

**97**

**RICE IN INDIA : PROBLEMS WITH THE  
ADOPTION OF NEW TECHNOLOGY  
— A SURVEY OF LITERATURE**

**BUDDHIN MISRA**

**RICE IN INDIA : PROBLEMS WITH THE  
ADOPTION OF NEW TECHNOLOGY  
- A SURVEY OF LITERATURE**

A DISSERTATION  
SUBMITTED TO THE  
**UNIVERSITY OF POONA**  
IN PARTIAL FULFILMENT  
OF THE REQUIREMENTS  
FOR THE DEGREE OF  
**MASTER OF PHILOSOPHY**  
( IN ECONOMICS )

BY  
**BUDDHIN MISRA**

GOKHALE INSTITUTE OF POLITICS AND ECONOMICS  
PUNE- 411 004  
JANUARY 1990

## ACKNOWLEDGEMENTS

The present study was undertaken under the guidance and supervision of Dr. Ashok K. Mitra. It is a great pleasure to acknowledge my sincere gratitude to him for his valuable suggestions, constant encouragement and for going through the draft with care and sympathy.

I thank the authorities of the Gokhale Institute of Politics and Economics, Pune, for admitting me as an M.Phil. student for the year 1988-89 under the UGC's Faculty Improvement Programme. I also wish to thank the Governing Body and the Principal of the Sibsagar Girls' College, Sibsagar, Assam, for granting me the required leave for the same.

I am ever grateful to my teachers, friends and family for their various help. I must thank the library and other staff of the Institute for their respective cooperation during the course of my study.

I thank Shri S. K. Athale for neat and beautiful typing of this dissertation.

Finally, I alone am responsible for the mistakes that remain.

Gokhale Institute of  
Politics & Economics  
Pune 411004

Buddhin Misra

## C O N T E N T S

	<u>Page</u>
ACKNOWLEDGEMENTS	(1)
LIST OF TABLES	(111)
<u>Chapter</u>	
I INTRODUCTION	1
II RICE AND INDIAN AGRICULTURE	6
III TRANSFORMATION OF AGRICULTURE	23
3.1 Need for Transformation	23
3.2 Beginning of the New Era	24
IV ROLE OF TECHNOLOGICAL FACTORS IN RICE PRODUCTION	35
4.1 HYV Seeds	36
4.2 Irrigation	40
4.3 Fertiliser	48
V ROLE OF INSTITUTIONAL FACTORS IN RICE PRODUCTION	56
5.1 Land Holding	56
5.2 Credit	70
VI SUMMARY AND CONCLUSION	83
APPENDIX	89
BIBLIOGRAPHY	94

LIST OF TABLES

<u>Table No.</u>		<u>Page No.</u>
2.1	Percentage of Area under Rice in Major Rice Producing Countries of the World	7
2.2	Yield Per Hectare of Rice in Major Rice Producing Countries of the World	9
2.3	Area under Principal Crops - All India	11
2.4	All India Land Utilisation	12
2.5	Production of Principal Crops - All India	13
2.6	Yield Per Hectare of Principal Crops - All India	14
2.7	All India Compound Growth Rates of Area, Production and Yield of Principal Crops	15
2.8	Area and Yield of Rice - Statewise	18
2.9	Per Capita Net Availability of Foodgrains in India	20
3.1	Area under HYV Rice and Total Area under Rice and Area under HYV Wheat and Total Area under Wheat - All India	31
3.2	Area Under HYV Rice, Wheat, Total HYV Area under Foodgrains and Total Area under Foodgrains - All India	32
4.1	All India Net Irrigated Area by Source	42
5.1	Percentage Distribution of Operational Holding and Area Operated over Size of Holding in Some Important Rice Growing States, 1980-81	58

<u>Table No.</u>		<u>Page No.</u>
5.2	Statewise Percentage Distribution of Area under Rice, HYV Rice, Irrigation, Per Hectare Consumption of Fertiliser and Yield Per Hectare	60
5.3	Percentage of Irrigated Area in Operational Holding and Percentage Distribution of Irrigated Area over Sources, 1981-82	64
5.4	Percentage of Area Leased Out/ Leased into Area Owned - Statewise, 1982	68
5.5	Distribution of Loans Advanced by Primary Agricultural Credit Societies by Size Group of Holdings, 1984-85	72
5.6	Distribution of Short Term Loans Issued by Scheduled Commercial Banks by Size Group of Holdings, 1984-85	73
5.7	Ranking of States for Short Term Cropwise Loan Issued Per Hectare, 1980-81	75
5.8	Comparison of Statewise Short Term Credit Requirement and Credit Supply for Crop Production in 1984-85	77
5.9	Correlation Coefficient between Credit and Fertiliser Consumption and Per Hectare Consumption of Fertiliser	81
 <u>Appendix</u>		
<u>Table No.</u>		
1	Area under Rice in Major Rice Producing Countries of the World	89
2	Production of Rice in Major Rice Producing Countries of the World	90
3	Area under Rice - Statewise	91
4	Production of Rice - Statewise	92
5	Yield of Rice - Statewise	93

## CHAPTER I

### INTRODUCTION

The importance of a particular sector in an economy can be ascertained either by its share in Gross Domestic Product (GDP) or percentage of working population in that sector. Considering these two aspects agriculture plays an important role in many developing countries, providing food for consumption and raw materials for industries. Growth of the economy of these countries is therefore, directly linked with the growth of the agricultural sector. In India, agricultural GDP as percentage to total GDP <sup>was</sup> is 36 per cent in 1980-81 and agricultural population as percentage to total population <sup>was</sup> is 69 per cent in 1980-81 (Government of India, 1983).

Among various agricultural activities, cultivation of foodgrains occupy an important place in most of the predominantly agricultural countries of the world. These countries aim at maximising domestic food production to feed their growing population, and India is no exception to that. In India, rice and wheat are the two common and widely consumed foodgrain cereals, on which much of her population depend. Unlike wheat, rice is cultivated in almost all the states of our country.

Many, though not all, of the major rice eating countries are characterised by population pressure on the land, which is further aggravated by the rapid expansion of the population, the low productivity of agriculture and inadequate industrial development. Institutional barriers, faulty marketing systems and many other general impediments to the economic growth of the developing countries are, in fact, typical problems facing the countries' rice cultivation (FAO, 1966).

There are considerable disparities in the production of rice among different rice producing regions of India. These disparities are not only due to different systems of cultivation but also due to differences in the economic and ecological conditions. The general practice is to cultivate one season paddy every year mainly under rainfed condition without proper irrigation facilities and application of fertilizer.

The 'Green Revolution', as is well known, is associated with the discovery of the High Yielding Varieties (HYVs) mainly for rice and wheat and was introduced in our country around 1965. New varieties of high yielding seeds of rice along with the other complementary inputs were introduced with the intention of replacing the local varieties in order to bring about rapid increase in the production of rice (Dharm Narain, 1971).



It is evident from the available information (Government of India, 1987) that whereas states like Punjab and Haryana improved their rice productivity, Assam, Bihar, Madhya Pradesh, Orissa and West Bengal seem to be lagging behind. This disparity in the performance of different states appears to be more prominent during the post-green revolution period.

The performance of Indian rice cultivation, when compared with that of wheat, more specifically in the post-green revolution period, is disappointing. The rate of growth of production of rice in the post-green revolution period is smaller than that in the pre-green revolution period being 2.54 per cent and 3.49 per cent respectively. This indicates that the impact of new technology on rice production is not significant.

While the rice plant can grow under different climatic conditions, it gives a good yield only if the basic conditions of soil, water, seed variety etc., are favourable. Some of these factors can be controlled, others cannot. Infertility of soil and lack of water are probably the two most common causes of low yield. Yet, it must be remembered that because of differing ecological responses, the same variety may produce quite different results under different environment.

Two rice crops of shorter duration do not always produce a larger total than one crop of long maturity.

Double cropping is much more demanding on irrigation and its adoption usually requires the introduction of new, quicker maturing variety, but, which may not be popular with local consumers. Further, more sophisticated and laborious techniques, such as transplanting, are needed to ensure that the land is free in time for the second crop. This in turn, will require increased mechanisation. All these factors tend to limit the spread of double cropping of rice and hence its total production.

The rice producing states of India provide certain important issues to study and analyse the implications of modern technology. The green revolution associated with the introduction of new varieties has had limited success in Indian rice production as observed by its relatively limited effect on total Indian rice production. This experience may provide important information about the constraints on foodgrains production in general. As rice is cultivated throughout India under diverse conditions, the behaviour of farmers under such conditions can provide evidence on the factors which restrict the increase in productivity (Antle, 1984).

An attempt is made in this study to examine the respective position of various factors associated with the rice cultivation, based on the review of the available studies carried out in recent past. The objective of such a review is to bring out and highlight some of the

technological and institutional constraints in the pursuit of enhancing rice production. The review is also envisaged to bring out in clear perspective the need for and urgency of improving rice production in the context of our own agricultural economy.

In pursuing the objectives mentioned above, the present study is divided into six chapters. In Chapter II, an attempt is made to analyse the importance of rice in the Indian economy with various available data. A comparison of rice with wheat as a major component of staple food has also been taken up in this chapter.

Chapter III discusses the transformation of agriculture from tradition oriented technology to modern technology. The first section emphasises the need for transformation and the second deals with the analysis of different rice seed varieties developed in India and in other countries.

In Chapter IV, we discuss the role played by different technological factors in the production of rice with their respective drawbacks. This chapter is divided into three sections focussing on three important factors, viz. HYV seed, irrigation and fertilizer respectively.

Chapter V deals with the role of institutional factors. In two sections of the chapter the different aspects of land holding and agricultural credit with respect to rice cultivation are discussed. Chapter VI gives the summary and conclusion of the study.

## CHAPTER II

### RICE AND INDIAN AGRICULTURE

There are two major components of agricultural commodities - foodgrains and non-foodgrains. Foodgrains naturally dominate the pattern of growth of Indian agricultural economy. Rice and wheat, the vanguards of our green revolution, share the large part of this growth over last three decades. Rice is the most important food crop of India as also of the world. Fixing the period of its origin or introduction in different countries of the world present much difficulties. In India rice has been cultivated since ancient times. Supported by archaeological evidences and many references, rice seems to have spread out to the rest of the world from India. Of the 7000 botanical varieties of rice known in the world, around 4000 have been identified as of Indian origin and over 280 are grown in this country which is the largest number for any single country (Rao, 1966).

India holds a very important position in the world's rice economy. In respect of area under rice, India occupies the first position among the rice growing countries of the world. About 28 per cent of the world's area under rice is in India followed by China with 23 per cent. (Table 2.1).

**Table 2.1 : Percentage of Area under Rice in Major Rice Producing Countries of the World**

Country	(5 yearly average ending at)		
	1975	1980	1985
India	27.7	27.8 (5.3)	27.9 (1.7)
China	25.8	25.3 (3.0)	23.1 (-7.3)
Bangladesh	7.3	7.1 (2.1)	7.2 (3.1)
Thailand	5.5	5.9 (13.9)	6.5 (11.9)
Indonesia	6.1	6.1 (4.1)	6.5 (7.8)
Brazil	3.5	4.2 (25.2)	3.8 (-8.5)
Burma	3.6	3.4 (0.7)	3.3 (-1.9)
Philippines	2.5	2.5 (3.6)	2.3 (-5.6)
Japan	2.0	1.8 (-3.6)	1.6 (-11.5)
Pakistan	1.1	1.4 (24.2)	1.4 (3.5)
<b>Total</b>	<b>85.1</b>	<b>85.1</b>	<b>83.6</b>
<b>World</b>	<b>100.0</b>	<b>100.0 (5.1)</b>	<b>100.0 (1.3)</b>

- Note :**
1. Countries are arranged in the descending order as per their share of area under rice in 1985.
  2. Figures in the brackets indicate the percentage increase/decrease in the share of area under rice over each successive period in each country.

**Source :** Area and Production of Principal Crops in India - Various issues; Ministry of Agriculture, Government of India, New Delhi.

Area under rice in India has increased over the period from 1971 to 1985 with the same pace of the world's area under rice. Actually no significant change in the share of each country in area under rice has taken place during the period. On the other hand, significant change has taken place in case of yield per hectare (Table 2.2). But the change in yield rate does not seem to have occurred in accordance to the area under rice. Generally the countries with larger share of area under rice (excluding China) has shown a lower yield rate, and countries with relatively smaller share of area under rice come up with higher yield rate. India with highest share of area under rice shows the yield rate as only 1350 kgs. per hectare while Japan's yield rate of rice is 5931 kgs. per hectare with only 2 per cent of world's area under rice (2295 thousand hectares).

The performance of Indian rice agriculture in comparison with other rice growing countries calls for further analysis especially in temporal context for the country. In India, area under foodgrains has increased by almost 14 per cent between 1960 to 1986. It occupies about 91 per cent of the net sown area. In 1986, among the foodgrains, cereals occupy 82 per cent of the area. Within this period, production of foodgrains has increased by 100.3 per cent. Accordingly yield of foodgrains has also nearly doubled by increasing from 631 kgs. per hectare in 1960 to 1112 kgs. per hectare in 1986, an increase of 76.2 per cent. Within

**Table 2.2 : Yield Per Hectare of Rice in Major Rice Producing Countries of the World (in kgs. per hectare)**

Country	(5 yearly average ending at)		
	1975	1980	1985
Japan	5826	5840 (0.24)	5931 (1.56)
China	3250	3816 (17.42)	4950 (29.72)
Indonesia	2498	2944 (17.85)	3817 (29.65)
Burma	1736	2184 (25.81)	3029 (38.69)
Pakistan	2317	2378 (2.63)	2468 (3.78)
Philippines	1600	2032 (27.00)	2445 (20.32)
Bangladesh	1674	1917 (14.52)	2057 (7.30)
Thailand	1879	1882 (0.16)	1991 (5.79)
Brazil	1476	1443 (-2.24)	1615 (11.92)
India	1106	1207 (9.13)	1350 (11.85)
World	2336	2719 (16.40)	3059 (12.50)

**Note :** 1. Countries are arranged in descending order according to their yield rate.

2. Figures in the brackets indicate the percentage increase/decrease in yield rate in each country in every successive period.

**Source :** Area and Production of Principal Crops in India - Various issues, Ministry of Agriculture, Government of India, New Delhi.

this period, the production of cereals has increased by 118.5 per cent and yield by 85 per cent.

Area under rice is 32 per cent of foodgrain area and 39 per cent of the area under cereals. Comparatively, wheat, the other component, claims only 18 per cent of the area under foodgrains and 22 per cent of the cereals area. While the share of rice area in area under foodgrains and cereals has remained more or less the same during the period 1960 to 1986 that of wheat has increased considerably (Table 2.3). In terms of share in net sown area, rice occupies 28 per cent of the net sown area while wheat only 16 per cent of the same (Table 2.4).

During the period, rice production has increased by 96 per cent and that of wheat by 366 per cent. Production of rice has increased from 289 lakh tonnes in 1960 to 566 lakh tonnes in 1986 while wheat production has increased from 93 lakh tonnes in 1960 to 433 lakh tonnes in 1986. The same situation is reflected in the case of the productivity of the two crops. Rice productivity has increased by 58 per cent and in case of wheat it showed an increase of 154 per cent. In absolute term, yield of wheat is higher by 454 kgs/hectare than rice yield (Tables 2.5 and 2.6).

It is revealed from the data presented in Table 2.7 that productivity of rice has not increased at the same pace as that of wheat, cereals and foodgrains in overall period from 1949-50 to 1985-86. During this period its production



**Table 2.3 : Area under Principal Crops - All India (in lakh hectares)**

Year (5 yearly average ending at)	Rice	Wheat	Total cereals	Total food- grains	Percentage share of cereals		Percentage share of foodgrains	
					Rice	Wheat	Rice	Wheat
1960	326	127	887	1124	36.8	14.3	29.0	11.3
1965	356 (9.2)	134 (5.5)	932 (5.1)	1172 (4.3)	38.2	14.4	30.4	11.4
1970	364 (2.2)	146 (9.0)	970 (4.1)	1192 (1.7)	37.5	15.1	30.5	12.3
1975	376 (3.3)	187 (28.1)	1006 (3.7)	1228 (3.0)	37.4	18.6	30.6	15.2
1980	396 (5.3)	215 (15.0)	1035 (2.9)	1269 (3.3)	38.3	20.8	31.2	16.9
6 yearly ave- rage ending at 1986	405 (2.3)	234 (8.8)	1045 (1.0)	1278 (0.7)	38.8	22.4	31.7	18.3
Percentage in- crease/decrease over the period of 26 years								
	24.2	84.3	17.8	13.7				

**Note :** Figures in the brackets indicate percentage increase/decrease in every successive period.

**Source:** Area and Production of Principal Crops in India, 1985-86, Ministry of Agriculture, Government of India, New Delhi.

Table 2.4 : All India Land Utilisation (in lakh hectares)

Year (5 yearly average ending at)	Rice area	Wheat area	Total cereals area	Total foodgrains area	Net sown area	Gross sown area
1960	326 (24.9)	127 (9.7)	887 (67.8)	1126 (86.1)	1307.7	1494.2
1965	356 (26.2)	134 (9.9)	932 (68.6)	1172 (86.2)	1359.1	1563.9
1970	364 (26.4)	146 (10.6)	970 (70.3)	1192 (86.4)	1378.9	1596.3
1975	376 (26.9)	187 (13.4)	1006 (71.9)	1228 (87.8)	1398.4	1654.4
1980	396 (28.1)	215 (15.3)	1035 (73.4)	1269 (90.0)	1409.9	1710.6
4 yearly average ending at 1984	401 (28.4)	232 (16.4)	1048 (74.1)	1280 (90.5)	1414.6	1759.8

Note : Figures in the brackets indicate the percentage of net sown area.

Source : Area and Production of Principal Crops in India, 1985-86, Ministry of Agriculture, Government of India, New Delhi.

**Table 2.5 : Production of Principal Crops - All India (in lakh tonnes)**

Year (5 yearly average ending at)	Rice	Wheat	Total cereals	Total food- grains	Percentage share of cereals		Percentage share of foodgrains	
					Rice	Wheat	Rice	Wheat
1960	289	93	595	710	48.6	11.6	40.7	13.1
1965	360 (24.6)	112 (20.4)	713 (19.8)	830 (16.9)	50.5	15.7	43.4	13.5
1970	358 (-0.6)	154 (37.5)	765 (7.3)	870 (4.8)	46.8	20.1	41.2	17.7
1975	416 (16.2)	242 (57.1)	925 (20.9)	1030 (18.4)	45.0	26.2	40.4	23.5
1980	479 (15.1)	314 (29.8)	1086 (17.4)	1200 (16.5)	44.1	28.9	39.9	26.2
6 yearly average ending at 1986	566 (18.2)	433 (37.9)	1300 (19.7)	1422 (18.5)	43.5	33.1	39.8	30.5
Percentage increase/de- crease over the period of 26 years								
	95.8	365.6	118.5	100.3				

**Note :** Figures in the brackets indicate percentage increase/decrease in every successive period.

**Source :** Area and Production of Principal Crops in India, 1985-86, Ministry of Agriculture, Government of India, New Delhi.

**Table 2.6 : Yield Per Hectare of Principal Crops -  
All India (kgs. per hectare)**

Year (5 yearly average ending at)	Rice	Wheat	Total cereals	Total food- grains
1960	886	729	671	631
1965	1017 (14.8)	835 (14.5)	764 (13.9)	708 (12.2)
1970	981 (-3.5)	1039 (24.4)	786 (2.9)	728 (2.8)
1975	1106 (12.7)	1294 (24.5)	919 (16.9)	839 (15.2)
1980	1207 (9.1)	1456 (12.5)	1049 (14.1)	945 (12.6)
6 yearly average ending at 1986	1396 (15.7)	1850 (27.1)	1244 (18.6)	1112 (17.7)
Percentage increase/ decrease over the period	57.6	153.8	85.4	76.2

**Note :** Figures in the brackets indicate percentage increase/decrease in every successive period.

**Source :** Area and Production of Principal Crops in India, 1985-86, Ministry of Agriculture, Government of India, New Delhi.

**Table 2.7 : All India Compound Growth Rates of Area, Production and Yield of Principal Crops (in per cent per annum)**

Crop	1949-50 to 1985-86			1949-50 to 1964-65			1967-68 to 1985-86		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Foodgrain	0.69	2.64	1.73	1.41	2.93	1.43	0.34	2.74	2.30
Cereals	0.79	2.98	1.85	1.30	3.24	1.68	0.31	2.97	2.21
Rice	0.90	2.52	1.60	1.33	3.49	2.13	0.65	2.54	1.92
Wheat	2.73	6.00	3.18	2.68	3.99	1.27	2.41	5.64	3.15

**Source :** Area and Production of Principal Crops in India, 1985-86, Ministry of Agriculture, Government of India, New Delhi.

has also been unable to keep pace with other cereals, particularly wheat. In the pre-green revolution period (1949-50 to 1964-65), rice productivity has increased at a faster rate than wheat, cereals and total foodgrains. But during post green revolution period (1967-68 to 1985-86) the growth rate in rice productivity has decreased substantially and is slower than those under wheat, total cereals and foodgrains. During this period, area increase is also very meagre in case of rice as compared to wheat. Number of factors may be responsible in this regard. It can be because rice area is traditionally fixed, i.e. rice cannot be cultivated everywhere like wheat. Secondly, it does not emerge as a good competing crop as wheat, or its yield is not increasing enough to attract new areas. Its contribution to the growth in cereals or foodgrain production is found to be substantial though not as good as wheat in relative terms. In overall period wheat economy shows a great success. All these mean that though rice occupies the major portion of the net sown area under cereals and foodgrains, it is not able to show good performances in productivity and hence in production in the last four decades.

Rice, though principally a tropical crop requiring high temperature and humidity for its growth, is cultivated both in the tropical and sub-tropical zones extending from  $40^{\circ}$  South to  $45^{\circ}$  North latitude. However, most of the rice area lies between Equator and  $40^{\circ}$  North latitude and between

70° to 140° F longitude. (Ghose and others, 1960). Rice is grown in almost all the states of India but its cultivation is mostly concentrated in the river valleys, deltas and low lying areas of North-Eastern and Southern India, in the states of Andhra Pradesh, Assam, Bihar, Maharashtra, Madhya Pradesh, Kerala, Karnataka, Tamil Nadu, Orissa, Uttar Pradesh and West Bengal which together contribute 82 per cent of the country's rice production. These states are known as traditionally rice growing states, while states like Punjab, Haryana are known as non-traditional (Abel and Easter 1971; Desai and Gandhi 1988). There exists a vast difference among various rice growing states in regard to area and yield and, hence, production (Table 2.8).

States are classified according to their respective contribution to area and yield of rice. It is seen from this classification that 82 per cent of the area under rice is concentrated only in 8 states while another 18 per cent is shared by 20 states, which reflects a skewed distribution. Again, most of the states with maximum amount of area under rice show a very low level of productivity. From the table, it is clear that in India, yield of rice is not related with the area cultivated. Uttar Pradesh with the highest area under rice shows the yield level of only 1166 kgs. per hectare which is even less than the all India average. On the other hand, states like Punjab, Haryana, Jammu & Kashmir show much higher yield with smaller area

Table 2.8 : Area and Yield of Rice - Statewise

Area ('000 hectares)	Yield rate		
	Over 2000 kgs/ha	1000-2000 kgs/ha	Below 1000 kgs/ha
Over 4000	-	U.P., West Bengal	Bihar, M.P.
2000-4000	A.P., Tamil Nadu	Assam	-
Below 2000	Punjab, Haryana, J&K	Maharashtra, Karnataka, Kerala, Gujarat, Rajasthan, H.P.	-

Note : States are arranged according to their respective area under rice.

Source: Area and Production of Principal Crops in India - Various issues, Ministry of Agriculture, Government of India, New Delhi.

under rice. In terms of yield Punjab ranks first with 2995 kgs. per hectare followed by Haryana with 2864 kgs. per hectare. Madhya Pradesh with 4895 thousand hectares of land area under rice shows the lowest yield among all the states, amounting to only 813 kgs. per hectare. It reveals that the majority of traditionally rice growing states are not able to show an increasing rate of productivity of rice while non-traditional rice growing states are in the forefront with higher productivity.



In India, rice is the staple food of people in Southern and Eastern states. It is also very popular in Northern states mainly in Uttar Pradesh. In India, share of cereals of Dietary Energy Supplies (DES) was 72.9 per cent in 1969-71 and 74.2 per cent in 1979-81 (FAO, 1987). As rice occupies about 32 per cent of area under total cereals, its importance is very much clear as a common cereal throughout the country. In India, per capita per day net availability of foodgrains in 1986 was 476.1 grams of which share of cereals was 434.2 grams. Among the available cereals, rice alone accounted for 213.3 grams. Availability of rice has increased from 192.6 grams in 1971 to 213.3 grams in 1986 with an increase of only 10.2 per cent over the period. On the other hand, per capita per day availability of wheat has increased from 103.6 grams in 1971 to 151.2 grams in 1986 with an increase of 46 per cent over the period (Table 2.9). India's annual requirement of rice has increased faster than the production as a result of which various measures have been taken to increase the rice production of the country. Success in improving the food situation in India depends on the breakthrough in food production resulting from a rice revolution. But experiences reveal that a rice revolution can be brought only through concentrated efforts at various levels of paddy rice system. Since rice is the only one, although quantitatively the single most important of the several cereals produced and

**Table 2.9 : Per Capita Net Availability of Foodgrains in India**

Year	Rice		Wheat		Total cereals		Total foodgrains	
	Kgs.per year	Grams per day	Kgs.per year	Grams per day	Kgs.per year	Grams per day	Kgs.per year	Grams per day
1971	70.3	192.6	37.8	103.6	152.4	417.6	171.1	468.8
1972	72.4	197.8	46.1	126.0	153.4	419.1	170.6	466.1
1973	62.8	172.0	43.1	118.1	138.9	380.5	153.9	421.6
1974	69.5	190.4	39.7	108.8	149.8	410.4	164.7	451.2
1975	58.0	158.9	40.9	112.1	133.5	365.8	148.0	405.5
1976	68.5	187.2	29.1	79.5	136.8	373.8	155.3	424.3
1977	61.6	168.8	41.8	114.5	141.0	386.3	156.8	429.6
1978	71.6	196.2	46.1	126.3	154.2	422.5	170.8	468.0
1979	73.1	200.3	48.3	132.3	157.6	431.8	173.9	476.5
1980	60.8	166.1	46.3	126.8	138.9	379.5	150.2	410.4
1981	72.0	197.3	47.1	129.0	151.9	416.2	165.6	453.7
1982	70.3	192.6	46.6	127.7	351.4	414.8	165.7	454.0
1983	61.9	169.6	52.6	144.1	144.9	396.9	159.3	436.4
1984	72.1	197.0	51.4	140.4	159.6	436.1	174.9	477.9
1985	69.0	189.0	50.6	138.6	151.7	415.6	165.6	453.7
1986	77.5	212.3	55.2	151.2	158.5	434.2	173.8	476.1

**Note :** Per capita net availability figures are not strictly representative of the actual level of consumption in the country especially as they do not take into account any changes in stocks in possession of traders, producers and consumers.

**Source :** Bulletin of Food Statistics, 1986; Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi.

consumed in India, the objectives of rice policy are not detachable from the policy objectives pertaining to other cereals; in fact, they are the same as the objectives of the foodgrain policy (Dharm Narain, 1971).

It has been noticed that as agricultural production cannot continuously be pushed to new lands, importance has to be given to raising productivity of land. Accordingly, in the pursuit of productivity increase, emphasis has been given on the use of chemical fertilizers, the expansion of land under irrigation, use of improved High Yielding Varieties of seeds, etc. The year 1966-67, which saw the introduction of a new technology package and ushered in what is popularly known as the 'Green Revolution', may be taken as a turning point for Indian agriculture. This technological revolution provided breakthrough in production techniques which has taken the potential production surface to a new high level. The high hopes generated by the breakthrough, however, cannot be considered as optimistic in relation to rice productivity at the present Indian situation (Kanith and Mehra, 1985).

The story of rice breakthrough is a story written in the first half of 1960s. The development of new varietal materials of high yield potential, opens the road to modernisation. Dwarf rice varieties are one factor setting the course to this modernisation. The other factors are the availability of fertilizers, responsiveness to plant

neutrient, controlled water distribution, etc. The move toward the modernisation should be accompanied by a significant change in the economics of farm production.

It has become clear from the above discussion that in India rice productivity remains considerably low even after various measures taken in different time to accelerate it. In the following chapters the various measures that have been taken in this connection and the factors responsible for the low productivity of rice will be discussed in detail.

## CHAPTER III

### TRANSFORMATION OF AGRICULTURE

#### 3.1 Need for Transformation

Efficiency in food production is a central issue in contemporal development policy. Its importance in a country like India, where millions of people live with the threat of malnutrition and starvation, does not require any emphasis. To the casual observer, it appears that food production in many of the countries of the world is subject to traditional technology which could not possibly be optimal (Evenson, 1975). In general terms, the raising production of foodgrains can be tackled from two sides, viz. (a) extension of cultivation to the uncultivated cultivable waste land and (b) improving farm production performances per unit of arable land. Further extension of cultivation has become extremely limited because of the changes in agrarian relations during the period 1950-51 to 1965-66. Since the future of arable land area expansion appears to be limited in India, at least in the absence of significant changes in water management, primary reliance must be placed on raising yields (Frankel, 1971). The basic ingredients for accelerating agricultural productivity focus on the improved technology, the means to exploit this

technology, diffusion of knowledge amongst the cultivators as well as making it available to them and creating an economic environment favourable to the adoption of the new technology. There is considerable scope for raising the foodgrains production per unit area in tradition oriented and subsistence gain farming in India (Singh, 1974).

In traditional agriculture there is a condition of economic equilibrium at a low level and yields are stagnant at near starvation level. Under these conditions, until the technology and price relationships are changed, the cultivator is constrained to use the production factors at his disposal in an economically rational way with all the limitations and risks inherent in the existing system. He extracts a meagre subsistence living from the soil. External attempts to help the farmer to improve himself by all types of self-help programmes usually fail. Under these circumstances, a general attitude of defeatism and pessimism often permeates the agricultural sector, including the people involved in planning for agricultural development.

### 3.2 Beginning of the New Era

By the early 1960s, it was becoming apparent that in many Asian countries there was very little land remaining that could be developed into paddy field at reasonable cost. In order to maintain the existing production trend, it was necessary to introduce a yield increasing technology.

It was noted subsequently that the land area constraint does not appear to have been operating in the same manner in the case of wheat or corn. Between 1955-65 and 1965-73, there was a substantial decline in the contribution of land area to rice output growth from 1.3 per cent per annum to 0.9 per cent per annum for South and South-east Asia as a whole. (FAO, 1975). Unfortunately, official statistics normally reports gross rather than net area. The decline in the net area has been offset to some extent by the expansion of the area under double cropping. The experience of India on a countrywide basis has been similar to the regional average, even though the national average obscures the marked contrast between different parts of the country.

Rice has been cultivated for several thousand years under controlled, deep water conditions in rainfed paddy fields without the use of fertilisers and in competition with vigorous weeds. The general characteristics of most indica rice varieties, traditionally cultivated in tropical Asia, are tall plant with vigorous growth, which results in low grain/straw ratio, long growth elevation, and strong photo-period sensitivity. Thus, these characteristics are well adopted to the traditional cultivation in tropical monsoon regions but show distinct disadvantages when modern technology is applied. For example, when fertiliser is used on traditional varieties, with vigorous vegetative characteristics, growth is stimulated to the point where lodging is

very likely to occur. It is not unusual for lodging to occur when the plants are before the heading stage. Even when it (lodging) does not, excessive vegetative growth in the later half of the growing season impedes the distribution of products of photosynthesis of grain development. Thus, the yield increasing effect of fertiliser is hardly manifested with these traditional varieties (Yamada, 1978).

In 1960, the International Rice Research Institute (IRRI) was established by the Rockefeller and Ford Foundation in cooperation with the Philippines Government in the premise of the University of Philippines College of Agriculture on the outskirts of Manila. Research which began at the institute in 1962 and over 10,000 varieties of rice have been collected from almost all rice growing areas of the world. Using Chinese discovery, in 1966, the institute announced the development of the first HYV, IR-8, a variety created by combining physiological potential for high yielding with the morphological structure required to fully express this potential, i.e. a desirable plant type. (Swaminathan, 1969). This concept of a suitable plant has been adopted in the national rice breeding programmes in many countries of tropical Asia (including India), and has helped in developing new national HYVs in these countries. Most of these were developed by using IR-8 and other semi-dwarf varieties as a parent for hybridization with local varieties (IRRI, 1970).



During the same period, Chinese scientists discovered a spontaneous mutant in the variety Dee-gee-woo-gen which had the following characteristics: (i) a dwarf plant habit, the plant attaining the height of about 60 cms., (ii) stiff and erect leaves, facilitating the maximum interception of sunlight, (iii) insensitivity of photo-period (i.e. length of the day) enabling the cultivation of the crop in any season and (v) absence of seed dormacy, rendering sowing possible immediately after harvest. Using this mutant, scientists in several parts of the tropics have developed fertiliser responsive and photoinensitive varieties, which have revealed enormous possibilities for increasing the yields of indica rices. Taichung Native-1, developed in Taiwan, is the first outstanding dwarf and photoinensitive variety developed in indica rice. It was developed by crossing a tall indica, Traiyuen Chung with Dee-gee-woo-gen. This variety has some characteristics like (a) stiff and upright leaves, (b) dwarf plant height, (c) synchronous tillering habit, (d) photoinensitivity, (e) drought resistance and (f) lack of seed dormacy (Swaminathan, 1969).

During early 1960s foodgrain production in India showed a declining trend confirming the uncertainty of agricultural production based on traditional methods and practices of cultivation. In order to arrest this trend, the Ministry of Food and Agriculture, Government of India,

with the active collaboration and participation of the Rockefeller Foundation and later the Ford Foundation, organised a number of scientists to explore the possibility of increasing agricultural production. This resulted in the initiation and adoption of a new strategy in agricultural development since 1966-67 in order to transform the traditional agrarian economy with the most pervasive forces (Singh, 1974).

This new strategy appears as a process of mobilising a vast quantity of already existing resources and raising their productivity. The distinguishing characteristics of a high productivity agriculture is not simply more of the traditional forms of land, labour and capital; rather it is the set of institutions and facilities which complement these existing resources and raise their productivity. (Mellor, 1962). The development of the new short-statured fertiliser responsive varieties of rice in the 1960s provided the vehicle for the introduction of modern inputs and the subsequent shift to dependence on yield increased production (Barker, 1979).

The initial high-yielding semi-dwarf varieties of wheat and rice came primarily from Mexico and the Philippines respectively, but to a large degree, have been replaced later by locally developed crosses between exogenous lines and local varieties. Prior to this new development, the varieties cultivated in India mostly belong to the subspecies

indica of oryza sativa. Taichung Native-1 (TN-1) arrived in India in 1963. By 1965, it was accepted by Indian rice scientists as having the physio-genetic qualities, on the basis of which new programme of plant breeding was developed. But it was not until 1966 that the decision was taken to use TN-1 as major element in the Government's new High Yielding Varieties Programme (HYVP) for an expanded rice output. Before TN-1 was adopted as a core element in the HYVP, Indian rice scientists recognised that the production potential of its plant type could be exploited through new varieties adopted to Indian conditions and a powerful new weapon would be forged for pursuit of national abundance. To create such a weapon, the Indian Council of Agricultural Research (ICAR) organised and financed the All India Coordinated Rice Improvement Project (AICRIP) to undertake a broad programme of plant breeding, testing, selection and production experimentation at centres located throughout India. Assistance in this new programme was provided by the Rockefeller Foundation and United States Agency for International Development (USAID) in cooperation with the International Rice Research Institute (IRRI). The AICRIP Conference held at the Central Rice Research Institute in November 1968, voted to recommend the release of two new lines, CR-28-25 developed at the CRRI and IET-723 developed at Rajendranagar, Hyderabad. Both lines came from selections made by crossing TN-1 and the Indian tall variety type 141, a variety that has good grain

quality and a wide adaptability to Indian conditions. These two breeder lines were released by ICAR in December 1968 under the name of Padma and Jaya respectively. Padma and Jaya are the first product of the all India research to exploit the higher yield potential of the dwarf plant type (Hopper and Freeman, 1969).

As observed by Dharm Narain (1971), most of the addition to rice output was expected to come from increases in per hectare yields through increased use of HYV seeds together with fertilisers and other inputs; and the rest through other programmes like extension of irrigation and multiple cropping. The programme, which began with the imported exotic varieties, is supported by a sizeable research effort devoted to evolving high yielding and short duration varieties adapted to local conditions and consumer preferences. The effort is organised in the AICRIP which undertakes a broad programme of plant breeding, testing, selection and production experimentation of centres located throughout the country.

While assessing the progress in foodgrain production in Indian agriculture in the last few decades, it is evident that a major transformation has taken place in case of wheat only (Tables 3.1 and 3.2). From a cursory view of aggregate data, it would appear that a similar transformation has not occurred in rice cultivation despite the fact that new dwarf rice varieties, physiologically similar to

**Table 3.1 : Area under HYV Rice and Total Area under Rice and Area under HYV Wheat and Total Area under Wheat - All India**

(In thousand hectares)

Year (1)	Area under rice (2)	Area under HYV rice (3)	Area under wheat (4)	Area under HYV wheat (5)
1966-67	35,251	888 (2.52)	12,838	541 (4.21)
1967-68	36,437	1,785 (4.90)	14,998	2,942 (19.62)
1968-69	36,967	2,681 (7.25)	15,958	4,793 (30.04)
1969-70	37,680	4,342 (11.52)	16,626	4,910 (29.53)
1970-71	37,592	5,588 (14.86)	18,241	6,480 (35.52)
1971-72	37,758	7,412 (19.63)	19,139	7,861 (41.07)
1972-73	36,688	8,168 (22.26)	19,463	10,177 (52.29)
1973-74	38,286	9,981 (26.07)	18,583	11,027 (59.34)
1974-75	37,889	11,208 (29.58)	18,010	11,194 (62.15)
1975-76	39,475	12,443 (31.52)	20,454	13,458 (65.80)
1976-77	38,511	13,337 (34.63)	20,922	14,522 (69.41)
1977-78	40,283	16,122 (40.02)	21,456	15,803 (75.5)
1978-79	40,482	16,882 (41.70)	22,641	15,899 (70.22)
1979-80	39,414	15,991 (40.57)	22,172	15,027 (67.77)
1980-81	40,152	18,234 (45.41)	22,279	16,104 (72.28)
1981-82	40,708	19,687 (48.36)	22,144	16,751 (75.65)
1982-83	38,262	18,842 (49.24)	23,567	17,837 (75.69)
1983-84	41,244	21,736 (52.70)	24,672	19,387 (78.58)
1984-85	41,159	22,778 (55.34)	23,565	19,090 (81.01)
1985-86	40,912	23,480 (57.39)	23,074	19,175 (83.10)

**Note :** 1) Figures in the brackets in column 3 indicate the percentage of HYV rice area to the total rice area.

2) Figures in the brackets in column 5 indicate the percentage of HYV wheat area to the total wheat area.

**Source :** Fertilizer Statistics, 1986-87, FAI, New Delhi, December 1987.

**Table 3.2 : Area under HYV Rice, Wheat, Total HYV Area under Foodgrains and Total Area under Foodgrains - All India**

(In thousand hectares)

Year (1)	HYV rice area (2)	HYV wheat area (3)	HYV foodgrain area (4)	Foodgrain area (5)
1966-67	888 (49.98)	541 (28.69)	1,886 (1.64)	1,15,302
1967-68	1,785 (29.57)	2,942 (48.74)	6,036 (4.97)	1,21,421
1968-69	2,681 (28.83)	4,793 (51.55)	9,297 (7.72)	1,20,430
1969-70	4,342 (38.04)	4,910 (43.02)	11,413 (9.24)	1,23,570
1970-71	5,588 (36.33)	6,480 (42.12)	15,383 (12.37)	1,24,316
1971-72	7,412 (40.79)	7,861 (43.26)	18,173 (14.82)	1,22,623
1972-73	8,168 (36.59)	10,177 (45.59)	22,321 (18.71)	1,19,277
1973-74	9,981 (38.33)	11,027 (42.35)	26,038 (20.58)	1,26,538
1974-75	11,208 (41.45)	11,194 (41.40)	27,038 (22.33)	1,21,075
1975-76	12,443 (39.02)	13,458 (42.20)	31,888 (24.88)	1,28,181
1976-77	13,337 (39.74)	14,522 (43.27)	33,560 (26.99)	1,24,356
1977-78	16,122 (41.41)	15,803 (40.59)	38,930 (30.53)	1,27,515
1978-79	16,882 (42.06)	15,899 (39.61)	40,134 (31.11)	1,29,009
1979-80	15,991 (41.66)	15,027 (39.15)	38,383 (30.66)	1,25,206
1980-81	18,234 (42.33)	16,104 (37.38)	43,079 (34.01)	1,26,667
1981-82	19,687 (41.94)	16,751 (36.03)	46,941 (36.00)	1,29,138
1982-83	18,842 (39.67)	17,837 (37.56)	47,491 (37.96)	1,25,095
1983-84	21,736 (40.45)	19,387 (36.08)	53,739 (40.97)	1,31,163
1984-85	22,778 (42.07)	19,090 (35.26)	54,140 (42.74)	1,26,683
1985-86	23,480 (42.37)	19,175 (34.60)	55,422 (43.62)	1,26,062

**Note :** Figures in the brackets in columns 2 and 3 indicate the percentage of total HYV foodgrain area.

**Source :** Fertilizer Statistics 1986-87, FAI, New Delhi, December 1987.

the exotic varieties that sparked the growth in wheat, are available to the rice growers also. In this regard there have been many explanations. Some observers (For example, Shah, 1984; Ladejinsky, 1973; Rao, 1976; Michael, 1976; etc.) have focussed on the biological aspects of the new plant materials. They point out that some farmers have tried the new dwarf varieties and have returned to their older rice types. They listed out disease incidence, difficulties of assuring grain maturity, poor grain quality and others as the causes for cultivator's dissatisfaction.

The other group of observers (For example, Boyce, 1987; Dharm Narain, 1971; Antle, 1984, etc.) centre their explanations on the rural institutions serving rice farmers such as credit, land holding, land tenure, poor administration of extension services, etc. that discourage the adoption of new varieties.

Discussing the problem Dharm Narain (1971) says, "An enquiry into the reasons for relatively slow spread of the HYVs of paddy and the lack of impact from even that spread which has already come about will help in identifying the problem areas where action is called for. Our experience at the field level so far is confined, by and large, to TN-1 and Tainan-3 varieties, which subsequently introduced but which soon displaced, to a large extent, the former varieties. While some of the factors which lie behind the phenomenon are by now well known, others are yet subject of a continuous

exploration. Many of the known factors pertain to the biological aspects of the new plant materials posing problems of adaptation to the conditions in which rice is grown in India. The handicaps of the imported varieties derived from their susceptibility to disease and insects, temperature sensitivity, non-photo-period sensitivity and poor grain quality." (p.4).

Factors that are responsible for not allowing the high yield of rice cultivation can be classified into two categories - those that affect the yield potential of the crop under farmers' environment, and those that affect the farmers' ability and willingness to achieve the yield potential on his own farm. The first category of factors relate directly to the development of new technology and hence, the organisation of research. The second is concerned, on the other hand, with the realisation of the production potential, given the existing technology and physical environment and on the other with the degree of equity among farmers' and landless workers' access to resources and inputs. These include issues such as diffusion of knowledge among farmers credit availability and land ownership patterns (Barker,1979).

The first group of factors as a whole is termed as technological and the second as institutional factors and an attempt has been made to discuss their role and drawbacks in the subsequent chapters.



## CHAPTER IV

### ROLE OF TECHNOLOGICAL FACTORS IN RICE PRODUCTION

In this chapter an attempt is made to discuss the role of various technological factors influencing the production of rice. But before we go into the analysis of the factors, let us discuss briefly about the concepts like 'technology', 'technological change' and 'technological factors'. Technology refers to the spectrum of techniques in an economy, it is a sum of knowledge of the means and methods of producing goods and services. According to Boyce (1987) "As a sum of knowledge, technology can be termed as the technically efficient set of available techniques, which produce maximum output for each input combination." (p.19). Technological change indicates the use of new inputs and knowledge over period of time. Technological change refers to the shift in the way resources are used such that either a larger output is obtained with a given input of resources or the same output is produced with a smaller amount of inputs (Sidhu and Singh, 1986).

The combination of inputs required, to obtain a given output may change along with a shift in the total input-output relation (Heady, 1952). A technological

change is labour saving if it increases the capital labour ratio, capital saving if it decreases it and neutral if it leaves it unchanged, whereas the concept of induced technological change (Hayami and Ruttan, 1971) has been extended to the rate of technological change as well as its direction.

By technological factors, in the present context, we mean the new or modern inputs such as high yielding seeds, fertiliser, pesticides, irrigation etc. that are associated with the new rice technology.

#### 4.1 HYV Seeds

The varieties that are introduced in various time have already been discussed in the previous chapter. Most of these varieties (TN-1 and IR-8) have drawbacks in their adoption to the widely diversified environmental conditions of India's many rice producing areas. Some of these drawbacks are predictable in nature. For example, the susceptibility of TN-1 to bacterial leaf blight was well known in Taiwan, where this variety was grown almost exclusively during the dry season when the weather does not favour blight. Others became apparent only from farmers' experience. For example, IR-8 had been developed under the hot humid conditions of the Philippines and it proved to be sensitive to the night temperatures of North India and of higher elevation of the Deccan, where delayed maturity

upset the timing of farm rotations. Both the varieties proved to be susceptible to the gall-midge, an insect not present in the Philippines or Taiwan but which reaches epidemic proportions in some restricted areas of India as well as South-East Asia (Hooper and Farmer, 1969).

The traditional varieties of rice were weather-resistant (being able to avoid pests), pests resistant. The HYVs helped yield increases under normal weather conditions, however, immunity to weather changes is low. Therefore, one witnessed a wider fluctuation as well as an upward trend in the production of the latter (Shah, 1984).

The disparity in the performance of rice varieties is that the varieties so far tried, demand different agro-climatic conditions. Rice is grown throughout India - there are two or three seasons for rice growing within a year, the requirement of each season being different. For every region with its different climate and soil conditions there has to be a suitable strain of rice. Failing to develop strains with a strong natural resistance to a variety of common diseases as well as maintaining accustomed consumption qualities forced the majority of the rice growers to retain the traditional Indian strains since they were reasonably certain of an assured crop, though the yield was low (Ladejinsky, 1973).

As the traditional rice growing regions receive heavy rainfall in kharif season, a part of their paddy fields, which are generally low lying, get flooded with rain water. Hence, the plants of HYV paddy, which are generally short-stemmed, may possibly get submerged under water in kharif season whenever the rainfall is heavy. This may be one of the reasons why HYV paddy could not become much popular in traditional rice growing regions mainly in kharif seasons. Apart from this, these varieties are also more susceptible to pests and diseases than the local varieties, particularly in kharif season when weather is damp and cloudy. Even in areas where rainfall is heavy these varieties perform relatively better in dry season when compared to the wet season (Singh & Govindraaj, 1976).

The overwhelming reliance on the photo period sensitive varieties for the rainfed rice areas has become a recent issue of debate. There is considerable argument in favour of the sensitive types as most of the modern insensitive rice varieties become unsuitable with increase in water level. Even varieties like Pankaj, Jayannath and Mashuri perform well only in a water depth of 30 cms and are among the most widely planted modern varieties in India. On the other hand, the larger duration photo period sensitive varieties are more appropriate for the water regimes, where monsoon ends in late September or early October (Barker and Pal, 1979).

The bulk of the rice crop in India is raised during the kharif season. The new varieties when raised during this season suffer in yield because of the paucity of sunshine resulting from the cloudy conditions of the monsoon period; the traditional kharif varieties, on the other hand, being photo period sensitive, mature and are ready for harvest during the sunny conditions after the retreat of the monsoon. The early planting of TN-1 and IR-8 results in faster grain maturity, the harvest of which has to be undertaken during the rainy season (i.e. the worst period of North-East Monsoon) in the southern rice growing States, warrants some drying facilities.

The factors inhibiting the spread of HYVs are underdeveloped infrastructure of paddy fields and water management facilities, rather than the innate characteristics of the varieties themselves (Yamada, 1978). HYVs can grow in paddy fields which are irrigated, drained and protected from flooding. As the rainfed paddy fields lack any other source of irrigation, it becomes essential in these fields to store as much rain water as possible. This results in the water level in these field to be very high. Because of the dwarf nature of these varieties, seedlings are very short and cannot be planted in deeply flooded fields. Shallow irrigation is definitely required for planting and for the full use of their high tillering ability. Shallow

irrigation can be practised only when there are drainage facilities, and an adequate supply of water available at all times. Since deep water in rainfed paddy fields reduces field rodent and weed infestations, measures must be taken to combat these pests when the irrigation is shallow. In addition, intensive field preparation and levelling are also required.

#### 4.2 Irrigation

Irrigation is viewed as a highly productive input. This crucial input is a prerequisite for the adoption of the new strategy. In his schematic account of irrigation's role in Asian rice agriculture Ishikawa (1967) identified three succeeding roles to be played by irrigation in the transition from one stage of rice agriculture to another. First, irrigation stabilises harvest fluctuations arising from unpredictable rainfall; secondly, it permits the introduction of a <sup>second</sup> record crop and finally, it makes possible increased applications of fertilisers as well as the use of improved varieties and techniques. However, in reality, irrigation seems to play these roles simultaneously rather than in succession (Boyce, 1987).

To increase the land productivity in Asian rice agriculture, irrigation, fertiliser and fertiliser responsive rice varieties are complementary inputs. The development of Asian rice irrigation has been very uneven in some

countries and regions than in others and this has had far-reaching implications for agricultural production. The character of irrigation development also varies in a number of important technological and economic dimensions, including water and power source; the capital labour ratio in construction, maintenance and operation; scale dimensions and the institutional arrangement governing water allocation (Boyce, 1988).

The major sources of output growth of rice are the expansion of areas adopting the new rice production technology and the continuous spread of irrigation. Irrigation ranges from handlifted buckets to massive reservoir and canal systems, which in some places require heavy infrastructural investments. (Table 4.1 shows the various sources of irrigation in India). In the rice growing areas water is available for only a portion of the land to grow a second crop, because of inadequate development of irrigation system.

There are indications that droughts have become severe over a period of time. The failure of the monsoon now causes a greater decline in output than a similar failure used to do decades ago. This is being misconstrued by some as a change in the rainfall pattern or environmental degradation. The problems of droughts and their increasing severity cannot be attributed to the changes in the rainfall pattern, and they are not isolated events. They are the

Table 4.1 : All India Net Irrigated Area by Source

(In thousand hectares)					
Sources	1950-51	1969-70	1974-75	1980-81	1983-84
Government canals	7,158 (34.33)	11,272 (37.15)	12,623 (37.65)	14,456 (37.25)	15,745 (37.53)
Private canals	1,137 (5.45)	984 (3.24)	861 (2.57)	836 (2.15)	495 (1.18)
Tanks	3,613 (17.33)	4,448 (14.66)	3,361 (10.02)	3,198 (8.24)	3,783 (9.02)
Wells (tube- wells & others)	5,798 (28.67)	11,146 (36.74)	14,258 (42.52)	17,734 (45.70)	19,521 (46.53)
Others	2,969 (14.23)	2,490 (8.21)	2,427 (7.24)	2,581 (6.65)	2,411 (5.75)
<b>Total</b>	<b>20,853</b> <b>(100.00)</b>	<b>30,340</b> <b>(100.00)</b>	<b>33,530</b> <b>(100.00)</b>	<b>38,805</b> <b>(100.00)</b>	<b>41,955</b> <b>(100.00)</b>

Note : Figures in the brackets indicate the percentage of the total in each period.

Source : Fertilizer Statistics, Various Issues, FAI, New Delhi.

products of the particular strategy of agricultural development followed and we have to find solutions in terms of basic changes in the strategies and policies (Rao, 1988).



Nearly 75 per cent of the rainfall in many regions of India is contributed by the South-East monsoon. It is confined to four months of the rainy season, i.e. from June to September. Due to the seasonality in rainfall in many regions even the total annual precipitation is grossly inadequate for crop growth and is less dependable. Prolonged dry spells during the rainy season and/or late commencement or early withdrawal of the monsoon further aggravates the uncertainty of crop prospects. In view of such uncertain variations in rainfall, irrigation is a crucial requirement not only in low and medium rainfall regions in all the crop seasons but it is also necessary in high rainfall regions, especially as a supplementary source of water in the kharif season and a main source for successful raising of rabi/summer crops (Sawant, 1986).

A significant portion of irrigation in India is based on storage of surface water in tanks and wells which depends on the rainfall and cannot guarantee a continuous supply of water round the year. Even the canal irrigation is subject to the fluctuation of rainfall in the catchment areas and does not guarantee supply of water throughout the year. Therefore, it is essential that the water supply is available throughout the year and in controlled quantities - which is the case with power operated deep wells and tube wells - ensuring maximum cropping intensity. However, it is clear that irrigation by itself does not ensure

double cropping, let alone of multiple cropping. (Rao, 1976).

A major source of irrigation in India is the surface water, which is extremely difficult to store and manage. Big projects which are in vogue in this country take decades to design and build, require large areas of precious land for submergence and for distribution system, are subject to serious evaporation and transmission losses, and demand stupendous outlays for their completion. They also create significant problem of water logging and drainage endangering the very land they are meant to serve and their command areas require large outlays for the full development of their potential. They require large staffs for maintenance and operation but find it difficult to give full satisfaction to the farmer in the matter of supplying water as and when required (Vohra, 1976).

New agriculture demands higher efficiency in water management. The basic requirement of water management is an effective control over irrigation. Water is required for the crop at specific intervals which does not always mean regular intervals. Water is required in specific quantities which again does not mean in equal quantities. Our surface irrigation systems are not designed to meet these requirements of new agriculture. Surface irrigation works are often classified as major, medium and minor works. Minor works are mostly rainfed. Major and medium

irrigation works are either barrages or reservoir dams with a distributive network. The soft nature of the rocks and the rapidity of the flow of rivers in the steep slopes results in the carriage of heavy debris and silt to the barrage and their diversion to the main and branch canals. This necessitates the closure of the canals for long periods for distribution works. Thus, although these barrages have perennial supply of water, their distribution systems functions only seasonally. They function in seasons when water is least required and close in seasons when water is more required (Michael, 1978).

Canal irrigation can in some instances result in water logging and soil salinity, reducing agricultural productivity and ultimately making land uncultivable. In India, it is estimated that at least 15 millions acres of once productive land have been lost in this way (Agarwal, 1982). The fertility of soil and its structure plays a crucial role in the choice of crops and determine the quantities of water required for them. Smallness of the size of our agricultural land holdings is not so serious impediment in water management when compared with fragmentation and irregular shape of fields. The drainage system available to the fields, both surface and sub-surface, further aggravate this problem. In this regard Bhattacharyya (1978) has also expressed the same view. According to him, lack of financial assistance has not

been the only hurdle in the erection of adequate network of field channels. Other factors such as small average size of operational holdings and high degree of fragmentation of holdings make construction of channels more difficult. For example, in some of the paddy growing regions, where plots are very small and are further fenced in by earth embankments for water logging of fields, it is not possible to dig field channels through a maze of small plots without the active cooperation of cultivation.

The new varieties of rice do not tolerate water stagnation. In the areas commanded by major and medium irrigation works, raising water table and consequent soil sickness is acquiring serious dimensions. Moreover, the condition of supply channels also create some problems. Usually, the medium and major irrigation project, works, in their distribution system, upto 1 or 2 cusec discharge level. The hierarchy in a typical distribution system are main canals, branch canals, distributions, minor and water courses. From these canal systems water is supplied to the fields through outlets of 0.5 to 2.00 cusec discharge capacity. On an average, one outlet may command 50 to 500 acres. It is left to the farmers to develop their own field channel system from the outlet point. Often irrigation takes place by groove from field to field. The adoption of high yielding dwarf varieties of paddy become risky under these conditions. Scientific fertiliser application

is also impossible. Besides, this practice contributes directly to the problem of sub-soil drainage (Lipton, 1976).

Another problem highlighted by Vohra (1976) regarding the functioning of certain irrigation projects related to power to operate those devices. Pumpsets for lifting water are run either by diesel or by electricity. Unfortunately, both are scarce and the farmer is unable to make up his mind about which energy to choose. Studies made on the economics of diesel operated pumps as compared to electrical sets show a definite advantage of electricity over diesel. With the present petroleum crisis and the escalating cost of diesel, the electric pumps should be more advantageous to the farmers. On the other hand, the current power shortage certainly provides a bottleneck for large and minor irrigation programme.

There is the possibility of crops <sup>being</sup> to be damaged by both inadequate and excessive water supply. Hence, drainage of surplus water from irrigated lands is as crucial to the crops as is the availability of irrigation water during the critical periods of growth. Accumulation of excessive surface water in the fields not only results from heavy precipitation or due to flood waters but also due to over irrigation or seepage from adjacent channels as well as percolation of irrigation water from other fields. Poorly drained fields depress crop production in several ways. Quite often high water conditions are also associated with

saline or alkaline soil conditions which severely affect crop yields. Therefore, the problem of drainage cannot be considered in isolation from those of irrigation; both are of vital importance for realising the full benefits of irrigation (Sawant, 1986).

#### 4.3 Fertiliser

Fertiliser with proper combination of good quality seeds and effective irrigation facilities, is considered as a key factor to achieve the expected output of the crop. "Thus, although the importance of increase in the use of fertiliser was known from the beginning of planning, the major break through in the consumption of fertilisers came with the introduction of new farm technology, which underlined the need for increased availability and use of non-conventional scientific inputs." (Sidhu and Singh, 1986, p. 146). Besides the management of input source, the efficient use of fertiliser needs to be augmented with effective water control and to be related with the factors including soil as well as rice varieties, the varietal reaction with pests and diseases, weed incidence, cropping systems, etc. Nevertheless, it depends on the source, mode of application, and synergistic effect with other nutrients (Pande and Reddy, 1984, Pillai, 1981).

Nitrogen (N), Phosphorus (P), Potassium (K), Zinc (Zn), etc., are the nutrients of soil on which increase of

rice yield depends. Deficiencies of these nutrient factors create the necessity of applying them from outside as manures and fertilisers. Generally, one variety of fertilisers can supply only one of the nutrient factors, for example, nitrogenous fertilisers can supply the nitrogen, and hence, varieties of fertilisers have to be applied to get the expected yield of rice from a particular piece of land. Again, all the lands do not require all the nutrients to be supplied at the same time for which soil testing becomes necessary.

Rice is cultivated under diverse soil and agro climatic conditions, viz., rainfed, freely drained, highly oxidised utisols and oxisols (upland), medium to low land irrigated paddy fields with or without adequate water control and deep water land (depth of water extending 3 to 4 meters). In the traditional rice growing areas, rice is grown in kharif, rabi as well as in summer seasons. In the nontraditional areas it is cultivated generally in the kharif season.

It has been well established that the high yielding rice varieties, with dwarf or semi-dwarf plant type, respond to fertiliser application better than that of the tall traditional varieties (David and Barker, 1978). The response of rice to fertiliser application varies according to the season of cultivation. It is poor during the wet season. Further, the response of a variety to fertiliser

management varies with the soil types. The heavy textured soil responds better than the tight textured soil. The overall utilisation of nitrogen has been found to be higher in the low rainfall areas than in the heavy rainfall areas. This is due to the uncontrolled water regime and more nutrient losses under the heavy rainfall situation. This is also evident from better grain yield response per unit of nutrient (NPK). The suitable and timely fertiliser management ensures better response to the fertiliser input. The varieties of medium and long duration cultivars in heavy rainfall areas respond to a maximum of 60 kg N/ha (Pande and Reddy, 1984).

It has been revealed by a study that it is possible to get an extra rice grain yield of one tonne per hectare by applying nearly 56 kg N/ha, of ordinary urea or 38 kg N/ha of urea supergranules or by applying 40 kg N/ha of sulphur coated urea. Similarly, to get 2 tonnes of grain yield, the quantity of nitrogen to be applied as urea/urea supergranules/sulphur coated urea would be around 98, 73 and 70 kg N/ha respectively. To obtain 3 tonnes grain yield per hectare it should be 135, 97 and 90 kg N/ha, respectively (Pillai, 1981). This means that any attempt to increase the grain yield requires lesser increase in the rate of use of nitrogen.

Studies conducted at many locations in India revealed that the response of rice to nitrogen was uniformly widespread, although that of potassium and phosphorus were



significant only under specified situations. Analysing the influence of N, P, and K on the development of yield components in rice, it was observed that nitrogen has a very significant influence in increasing panicle production as well as panicle weight, while potash has a positive influence only on panicle weight (Mahapatra, et.al, 1981).

The recovery of applied fertilisers in rice is a matter of considerable interest especially because of the different rates of recovery level for different fertilisers. It is normally very high in the case of nitrogenous fertilisers. Unlike in the case of N, the recovery of applied phosphorus is very low and has greater residual effect of P for the succeeding rice crop. Recovery of added P by the first crop is reported to be only around 15 per cent. Although the ability of the flooded rice system to make better use of soil P is an indisputable fact, precise estimates of the residual effect of added P for succeeding rice crop in a rice-rice cropping system, however, is limiting, while, the utilisation efficiency of applied potassium is fairly high in the range of 80 to 90 per cent. However, several management factors may result in a lower efficiency (Roy, et.al, 1978).

The recovery of fertiliser nitrogen by the rice plant is low, particularly when applied at an early stage of growth. The poor utilisation of nitrogen fertiliser by rice is thought to be largely caused by greater losses of

nitrogen from the soil plant system. Some of the major nitrogen loss mechanisms are peculiar to water logged soils and especially this account for the low N-use efficiency of rice, compared to other irrigated upland crops. The desired increase in grain yield through nitrogen fertilisation is a function of both N absorption and efficiency with which it is utilised for grain production (Pillai, 1981).

Among the micro-nutrient disorders, zinc deficiency and iron chlorosis are the two most important problems in rice. Greater use of chemical fertilisers may lead to the deficiency of micro-nutrients in the soil, which has increased since the introduction of HYVs. Deficiencies of boron, copper, iron, manganese, molybdenum and zinc have been reported in areas where agricultural intensity is high. (Randhawa, 1974). Wide occurrence of zinc deficiency is confirmed by a significant increase in response to NPK by zinc in the experiments conducted in the farmer's field. Application of zinc sulphate to soil has been suggested to overcome this shortage. However, the recovery of soil applied zinc in rice is very low. For instance, 10 tonnes of rice crop (grain + straw) can remove hardly 50 grams zinc out of 10 kg zinc applied to a plot of one hectare (Mahapatra, et al, 1981).

It is well known that farmers are generally not in a position to apply the recommended dose of fertilisers to their crops in view of high input cost, shortage in supply

and not being prepared to take up the risk involved in the expected gain. Experiments (Mahapatra, et al, 1981) were conducted to study the extent to which this input could safely be reduced without causing appreciable decline in total production of rice. The percentage reduction for different graded fertilisers were, however, of a varying order in different centres of study. The findings of the study revealed a decreasing trend in total yield. A reduction of 25 per cent of recommended fertiliser dose was found responsible in causing maximum loss of yield.

There appears a number of problems from fertilisers use which can be made responsible for lower productivity of rice. Urea is the principal source of nitrogen fertiliser in India. However, the problems with urea include its hygroscopic nature, rapid dissolution and susceptibility to ready decomposition to ammonia associated with the rice soil. Denitrification and ammonia volatilization losses are considered to be the major reasons for the lower efficiency of applied urea nitrogen in rice culture (Pillai, 1981).

Among the major plant nutrients, nitrogen is the major element of our agricultural abundance. The potential for N-use for rice in India towards stabilising the mean yield of rice at 2.4 ton per hectare (t/ha) is estimated to be around 65 kg N/ha (Pande and Reddy, 1984). But the average nitrogen use is much less than this estimated amount (around 25 kg N/ha). This lag between the actual and

potential amount for N-use for rice can be explained in large part by the varying abilities of farmers to accept the risk involved in fertiliser use under uncontrolled erratic water situations and more complex systems of rice farming in India. The environmental barriers and soil conditions adding to the risk factor is further compounded by the lack of an appropriate technology in most cases for fertiliser use under such erratic and adverse conditions. The low N-recovery of rice is a major deterrent in the use of required quantity of nitrogen for the modern rice varieties, particularly in most of the rainfed rice areas in India (Roy, et al, 1978).

The study conducted by Asian Development Bank (1969), Barker and Pal (1979), reveal that application of fertiliser turns out to be an expensive affair for the cultivators as the cost of fertilisers as well as other cost of production are quite high. As a result, the farmers use less than the recommended dose or hardly use fertilisers in India.

The optimum use of fertilisers is not by itself the solution for increased crop production, but in scientific combinations with indigenous organic manure along with other inputs. The output from the use of fertilisers depends not only on the quantity of fertiliser used but also on their effective use which include the forms in which fertilisers are applied, soil and water management, crop sequence and time and method of application (Roychoudhari, 1975).

In the foregoing pages, the different roles played by all the three factors in rice cultivation has been discussed along with various problems therein. Some of the problems are due to the factors themselves while some others derived from the adverse agro-climatic conditions. It has been seen from the discussion that for optimum utilisation of the potentialities of these factors, proper measures should be taken to make those conditions suitable along with the improvement of the factors.

## CHAPTER V

### ROLE OF INSTITUTIONAL FACTORS IN RICE PRODUCTION

In the previous chapter, we discussed about the technological factors associated with the modern rice technology. Apart from those factors, there are certain other factors which can affect the farmer's ability and willingness to adopt the new technology. In fact, there exist some type of relationship between the technological factors and the institutional factors. Institutional factors provide the necessary infrastructural facilities to the technological factors to enhance their potentialities. Discussing these factors, Boyce (1987) mentions about the three aspects of agrarian institutions - farm size, tenancy and management of water. However, credit and extension services are also considered as important factors in providing institutional facilities in this regard. In this chapter, an attempt is made to discuss in detail only two factors viz. land holding and credit, their role and drawbacks with regard to rice cultivation.

#### 5.1 Land Holding

In India, the distribution of land holding is very skewed. In some states a large portion of land belong to

marginal and small size of holdings (0 to 2 hectares) while in some others major portion concentrates on medium and large size of holdings (over 4 hectares). A sizewise percentage distribution of operational holding and area operated in some of the rice growing states is presented in Table 5.1. It is seen from the table that in Kerala about 96 per cent of total operational holding belong to less than 2 hectares holding size. The major portion of the area operated (about 69 per cent) belong to this category. Likewise, it is about 91 per cent and 58 per cent respectively in the case of West Bengal, while in Assam, they are approximately 75 per cent and 56 per cent respectively. On the other hand, in certain states like Punjab and Haryana, percentage of operated area in this category is significantly small (13 and 11 per cent respectively) though the percentage of operational holdings are large. Consequently, position in the medium and large size of holding is quite different for both the groups. For first group of states, both the percentage of holding as well as the percentage of operated area are small; whereas in the other group percentage of holding is small compared to the percentage of operated area. It is apparent from the table that the average size of holding is also comparatively small in the states belong to the first group. Kerala's average area of operational holding is the smallest of all with 0.43 hectares followed by West

Table 5.1 : Percentage Distribution of Operational Holding and Area Operated over Size of Holding in Some Important Rice Growing States 1980-81

State	Below 1.0 hectare		1.0 to 2.0 hectares		2.0 to 4.0 hectares		4.0 to 10.0 hectares		10.0 hectares		Average size of operational holding (hectares)
	Operational holding	Area operated	Operational holding	Area operated	Operational holding	Area operated	Operational holding	Area operated	Operational holding	Area operated	
Andhra Pradesh	48.64	10.26	22.13	15.37	<u>25.51</u>	21.08	10.80	30.20	2.93	<u>23.10</u>	2.00
Assam	61.55	22.12	24.06	<u>33.51</u>	11.33	<u>29.34</u>	2.68	13.65	0.10	1.38	1.05
Bihar	68.71	22.42	17.62	25.85	9.90	27.08	3.38	18.78	0.41	5.87	1.00
Kerala	<u>88.96</u>	<u>45.45</u>	7.28	23.09	2.89	18.47	0.82	10.06	0.07	2.93	0.43
Madhya Pradesh	32.94	3.67	22.51	13.31	23.12	24.18	17.85	38.60	<u>3.58</u>	20.24	<u>2.70</u>
Tamil Nadu	71.39	22.37	16.72	26.72	8.28	25.37	3.35	20.68	0.28	4.84	0.98
Uttar Pradesh	59.62	18.08	21.59	23.76	12.88	28.04	5.40	23.62	0.54	6.49	1.28
West Bengal	75.12	29.27	15.83	28.77	8.07	23.25	1.67	11.39	0.09	2.32	0.77
Orissa	54.47	17.02	<u>26.11</u>	26.48	14.08	26.16	4.63	17.84	0.63	12.50	1.45
Maryana	47.23	3.75	12.74	7.29	22.88	25.56	<u>18.81</u>	45.57	3.35	17.85	2.50
Punjab	69.03	3.91	10.39	8.92	13.96	21.76	14.15	<u>45.84</u>	2.48	19.58	1.81
All India	56.4	12.1	18.1	14.2	14.1	21.1	9.1	29.7	2.4	23.0	1.67

Source : Agricultural Census, 1980-81.



Bengal with 0.77 hectares. Average area of operational holding in seven out of eleven states is even smaller than all India average holding size standing at 1.67 hectares.

Statewise percentage of area under rice cultivation to their total cropped area is presented in column 2 of Table 5.2. It shows that states having higher proportion of their operated area in the size group below 2 hectares, for example, West Bengal, Assam, Bihar, Orissa, cultivate rice in a major portion of their total cropped area when compared to the other states. This percentage is relatively low in case of Punjab and Haryana. In West Bengal almost 70 per cent of the total cropped area is devoted to paddy cultivation followed by Assam with about 65 per cent. From this analysis it reflects that the cultivation of rice in India is mostly concentrated in the states where large number of operated area is dominated by small and marginal size of holding.

The nature of the relationship between farm size and yield per unit of land was hotly debated in the early sixties. A series of studies based on Farm Management Surveys (FMS) in various states of India claimed to find an inverse relationship between farm size and yield; the larger the farm size, the smaller the amount produced per unit of land (Sen 1962, 1964; Khusroo 1964; Agarwala 1964a, 1964b; Bharadwaj 1974). The smaller farms are more

**Table 5.2 : Statewise Percentage Distribution of Area under Rice, HYV Rice, Irrigation, Per Hectare Consumption of Fertiliser and Yield Per Hectare**

State	Percentage of rice area to total cropped area	Percentage of HYV rice area to total rice area	Percentage of irrigated area to total cropped area 1982-83	Percentage irrigated rice area to total rice area 1983-84	Per hectare consumption of fertilisers (N+P+K) kg/hectare 1984-85	Yield per hectare of rice kg/hectare 1985-86
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	28.5	81.1	27.6	94.2	75.14	3313
Assam	64.7	41.2	16.1	23.0	4.01	1733
Bihar	46.6	51.6	24.1	32.7	35.90	1692
Kerala	27.2	36.9	9.0	38.8	43.94	2577
Madhya Pradesh	21.9	41.2	12.0	17.5	17.13	1741
Orissa	48.7	37.7	14.6	27.4	13.04	1804
Tamil Nadu	31.3	96.4	37.4	93.3	99.94	3761
Uttar Pradesh	20.5	66.5	40.0	28.0	65.11	2232
West Bengal	69.4	39.7	26.2	25.5	54.81	2333
Haryana	9.2	84.6	44.4	44.5	57.78	4195
Punjab	10.1	95.7	57.3	98.7	151.19	4799
All India		57.1	23.2	42.3		2355

Source : 1) Columns 2, 3, 4, 5 and 7, Area and Production of Principal Crops in India  
2) Column 6, Indian Agriculture in Brief, 21st edition.

efficient in terms of production from a unit of land, but less efficient in terms of returns to capital, labour, productivity and marketable surplus (Dasgupta, 1977).

By the mid sixties, when the new technology associated with the high yielding seed varieties was introduced, its implications for farms of different size categories became a major issue of debate. The proponents of the new technology countered by argument that it is 'scale-neutral', new inputs like fertilisers, insecticides and seeds are divisible and can be used in the same proportion by both the large and small farms alike (Sen, 1974). On the other hand, the opponents argue about the imperfections in the factor market and the small farmer's limited access to it. Since most of the new inputs have to be purchased from the market with cash or through the cooperatives or banks, and because of the unequal access to credit and cooperative resources by the farmers of different size categories, they are of the view that the new technology has increased the disparity between the poor and rich farmers (Rao, 1966). In this context, Fedder and O'Mara (1981) observe that even the modern technology is divisible and neutral to scale, the adoption of which may not be affected by farm size and in fact, it is related to farm size, in practice. They are of the view that due to the presence of fixed cost, the new technology is not profitable for the small farmers even in a situation of full certainty.

Farm size can have different effects on the rate of adoption depending on the characteristics of the technology and institutional settings. More specifically, the relationship of farm size to adoption depends on such factors as fixed adoption costs, risk preferences, credit constraints, labour requirements, tenure arrangements, and so on. An often mentioned impediment to adoption of new technology by smaller farms relates to fixed costs of implementation. Studies suggest that large fixed cost reduce the tendency to adopt and slow the rate of adoption by smaller farms. Again, inadequate farm size also impedes an efficient utilisation and adoption of certain types of irrigation equipments such as pumps and tube wells (Dobbs and Foster, 1972; Gafsi and Roe, 1979).

Adoption of HYV rice cultivation in India seems to be related with the size of holding. Size of operated area and fragmentation of holding can be considered responsible for non-adoption of HYV rice cultivation equally by all the rice growing states. It reveals from the data presented in the column 3 of Table 5.2 that States with proportionately large operated area, medium and large category, are in the forefront in the adoption of HYV rice cultivation. The relative advantage of large operated area in getting all the vital inputs associated with HYV rice cultivation, may make this process more easier. It is seen from the data (columns 4, 5 and 6) that States with

high proportion of operated area under the size group medium and large with less fragmentation shows higher accessibility to inputs like irrigation and fertiliser. One of the crucial factors for the cultivation of rice is controlled water supply. Statewise percentage of irrigated area and percentage of area irrigated by different source is presented in Table 5.3. It is revealed from the table that very little area is irrigated in almost all the traditionally rice growing States compared to non-traditionally rice growing states of Punjab and Haryana. Again in these two states, major portion of irrigated area is covered by assured source like tube-wells. This may advocate the advantage of large farm size over small farm size.

The cultivation of HYV rice and others involve various kinds of uncertainty. First is the uncertainty derived from the varieties themselves which has already been discussed in the previous chapter. Secondly, uncertainty due to inability to apply all the necessary inputs in required amounts for cultivation, mainly assured water supply. Thirdly, of course, is the uncertainty regarding price and market conditions. While these uncertainties are high for farmers of all size categories, the degree of uncertainty is higher for the smaller farmers. This is partly a function of the imperfections in the distribution of knowledge between the richer and the poorer farmers. It is also partly because the smaller farmer is

Table 5.3 : Percentage of Irrigated Area in Operational Holding and Percentage Distribution of Irrigated Area over Sources, 1981-82

State	Percentage of irrigated area	Percentage of area irrigated over source						Total
		Canal	Tank	Tube-well	Well	Others	Not recorded	
Andhra Pradesh	15.55	35.72	<u>24.22</u>	2.16	29.31	8.19	<u>0.40</u>	100.00
Assam	0.51	58.77	-	21.37	-	<u>19.86</u>	-	100.00
Bihar	24.82	37.62	3.19	42.00	7.19	9.92	0.08	100.00
Kerala	11.99	52.55	6.60	0.94	25.18	14.72	0.00	100.00
Madhya Pradesh	10.75	39.50	5.54	3.77	45.86	5.26	0.07	100.00
Orissa	11.39	<u>73.51</u>	12.09	1.08	3.40	9.93	0.00	100.00
Tamil Nadu	46.98	28.73	18.39	3.58	<u>43.16</u>	6.11	0.00	100.00
Uttar Pradesh	59.59	29.82	2.71	53.72	9.67	3.91	0.17	100.00
West Bengal	22.29	37.70	18.92	24.11	5.04	14.22	0.02	100.00
Haryana	66.20	54.22	1.61	42.75	0.47	0.95	-	100.00
Punjab	<u>78.00</u>	33.78	1.07	<u>63.97</u>	0.81	0.38	-	100.00
All India	24.84	32.87	5.71	32.92	22.74	5.64	0.12	100.00

Source : Sarvekshana, Vol.XII, No.1, Issue No. 36, July 1988.

likely to get a lower price for his HYV produce than his larger counterparts; given his lack of storage facilities and inability to hoard the produce until the price is favourable. The smaller farmer's greatest disadvantage in comparison with the large farmer is in terms of their risk bearing capacity. Given their limited resources, the small farmers are forced to operate with a short time horizon which restricts the scope for adopting the new technology. A large farmer with the security of a large stock of assets is able to plan over a period of several years and capable of withstanding occasional losses from crop failure whereas a small farmer can plan only on a year to year basis (Dasgupta, 1977).

A farm's ability to profit from the new agricultural technology is largely conditional on the size and composition of its assets. Bigger asset holding, particularly of land, increases credit worthiness, especially when borrowing from institutional sources. Secondly, it enables the farm to go for high return high risk investments in new crop varieties and technology and to plan activities over a longer time horizon. Thirdly these assets also provide their owners with social and political status in the village hierarchy and among the government officials, an important factor in ensuring regular access to modern agricultural inputs (Rao, 1966).

Most of the evidences (Hayami, 1981) indicate that

the incidence of adoption of HYVs is positively related to size of the farm. Some theoretical studies suggest that scale neutral technologies such as HYV may entail significant set up costs in terms of learning, locating and developing markets, and training hired labourers. When these factors are considered as fixed expenses, the theoretical models imply that they tend to discourage the adoption by small farms (Feder, et al, 1985).

Verma and Brombey (1987) are of the view that fragmentation of holding, not the amount of holding, is responsible for the non-utilisation of modern techniques of production by all the farmers. In this case, all the farmers may have to face the same problem. Citing the example of the use of tractor, they say that in spite of having sufficient means to acquire a tractor on the basis of holding, a large farmer may also find it difficult and inefficient to use it on any particular parcel of land in a technical sense due to the scatterness of holdings among a number of locations.

Farm size can be important in both relative and absolute senses. Small farms are generally expected to have an ample supply and low opportunity cost for family labour which leads to intensive cultivation and higher yields than on large farms. But this labour advantage may be offset by the relative disadvantage of the benefit from the new technology. It is revealed through some studies



that both the small and large farmers face different prices for the same inputs in spite of the conventional notions that all producers face the same price. Due to the lack of sufficient amount of capital, small farmers have to buy the inputs in smaller quantity and hence their total cost of production is much higher than the large farmers who can buy the whole amount of input at one go and at cheaper price. Again, as a result of abundant labour forces small farmers face relatively low labour cost and high capital cost, while large farmers face low capital cost but high labour cost. These relative prices force the small farmers to use large amount of labour and less amount of capital. This ultimately deprive both the group of farmers from adopting modern technology (Verma and Brombey, 1987).

Bell (1972) shows that in a simple case where only the modern production technology is considered small farmers will apply less fertiliser per unit of land. The subsistence requirements of the small farmers are higher than those of large farmers which force them to refrain from spending too much cash on fertilisers and as a result their fields do not show a high yield.

Table 5.4 shows the statewise percentage of area leased out and leased in to area owned. It is evident from the table that except in Andhra Pradesh and Madhya Pradesh the percentage of leased in area is relatively more than the percentage of leased out area in all the other states.

Table 5.4 : Percentage of Area Leased Out/Leased in to Area Owned - Statewise, 1982

State	Percentage of area leased out	Percentage of area leased in
Andhra Pradesh	6.30	6.51
Bihar	4.95	10.42
Kerala	0.43	2.29
Madhya Pradesh	3.28	3.81
Tamil Nadu	5.89	13.39
Uttar Pradesh	4.80	11.39
West Bengal	2.48	12.31
Orissa	5.45	8.04
Haryana	10.64	19.65
Punjab	11.07	18.99

Source : Sarvekshana, Vol. XI, No.2, Issue No. 33, October 1987.

It is clear from the earlier discussion that in Punjab, and Haryana, the size of operated area is generally large and fragmentation is also less. In these two states, farmers (particularly medium and large) are supposed to have all kinds of modern inputs and there is every possibility for the underutilisation of those inputs. Therefore, though

their percentage of leased out and leased in area is high, they are exempted from the present discussion assuming their tenurial system does not pose any problem. In other states, where the country's major portion of rice is grown, tenurial system may be said to pose certain problems in the adoption of modern rice technology.

Tenurial arrangements may play an important role in the adoption decision. Bhaduri (1973) developed a model showing that a landlord's double role as a provider of credit and as a landowner creates a situation such that the landlord may not permit the adoption of yield increasing innovations. The landlord is the decision maker regarding the variety of crops to be grown on leased land. This is because adoption will reduce the tenants' indebtedness to the landlord.

In some cases, where the landlords do not participate in the cost, production decisions are taken exclusively by the tenants. Most of the tenants are those with insignificant amount of land (or no land) and therefore, they do not possess other assets. They cannot afford to go in for the adoption of HYV crops which have cash requirements higher than those of traditional ones and which they themselves cannot procure. Even though some landlords are ready to invest, they are very less in number (Ratan and Chakravarty, 1982). This takes us to the problem of credit requirement and credit availability from various sources.

## 5.2 Credit

The introduction of new agricultural technology with modern inputs demonstrated the need for effective credit support to the farming communities. Depending on the purpose of borrowing, agricultural credit can be divided into two broad types - short term production credit to enable the farmers to purchase inputs like seeds, fertilisers, pesticides, etc., medium or long term investment credit for the installation of wells/dug wells to provide dependable irrigation for the high yielding crops as well as for the purchase of mechanical inputs like tractors so that the farmer can grow more than one crop in a year.

Agricultural credit is a part of the total credit picture of the economy. The adequacy of its quantum, distribution and appropriateness of its price is considered as an integral and important element of the national credit policy. The absence of proper credit facilities has been regarded as a major reason for the slower rate of adoption of HYV rice techniques by cultivators, especially the small farmers. The cooperatives play an important role in lending to the cultivators in the HYV areas and of late by the nationalised commercial banks as well. However, the proportion of lending by these agencies vary considerably between and even within the states (Athavale, et al, 1971).

A wide range of disparities is evident from the

total supply of cooperative credit (Table 5.5) and credit by the scheduled commercial banks (Table 5.6) in India per hectare credit issued by the primary agricultural credit societies ranged from Rs. 24 in Bihar to Rs. 1490 in Kerala. Most of the traditionally rice growing states, like Bihar, Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal have relatively lower amount of cooperative credit available per hectare than the national average of Rs. 165 per hectare. The amount of loan issued per borrower is also relatively low in these states. Again the percentage of farmers covered by these loans in most of the states (9 to 34) are also very negligible compared with those of Punjab and Haryana (90 and 69 per cent respectively). The distribution of credit per borrower is highest in Punjab followed by Haryana, though their per hectare availability of credit is lower than Kerala. Taking the country as a whole, it is clear from the table that though the per hectare cooperative credit is relatively double in the case of small and marginal size farms, the per borrower credit availability is relatively more in the case of medium and large farms. An almost similar picture emerges in the case of distribution of loans by the scheduled commercial banks. But the percentage of borrowers covered under commercial banks' loan is much smaller than that of the cooperatives.

Cooperative credits provided by the PACS, are mainly used for buying seeds and pesticides. The proportion of

**Table 5.5 : Distribution of Loans Advanced by Primary Agricultural Credit Societies by Size Group of Holdings, 1984-85**

State	Below 2 hectares			Above 2 hectares			Total		
	Amount per hectare	Amount per borrower	Percentage of farmers covered	Amount per hectare	Amount per borrower	Percentage of farmers covered	Amount per hectare	Amount per borrower	Percentage of farmers covered
Andhra Pradesh	327	1134	26	95	1559	39	165	1223	34
Bihar	19	238	5	29	227	54	24	231	12
Kerala	1293	1588	54	1589	5770	100	1490	1979	69
Madhya Pradesh	135	834	22	63	1509	33	76	2211	27
Orissa	75	553	22	90	2010	39	83	992	25
Tamil Nadu	224	1584	12	225	2016	74	224	1710	22
Uttar Pradesh	92	708	18	81	1154	41	86	862	22
West Bengal	75	800	7	46	1179	20	65	862	9
Haryana	753	1762	46	182	2483	77	303	2341	69
Punjab	1158	1831	48	435	3943	100	621	2751	90
All India	264	1262	20	126	2181	42	165	1532	27

**Source :** T. Haque and Sunita Verma, "Regional and Class Disparities in the Flow of Agricultural Credit in India", IJAE, Vol.XLIII, No.3, July-September 1988, p. 361.

Table 5.6 : Distribution of Short Term Loans Issued by Scheduled Commercial Banks by Size Group of Holding, 1984-85

State	Below 2 hectares			Above 2 hectares			Total		
	Amount per hectare	Amount per borrower	Percentage of farmers covered	Amount per hectare	Amount per borrower	Percentage of farmers covered	Amount per hectare	Amount per borrower	Percentage of farmers covered
Andhra Pradesh	842	2702	29	99	2782	23	290	2721	27
Assam	13	1176	1	18	11836	8	15	2212	1
Bihar	50	1128	3	17	1728	4	33	1244	3
Kerala	629	2275	18	208	6709	23	500	2482	18
Madhya Pradesh	29	1492	3	8	2510	3	19	3121	3
Orissa	84	1611	8	54	2576	18	67	1944	10
Tamil Nadu	757	2347	23	210	5265	26	479	3173	24
Uttar Pradesh	43	964	4	21	1703	7	30	1263	5
West Bengal	135	1273	8	62	6362	5	104	1590	8
Haryana	67	325	2	15	4837	3	21	4135	3
Punjab	140	2175	5	71	5135	15	86	4230	8
All India	131	2665	5	30	5882	4	58	3339	4

Source : T. Haque and Sunita Verma, "Regional and Class Disparities in the Flow of Agricultural Credit in India", IJAE, Vol. XLIII, No. 2, July-September 1988, p. 360.

cash expenditure met by the cooperatives decreases as the farm size increases. Large farms are seemed to meet their cash expenses from other sources, usually from their own savings. The availability of credit and uncertainty appear to be inter-related. On the other hand, the demand for credit may also significantly be affected by uncertainty. Therefore, small farmers are normally less in number in the credit market (Desai and Prakash, 1971; Desai and Naik, 1971).

A distribution of cropwise loan per hectare (Table 5.7) reveals again the disparities among the states. In the case of loans per hectare for foodgrains as a whole Kerala is the only state in receiving more than Rs. 500. The other states, except Punjab and Haryana, are getting less than Rs. 100. Assam is getting the lowest amount of Rs. 4.45 followed by Bihar with Rs. 11.63. Cropwise loan for rice shows that almost all the traditionally rice growing states, except Kerala (Rs. 214.08) and Andhra Pradesh (Rs. 149.92), are getting less than Rs. 100. It is very less in the case of the Assam with only Rs. 4.26 followed by Bihar with only Rs. 9.93. The non-traditional rice growing states of Punjab and Haryana are getting the highest amount.

For the adoption of modern agricultural technology (including cultivation of HYV rice) farmers have to purchase most of the inputs from the market. As a result,



Table 5.7 : Ranking of States for Short Term Cropwise  
Loan Issued Per Hectare 1980-81

State	Rice		Wheat		Foodgrains	
	Amount Rs.	Rank	Amount Rs.	Rank	Amount Rs.	Rank
Andhra Pradesh	149.92	8	1608.87	9	72.55	8
Assam	4.26	1	8.94	1	4.45	1
Bihar	9.93	2	30.50	2	11.63	2
Kerala	214.08	9	-	-	529.51	11
Madhya Pradesh	52.50	5	112.33	5	48.13	4
Orissa	100.24	7	210.55	6	65.60	7
Tamil Nadu	32.89	3	-	-	22.06	3
Uttar Pradesh	77.66	6	86.54	4	62.91	6
West Bengal	51.85	4	44.20	3	48.87	5
Haryana	462.99	10	337.11	8	228.80	9
Punjab	473.08	11	323.19	7	362.88	10

Source : 1) Statistical statements relating to the co-operative movement in India 1980-81, Part I, Credit Societies, NABARD.

2) Area & Production of Principal Crops in India 1985-86, Government of India, Ministry of Agriculture, 1987.

their requirement of credit is very high. But the present supply of credit is not proportionate to the requirement of the credit (Table 5.8). The percentage of credit supply to requirement is outstanding in Kerala (102%). But in other states, it is very insignificant. Except Andhra Pradesh and Kerala, in other traditionally rice growing states, these percentages are less than 10. It is quite insignificant in Assam (0.3%) and also in Bihar, West Bengal and Orissa (2, 3 and 4 per cent respectively). All these reflect that whatever be the kind of credit, it is always very low in most of the traditional rice growing states, where rice could not show a better performance.

Credit has a relationship with the size of holding. Cost of borrowing varies systematically with land ownership. Numerous factors act against the small and marginal farmers in obtaining credit at the same interest rate as the large farmers. The small farmers do not possess sufficient assets to offer as collateral. Moreover, their income is also small and the needs for consumption loan is disproportionately greater. These conditions force them to pay a higher price for borrowed funds (Bhalla, 1979). Again, among the states loans advanced against collateral also varies. In states like Assam, West Bengal, Bihar and Orissa, the amount of credit advanced against collateral is very low compared to Haryana and Punjab. It ranges from Rs. 1208 in Assam to Rs. 13,098 in Haryana (Sarvekshana, July 1987).

**Table 5.8 : Comparison of Statewise Short Term Credit Requirement and Credit Supply for Crop Production in 1984-85**

(Rs. crores)			
State	Credit supply	Credit requirement	Percentage of credit supply to requirement
Andhra Pradesh	493	2339	21
Assam	3	870	0.3
Bihar	43	1830	2
Kerala	429	419	102
Madhya Pradesh	185	2236	8
Orissa	87	2172	4
Tamil Nadu	367	2298	16
Uttar Pradesh	281	3252	9
West Bengal	101	2959	3
Haryana	187	1284	15
Punjab	351	2118	17

**Source :** D. K. Desai, "Institutional Credit Requirement for Agricultural Production - 2000 A.D.", Indian Journal of Agricultural Economics, Vol. XLIII, No.3, July-September 1988, p. 347.

There exist a fixed cost for both borrowing and lending transaction which varies according to the size of loan. In this regard small and large farmers face different conditions. In the absence of any control, the lenders have a choice between lending to large farmers and small farmers. Normally small farmers demand a small loan while the large farmers a big one. (This is because, the required amount of loan also depends on the area of cultivation.). In this situation, unless the lenders are able to charge a proportionately high transaction cost of small loans issued to the small farmers either as a fixed fee or as an increased interest rate, they hesitate to lend to small farmers. If they cannot do this, the market for small borrowers cease to exist from the lenders' side (Binswanger, 1983).

There seems to be a tendency for systematic variation in the behaviour of the small and marginal farmers regarding the entry in the credit market. It is said that higher the landbase (ownershipwise), higher is the participation in the credit market as receivers. The poorer are found to participate less, obviously not because their credit requirement is low; they get less loan because they are less credit worthy. The collateral they can offer is often unacceptable to the lenders (Ratan and Chakravarty, 1982).

The problems faced by the farmers in acquiring credit facilities are also related to the lending procedures followed by different credit agencies. These procedures, though uniform all over the country, sometimes vary from state to state (Ghatak, 1976).

Inadequately managed extension services of the lending agencies which are not properly linked upto specific schemes or categories of borrowers are considered as an important drawback of our agricultural credit. Because of these, available credit and other facilities are not able to reach the farmers in time and effectively. In this regard, commercial banks are trying to maintain technical staff, but the cooperatives are yet to take up this issue (Shivamaggi, 1986). At the same time, specific programmes of agricultural development are generally target oriented. With limited facilities and being restricted by time for the fulfilment of certain targets, officials of the credit agencies are seem to take up their work hurriedly and without proper care. As a result, many small and marginal farmers (who are generally less powerful) are normally left out of the scene (Shastri, 1971).

In their survey, Vasanthakumar and Singh (1987) have also highlighted the inadequacy, non-availability and complicated procedures of credit system as its main drawbacks. Even though the available amount of credit is considered as adequate, the procedures involved therein are not favourable

to the farmers. In this regard, citing the example of a loan for digging well or buying pumpset, Dandekar (1988) explains the different procedures and the number of officials from various departments the borrower has to follow and visit. These lengthy and troublesome procedures create unwillingness among the farmers in acquiring credit. Again, even after meeting all these formalities the loan is finally available to the farmers when it is no longer necessary.

There seems to exist a high degree of correlation between credit and fertiliser consumption (Table 5.9). It seems from the table that except in case of Assam (0.17) and West Bengal (0.61), this correlation coefficient is very high. But per hectare consumption of fertiliser is very low in most of the traditionally rice growing states, which reflects the non-availability of credit facilities in these states.

It is obvious that private moneylenders as well as the big landlords occupy a significant position in the rural credit market. Small and marginal farmers have a generation old relationship with these people. Apart from providing production loans, they also provide consumption and other loans to the farmers, which is generally not seen in the case of the institutional agencies dealing with agricultural credit (Vasanthakumar and Singh, 1987). Farmers (particularly the small and marginal) are hesitant to deal with the banks for the fear of losing their

Table 5.9 : Correlation Coefficient between Credit and Fertiliser Consumption and Per Hectare Consumption of Fertiliser

State	Correlation coefficient	Consumption of fertiliser kg/hectare
Assam	0.17	4.01
Bihar	0.89	35.90
Madhya Pradesh	0.82	17.13
Orissa	0.86	13.04
Uttar Pradesh	0.87	65.11
West Bengal	0.61	54.81
Haryana	0.98	57.78
Punjab	0.90	151.19

Source : 1) M. V. Gadgil, "Agricultural Credit in India : A Review of Performance and Policies", IJAE, Vol.XLI, No.3, July-September 1986, p. 297.

2) Indian Agriculture in Brief, 21st edition.

relationship with the moneylenders in the village. As a result, these categories of farmers seem to be out of the stream of modern technologies for not having sufficient capital (Dandekar, 1988; Jodha, 1981).

Analysing the ownership of irrigated land, Bowonder (1981) shows that larger farms are better irrigated than the smaller farms, whose owners do not possess

enough capital to invest in pumpset. The major part of the benefits of irrigation are availed by the richer farmers. They use social and political influence to get a larger share of agricultural credit; the banks and cooperatives being dominated by the richer section of the society, also favours mainly the rich farmers.

In pursuance of the changing lending procedure, institutional lending agencies are following certain new policies. One of such policy is to provide loans to the farmers partly in cash and partly in kind. The 'kind' component of the loans mainly consist of seeds, fertilisers, pesticides, etc. But in many cases, farmers who are receiving these kind loans, express their dissatisfaction regarding the quality of the inputs. Moreover, like the cash loans due to various official formalities, often the inputs are made available to the farmers quite late. All these shortcomings make the farmers unwilling to receive the loan in kind (Vasanthakumar and Singh, 1987).

The above discussion tells us that like the technological factors, these institutional factors are also equally responsible for the slower development of rice cultivation which is concentrated in states having preponderance of small and marginal holdings. To gear up the rice production in the country, coordination between technological and institutional factors becomes highly essential.



## CHAPTER VI

### SUMMARY AND CONCLUSION

An attempt is made in this chapter to summarise the findings of each chapter separately and a concluding remark thereof at the end. After projecting the problem of our study in the introductory chapter, we discuss the relative position of rice in Indian agriculture in Chapter II. Rice and wheat are the two competing cereals in India. Area under rice in India is the highest in the world. But its production and productivity are not proportionate to the acreage compared to some other countries. In India, comparatively, rice is more widely spread over than wheat. Almost all the states in our country cultivate rice. Some of them are traditionally rice growing states, while some others have taken it up recently. Among the rice growing states, there exists a wide range of disparity. Through a comparative analysis of wheat and rice, we arrive at the conclusion that rice production in India is not as promising as that of wheat. Certain factors are responsible for the poor performance of Indian rice cultivation.

Present agricultural operations are mainly based on modern technology. We discuss the need for adopting

this modern technology in Indian rice cultivation in Chapter III. The earlier part of the chapter shows that it is not possible to increase the production of rice with the tradition oriented agricultural practices. As a result, like many other countries, introduction of modern technology is considered as an essential aspect of farming in India. In this new phase, rice and wheat get the priority. We trace out the different varieties of HYV rice seed developed within and outside the country with their characteristic features. We discuss about the rate of adoption of these high yield promising varieties of rice in our country in comparison to that of wheat. Rice remains far behind of wheat in the process of adoption which indicates the presence of certain determining factors. Based on the findings of various studies in this regard, we divide these factors into two groups - technological and institutional. The first group of factors is present in the technology itself while the other group is associated with the various agricultural institutions.

In Chapter IV, we discuss three main technological factors, viz., HYV seed, irrigation and fertiliser. Discussion of the HYV seeds shows that varieties tried are not uniformly suitable for all the rice growing states. They are having good production potentialities, but fail to resist in the diversified agro-climatic conditions. High sensitivity to pests and diseases and involvement of

high cost of cultivation restricted their adoption in many places. Water requirement for rice is higher in comparison to other crops. Irrigation is the leading input in High Yielding Variety Programme. Irrigation system of our country is not sufficient to provide adequate water for the rice crop. Except the states of Punjab and Haryana, farmers of other states lack reliable source of irrigation. Most of the paddy fields in these states remain dry in the crucial periods of crop growth. Moreover, both flood and drought create additional problems in this regard. Fertiliser is the third factor we discuss about. It is revealed from the discussion that fertiliser use is essential for optimum utilisation of the potentialities of HYVs. But lack of appropriate information about the type, time and methods of fertiliser use for rice become a handicap in its application. Further, the quality of fertiliser is also not seemed to be doubt-free in some cases. Due to differences of the soil requirements, all fertiliser is not equally responded in all places. Cost of fertiliser is another reason for its low rate of application. From a combined look on all these factors it becomes clear that they are not independent of each other; rather they are complementary to one another. Perfect coordination among the three is highly essential to explore the potentialities of each factor.

Discussions in Chapter V carry out the importance

of two major institutional factors - land holding and credit. Due to lack of appropriate information about these two factors, related directly to the cultivation of rice, we continue our discussion more or less depending on the general pattern of land holding and agricultural credit of the major rice growing states. It seems that a major portion of rice acreage in our country is dominated by the states where size of operated area is mostly small or marginal with high fragmentation. Small size of operated area stands as a barrier in the adoption of the inputs associated with the new rice technology. Inputs like fertiliser, irrigation, mechanical implements, etc. are not accessible to the small and marginal farmers. In the field of credit also, wide disparities exist among various states. Accessibility to credit seems to be related with the size of operational holdings. Traditionally rice growing states in the country are considered as agriculturally less developed in general. It is reflected from the discussion that only the developed states (Punjab and Haryana) are getting maximum benefit of credit and other facilities. These two factors, instead of providing the necessary facilities for the adoption of new rice technology, are found to be acting as constraints in the way of adoption.

### Conclusion

Throughout the study we observe the various

impediments acting against the desired goal, increase of rice production, in different ways. Overcoming all these is not an easy task. Certain problems mentioned above can be checked, but others cannot. For this, effective research should be undertaken to develop suitable varieties for different regions. Moreover, link between research stations and cultivators' fields has to be established. There should be a flow of information from the research stations to the cultivators with a provision of carry back the production difficulties encountered in the actual field to the research stations. For this, extension services should be designed as service oriented instead of making it target oriented.

To ensure regular and reliable supply of water to the fields, separate policy seems to be essential for each states depending on their accessibility to the sources. Government should take the initiatives, instead of passing it on to the farmers, as heavy capital investment is required for irrigation development. Soil testing is the pre-condition for the application of fertilisers. Proper demonstration and training should be provided to the cultivators relating to the various techniques in the application of fertilisers at different stages under different conditions. Above all, measures should be taken for effective and timely distribution of these inputs along with the improvement in the quality.

It is quite obvious that the present land holding system needs various modifications for the improvement of rice production in our country. As a matter of fact, only government can take sufficient measure in this field. To remove inequalities in the distribution, proper understanding of the developmental role and efficient credit allocation procedure formulation is needed. Formalities in the allocation of credit should be minimised and provision for supervising the use of borrowed funds in the right direction should be made.

All the factors discussed above are not individually sufficient, they are complementary to each other. To explore the potentialities of Indian rice cultivation, coordination among all these factors command high priority. At last, economists, agricultural scientists, government officials, cultivators and the community as a whole should share their respective responsibilities.

Appendix Table 1 : Area under Rice in Major Rice Producing Countries of the World

Country	(In thousand hectares)		
	5 yearly average ending at		
	1975	1980	1985
Bangladesh	9,881	10,092	10,408
Brazil	4,763	5,964	5,460
Burma	4,825	4,860	4,768
China	35,037	36,085	33,443
India	37,643	39,633	40,305
Indonesia	8,349	8,692	9,374
Japan	2,690	2,592	2,293
Pakistan	1,553	1,929	1,996
Philippines	3,421	3,544	3,345
Thailand	7,428	8,461	9,465
World	1,35,820	1,42,791	1,44,614

Source : Area and Production of Principal Crops in India, Various issues, Government of India, Ministry of Agriculture.

Appendix Table 2 : Production of Rice in Major Rice  
Producing Countries of the World

Country	(In thousand tonnes)		
	5 yearly average ending at		
	1975	1980	1985
Bangladesh	19,791	19,352	21,405
Brazil	7,012	8,633	8,752
Burma	8,386	10,566	14,435
China	1,14,012	1,37,336	1,34,421
India	41,634	47,886	54,486
Indonesia	20,878	25,635	35,794
Japan	15,677	15,157	13,609
Pakistan	3,593	4,588	4,925
Philippines	5,482	7,202	8,169
Thailand	13,948	15,929	18,850
World	3,17,572	3,82,097	4,42,453

Source : Area and Production of Principal Crops in  
India, Various issues, Government of India,  
Ministry of Agriculture.



Appendix Table 3 : Area under Rice - Statewise

State	(In thousand hectares)				
	5 yearly average ending at				
	1965	1970	1975	1980	1985
Andhra Pradesh	3431.0	3243.1	3284.3	3714.1	3744.6
Assam	1902.9	2085.6	2027.9	2229.9	2294.5
Bihar	5177.0	5184.1	5162.1	5366.8	5098.0
Haryana	Includ- ed in Punjab	213.0	283.7	394.4	511.4
Jammu & Kashmir	227.0	228.4	228.1	260.2	270.8
Karnataka	1084.4	1111.5	1122.7	1104.8	1151.3
Kerala	803.0	841.9	876.0	834.5	771.5
Madhya Pradesh	4259.0	4259.1	4511.6	4709.3	4895.2
Maharashtra	1352.6	1351.8	1327.5	1476.6	1509.3
Orissa	4359.6	4331.1	4559.7	4391.4	4213.7
Punjab	485.6	323.5	480.9	858.2	1378.4
Tamil Nadu	2641.0	2623.0	2633.9	2658.5	2289.3
Uttar Pradesh	4358.8	4421.2	4532.0	4868.1	5320.4
West Bengal	4549.1	4773.6	5130.1	5145.1	5163.8

Source : Area and Production of Principal Crops in India, Various issues, Government of India, Ministry of Agriculture.

Appendix Table 4 : Production of Rice - Statewise

State	(In thousand tonnes)				
	5 yearly average ending at				
	1965	1970	1975	1980	1985
Andhra Pradesh	4492.9	4505.7	5008.7	6145.0	7650.1
Assam	1798.5	1978.4	2023.1	2157.5	2458.8
Bihar	4567.8	3969.0	4517.8	4837.3	4660.0
Haryana	Includ- ed in Punjab	270.0	478.2	915.0	1288.0
Jammu & Kashmir	235.6	333.2	405.2	464.9	566.7
Karnataka	1560.1	1776.2	1983.1	2112.8	2268.2
Kerala	1114.3	1164.0	1323.4	1294.4	1276.3
Madhya Pradesh	3045.5	2602.0	3310.3	3293.3	3978.8
Maharashtra	1419.1	1239.2	1355.1	2126.3	2228.3
Orissa	4140.6	3949.5	3902.8	3888.5	4087.6
Punjab	560.6	416.4	986.2	2362.8	4142.6
Tamil Nadu	3983.0	4073.5	5067.7	5296.1	4619.5
Uttar Pradesh	3244.9	2814.4	3226.5	4461.0	6209.2
West Bengal	5168.5	5505.1	6141.3	6574.7	6856.1

Source : Area and Production of Principal Crops in India, Various issues, Government of India, Ministry of Agriculture.

Appendix Table 5 : Yield of Rice - Statewise

State	(Kgs. per hectare)				
	5 yearly average ending at				
	1965	1970	1975	1980	1985
Andhra Pradesh	1309	1389	1524	1651	2040
Assam	945	948	997	967	1071
Bihar	866	753	876	898	908
Haryana	N.A.	1255	1683	2332	2864
Jammu & Kashmir	998	1036	1774	1782	2092
Karnataka	1440	1589	1767	1902	1970
Kerala	1388	1378	1511	1553	1655
Madhya Pradesh	715	610	734	700	813
Maharashtra	1049	913	1017	1441	1476
Orissa	951	911	855	880	967
Punjab	1149	1272	2035	2736	2995
Tamil Nadu	1508	1552	1912	1988	2006
Uttar Pradesh	744	635	800	917	1166
West Bengal	1134	1151	1198	1278	1323

Note : N.A. - Not Available

Source : Area and Production of Principal Crops in India, Various issues, Government of India Ministry of Agriculture.

## BIBLIOGRAPHY

- Abel, Martin E., and Easter, William (1971). "Agricultural Development Planning and Program Evaluation With a Focus on Regional Restraints", in IRRI, Viewpoints on Rice Policy in Asia.
- Agarwal, A. (1982). The State of India's Environment.
- Agarwala, Ramgopal (1964a). "Size of Holding and Productivity : A Comment", The Economic Weekly, Vol. 16, No.15, April 11, p. 695.
- \_\_\_\_\_ (1964b). "Size of Holding and Productivity : Further Comments", The Economic Weekly, Vol.16, No.47, November 21, pp. 1849-1851.
- Antle, John M. (1984). "Human Capital, Infrastructure and the Productivity of Indian Rice Farmers", Journal of Development Economics, Vol.14, Nos.1 & 2, January-February, pp. 163-181.
- Asian Development Bank (1969). Asian Agricultural Survey.
- Athavale, M. C., Yadav, K. C. and Mishra, J. P. (1971). "Green Revolution and Short-term Co-operative Credit - A Study in Two Districts of Madhya Pradesh", Indian Journal of Agricultural Economics, Vol.26, No.4, October-December, pp. 519-523.

- Barker, R., and Anden, T. (1975). "Factors Influencing the Use of Modern Rice Technology in the Study Areas", in IRRI, Changes in Rice Farming in Selected Areas of Asia.
- Barker, R. (1979). "Adoption and Production Impact of New Rice Technology - The Yield Constraints Problem", in IRRI, Farm-Level Constraints to High Rice Yields in Asia - 1974-77.
- Barker, R., and Pal, T. K. (1979). Barriers to Increased Rice Production in Eastern India, IRRI Research Paper Series No.25, March.
- Bell, Clive (1972). "The Acquisition of Agricultural Technology : Its Determinants and Effects", Journal of Development Studies, Vol.9, No.1, October, pp. 123-159.
- Bhaduri, Amit (1973). "A Study in Agricultural Backwardness under Semi-Feudalism", Economic Journal, Vol. 83, March, pp. 120-37.
- Bhalla, G. S., and Alagh, Y. K. (1979). Performance of Indian Agriculture - A District-wise Study, Sterling Publishers Pvt. Ltd., New Delhi.
- Bhalla, Surjit S. (1979). "Farm Size, Productivity and Technical Change in Indian Agriculture", in R. Albert Berry and William R. Cline (ed.), Agrarian Structure and Productivity in Developing Countries, The Johns Hopkins University Press.

- Bharadwaj, Krishna (1974). "Notes on Farm Size and Productivity", *Economic and Political Weekly*, Vol. IX, No.13, March 30, pp. A-11 to A-24.
- Bhattacharyya, A. K. (1978). "Irrigation and Water Management by the Damodar Valley Corporation", *Journal of Development Studies*, Vol.15, No. 1, October, pp. 34-58.
- Binswanger, Hans P., and Sillers, Donald A. (1983). "Risk Aversion and Credit Constraints in Farmers' Decision-Making : A Reinterpretation", *The Journal of Development Studies*, Vol.20, No.1, October, pp. 5-21.
- Bowonder, B. (1981). "The Myth and Reality of HYVs in Indian Agriculture", *Development and Change*, Vol. 12, No. 2, April, pp. 293-313.
- Boyce, James K. (1987). *Agrarian Impasse in Bengal : Agricultural Growth in Bangladesh and West Bengal, 1949-1980*, Oxford University Press, Bombay.
- \_\_\_\_\_ (1988). "Technological and Institutional Alternatives in Asian Rice Irrigation", *Economic and Political Weekly*, Vol. XXIII, No.13, March 26, pp. A-6 to A-22.
- Dandekar, M. N. (1988). "Farm Credit in India", *Journal of Rural Development*, Vol.7, No.2, March, pp. 137-170.

- Dasgupta, Biplab (1977a). "Indian Green Revolution",  
Economic and Political Weekly, Vol.12, Nos. 6,7 & 8,  
Annual Number, February, pp. 241-260.
- \_\_\_\_\_ (1977b). The New Agrarian Technology and India,  
The Macmillan Company of India Ltd., Madras.
- David, Cristina C., and Barker, R. (1978). "Modern Rice  
Varieties and Fertilizer Consumption", in IRRI,  
Economic Consequences of the New Rice Technology.
- Desai, B. M. and Desai, D. K. (1970). "Is Inadequacy of  
Institutional Credit a Problem in Changing Agri-  
culture?", Economic and Political Weekly, Vol. V,  
No.39, September 26, pp. A-101 to A-110.
- Desai, D. K. (1988). "Institutional Credit Requirements  
for Agricultural Production - 2000 AD", Indian  
Journal of Agricultural Economics, Vol. XLIII, No.3,  
July-September, pp. 326-355.
- \_\_\_\_\_ and Prakash, Hari (1972). "Planning and Implementa-  
tion of Financing the Area Development Scheme",  
Economic and Political Weekly, Vol. VII, No.13,  
March 25, pp. A-13 to A-22.
- \_\_\_\_\_ and Gandhi, Madalsa (1988). Rice-Production, Pro-  
ductivity and Research Management, Oxford and IBH  
Publishing Co.Pvt.Ltd., New Delhi.
- Desai, D. M. and Naik, B. D. (1971). "Prospects of Demand  
for Short-term Institutional Credit for HYVs",  
Indian Journal of Agricultural Economics, Vol.26,  
No.4, October-December, pp. 458-67.

- Dobbs, Thomas, and Foster, Phillips (1972). "Incentives to Invest in New Agricultural Inputs in North-India", *Economic Development and Cultural Change*, Vol.21, No.1, October, pp. 101-117.
- Evenson, Robert (1975). "Technology Generation in Agriculture", in Lloyd G. Reynolds (ed.), *Agriculture in Development Theory, Economic Growth Centre*, Yale University.
- Farmer, B. H. (1979). "The Green Revolution in South Asian Rice Fields : Environment and Production", *Journal of Development Studies*, Vol.15, No. 4, July, pp. 304-319.
- Feder, Gershon, Just, Richard E. and Zilberman, David (1985). "Adoption of Agricultural Innovations in Developing Countries : A Survey", *Economic Development and Cultural Change*, Vol.33, No. 2, January, pp. 255-280.
- \_\_\_\_\_ and O'Mara, Gerald T., "Farm Size and Diffusion of Green Revolution Technology", *Economic Development and Cultural Change*, Vol. 30, No. 1, October, pp. 59-76.
- Food and Agricultural Organisation of UN (1966). *Rice - Grain of Life*, Rome.
- \_\_\_\_\_ (1987). *The 5th World Survey - 1985*, Rome.



- Frankel, Francine R. (1971). *India's Green Revolution Economic Gains and Political Costs*, Oxford University Press, Bombay.
- Gadgil, M. V. (1986). "Agricultural Credit in India : A Review of Performance and Policies", *Indian Journal of Agricultural Economics*, Vol. 41, No. 3, July-September, pp. 282-309.
- Gafsi, Salem and Roe, Terry (1979). "Adoption of Unlike High Yielding Wheat Varieties in Tunisia", *Economic Development and Cultural Change*, Vol.28, No. 1, October, pp. 119-134.
- Ghatak, Subrata (1976). *Rural Money Market in India*, The Macmillan Co. of India Ltd., Delhi.
- Ghose, R. M., Ghatge, M. B. and Subrahmanyam, V. (1960). *Rice in India*, Indian Council of Agricultural Research.
- Government of India (1987). *Area and Production of Principal Crops in India*, Ministry of Agriculture.
- \_\_\_\_\_ (1983). *National Accounts Statistics - 1970-71 to 1980-81*, Central Statistical Organisation.
- Haque, T. and Verma, Sunita (1988). "Regional and Class Disparities in the Flow of Agricultural Credit in India", *Indian Journal of Agricultural Economics*, Vol.43, No.3, July-September, pp. 356-363.

- Hayami, Y. and Ruttan, V. (1971). Agricultural Development : An International Perspective, Baltimore : Johns Hopkins University Press.
- Heady, Earl O. (1952). Economics of Agricultural Production and Resource Use, Prentice Hall, Inc., New York.
- Hopper, W. David and Freeman, Wayne H. (1969). "From Unsteady Infancy to Vigorous Adolescence : Rice Development", Economic and Political Weekly, Vol. 4, No. 13, March 29, pp. A-17 to A-21.
- International Rice Research Institute (1970). Annual Report.
- Ishikawa, Shigeru (1967). Economic Development in Asian Perspective, Kinokuniya Book Store Co.Ltd., Tokyo, Japan.
- Jasbir Singh (1974). The Green Revolution in India - How Green It Is?, Vishall Publications, Haryana.
- Jodha, N. S. (1978). "Effectiveness of Farmers' Adjustments to Risk", Economic and Political Weekly, Vol. XIII, No. 25, June, pp. A-38 to A-48.
- Kainth, G. S. and Mehra, P. L. (1985). Rice - Production, Potential and Constraints, Inter India Publications, New Delhi.
- Khusro, A. M. (1964). "Returns to Scale in Indian Agriculture", Indian Journal of Agricultural Economics, Vol. 18, No. 4, October-December.

- Ladejinsky, Wolf (1973). "How Green Is The Green Revolution?", *Economic and Political Weekly*, Vol.8, No.52, December 29, pp. A-1333 to A-1344.
- Lipton, Michael (1976). "Agriculture and Non-agriculture in Institutional Credit : A Note", *Economic and Political Weekly*, Vol. 11, No. 39, September 25, p. 1571.
- Mahapatra, I. C., Pillai, K. G., Bhargava, P. N. and Jain, H. C. (1981). "Fertiliser Use in Rice - Rice Cropping System", *Fertiliser News*, Vol.26, No. 9, September, pp. 3-15.
- Mellor, John W. (1962). "Increasing Agricultural Production in Early Stages of Economic Development, Relations, Problems and Prospects", *Indian Journal of Agricultural Economics*, Vol. 17, No.2, April-June, pp. 29-46.
- Nagaraj, R. (1982). "Trend Deceleration in Fertiliser Consumption : A Preliminary Exploration", *Economic and Political Weekly*, Vol. 17, No. 39, September 25, pp. A-74 to A-84.
- Narain, Dharm (1971). "Rice : Policies and Problems", in IRRI, *View Points on Rice Policy in Asia*.
- Narasimhan, M. (1971). "National Credit Policy", *Economic and Political Weekly*, Vol. 6, No. 2, January 9, pp. 94-102.

- Ray, R. N., Seetharaman, S. and Singh, R. N. (1978).  
 "Fertiliser Use Research in India", Fertiliser News,  
 Vol. 23, No. 11, November, pp. 22-32.
- Sawant, S. D. (1986). "Irrigation and Water Use", in  
 M. L. Dantwala (ed.), Indian Agricultural Develop-  
 ment Since Independence, Oxford and IBH Publishing  
 Co.Pvt.Ltd., New Delhi.
- Schultz, Teodore W. (1964). Transforming Traditional  
 Agriculture, Lyall Book Depot, Ludhiana.
- Sen, A. K. (1962). "An Aspect of Indian Agriculture", The  
 Economic Weekly, Annual Number, Vol. 14, Nos. 4,5 &  
 6, February, pp. 243-246.
- \_\_\_\_\_ (1964). "Size of Holding and Productivity", The  
 Economic Weekly, Annual Number, Vol.16, Nos. 5, 6 &  
 7, February, pp. 323-324.
- Sen, Bandhudas (1974). The Green Revolution in India,  
 Delhi.
- Shah, C. H. (1984). "Development Perspective for Indian  
 Agriculture : A Hopeful View", Economic and Political  
 Weekly, Vol.19, No.30, July 28, pp. 1218-1223.
- Shastri, B. D. (1971). "Quickening the Pace of Agricul-  
 tural Development", Economic and Political Weekly,  
 Vol.6, No.26, June 26, pp. A-95 to A-98.
- Shastri, S. V. S. (1974). "Fertiliser : A Comment, Not a  
 Substitute for Good Management", Indian Farming,  
 February.

- Shivamaggi, H. B. (1986). "Credit for Agriculture and Rural Development", in M. L. Dantwala (ed.), Indian Agricultural Development Since Independence, Oxford and IBH Publishing Co.Pvt. Ltd., New Delhi.
- Sidhu, D. S. and Singh, A. J. (1986). "Technological Change in Indian Agriculture", in M. L. Dantwala (ed.), Indian Agricultural Development Since Independence, Oxford and IBH Publishing Co.Pvt.Ltd., New Delhi.
- Singh, J. P. (1987). Evaluation of Centrally Sponsored Scheme of SRPP in Eastern Uttar Pradesh, Agricultural Economy Research Centre, University of Delhi.
- \_\_\_\_\_ and Govindaraj, K. V. (1976). New Technology of Paddy in Karnataka : Adoption and Yield Differentials, Institute of Social and Economic Change, Bangalore.
- Swaminath, M. S. (1969). "Scientific Implications of HYV Programme", Economic and Political Weekly, Annual Number, Vol.4, Nos. 1 & 2, pp. 67-75.
- Vasanthakumar, J. and Singh, S. N. (1987). "Constraints to Agricultural Development of Small and Marginal Farmers", Journal of Rural Development, Vol.6, No.3, May, pp. 309-314.
- Verma, B. N. and Brombay, Daniel W. (1987). "The Political Economy of Farm Size in India : The Elusive Quest", Economic Development and Cultural Change, Vol.35, No.4, July, pp. 791-808.

- Vohra, B. B. (1976). "A Policy for Water", in Indian Society of Agricultural Economics, Role of Irrigation in the Development of India's Agriculture, Bombay.
- Yamada, Noboru (1978). Possibilities of Increasing Rice Production in Southeast Asia by Improving Agricultural Technology : HYVs and Fertiliser Use, IDE Special Paper No. 10, Institute of Developing Economics, Tokyo, Japan.