate weed and pest control, and soil and water management will be studied directly in farmers' fields. Some of these factors will surely prove to be affecting crop production.

B. COMPONENT TECHNOLOGY STUDIES

The following are the results of component technology studies carried out at the Thakurgaon BWDB research station during 1981-1982:

a) Effect of different rates of NPK on the yield of the local rice variety Kalam (t.aman):

The experimental design was a CRB (complete randomized block) with three replications and plot sizes of 20 m^2.

The results indicated a linear response of Kalam to N applications in the presence of 40 kg/ha of P_2O_5 of K_2O. The maximum yield (3.42 t/ha) was obtained with application of 60-40-20 kg/ha NPK. In the absence of P, that is with 60-0-20 kg/ha NPK of NPK the yield was 3.00 t/ha. When potash was not applied (60-40-0 kg/ha NPK), the yield was 3.09 t/ha, indicating also a response to that element (Table-105).

b) Effect of the age of seedlings on the yield of some local and HYVs of rice (t.aman):

This experiment was conducted to assess the yield of rice varieties BR-4, BR-10, BR-11 Pajam and Kalam when seedlings of different ages (30, 40, 50 days old) were transplanted. The experiment was established in a split plot design with three replications. The HYVs were fertilized with 80-60-40 kg/ha NPK and the local varieties with 60-40-20 kg/ha NPK. Fifty per cent of the N and all P and K were applied at transplanting time. The rest of the N was split into two applications at 25 and 40 DAT.

The results showed that in all cases maximum yields were obtained when 30-day-old seedlings were utilized (Table-106).

c) Effect of hill spacing on the yield of local and HYVs of rice(t.aman):

The experiment was conducted in a split plot design with three replications. The main plots were 45 m^2 and the sub-plots 15 m^2. All plots were fertilized with 80-60-40 kg/ha NPK. All P and K and 50% N were applied at transplanting. The rest of the N was applied in equal amounts at 25 and 45 DAT.

All improved varieties (BR-4, BR-11, Pajam) gave the highest yield with 20 x 15cm plant spacing. The local variety Kalam, widely adopted by farmers, gave the highest yield with 15 x 15cm plant spacing (Table-107).

d) The effect of different N rates on the yield of rice variety BR-4:

This experiment was established in a CRB design with three replications and plots of 20m^2. All P, 25% N and 75% K_2O were applied as basal. The rest of the fertilizer was divided in two top dressings. The first, 25 DAT, and the second 45 DAT were each 37.5% N, 12.5% K_2O.

BR-4 responded to applications of up to 60 kg/ha of N. Further increase in N application did not increase the yield significantly (Table-108)

e) Performance of high yielding varieties of rice in the late kharif season (aman):

In this experiment the performance of four rice varieties released by BRRI, (BR-9 BR-10, BR-4) was compared with the performance of Pajam,

an improved variety widely adopted by farmers in Bangladesh. Maximum yields were observed with variety BR-4 (4.43 t/ha) (Table-109). Next highest yield was observed in Pajam (3.96 t/ha). Pajam had the longest growing period (161 days), and BR-9 the shortest (135 days). The maturity period for the rest of the varieties was 150 days (Table-109).

f) Performance of three local varieties of rice (t.aman):

In this trial the performance of local varieties Kalam, Lohajang and Panishail were compared. The three varieties were transplanted on 22 July, 1981 using 30-day-old seedlings. The yields of the three varieties were similar (Table-110).

g) Performance of some promising varieties of wheat:

The performance of wheat varieties Sonalika, Inia-66, Jupateco, Pavon, Balaka and BAW-18, was evaluated in this trial. Maximum yield was observed in Pavon (5.57 t/ha) and the minimum yield in Jupateco (2.80 t/ha) (Table-111). Sonalika had the shortest growing period (111 days). The other varieties had similar growing periods (116 to 117 daya).

h) Effect of different nitrogen levels on the yield of wheat, variety Sonalika:

A randomised complete block design with three replications was used in this trial. All plots received a uniform application of 80 kg/ha P_2O_5 and 60 kg/ha K_2O. All P, 1/3 N and 1/3 K_2O were applied at planting time; the rest of the fertilizer was applied in two top dressings. The first 20 DAS, 1/3 N and 1/3 K_2O, the second 40 DAS, 1/3 N and 1/3 K_2O.

i) Effect of different seed rates on the yield of wheat, variety Balaka:

Seed rates from 75 to 200 kg/ha in 25 kg increments were studied in wheat variety Balaka. Increase in yields was observed for every increment seed rate. The very low tillering may be the reason for this behavious. The yield of wheat was increased from 1.5 t/ha with a seed rate 75 kg/ha to 2.3 t/ha with a seed rate of 200 kg/ha (Table-113).

j) Effect of number of hand weedings on the yield of wheat, variety Sonalika:

This trial was conducted to evaluate the effect of different numbers of hand weedings on the yield of wheat. The statistical design was a CRB with three replications. The plots were fertilized with 80-60-40 kg/ha of NPK. All P, 33% N and 33% K_2O were applied at planting time. The rest of the fertilizer was applied in two top dressings. The first, 20 DAS, 33% N and 33% K_2O and the second 35 DAS, 33% N and 33% K_2O.

Maximum yields (3.77 t/ha) of wheat were obtained when two handweedings, 20 and 30 DAS were made. Without weeding the yield of wheat was 1.85 t/ha (Table-114).

TABLE:105: Effect of different rates of NPK on the yields of the local variety of rice Kalam (t. aman), Thakurgaon, 1981-1982.

Treatments kg/ha			No of tillers		Length of head (cm)	Total grains/ head	Total filled grains per head	Weight of 1000 grains (grams)	Yield (t/ha)
N	P	K	Total	Effective					
60	40	20	7.3	7.3	22.7	89	74	12.0	3.42
60	40	0	6.6	6.6	23.7	88	66	11.8	3.09
0	40	20	7.0	7.0	22.0	97	81	12.1	2.61
40	40	20	6.6	6.6	22.3	99	76	12.3	3.25
20	40	20	6.3	6.3	21.0	90	74	11.9	2.89
60	0	20	6.5	6.5	22.0	92	76	12.2	3.00

TABLE:106: Effect of age of seedling on the yields of some local and HYVs of rice, Thakurgaon, 1981-1982.

Seedling Age	Variety	Growing period (days)	No of tillers		Length of head (cm)	No of total grains/ head	Total filled grains/ head	Weight of 1000 grains (grams)	Yield (t/ha)
			Total	Effective					
30	BR 4	148	6.6	6.6	23.3	149.3	108.66	12.26	4.35
40	"	160	6.0	6.0	24.0	163.0	122.0	12.58	3.75
50	"	170	5.6	5.3	23.0	112.6	82.0	12.0	3.59
30	BR 10	148	6.3	6.0	22.0	122.3	113.0	12.9	4.38
40	"	100	6.3	6.3	23.0	142.0	110.0	13.0	4.38
50	"	170	6.6	6.6	23.3	135.0	113.3	13.0	3.91
30	BR 11	148	7.3	6.3	20.3	115.0	82.66	12.9	4.29
40	"	160	5.6	5.0	21.6	149.6	115.66	12.03	3.06
50	"	170	6.6	6.0	20.6	119.3	95.3	12.93	3.89
30	Pajam	148	6.6	6.0	21.0	145.3	130.0	12.26	3.59
40	"	160	6.3	6.3	21.0	171.3	144.0	12.23	3.44
50	"	170	7.0	6.6	20.6	130.0	111.3	12.27	3.01
30	Kalam	153	5.3	5.3	22.3	86.0	62.6	13.66	3.29
40	"	165	6.0	6.0	21.3	83.3	65.0	13.9	3.29
50	"	175	6.0	6.0	21.6	82.6	70.0	13.68	2.84

TABLE:107: Effect of spacing on the yield of local and HYV varieties of rice, Thakurgaon, 1981-1982.

Variety	Spacing (Rows x hill/cm)	No of tillers		Length of head (cm)	No of total grains/ head	No of filled grains/ head	Weight of 1000 grains (grams)	Yield (t/ha)
		Total	Effective					
BR 4	20 x 15	10.0	10.0	25.0	172	134	12.56	5.05
"	20 x 10	9.3	9.0	24.6	168	130	12.73	4.92
"	15 x 15	7.0	6.6	24.3	138	107	12.46	4.74
BR 11	20 x 15	8.6	8.6	24.3	184	141	12.70	4.83
"	20 x 10	6.0	5.3	23.0	141	110	12.93	4.43
"	15 x 15	10.0	10.0	24.0	168	129	12.93	4.40
Pajam	20 x 15	10.0	10.0	21.3	204	178	12.16	4.14
"	20 x 10	6.0	6.0	20.6	153	135	12.10	3.78
"	15 x 15	8.6	8.0	23.0	202	175	12.10	3.72
Kalam	20 x 15	6.3	6.3	23.3	95	64	14.04	2.91
"	20 x 10	6.3	6.3	22.0	99	52	14.03	2.72
"	15 x 15	8.6	8.6	23.0	111	65	14.74	3.14

TABLE:108: Effect of different levels of nitrogen on the yield of rice variety BR 4, Thakurgaon, 1981-1982.

Treatments kg/ha			No of tillers		Length of head (cm)	No of grains/ head	No of filled grains/ head	Weight of 1000 grains (grams)	Yield (t/ha)
N	P	K	Total	Effective					
0	0	0	7.19	6.91	23.45	148	109	13.10	3.00
0	60	40	6.80	6.71	23.61	143	116	12.47	3.46
20	60	40	8.04	7.90	22.80	147	112	12.70	3.68
40	60	40	7.19	6.90	24.28	154	103	12.80	3.95
60	60	40	8.52	8.18	24.47	154	110	13.20	4.91
80	60	40	8.47	8.09	23.18	137	105	13.10	4.93

TABLE:109: Performance of high yielding varieties of rice in the late kharif season (aman), Thakurgaon, 1981-1982.

Variety	Growing period (days)	No of tillers		Length of head (cm)	No of grains per head	No of filled grains/ head	Weight of 1000 grains (grams)	Yield (t/ha)
		Total	Effective					
BR 9	135	9.0	8.3	25.66	146	96	19.63	3.35
BR 10	150	9.3	8.6	25.00	184	136	13.11	3.76
BR 11	150	7.0	7.0	23.00	127	90	16.12	3.50
BR 4	150	9.6	9.0	25.66	178	139	12.76	4.43
Pajam	161	7.0	6.0	22.30	202	174	12.54	3.96

TABLE:110: Performance of three local varieties of rice (t. aman), Thakurgaon, 1981-1982.

Variety	Growing period (days)	No of tillers		Length of head (cm)	Total No of grains/ head	No of filled grains/ head	Weight of 1000 grains (grams)	Yield (t/ha)
		Total	Effective					
Kalam	176	7.3	6.3	24.66	117	84	15	3.34
Lohajang	160	7.6	7.3	24.66	85	64	13	3.23
Panishail	176	6.0	6.0	24.30	106	75	17	3.06

TABLE:111: Performance of some promising varieties of wheat, Thakurgaon, 1981-1982.

Variety	Growing period (days)	No of tillers		Length of head (cm)	Yield (t/ha)
		Total	Effective		
Sonalika	111	8	8	11	4.88
Inia 66	116	7	7	10	3.23
Jupateco	117	6	6	10	2.80
Pavon	117	9	9	10	5.57
Balaka	116	9	9	10	4.71
LAN 18	116	10	10	11	3.10

TABLE: 112: Effect of different levels of nitrogen on the yield of wheat, variety Sonalika, Thakurgaon, 1981-1982.

Treatment			Growing period (days)	No of tillers		Length of head (cm)	Yield (t/ha)
N	P	K		Total	Effective		
0	80	60	111	3	3	10	2.33
20	80	60	111	4	4	9	2.58
40	80	60	109	3	3	10	3.66
60	80	60	109	4	4	10	3.83
80	80	60	109	4	4	10	4.05
80	80	60	109	4	4	11	4.20

TABLE:113: Effect of different seed rates on the yield of wheat variety Balaka, Thakurgaon, 1981-1982.

Seed rate per ha in kg	Growing period (days	No of tillers		Length of head (cm)	Yield (t/ha)
		Total	Effective		
75	119	2	2	10	1.50
100	119	2	2	9	1.88
125	119	2	2	8	1.99
150	119	2	2	8	2.17
175	119	2	2	9	2.28
200	119	2	2	9	2.30

TABLE:114: Effect of number of weedings on the yield of wheat, variety Sonalika, Thakurgaon, 1981-1982.

Treatment	Growing period (days	No of tillers		Length of head (cm)	Yield (t/ha)
		Total	Effective		
No weeding	107	2	2	9	1.85
One weeding 20 DAS	107	3	3	10	2.25
Two weedings 20 and 30 DAS	107	2	2	10	3.77

C. CROPPING PATTERN TESTING

The predominant cropping pattern in the Thakurgaon project area is L. Rice-L.Rice-L. Wheat. There are several alternative ways to improve this system as indicated by the results of cropping pattern testing in 1981-1982 (Table-115). The major contribution to improvement lies in replacing local with improved varieties and adding fertilizer at medium levels in the aman season. The use of alternative improved varieties of wheat (Jupateco, Balaka, Pavon) in the cropping patterns also increased the yields and net returns. The inclusion of a legume (mungbean) offers scope for improveing existing patterns. Selection by the farmer will be based on the reliability of the schedules for irrigation, the total field duration of each pattern, the availability of inputs and the differences in cost of production.

TABLE:115: Agronomic and economic performance of several cropping patterns tested under experimental conditions in Thakurgaon Regional Research Station, B W D B, 1981 - 1982.

Land Type		HIGHLAND IRRIGATED					
Pattern Management		(R.M)	(R.M)	(R.M)	(R.M)	(R.M)	(R.M)
Crops in the Pattern	C1	Rice(aus)	Rice(aus)	Mungbean	Kaon	Fallow	Green manur
	C2	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)	Rice(t.aman)
	C3	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat
Varieties	C1	Sani	Dharial	Local	Local	-	Sesbenia
	C2	Kalam	BR-11	BR-10	Pajam	BR-4	BR-4
	C3	Sonalika	Jupateco	Balaka	Pavon	Pavon	Pavon
Planting Dates (Range)	C1	April-26	April-30	April-29	April-26	-	April-26
	C2	September-8	August-20	August-27	August-4	August-4	August-1
	C3	December-28	December-18	December-15	December-18	November-22	December-18
Seed Rate(kg/ha)	C1	100 D.S.	100 D.S.	25	-	-	50
	C2	50	50	50	50	50	50
	C3	125	125	125	125	125	125
NPK (kg/ha)	C1	60-40-20	60-40-20	20-60-40	60-40-20	-	-
	C2	60-40-20	80-60-40	80-60-40	60-40-20	80-60-40	80-60-40
	C3	80-60-40	80-60-40	80-60-40	80-60-40	80-60-40	80-60-40
Field Duration (days)	C1	110	99	69	58	-	55
	C2	92	101	97	109	110	113
	C3	102	119	122	116	117	117
Yield (t/ha)	C1	1.91	1.68	0.70	1.12	-	-
	C2	1.57	4.19	3.73	4.13	4.53	4.03
	C3	1.30	2.33	2.65	3.43	3.73	3.47
Yield (kg/ha/day)	C1	17.4	16.9	10.1	19.3	-	-
	C2	17.0	41.5	38.4	37.9	41.2	35.7
	C3	12.7	19.6	21.7	29.6	31.9	29.6
Cost of production (Tk/ha)	C1	2,899	3,089	2,917	1,496	-	901
	C2	2,362	3,828	4,117	3,694	3,687	3,836
	C3	4.428	4.947	5,664	5,043	4,737	6,231
Gross Benefit(Tk/ha)	C1	4,623	6,298	3,748	2,073	-	-
	C2	4,785	13,473	11,995	13,277	14,563	12,960
	C3	3,423	9,684	10,847	14,261	15,499	14,405
Gross Margin(Tk/ha)	C1	1,724	3,209	831	577	-	901
	C2	2,423	9,645	7,878	9,583	10,876	9,124
	C3	995	4,737	5,183	9,218	10,762	8,174
Benefit Cost Ratio	C1	1.68	2.03	1.28	1.38	-	-
	C2	2.02	3.51	2.91	3.59	3.94	3.37
	C3	1.22	1.95	1.91	2.82	3.27	2.31

R.M = Research Managed.

Annex 2

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ANNEX: 1 – Some characteristics of Cropping Systems Research sites in Bangladesh.

Institute Site	Tc mean rainfall mm	Month with more than 200mm of rainfall	Mean annual temperature C mas	min	Mean year total evaporation	Average or range farm size (ha)	Average family size (member)	Land Type
1. BARI								
Hathazari	2615	5	29.7	21.4	1.432	0.27	5.2	Irrigated and rainfed highland and lowland
Jessore	1765	4	31.1	20.3	1.183	1.47	8.9	Highland and medium highland
2. BJRI								
Manikganj	1702	5	30.2	21.0	1.166	0.4	7.9	Highland and medium highland
Kishorganj	2433	5	30.1	20.5	1.109	0.4-0.86	6.6	Highland and medium highland irrigated
3. BAU								
Trishal	2.231	5	30.1	20.5	1.109	0.6-1.2	7.4	Highland and medium highland rainfed
4. BWDB								
Thakurgaon	2150	5	33		850	1.2-2.2	6.6	Highland irrigated
5. SRTI								
Ishurdi	1700	4	31.4	21.0	N.A.	1.0-4.0	9	Highland rainfed

SCIENTISTS INVOLVED IN THE COORDINATION, PLANNING, IMPLEMENTATION AND EVALUATION OF THE NATIONAL COORDINATED CROPPING SYSTEMS RESEARCH PROGRAMME.

The following is an alphabetical list by research institutions of the scientists who have been involved in the organization, planning implementation or evaluation activities of the National Coordinated Cropping Systems Research Programme, since 1979.

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