Study No. 108

SPREAD OF NEW VARIETIES OF HYBRID RICE AND THEIR IMPACT ON THE OVERALL PRODUCTION AND PRODUCTIVITY IN MADHYA PRADESH

AGRO- ECONOMIC RESEARCH CENTRE FOR MADHYA PRADESH AND CHHATTISGARH
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.)

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PROJECT TEAM

Data collection

Mr. C.K. Mishra
Mr. Arvind Dangi
Mr. S. C. Meena
Mr. Satyendra Thakur

Tabulation & Compilation of Data

Mr. Arvind Dangi
Mr. Ravi Singh Chouhan
Mr. C. K. Mishra
Mr. S. C. Meena
Mr. Dushyant Kumar

Interpretation and Report Writing

Dr. Hari Om Sharma
Dr. Deepak Rathi

Coordinator

Dr. Debashis Sarkar
Professor and Director
Agro-Economic Research Centre Visva-Bharti,
Santiniketan, West Bengal-731235

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PREFACE

The present study entitled **"Spread of New Varieties of Hybrid Rice and their Impact on the Overall Production and Productivity in Madhya Pradesh"** *has been assigned by the Directorate of Economics and Statistics Ministry of Agriculture Government of India to this centre under the close Agro-Economic Research Centre Visva Bharti, Santiniketan,West Bengal-731235.*

*The study comprises of 80 Hybrid Rice adopters and 20 HYV non-adopters of two districts (Rewa and Mandla NFSM districts) of Madhya Pradesh. The study revealed that the expenses on seed (0.152***), chemical fertilizer (0.082***), human labour (0.243***) were positive and highly significant, which reveals that if all things remains constant and at the present level of technological adoption an additional expense of Rs. 1/- each on seed, chemical fertilizer and human labour will be able to increase the yield of hybrid rice up to 0.152, 0.082 and 0.243 kg/ha respectively. The expenses on manures, pesticides, machine labour were found to be positive but non significant, which shows the need to provide extra attention while using these crucial inputs at their farms. There is also a need to provide skill oriented training and demonstration to them at their field.*

The present study was conducted by Dr. H. O. Sharma and Dr. Deepak Rathi of this Centre. They have respectively done field investigation, tabulation and analysis, and interpretation and drafting of the report. I wish to express my deep sense of gratitude to them and their team members namely; Mr. Arvind Dangi, Mr. C.K. Mishra, Mr. S.C. Meena, Mr. Dushyant Kumar, Mr. Ravi Singh Chouhan, Mr. H. C. Birla and Mr. Satyendra Thakur for their untiring efforts in bringing this innovative study to its perfect shape. I extend my heartfelt thanks to the Coordinator of this study Dr. Debashis Sarkar Professor and Director, Agro-Economic Research Centre, Visva-Bharti Santiniketan, West Bengal for provided necessary guidelines and time to time suggestions through e-mails for conducting the study.

On behalf of the Centre, I express my deep sense of gratitude to Dr. V.S. Tomar, Hon'ble Vice-Chancellor, Dr. S.S. Tomar, Director Research Services and Dean, Faculty of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur for providing all facilities and help during various stages in successful completion of this study of high importance.

I express my sincere thanks to Shri K. S. Netam, Deputy Director of Agriculture, Mandla and Shri Abhitab Tiwari, Deputy Director of Agriculture, Rewa and their field staff for providing not only secondary data but also extending help in collection of field data from the selected respondents .

I hope the findings and suggestions made in the study would be useful to policy makers of the states and Govt. of India

Date : 22.03.2013 **(N.K. Raghuwanshi)**
Place: Jabalpur Prof. & Head

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CHAPTER I

INTRODUCTION

1.1 Background of the study

Rice is the most important cereal crop in India in terms of area occupied, production and consumption as a principal food and occupies a prominent place in Indian agriculture. India produces 98.09 million tones of rice (2009-10). It is cultivated over an area of 41.92 million hectares which account for 23.25 per cent of the gross cropped area and 37.08 per cent of the area sown to that food-grain. It is the staple food for more than 60 per cent of Indian population and it accounts for 43 per cent of total food grain production and 46 per cent of total cereal production. To meet out the demand of increasing population and to maintain food self-sufficiency, the present production level of 99.18 million tons needs to be increased up to 120 million tons by the year 2020. This increase in production has to be achieved in the back drop of declining and deteriorating resources such as land, water, labour and other inputs and without adversely affecting the environment. The erratic monsoon pattern like the one witnessed during 2009 puts additional pressure to fill the food grain deficit (Viraktamath *et al.*, 2010).

Over the last four decades, the country witnessed an impressive growth in rice production due to the adoption of semi dwarf high yielding varieties coupled with the adoption of intensive input based management practices. However, in recent years the growth in production has decelerated from 4 per cent during 1980s' to 1.7 per cent during 1990s'. This deceleration is largely on account of slowing down in the growth of yield from 3.6 per cent during the 1980s to 1.3 per cent during the 1990s. Plateauing trend in the yield of High Yielding Varieties (HYVs), declining and degrading natural resources like land and water and acute shortage of labour make the task of increasing rice production quite challenging. The current situation necessitates looking for some innovative technologies to boost rice production.

The achievements so far in respect of raising yields and reducing variability in the unfavourable agro-climatic regions are not comparable with those realized for the favourable environments. The limited spread of the green

revolution can be explained partly by the nature of available technology itself and partly by the uneven development of infrastructure, physical as well as institutional which is pre-requisite for the adoption of improved practices. Against such a background it is necessary to examine the needed changes in agricultural research strategy to boost up agricultural production in the light of emerging agro-climatic and socio-economic challenges. Redressal of crop regional imbalances in growth, imparting stability to agricultural output and bringing the benefits of agricultural research technology to the resource poor farmers are the three major concerns.

Table 1.1 State wise Hybrids Rice Released (2010)

State	Hybrids Rice Released
Andhra Pradesh	APHR-1, APHR-2, PHB-71, PA-6201, PA-6444, RH-204, Suruchi, DRRH-1, GK-5003, PAC 837, US 312, DRRH-3
Bihar	KRH-2, PA-6201, Ganga, JKRH-401
Chhattisgarh	Indira Sona, Suruchi, HRI 157, DRH775, PAC 837
Delhi	Pusa RH 10
Gujarat	Suruchi, HRI 157, PAC 835, PAC 837, DRRH-3, NK 5251
Goa	KRH-2
Haryana	Pusa RH 10, Ganga, HKRH-1, PHB-71, RH-204, Suruchi, DRRH-2, Sahyadri-4
Karnataka	KRH-1, KRH-2, PHB-71, PA-6201, PA-6444, RH-204, Suruchi, GK-5003, PAC 837, HRI 157, US 312, NK 5251
Maharashtra	KRH-2, PA-6444, Suruchi, Sahyadri, Sahyadri-2, Sahyadri-3, Sahyadri-4, NK5251
Madhya Pradesh	PA-6201, JRH-4, JRH-5, JRH-8, HRI 157 and DRRH-3
Orissa	KRH-2, PA-6201, PA-6444, Ganga, Suruchi, Rajlaxmi, Ajay, JKRH-401, PAC 835, DRRH-3
Punjab	Pusa RH 10, Ganga, PHB-71, PA 6129, Sayadri
Pondicherry	KRH-2, PA 6129, HRI 157
Rajasthan	KRH-2, RH-204
Tamil Nadu	MGR-1, KRH-2, CORH-2, ADTRU-1, PHB-71, PA-6201, RH-204, DRRH-2, CORH-3, PA 6129, US 312, NK 5251
Tripura	KRH-2, PA-6201, PA-6444
Uttar Pradesh	KRH-2, Pant Sankar Dhan-1, Narendra Sankar Dhan-2, PHB-71, PA-6201, PA-6444, Pusa RH 10, Ganga, Narendra Usar Sankar Dhan-3, Sahyadri-4, HRi 157, US 312, DRRH-3
Uttarakhand	PA-6444, Ganga, RH-204, Pant Sankar Dhan-3, DRRH-2
West Bengal	KRH-2, CNRH-3, PA-6201, RRH-2, JKRH-401, Sahyadri-4, DRH 775, US 312
Jharkhand	DRH 775
Jammu & Kashmir	PAC 837

All these had necessitated widening the base of research involving evolution of high yielding seeds incorporating multiple resistances to the biotic (insects and diseases) and a-biotic stresses like draught, rain fed upland, saline/alkaline soil condition etc. to cover a large number of crops grown under diverse agro-climatic conditions. Rice being the dominant staple food for millions

of people in the country, agricultural scientists and policy makers are constantly making efforts to find solutions to various production constraints through technology development. The research scientists considered hybrid rice technology as a readily available option to shift the yield frontier upward in the face of declining trend of the yield potential of the existing varieties. It was projected that hybrid rice technology would bring about another rice revolution in the country. However, although a number of varieties of hybrid rice are released by the Government (Table 1.1), the extent of adoption of hybrid rice varieties in the country is too meager to make an impact on rice production. Against this backdrop, the present study is conceptualized and undertaken at the instance of the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India with a view to assessing the actual spread of hybrid rice varieties replacing the conventional HYVs to make an overall impact of rice production.

1.2 Evolution of Hybrid Rice Technology in India

Encouraged by the success of hybrid rice technology in enhancing the rice production and productivity in China, the Indian Council of Agricultural Research (ICAR) initiated a national program for development and large scale adoption of hybrid rice in the country in December 1989. The project was implemented through a National Network comprising research, seed production and extension networks. The hybrid rice research network consisted of 11 research centre's and many voluntary centre spread across the country. The seed production network consisted of public sector seed production agencies such as National Seed Corporation, State Farms Corporation of India and the State Seed Development Corporations in addition to many private sector seed companies. The extension network consisted of state departments of Agriculture, extension wings of the State Agriculture Universities, Krishi Vigyan Kendras (Farm science centres) and the Non Govt. Organizations. Effective linkages were established within the different sub-components of the network. The entire project was co-ordinated and implemented by the Directorate of Rice Research (DRR), Hyderabad. The project initiated by the ICAR, was strengthened by the technical support from International Rice Research Institute (IRRI) Philippines and Food and Agriculture Organization (FAO). The financial support from the United Nation Development Programme (UNDP), Mahyco Research Foundation (MRF),

and World Bank funded National Agricultural Technology Project (NATP) and IRRI/Asian Development Bank (ADB) Project on Hybrid Rice.

Hybrid rice technology is likely to play a key role in increasing the rice production. During the year 2008, hybrid rice was planted in an area of 1.4 Million ha and an additional rice production of 1.5 to 2.5 Million t. was added to Indian's food basket through this technology. More than 80 per cent of the total hybrid rice area is in eastern Indian states like Uttar Pradesh, Jharkhand, Bihar, Chhattisgarh, with some little area in states like Madhya Pradesh, Assam, Punjab and Haryana. As rice is a key source of livelihood in eastern India, a considerable increase in yield through this technology will have a major impact on household food and nutritional security, income generation, besides an economic impact in the region. In view of this, hybrid rice has been identified as one of the components under the National Food Security Mission (NFSM) launched by the Government of India (GOI) with the aim to enhance rice production by 10 million tonnes by 2011-12. Under the scheme it has been targeted to cover 3 million ha area under hybrid rice by the year 2011-12. The approach is to bridge the yield gap in respect of rice through dissemination of improved technology and farm management practices. Similarly, added emphasis is being given for adoption of hybrid rice under the special scheme Bringing Green Revolution in Eastern India (BGREI) of GOI to bring green revolution to eastern India.

As a result of concerted efforts for over two decades, a total of 43 hybrids have been released for commercial cultivation in the country. Though 43 hybrids have been released in the country so far, some of them have been outdated, and some are not in the production chain. Such hybrids which are in the production chain and available for commercial cultivation are Presented in Table 1.1.

1.3 Need for the Study

The spread of the newer varieties replacing the older varieties need to be closely monitored to take advantage of the superior characters of these newer varieties released by various research Institutions. This will help to break the yield plateau that has been experiencing in rice crop in the recent past and to increase the production and productivity of the crop. Though a number of steps are being taken by the Government to popularize these varieties like Frontline

Demonstration, minikit supply, organizing training programmes (1-21days) for farmers, farm women, seed growers, seed production personnel of public and private seed agencies, extension functionaries of state departments of agriculture, officials of state agricultural universities and NGOs, there is no concrete data to prove that the newer varieties of rice are spreading faster and replacing the older ones. Therefore, Present study has been conducted to assess the actual spreading of these newer varieties in terms of area with simultaneous reduction in the area under older varieties for rice crop and the increases in the average yield/ha. This will help the Government to draw a plan for augmenting the spread of the superior newer varieties in place of the age old varieties.

1.4 Objectives of the Study:

1. To determine the extent of adoption and the level of participation by the different categories of farmers in the cultivation of hybrid rice.
2. To assess the overall impact on rice production and productivity of hybrid rice cultivation.
3. To study the economics of cultivation of hybrid rice varieties *vis-a-vis* inbred varieties.
4. To identify factors determining the adoption of hybrid rice varieties.
5. To address various constraints and outline the prospects for increasing hybrid rice cultivation and finally
6. To suggests policy measures for expansion of hybrid rice cultivation.

1.5 Data Base, Sampling Design, Methodology and Coverage of the Study

The study is based on both secondary and primary data. Secondary data relating to area, production and productivity of rice obtained from government publications viz. various issued of Madhya Pradesh agriculture statistics, Land Record Office of Gwalior Madhya Pradesh and web sites like www.agricoop.nic.in, www.mpkrishi.org, www.dacnet.nic.in were used to arrive at the trends in area, production and productivity. For the sake of comparison, it is usual to compare the performance of rice in the pre-introduction period of hybrid rice with that in post-introduction period as a whole. Keeping in mind that the first hybrid was developed and released for commercial cultivation in India in

1994, the study period was thus divided into three sub-periods viz. 1984-85 to 1993-94, 1994-95 to 2003-04 and 2004-05 to 2009-10. The period-I viz. 1984-85 to 1993-94 refers to the pre-introduction period of hybrid rice while other two period's viz. period-II & III correspond to post-introduction periods considering the base year (The average of first three years) and the current year (The average of last three years). Besides, official data regarding the activities undertaken by the government to popularize hybrid varieties like Frontline Demonstrations, Minikit Supply, and Organizing Training Programme etc. were incorporated and analyzed in the study.

Primary survey was confined to the National Food Security Mission (NFSM) districts in Madhya Pradesh. The two districts i.e. Rewa and Mandla having relatively higher concentration of area under rice cultivation within the group of NFSM districts were chosen for the present study (Table 1.2).

Table 1.2: Area of Rice in Different NFSM Districts of Madhya Pradesh (TE 2010)

NFSM Districts	Area (000'ha)	% age
Katni	87.83	10.83
Mandla	113.27	13.97
Damoh	55.27	6.82
Panna	55.07	6.79
Rewa	131.13	16.17
Satna	87.53	10.80
Shahdol	105.43	13.00
Anuppur	99.43	12.26
Dindori	75.90	9.36
Total NFSM districts	810.87	49.41
Other districts	830.13	50.59
M.P. State	1641	100.00

Two representative blocks namely Rewa & Raipur karchuliyan from Rewa district and Mandla & Nainpur blocks from Mandla district were selected for the invistigation. Within each block two villages namely Padokher and Atriya, Mehsuva and Gorgaon 164 were selected from Rewa and Raipur Karchuliyan development blocks respectively.

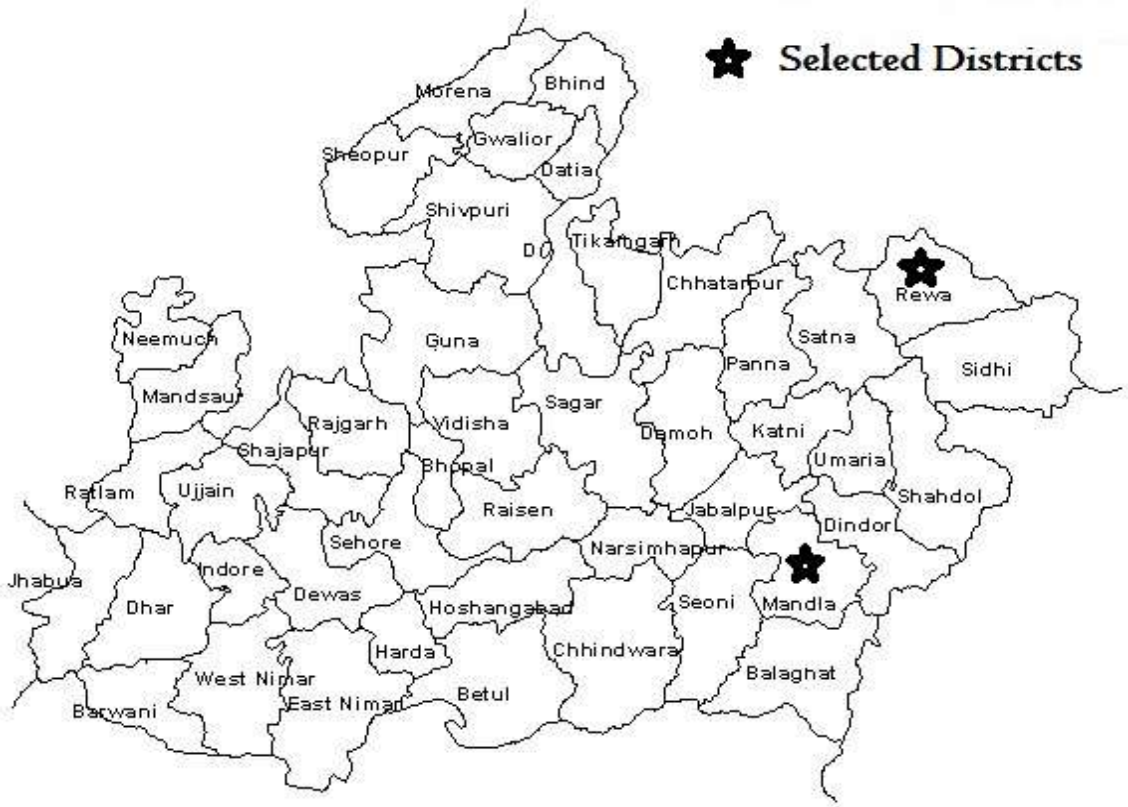

Fig. 1.1 Map of Madhya Pradesh showing selected districts

In case of Mandla district Semarkhapa and Padami, Tuiapani and Rewada were selected from Mandla and Nainpur development blocks respectively for the study (Table 1.3).

Table 1.3: Selected NFSM Districts/Blocks/Villages in Madhya Pradesh

S.No.	Selected District	Blocks	Villages
1	Rewa	Rewa	Padokher
			Atriya
		Raipur karchuliyan	Mehsuva
			Gorgaon 164
2	Mandla	Mandla	Semarkhapa
			Padami
		Nainpur	Tuiapani
			Rewada

In each village a complete list of cultivating households growing hybrid rice varieties and inbred varieties were prepared and stratified according to four standard land size groups such as marginal (less than 1 hectare), small (1 to 2 hectares), medium (2 to 4 hectares) and large (more than 4 hectares) including SC, ST and women farmers. In each district, 40 hybrid rice growers from the list of hybrid rice growing cultivators were drawn at random from different land size groups on the basis of their proportion in the universe. In addition to this sample,

10 inbred variety (traditional HYVs) rice growers but non-adopters of hybrid rice were selected randomly from the different land size groups amongst inbred rice growing cultivators following the same procedure. Thus, altogether, 50 rice growing cultivators were selected from each selected district. In all, 100 rice growing cultivators equally spread over two selected districts constituted the size of the sample in the study.

For the primary survey, the reference years were 2009-10. Accordingly, kharif seasons for the rice crop covered in the study. Primary data were obtained by administering a structured schedule/questionnaire provided by the Coordinator, Agro-Economic Research Centre Visva-Bharati, Santiniketan West Bengal.

1.6 Analytical Approach

A simple tabular analysis was done to analyze the farm level data in ascertaining the farm level spread and impact of hybrid rice technology. In order to identify the factors affecting the yield of rice, yield response function separately for hybrid and inbred rice was estimated using Log linear models. Eight independent variables (Age, Education, Household size, Size of worker, Land ownership dummy, Farm size, Access to Source of information, Size of irrigated land) were found to be regressed upon the dependent variable yield per hectare of rice. The explanatory variables includes seed (kg/ha), manure (Rs./ha), fertilizer (Rs/ha), irrigation (number of irrigation/ha), human labour (man days/ha), machinery labour (hrs/ha), plant protection Chemicals (Rs./ha). In finding out the determinants of participation in hybrid rice cultivation, Logit Model was used to drawn conclusion. For secondary data obtained from the official publications, the equation of the exponential curve was used to measure the growth in area, production and productivity of the crop. In measuring the instability in crop production, the co-efficient of variation technique was used for interpretation of tabulated data.

1.7 Organization of the Study

This study is organized into eight chapters. Chapter one covers the introductory part of the study followed by status of rice in the State. Status of adoption of hybrid rice at the farm level covered under chapter three. Chapter

four deals with the Impact of hybrid rice cultivation on overall production of rice. Comparative economics of hybrid and inbreed rice cultivation has been discussed in chapter five, while the grain quality considerations and the aspect of marketing are presented in chapter six. Chapter seven converses about problems and prospects for increasing hybrid rice cultivation. Summary and policy recommendations are given in chapter eight followed by references and annexure.

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CHAPTER II

STATUS OF RICE IN MADHYA PRADESH

The chapter deals with the study area i.e. Madhya Pradesh, Trend, Growth, Instability and Performance of rice under NFSM and different districts of Madhya Pradesh.

2.1 Study Area: Madhya Pradesh

Madhya Pradesh, in its present form, came into existence on November 1, 2000 following its bifurcation to create a new state of Chhattisgarh. The undivided Madhya Pradesh was founded on November 1, 1956.Madhya Pradesh, because of its central location in India, has remained a crucible of historical currents from North, South, East and West.

Table 2.1: Location of Madhya Pradesh

S. No.	Particulars	
1	Number of Division	10
2	Number of Tehsil	342
3	Number of Blocks	313
4	Number of Villages	54,903
5	Latitude	21° 53` to22° 59`N
6	Longitude	76°47` to 78°44` E
7	Height from see means level	50-1200
8	No of districts	50
9	No. of Gram Panchayat	23,012
10	No. of electrified Villages	35910
11	Percentage of electrified villages to total Villages	65.41

Madhya Pradesh is situated in the heart of India between latitudes 21^0 -53' to 22^0 53' North and longitude 77^0 47' to 78 ^{0} 44' East. It is the second largest state after Rajasthan of Indian Union with a total geographical area of 307.56 thousand square Kilometers. In terms of population (72,597,565) it occupies 7^{th} position in India (2011). It has 10 -commissionaire division (Chambal, Gwalior, Bhopal, Ujjain, Indore, Sagar, Rewa, Jabalpur, Hosangabad and Shahdol) divided into 50 districts, 342 Tehsil, 313 block & 376 towns and 54,903 villages. (Table 2.1) It is abundantly rich in minerals and bio resources with 27 per cent of land area under forests; it supports a wide variety of animal and plant life. The state has a rich history, culture and crafts.

The Physiography of the state exhibits a great deal of diversity with areas ranging from less than 50 meter above mean sea level to more than 1200 meter.

The state falls under the catchments of Jamuna, Ganga, Narmada, Mahanadi and Godavari. On the basis of broad land features and different soil and rain fall pattern, the state could be classified in 5 physiographic regions and 11 agro-climatic zones (Table 2.2)

1. Northern low lying plains comprising Gwalior, Bhind and Morena districts and extend to Bundelkhand up to the west of Panna range and excludes certain parts of Rewa district between Panna and Kaymore hills of Baghelkhand.

2. The Malwa and Vindhyan Plateau comprises of Vidisha, Shivpuri, Datia, Guna, Ujjain and Mandsour districts and parts of Sehore, Raisen and Dewas districts. It consists of large undulating plains of black cotton soil dotted with flat-topped hills. It has also hilly Vindhyan Plateau situated it the north of Narmada Valley and to the south of the low-lying regions of Bundelkhand and Baghelkhand. It spared from east of Malwa plateau to Maikal and Dorea hills Satpura range.

Fig. 2.1: Agro-Climatic Zones of Madhya Pradesh

3. The Narmada Valley stretching from Jabalpur in the east up to Barwani district in the west. It is nearly 560 Km long and 48 Km wide and is walled on the north by the Vindhyan range and on the south by Satpura range. It covers the

districts of Jabalpur, Nasinghpur, Hoshangabad, Khandwa, Khargone, Barwani, Dhar, and some parts of Raisen, Sehore, and Dewas districts.

4. The Satpura range runs from west to east for about 640 Km through Khandwa, Betul, Chhindwara, Seoni, Mandla, Bilaspur and Sarguja districts. Its northern spurs go into Hoshangabad and Nasinghpur districts and in the south an extensive spur of 160 Km covers entire Balaghat districts.

5. Madhya Pradesh also covers Balaghat and Shahdol district of Chhattisgarh Plains and Northern Hills of Chhattisgarh zone respectively. The state is bordered on the west by Gujarat, on the northwest by Rajasthan, on the northeast by Uttar Pradesh, on the east by Chhattisgarh, and on the south by Maharashtra.

Table-2.2: Agro-Climatic Regions and covered Districts /Tehsils in Madhya Pradesh

(Area in Lakh ha)

Agro-Climatic Regions	Districts /Tehsils	Geographical Area	Percent to Geographical Area
1. Malwa Plateau	Indore, Dhar, (Dhar, Badnawar, Sardarpur tehsils) Shajapur, Mandsour, Nimuch, Ratlam, Ujjain, Dewas Rajgarh districts and Petlawad tehsil of Jhabua district	51.47	16.74
2.Vindhyan Plateau	Bhopal, Vidisha, Sehore (Sehore, Ashta, Ichhawar, Narsullaganj tehsils) Raisen (Raisen, Gairatganj, Begamganj, Silwani, Goharganj, Udaipura tehsils), Damoh, Guna (Chachora & Raghogarh tehsils) & Sagar districts	42.59	13.85
3.Central Narmada Valley	Hoshangabad (Seoni-Malwa, Hoshangabad, Sohagpur tehsils), Harda, Nasinghpur districts, Budhani and Barelli tehsil of Sehore and Raisen districts respectively	17.45	5.67
4.Satpura Plateau	Betul, Chhindwara districts	21.93	7.13
5.Jhabua Hills	Jhabua, Jobat, Alirajpur tehsils of Jhabua district & kukshi tehsil of Dhar district	6.88	2.24
6.Gird Region	Gwalior, Bhind, Morena, Shivpur-Kalan, Guna (Mungawali and Ashoknagar tehsils), Shivpuri (Shivpuri, Kalaras, Pohari tehsils)	31.85	10.36
7. Kymore Plateau	Jabalpur, Katni, Rewa, Panna, Satana, Sidhi, Seoni and Gopadbanas & Deosar tehsils of Sidhi district.	49.97	16.25
8.Bundel Khand Region	Tikamgarh, Chhatarpur, Datia districts, Karela, Pachore tehsil of Shivpuri and Guna tehsil of Guna district	22.82	7.42
9.Nimar Valley	Khandwa, Khargone, Barwani district, Manawar tehsil of Dhar district and Harda district	25.17	8.18
10.Northern Hills of Chhattisgarh	Shahdol, Umariya Mandla, Dindori district & Singrauli tehsil of Sidhi district	28.17	9.16
11.Chhattisgarh plain	Balaghat district	9.25	3.00
Madhya Pradesh		**307.55**	**100.00**

The main soil types found in Madhya Pradesh are alluvial, deep black, medium black, shallow black, mixed red and black, mixed red and yellow and skeletal soils. (Table 2.3)

Table 2.3: Soil types and districts covered in Madhya Pradesh.

Types of Soil	Districts covered
Alluvial Soil	Bhind, Morena and Gwalior
Deep Black Soil	Hoshangabad and Nasinghpur
Medium Black Soil	Jabalpur, Sagar, Vidisha, Sehore, Damoh, Guna, Bhopal, Raisen, Rajgarh, Indore, Dewas, Ujjain, Mandsour, Shajapur, Ratlam, Dhar, Khargone and Khandwa
Shallow Black Soil	Betul, Chhindwara and Seoni
Red & Black Soil	Shivpuri, Rewa, Satna, Panna, Sidhi, Chhaterpur, Tikamgarh, Datia and some parts of Guna district.
Red & Yellow Soil	Balaghat.
Gravelly Soil	Mandla.

The climate of Madhya Pradesh by virtue of its location is predominately moist sub humid to dry sub humid, semi arid to dry sub-humid and semi arid in east, west and central plateau and hills respectively, according to agro-climatic regions of India. The seasons in Madhya Pradesh are as given below (Table 2.4)

Table 2.4: Seasons and their periods in Madhya Pradesh

Seasons	Period	
	From	To
Rainy	June	September
Post Monsoon	October	November
Winter	December	February
Summer	March	May

The annual rainfall received in the state varies from 800 mm. in the northern and western regions to 1600 mm in the eastern districts. In some years rainfall goes much below to the normal. Most of rainfall is received in the Monsoon season from June to September and about 10 per cent of the rainfall is received in the remaining part of the year.

The maximum temperature during extreme summer reaches as high as 47^0C and the minimum during winter dips up to 5^0C. The maximum normal temperature varies between 25 and 35^0C and minimum normal between 10^0 to 20^0C.The relative humidity ranges from 40 to 70 per cent throughout the year.

According to 2011 census the population of the state was 72,598 thousand comprises of 51.81 per cent of male and 48.19 per cent female. Over 1000 male

there were only 930 females. State had a rural background as the 72.40 per cent of total population lives in villages and rest 27.60 per cent in urban areas.

Table 2.5: Population parameters of Madhya Pradesh (Census 2011)

(In Thousands)

S. No.	Particulars	Population	Percentage to total
1	Total Population	72,598	100
A	Male	37,613	51.81
B	Female	34,985	48.19
2	Sex ratio 1000 :	930	
3	Rural Population	52,538	72.4
4	Urban Population	20,060	27.6
5	Population of Schedule Caste*	91551	15.17
6	Population of Schedule Tribes*	12233	20.27
7	Number of Literate persons	43,827	60.37
8	Number of Farmers	11038	18.32
9	Agriculture Labour	7401	12.23
10	Home Industry	1033	1.67
11	Other Workers	6322	10.45
12	Total Main Workers	19103	31.61
13	Marginal Workers	6691	11.07
14	Total Workers	25794	42.68
15	Non Workers	34554	57.16

* Census 2001

The percentage of literacy was found only 60.37 per cent, Madhya Pradesh comes under tribal area 20.27 per cent of total population were belongs to scheduled tribes. The percentage or workers were 42.68 per cent of total population, while 57.16 per cent of total population belongs to non worker category. 31.61 per cent population classified order main worker category, while, only 18.32 per cent were falls in farmers. (Table 2.5)

Table 2.6: Land use Classification of Madhya Pradesh

S.No.	Particulars	Area (Lakh ha)	Percentage to Geographical Area
1	Geographical Area	307.56	100
2	Forest	85.89	27.93
3	Area not available for cultivation	33.89	11.02
4	Other non agricultural land (excluding fallow land)	13.58	4.42
5	Cultivable Waste lands	11.61	3.77
6	Fallow land	11.85	*3.85*
7	Net area sown	150.74	49.01
8	Double cropped Area	46.37	
9	Gross Area sown	197.11	
10	**Cropping Intensity (%)**	**130.76**	

The total geographical area of the State is 307.56 lakh ha in which 49.01 per cent land was found to be under cultivation (Table 2.6) and 11.02 per cent

land not available for cultivation. The 4.42 per cent of total land was classified under cultivable waste land, while 3.38 per cent of total is in fallow land. The cropping intensity of the state was found to be 130.76 per cent.

Wells (39.93%), tube wells (25.51%), canals (18.31%) and tanks (2.36%) are the major sources of irrigation in M.P. The state had 5,681 thousand hectare area under irrigation. (Table 2.7)

Table 2.7: Irrigation Status of Madhya Pradesh

S. No.	Source	Net Irrigated Area	Percentage to total	Gross Irrigated Area	Percentage to total
1	Canal	1030	18.13	1076	18.31
2	Tanks	134	2.36	138	2.35
3	Tube-well	1449	25.51	1494	25.42
4	Well	2246	39.54	2347	39.93
5	Others	822	14.46	823	14.00
6	Total	5681	100.00	5878	100.00

Madhya Pradesh has rich diversity and occupied the space by nearly all the cereals (42%), pulses (23 %), oilseeds (35%) and others (2%) in its total food basket (i.e. 18694.5 thousand ha.)

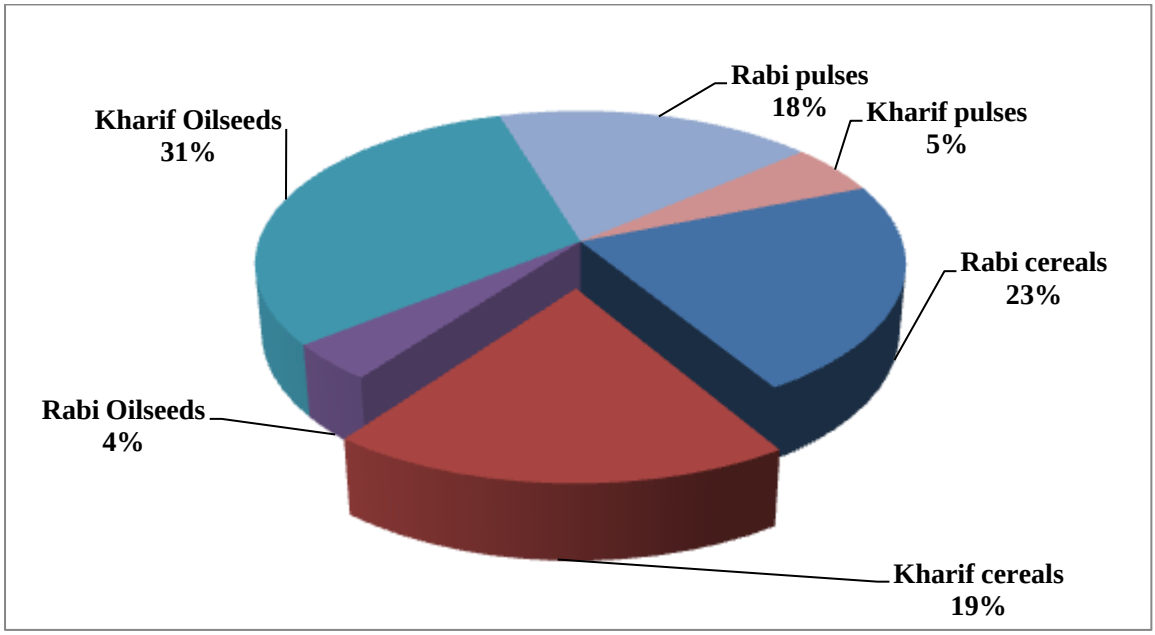

Fig 2.2: Percentage share of area of different Food grains in Madhya Pradesh. (Total 18694.5 thousand ha)

The wheat (53%), paddy (21%), jowar (7%), maize (11%), kodo kutki (4%) and bajra (3%) were found the main cereals (77296 thousand ha.) crops of the state. In pulses, chickpea, tur, lentil, peas, are the main pulse crops of the state.

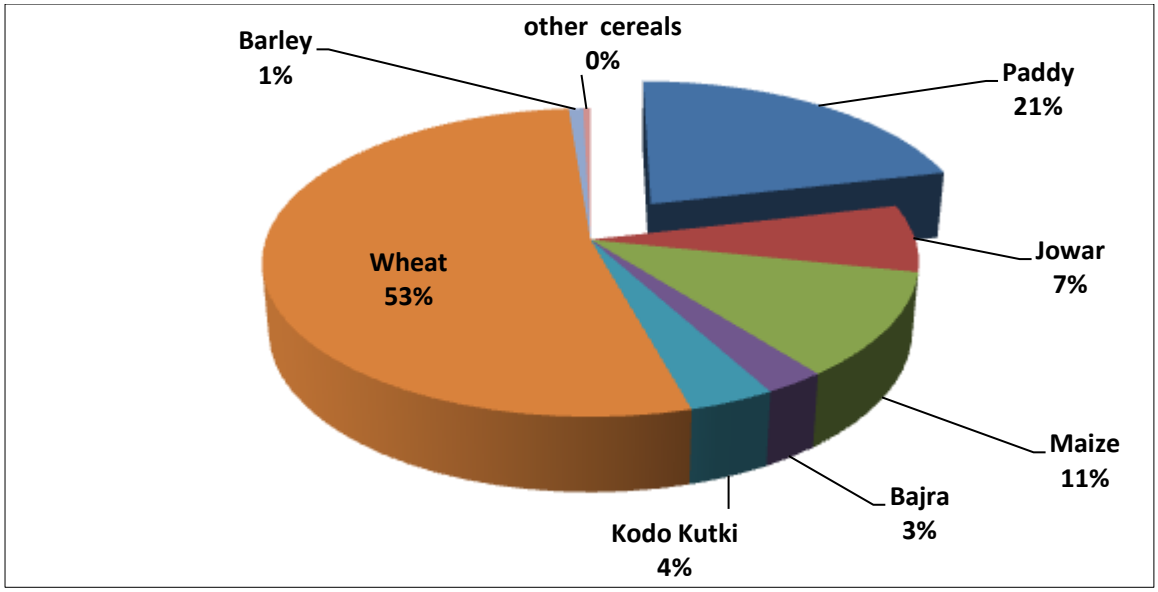

Fig 2.3: Percentage share of area of different Cereals in Madhya Pradesh.
(Total 7729.6 thousand ha)

Madhya Pradesh known for soybean production and about 55 per cent of total soybean area of the country exists in the state. Apart from soybean, the other crop like sesame, linseed, groundnut, mustard and rape seed were the other oilseeds grown by the majority cultivators in the state.

2.2 Trend and Composition of Rice

The trend and composition of rice in three different periods of the study i.e. period I (1985-1994), period II (1995-2004) and Period III (2005-2011) and its composition with comparison to India has been analyzed and presented in this section.

2.2.1 Period I (1985-1994)

The trend of area, production and productivity of rice was found to be positive in M.P. in period I of the study.

Area

The area of rice in M.P. showed increasing trend in period I (1985-94) with a rate of -0.00 million ha per year from 1.53 million ha (1985) to 1.53 million ha (1994)

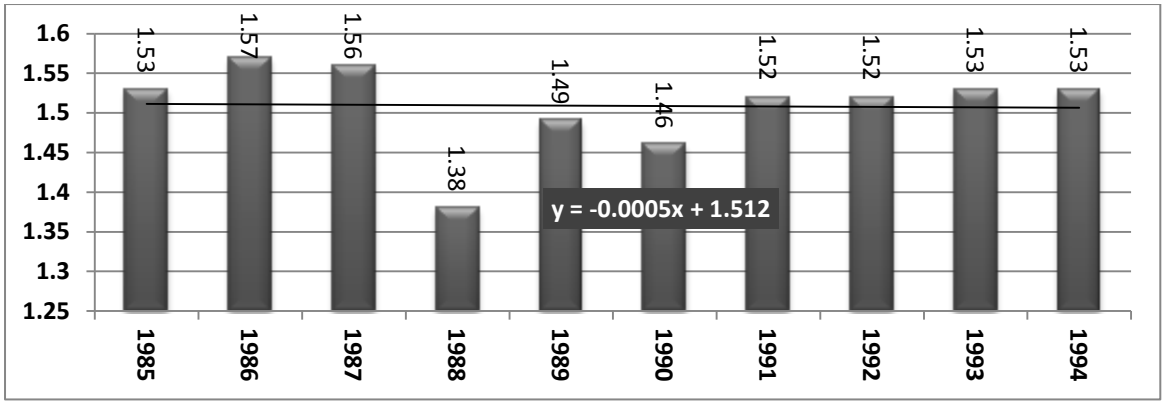

Fig. 2.4: Trend of area of rice (in million ha) in Madhya Pradesh in period I

Production

The production of rice in M.P. also showed increasing trend in period I (1985-94) with a rate of 0.02 million t per year from 0.75 million t (1985) to 1.31 million t considering the average of first three years as a base year and the average of last three years as current year for the periods (1994).

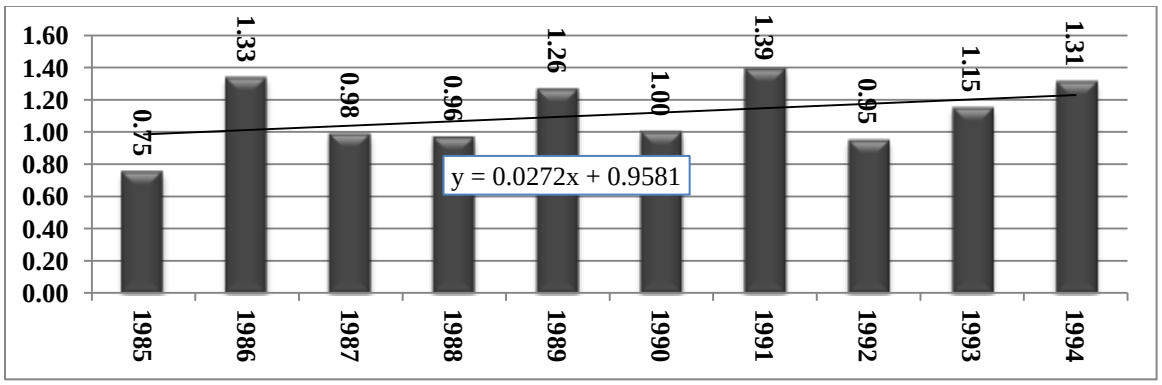

Fig. 2.5: Trend of production of rice (in million t) in Madhya Pradesh in period I

Productivity

The productivity of rice in M.P. also showed increasing trend in period I (1985-94) with a rate of 17.937 kg/ ha per year from 493 kg/ha (1985) to 854 kg/ ha (1994).

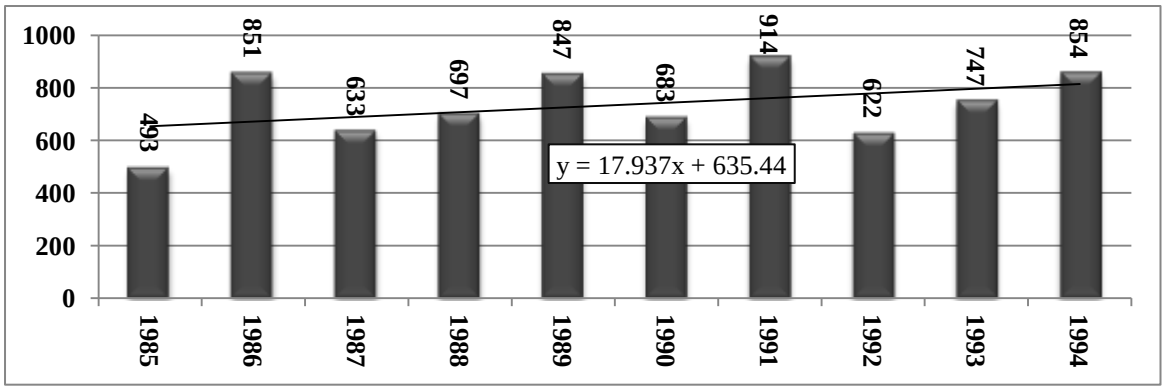

Fig. 2.6: Trend of productivity of rice (in kg/ha) in Madhya Pradesh in period I

2.2.2 Period II (1995-2004)

The trend of area, production and productivity of rice has also been found to positive in M.P. in period II of the study.

Area

The area of rice in M.P. showed increasing trend in period II (1995-2004) with a rate of 0.017 million ha per year from 1.58 million ha (1995) to 1.71 million ha (2004)

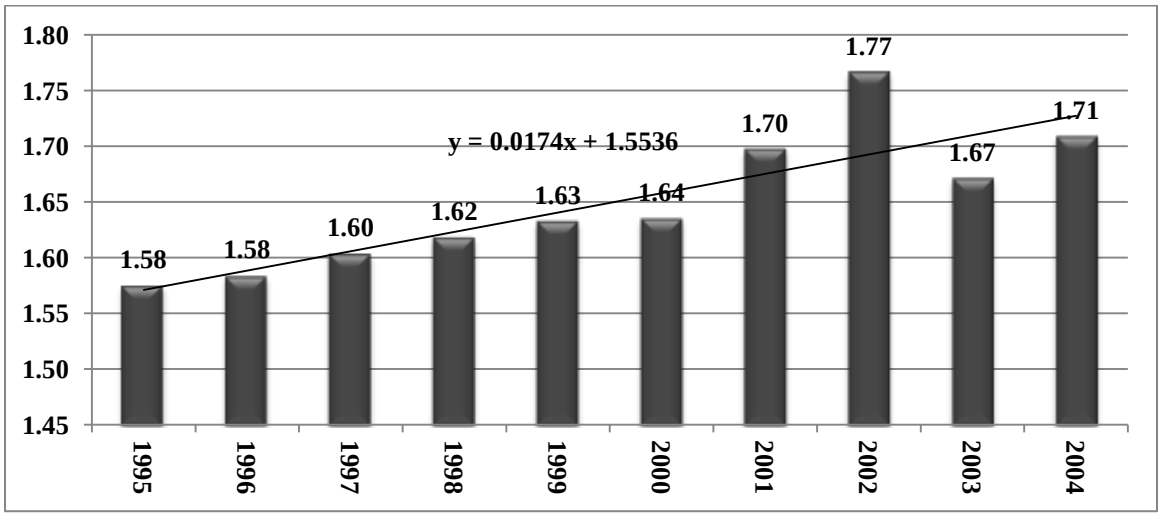

Fig. 2.7: Trend of area of rice (in million ha) in Madhya Pradesh in period II

Production

The production of rice in M.P. showed increasing trend in period I (1985-94) with a rate of 0.025 million per year from 1.42 million t (1995) to 1.87 million t (2004)

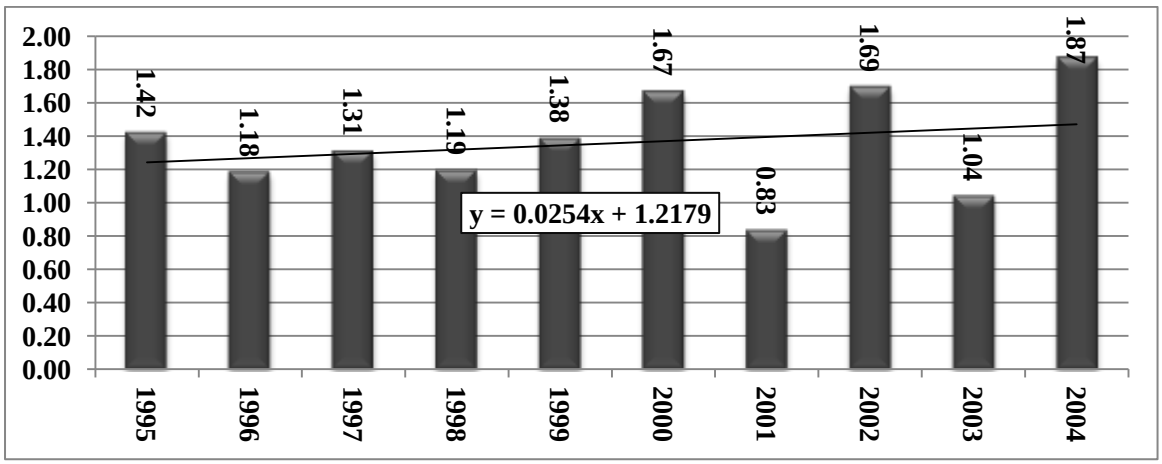

Fig. 2.8: Trend of production of rice (in million t) in Madhya Pradesh in period II

Productivity

The productivity of rice in M.P. showed decreasing trend in period I (1985-94) with a rate of 1.7119 kg/ha per year from 900 kg/ha (1995) to 978 kg/ ha (2004)

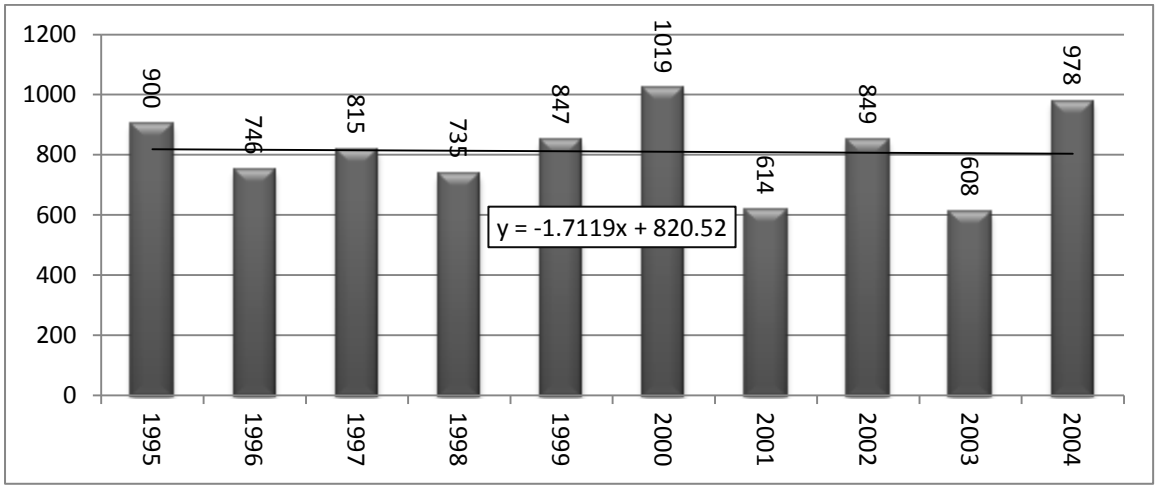

Fig. 2.9: Trend of productivity of rice (in kg/ha) in Madhya Pradesh in period II

2.2.3 Period III (2005-2011)

The trend of area showed negative trend while trend of production and productivity of rice showed positive in M.P. in period III of the study

Area

The area of rice in M.P. showed decreasing trend in period III (2004-11) with a rate of 0.0143 million ha per year from 1.68 million ha (2004) to 1.60 million ha (2011)

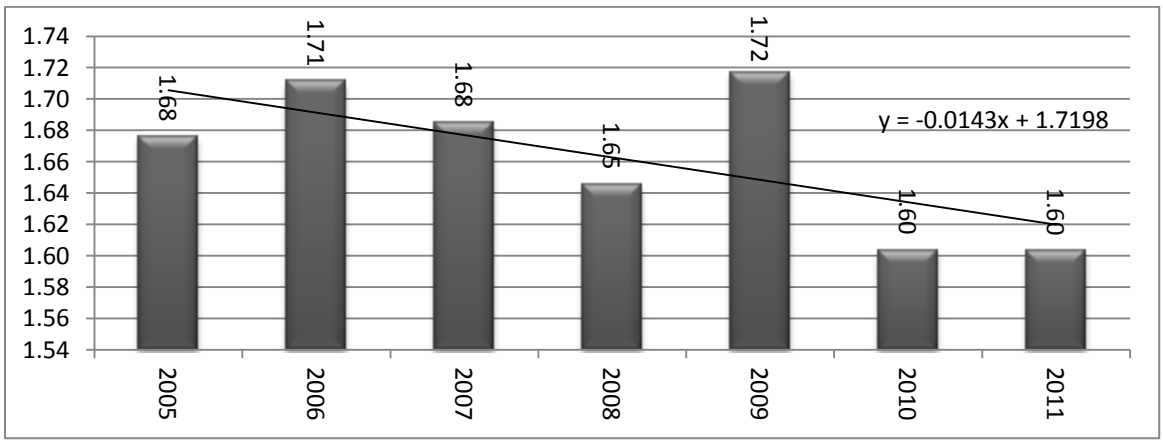

Fig. 2.10: Trend of area of rice (in million ha) in Madhya Pradesh in period III

Production

The production of rice in M.P. showed increasing trend in period III (2004-11) with a rate of 0.034 million t per year from 1.29 million t (2004) to 1.77 million t (2011)

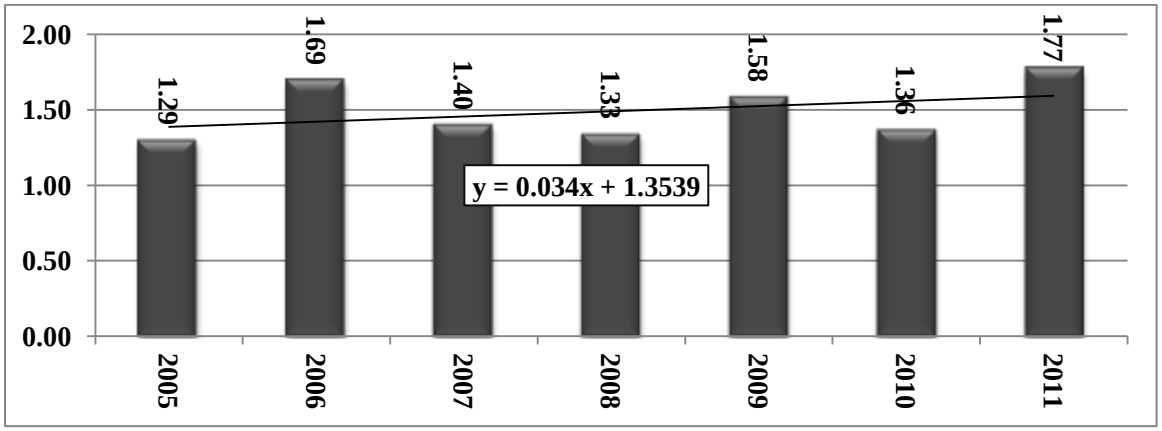

Fig. 2.11: Trend of production of rice (in million t) in Madhya Pradesh in period III

Productivity

The productivity of rice in M.P. showed increasing trend in period III (2004-11) with a rate of 31.692 kg/ ha per year from 804 kg/ ha (2004) to 1167 kg/ha (2011)

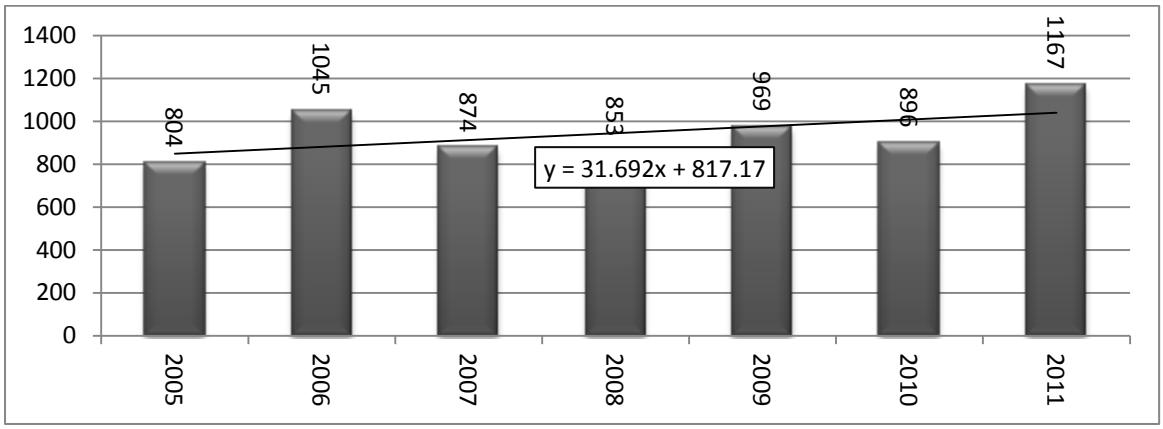

Fig. 2.12: Trend of productivity of rice (in kg/ha) in Madhya Pradesh in period III

2.3 Growth and Instability of Rice production in Madhya Pradesh

The growth and instability of area, production and productivity of rice in M.P. has been undertaken in three different periods of the study i.e. period I (1985-1994), period II (1905-2004) and Period III (2005-2011) considering the average of first three years as a base year and the average of last three years as current year for these periods.

2.3.1 Area

The share of area of rice in Madhya Pradesh to India's area of wheat was found to be decrease from 3.76 per cent (The base year) to 3.61 per cent (The current year) in period I (1985-1994). In this period the area of rice decreased in M.P from 1.55 million ha (The Base year) to 1.53 million ha (The Current year), showed -1.39 per cent of relative change with an annual fluctuation of 3.56 per cent as against a 2.83 per cent of relative change with fluctuation of 21.41 per cent in India.

Table 2.8: Percentage Share of Rice Area (million ha) in M.P. as compared to India in period I.

Year	India	M.P.	% share
1984-85	41.16	1.53	3.71
1985-86	41.14	1.57	3.81
1986-87	41.17	1.56	3.78
1987-88	38.81	1.38	3.56
1988-89	41.73	1.49	3.57
1989-90	42.17	1.46	3.46
1990-91	42.69	1.52	3.55
1991-92	42.65	1.52	3.56
1992-93	41.78	1.53	3.67
1993-94	42.54	1.53	3.60
SD	8.35	0.05	
Mean	39.01	1.51	
CV	21.41	3.56	
Base year	41.16	1.55	3.76
current year	42.32	1.53	3.61
Absolute C.	1.17	-0.02	
Relative C	2.83	-1.39	
t-b	59.44	38.79	
Co. b	0.22	0.00	
R2-b	0.99	0.06	
SGR	0.57	0.00	
CGR	0.53	0.01	

The area of rice increased with an annual linear and compound growth of 0.00 per cent (linear) and 0.01 per cent % (compound) per year respectively as against of 0.57 per cent (linear) and 0.53 per cent (compound) of India.

Madhya Pradesh holds a share of 3.69 per cent (The base year) to 4.01 per cent (The current year) of India's area in period II (1995-2004. The share of Madhya Pradesh increased in this period as compared to period I. In this period the area of rice increased from 1.59 million ha (The Base year) to 1.72 million ha (The current year) showed 8.05 per cent of relative change with an annual

fluctuation of 3.69 per cent as against the -0.32 per cent relative change with fluctuation of 2.95 per cent in India.

Table 2.9: Percentage Share of Rice Area in M.P. as compared to India in period II

(Area in Million ha)

Year	India	M.P.	% share
1994-95	42.81	1.58	3.68
1995-96	42.84	1.58	3.70
1996-97	43.43	1.60	3.69
1997-98	43.45	1.62	3.72
1998-99	44.80	1.63	3.64
1999-00	45.16	1.64	3.62
2000-01	44.71	1.70	3.80
2001-02	44.90	1.77	3.93
2002-03	41.18	1.67	4.06
2003-04	42.59	1.71	4.01
SD	1.29	0.06	
Mean	43.59	1.65	
CV	2.95	3.69	
Base year	43.03	1.59	3.69
current year	42.89	1.72	4.01
Absolute C.	-0.14	0.13	
Relative C	-0.32	8.05	
t-b	46.81	70.15	
Co. b	43.66	1.55	
R2-b	1.37	0.03	
SGR	-0.03	1.05	
CGR	-0.04	1.06	

The area of rice increased with an annual linear and compound growth of 1.05 per cent and 1.06 per cent per year respectively, while decreasing trend against of 0.03 per cent and 0.04 per cent was found in India.

Madhya Pradesh had a share of 3.91 per cent (The base year) to 3.78 per cent (The current year) in India's area in period III (2005-2011). The share of Madhya Pradesh increased in this period as compared to period I & II. In this period the area of rice decreased from 1.69 million ha (The Base year) to 1.64 million ha (The Current year) in M.P. data showed that -2.91 per cent of relative change with an annual fluctuation of 102.11 per cent was found in M.P. as against the 0.49 per cent relative change with annual fluctuation of 3.54 per cent in India.

Table 2.10: Percentage Share of Rice Area in M.P. as compared to India in period III (Area in Million ha)

Year	India	M.P.	% share
2004-05	41.91	1.68	4.00
2005-06	43.66	1.71	3.92
2006-07	43.81	1.68	3.84
2007-08	43.91	1.65	3.75
2008-09	45.54	1.72	3.77
2009-10	41.92	1.60	3.82
2010-11	42.56	1.60	3.77
SD	1.53	1.70	
Mean	43.33	1.66	
CV	3.54	102.11	
Base year	43.13	1.69	3.91
current year	43.34	1.64	3.78
Absolute C.	0.21	-0.05	
Relative C	0.49	-2.91	
t-b	35.96	52.35	
Co. b	43.30133	1.719793	
R2-b	1.424589	0.038874	
SGR	0.02	-0.86	
CGR	0.01	-0.87	

The area of rice decreased with an annual linear and compound growth of -0.86 per cent and -0.87 per cent per year respectively as against of 0.02 per cent and 0.01 per cent of India.

2.3.2 Production

Madhya Pradesh contributed 1.67 per cent (The base year) to 1.75 per cent (the current year) in India's rice production basket in period I (1985-1994). In this period the production of rice in M.P. showed 10.73 per cent of relative change with an annual fluctuation of 18.89 per cent as against the 24.69 per cent of relative change with an annual fluctuation of 11.74 per cent in India.

The production of rice increased with an annual linear and compound growth of 2.46 per cent and 2.81 per cent per year respectively as against of 3.42 per cent and 3.51 per cent of India.

Madhya Pradesh contributed 1.62 per cent (The base year) to 1.89 per cent (The current year) in India's rice production basket in period II (1995-2004). In this period the production of rice in M.P. showed 17.73 per cent of relative change with a fluctuation of 23.44 per cent as against the 5.47 per cent with fluctuation of 7.49 per cent in India during the period under study.

Table 2.11: Percentage Share of Rice Production in M.P. as compared to India in period I (Production in Million Tone)

Year	India	M.P.	% share
1984-85	58.34	0.75	1.29
1985-86	63.83	1.33	2.09
1986-87	60.56	0.98	1.63
1987-88	56.86	0.96	1.70
1988-89	70.49	1.26	1.79
1989-90	73.57	1.00	1.35
1990-91	74.29	1.39	1.87
1991-92	74.68	0.95	1.27
1992-93	72.86	1.15	1.57
1993-94	80.3	1.31	1.63
SD	8.05	0.21	
Mean	68.58	1.11	
CV	11.74	18.89	
Base year	60.91	1.02	1.67
current year	75.95	1.13	1.75
Absolute C.	15.04	0.11	
Relative C	24.69	10.73	
t-b	20.24	6.87	
Co. b	55.68	0.96	
R2-b	4.03	0.20	
SGR	3.42	2.46	
CGR	3.51	2.81	

Table 2.12: Percentage Share of Rice Production in M.P. as compared to India in period II (Production in Million Tone)

Year	India	M.P.	% share
1994-95	81.81	1.42	1.73
1995-96	76.98	1.18	1.54
1996-97	81.74	1.31	1.60
1997-98	82.53	1.19	1.44
1998-99	86.08	1.38	1.61
1999-00	89.68	1.67	1.86
2000-01	84.98	0.83	0.98
2001-02	93.34	1.69	1.81
2002-03	71.82	1.04	1.44
2003-04	88.53	1.87	2.11
SD	6.27	0.32	
Mean	83.75	1.36	
CV	7.49	23.44	
Base year	80.18	1.30	1.62
current year	84.56	1.53	1.89
Absolute C.	4.39	0.23	
Relative C	5.47	17.73	
t-b	18.44	5.44	
Co. b	80.64	1.22	
R2-b	6.40	0.33	
SGR	0.68	1.87	
CGR	0.62	1.21	

The production of rice increased with an annual linear and compound growth of 1.87 per cent and 1.21 per cent per year in M.P. respectively as against of 0.68 per cent and 0.62 per cent of India.

Madhya Pradesh contributed 1.63 per cent (The base year) to 1.66 per cent (The current year) to India's rice production basket in period III (2005-2011). In this period the production of rice in M.P. showed 7.48 per cent of relative change with an annual fluctuation of 12.78 per cent as against the 5.71 per cent relative change with an annual fluctuation of 5.76 per cent in India.

Table 2.13: Percentage Share of Rice Production in M.P. as compared to India in period III (Production in Million Tone)

Year	India	M.P.	% share
2004-05	83.13	1.29	1.56
2005-06	91.79	1.69	1.85
2006-07	93.36	1.40	1.50
2007-08	96.69	1.33	1.38
2008-09	99.18	1.58	1.59
2009-10	89.09	1.36	1.53
2010-11	95.33	1.77	1.86
SD	5.33	0.19	
Mean	92.65	1.49	
CV	5.76	12.78	
Base year	89.43	1.46	1.63
current year	94.53	1.57	1.66
Absolute C.	5.11	0.11	
Relative C	5.71	7.48	
t-b	20.95	8.33	
Co. b	87.37	1.35	
R2-b	4.93	0.19	
SGR	1.43	2.28	

The production of rice increased with an annual linear and compound growth of 2.28 per cent and 2.27 per cent per year respectively as against of 1.43 per cent and 1.48 per cent of India.

2.3.3 Productivity

The average productivity of rice in Madhya Pradesh showed a difference of 701 kg/ha (1985-86) to 1129 kg/ha (1991-91) in period I (1985-1994) of the study as compared to India. In this period the yield of rice in M.P. showed 12.50 per cent of relative change with an annual fluctuation of 18.07 per cent as against the 21.23 per cent relative change with an annual fluctuation of 9.58 per cent in India during the period under study.

Table 2.14: Difference in Rice Productivity in M.P. as compared to India in period I

(Productivity in Kg/ha)

Year	India	M.P.	Difference
1984-85	1417	493	925
1985-86	1552	851	701
1986-87	1471	633	838
1987-88	1465	697	768
1988-89	1689	847	842
1989-90	1745	683	1062
1990-91	1740	914	826
1991-92	1751	622	1129
1992-93	1744	747	997
1993-94	1888	854	1034
SD	157.77	132.62	
Mean	1646.15	734.09	
CV	9.58	18.07	
Base year	1479.97	658.68	
current year	1794.18	741.05	
Absolute C.	314.21	82.37	
Relative C	21.23	12.50	
t-b	29.87	7.25	
Co. b	1384.17	635.44	
R2-b	67.84	128.33	
SGR	2.89	2.44	
CGR	2.96	2.80	

The yield of rice increased with an annual linear and compound growth of 2.44 per cent and 2.80 per cent per year respectively as against of 2.89 per cent (linear) and 2.96 per cent (compound) of India.

The average productivity of rice in Madhya Pradesh showed a difference of 967.29 kg/ha (1999-2000) to 1287.14 kg/ha (2000-01) in period II (1995-2004) of the study as compared to India. In this particular period the yield of rice decreased from 820.27 kg/ha (The base year) to 811.85 kg/ha (The current year) in M.P. showed -1.03 per cent of relative change with an annual fluctuation of 17.03 per cent as against the 5.55 per cent relative change with an annual fluctuation of 5.56 per cent in India. This was due to the drought of the year 2002-03.

Table 2.15: Difference in Rice Productivity in M.P. as compared to India in period III

(Productivity in Kg/ha)

Year	India	M.P.	Difference
1994-95	1911.00	899.57	1011.43
1995-96	1796.92	746.45	1050.47
1996-97	1882.11	814.79	1067.32
1997-98	1900.00	735.48	1164.52
1998-99	1921.43	846.93	1074.50
1999-00	1986.00	1018.71	967.29
2000-01	1900.69	613.56	1287.14
2001-02	2079.00	849.33	1229.67
2002-03	1744.00	608.00	1136.00
2003-04	2077.00	978.23	1098.77
SD	106.82	138.16	
Mean	1919.82	811.11	
CV	5.56	17.03	
Base year	1863.34	820.27	
current year	1966.67	811.85	
Absolute C.	103.32	-8.42	
Relative C	5.55	-1.03	
t-b	25.73	8.20	
Co. b	1847.33	820.52	
R2-b	105.10	146.44	
SGR	0.69	-0.21	
CGR	0.65	-0.50	

Table 2.16: Productivity of Rice in M.P. and India in period III

(Productivity in Kg/ha)

Year	India	M.P.	Difference
2004-05	1984	804	1180
2005-06	2102	1045	1057
2006-07	2131	874	1257
2007-08	2202	853	1349
2008-09	2178	969	1209
2009-10	2125	896	1229
2010-11	2240	1167	1073
SD	82.93	126.34	
Mean	2137.44	943.93	
CV	3.88	13.38	
Base year	2072.33	907.51	
current year	2181.04	1010.67	
Absolute C.	108.70	103.15	
Relative C	5.25	11.37	
t-b	43.83	8.31	
Co. b	2014.45	817.17	
R2-b	54.38	116.31	
SGR	1.44	3.36	
CGR	1.47	3.32	

The yield of rice decreased with an annual linear and compound growth of -0.21 per cent and -0.50 per cent per year respectively as against of 0.69 per cent (linear) and 0.65 per cent (compound) of India.

The average productivity of rice in Madhya Pradesh showed a difference of 1057 kg/ha (2005-06) to 1349 kg/ha (2007-08) in period III (2005-11) of the study as compared to India. In this period the yield of rice increased from 907.51 kg/ha (The base year) to 1010.67 kg/ha (The current year) in M.P. showed 11.37 per cent of relative change with an annual fluctuation of 13.38 per cent as against the 5.25 per cent relative change with an annual fluctuation of 3.38 per cent in India.

The yield of rice in M.P. increased with an annual linear and compound growth of 3.36 per cent and 3.32 per cent per year respectively as against of 1.44 per cent (linear) and 1.47 per cent (compound) of India.

2.4 Performance of Paddy under NFSM districts in Madhya Pradesh

The NFSM districts cover only 49.41 percent of total rice area of M.P. The maximum area was found to be in Rewa district (16.17%) followed by Mandla (13.97%), Shahdol (13%), Annuppur (12.26) Katni (10.83%), Satna (10.80%), Dindori (9.36%), Damoh (6.82%) and Panna (6.79%) districts. The productivity of rice was found to be higher in other districts (1227.15 kg/ha) districts as compared to total NFSM districts. (Table 2.17).

Table 2.17: Area, Production and Yield of Paddy under NFSM Districts of M.P. (TE 2010) (Area:-000'ha, Production:-000'tonnes, Yield:-Kg./ha)

Districts	**Area**	**% age**	**Prod.**	**% age**	**Yield**
Katni	87.83	10.83	57.33	10.38	651.00
Mandla	113.27	13.97	70.27	12.73	652.33
Damoh	55.27	6.82	37.33	6.76	710.00
Panna	55.07	6.79	32.10	5.81	609.33
Rewa	131.13	16.17	94.17	17.05	751.00
Satna	87.53	10.80	48.83	8.84	590.00
Shahdol	105.43	13.00	79.10	14.33	791.00
Anuppur	99.43	12.26	75.17	13.61	794.33
Dindori	75.90	9.36	57.87	10.48	799.33
Total NFSM districts	810.87	49.41	552.17	35.15	705.37
Other districts	830.13	50.59	1018.70	64.85	1227.15
M.P. State	**1641**	**100.00**	**1570.87**	**100.00**	**1010.67**

2.5 Performance of Rice in Madhya Pradesh

As regard the different rice growing districts of Madhya Pradesh. Rice has been found to be concentrated in Jabalpur, Katni, Balaghat, Chhindwara, Mandla, Narsinghpur, Damoh, Panna, Tikamgarh, Chhatarpur, Rewa, Sidhi, Singroli, Satna, Shahdol, Umariya, Anuppur, Dindori, Jhabua, Raisen, Hosangabad, Harda, and Betul. These 25 districts contributed 97.47 per cent of total rice of area of Madhya Pradesh. The remaining 25 districts contributed only 2.53 per cent of area of rice in Madhya Pradesh. The highest area of rice was found in Balaghat (15.18%) followed by Rewa (7.99%), Seoni (7.14%), Mandla (6.90%), Shahdol (6.06%), Sidhi (5.40%), Katni (5.35%), Dindori (4.63%) and Jabalpur (4.04%).

Table 2.18: Area, Production and Yield of Paddy in different districts of M.P. (TE 2010). (Area:-000'ha, Production:-000'tonnes, Yield:-Kg./ha)

S.No	Districts	Area	% age	Prod.	% age	Yield
1	Jabalpur	66.27	4.04	48.33	3.08	767.33
2	Katni	87.83	5.35	57.33	3.65	651.00
3	Balaghat	249.13	15.18	322.50	20.53	1363.00
4	Chhindwara	19.53	1.19	15.63	1.00	842.00
5	Seoni	117.13	7.14	129.20	8.22	1160.33
6	Mandla	113.27	6.90	70.27	4.47	652.33
7	Narsinghpur	13.13	0.80	13.27	0.84	1064.33
8	Damoh	55.27	3.37	37.33	2.38	710.00
9	Panna	55.07	3.36	32.10	2.04	609.33
10	Tikamgarh	12.43	0.76	4.83	0.31	402.33
11	Chhatarpur	10.77	0.66	5.13	0.33	502.67
12	Rewa	131.13	7.99	94.17	5.99	751.00
13	Sidhi	88.53	5.40	58.40	3.72	695.00
14	Singroli	47.90	2.92	25.70	1.64	568.00
15	Satna	87.53	5.33	48.83	3.11	590.00
16	Shahdol	105.43	6.42	79.10	5.04	791.00
17	Umaria	43.00	2.62	27.30	1.74	672.67
18	Anuppur	99.43	6.06	75.17	4.79	794.33
19	Dindori	75.90	4.63	57.87	3.68	799.33
20	Jhabua	16.73	1.02	8.40	0.53	515.00
21	Gwalior	21.23	1.29	50.90	3.24	2330.33
22	Raisen	20.67	1.26	20.43	1.30	1045.67
23	Hoshangabad	17.83	1.09	28.33	1.80	1666.67
24	Harda	15.17	0.92	1.30	0.08	2262.33
25	Betul	29.13	1.78	45.83	2.92	1105.67
Total Rice growing Districts		**1599.47**	**97.47**	**1357.67**	**86.43**	**932.47**
Other Districts		**41.53**	**2.53**	**213.20**	**13.57**	**923.18**
M.P. STATE		**1641.00**	**100.00**	**1570.87**	**100.00**	**1010.67**

Balaghat districts (20.53%) also contributed maximum production of rice in Madhya Pradesh followed by Seoni (8.22%), Rewa (5.99%), Shahdol (5.04%),

Annuppur (4.79), Mandla (4.47%), Dindori (3.68%), Katni (3.65%), Gwalior (3.24%) and Jabalpur (3.08%).

The farmers of Gwalior district (2330.33 kg/ha) obtained the highest yield of rice in Madhya Pradesh followed by Harda (2262.23 kg/ha), Hoshagabad (1666.67 kg/ha), Balaghat (1363 kg/ha), Seoni (1160.33 kg/ha) and Narsinghpur (1064.33 kg/ha) (Table 2.18).

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CHAPTER – III

STATUS OF ADOPTION OF HYBRID RICE AT THE FARM LEVEL

This chapter deals with the socio economic characteristic of sample respondents related to adopter and non adopter of hybrid rice technology, their distribution according to farm size, cropping pattern during the year 2009-10 and 2010-11 and extent of adoption of hybrid rice technology according to different size of farms. The chapter also deals with the sources and quality of information received by the farmer respondents.

3.1 Socio economic characteristic of sample respondents

The socio economic characteristic of sample farmers related to hybrid rice technology adopter (80) non adopter (20) and their aggregate are presented in Table 3.1. It is observed from the data that the majority of adopter respondents were male (96.28%), comes under the age group of 16-60 years (90%). Educated up to secondary (52.50 %) following by graduate (15%), primary (12.50%), and illiterate (10.0%) and above graduate (6.24%) categories. The majority of non adopters were found to be educated up to secondary level (55%) followed by illiterate (20%), up to graduate level (15%) and up to primary (10%), Hence, it is clear that adopters of hybrid rice technology are more educated than the non adopters.

As regards to the caste of sample respondents it was found majority of adopter were under OBC category (57.5%), followed by General (16.25%), SC (13.75%) and ST (12.50%) categories, while majority of non adopters also belongs to OBC (60%), followed by General (25%), SC (10%) and ST (5%) categories.

Self employed farming was found to be main occupation of the head of the family in both the categories i.e. adopters (73.75%) and non adopters (65%). The 11.25 per cent adopters and 20 per cent non adopters were found to be worked as agricultural labour in the study area.

Table 3.1: Socio-economic characteristics of sample farm households.

Characterizes		Hybrid adopters	Non-adopters	Aggregate
Household size	Male	77.00	19.00	96.00
	%	**96.25**	**95**	**96**
	Female	3.00	1.00	4.00
	%	**3.75**	**5**	**4**
	Total	80.00	20.00	100.00
Size of worker	Male	2.00	2.00	2.00
	%	**66.66**	**66.66**	**66.66**
	Female	1.00	1.00	1.00
	%	**33.33**	**33.33**	**33.33**
	Total	3.00	3.00	3.00
Age group	< 18	0.00	0.00	0.00
	%	**0.00**	**0.00**	**0.00**
	16 – 60	72.00	17.00	89.00
	%	**90**	**85**	**89**
	> 60	8.00	3.00	11.00
	%	**10**	**15**	**11**
Educational status	Illiterate	8.00	4.00	12.00
	%	**10.00**	**20.00**	**12.00**
	Up to Primary	10.00	2.00	12.00
	%	**12.50**	**10.00**	**12.00**
	Up to secondary	42.00	11.00	53.00
	%	**52.50**	**55.00**	**53.00**
	Up to Graduate	15.00	3.00	18.00
	%	**18.75**	**15.00**	**18.00**
	Above Graduate	5.00	0.00	5.00
	%	**6.25**	**0.00**	**5.00**
Caste	SC	11.00	2.00	15.00
	%	**13.75**	**10**	**15**
	ST	10.00	1.00	11.00
	%	**12.50**	5	11
	OBC	46.00	12.00	58.00
	%	**57.50**	60	58
	General	13.00	5.00	18.00
	%	**16.25**	**25**	**18**
Main occupation of the head	Self-employed Farming	59.00	13.00	72.00
	%	**73.75**	**65**	**72**
	Self-employed Non-farming/ Business	3.00	1.00	4.00
	%	**3.75**	**5**	**4**
	Salaried Person	2.00	0.00	2.00
	%	**2.5**	**0**	**2**
	Agriculture Labour	9.00	4.00	13.00
	%	11.25	20	13
	Non-agricultural Labour	6.00	1.00	7.00
	%	**7.5**	**5**	**7**
	Pensioner,	1.00	1.00	2.00
	%	**1.25**	**5**	**2**
	Household Work	0.00	0.00	0.00
	%	**0.00**	**0.00**	**0.00**
	Student	0.00	0.00	0.00
	%	**0.00**	**0.00**	**0.00**
	Others (specify)	0.00	0.00	0.00
	%	**0.00**	**0.00**	**0.00**
Average size of holding (ha)	Ownership holdings	4.29	3.66	3.98
	Operational holdings	4.73	4.09	4.41
Average size of irrigated land (ha)	Kharif	4.64	3.82	4.23
	%	**98.10**	**93.40**	95.75
	Rabi	4.58	3.74	4.16
	%	**96.83**	**91.44**	94.14
	Total	4.73	4.09	4.41

The average size of operational land holding of adopters and non adopters was found to be 4.73 ha and 4.09 ha and ownership land holding was 4.29 ha and 3.66 ha. respectively in the above categories.

Though, paddy required more irrigation as compared to other crops and the respondents were related to adopter and non adopter of hybrid rice, hence irrigated land receptively respectively 98.39%, and 93.39%, receptively for adopter and non adopter in Kharif season of operational holdings.

3.2 Distribution of sample farmers

The distribution of sample farmers according their farm size presented in Table 3.2. It is observed from the data that 16 adopter and 4 non adopter of hybrid rice were taken into consideration in all the five categories i.e. < 1 ha (marginal), 1-2 ha (small), 2-4 ha (semi-medium), 4-10 ha (medium), and > 10 ha (large) of farmers Thus, 20 percent of rice farmers in each category were taken for depth study.

Table 3.2: Distribution of sample farmers according to farm size

Size classes of operational holdings (ha)	Hybrid adopters		Non-adopters	
	No of farms	Percent of farms	No of farms	Percent of farms
Marginal (Below 1ha)	16	20	4	20
Small (1 – 2 ha)	16	20	4	20
Semi medium (2 – 4 ha)	16	20	4	20
Medium (4 – 10 ha)	16	20	4	20
Large (10 ha and above)	16	20	4	20
Total	**80**	**100**	**20**	**100**

3.3 Cropping Pattern

Cropping pattern of adopters and non adopters of hybrid rice technology for the year 2009-10, and 2010-11 is presented in table 3.3. It is observed from the data that both Kharif and Rabi were found to be the main seasons in the study area in which adopter and non adopter of hybrid rice were devoted their 50-50 percent of total area cultivated in a year.

Hybrid rice (37.63%), followed by soybean (28.37%), HYV paddy (27.63%) were found to be main crops cultivated by adopter in Kharif season,

while HYV paddy (60.44%), soybean (26.73%) were the major crops grown by the non adopter of hybrid rice farmers in the year 2009-10.

Table 3.3: Cropping pattern for the years 2009-10 and 2010-11

Seasons/ Crops	Hybrid adopters				Non-adopters			
	2009-10		2010-11		2009-10		2010-11	
	Area (ha)	percent	Area (ha)	percent	Area (ha)	percent	Area (ha)	percent
Kharif								
Hybrid paddy	1.66	37.63	1.85	41.03	0.00	0.00	0.00	0.00
HYVs Paddy	1.22	27.63	1.21	26.74	2.29	60.44	2.38	61.71
Soybean	1.26	28.37	1.24	27.58	1.01	26.73	1.17	30.42
Urd & moong	0.19	4.28	0.14	3.18	0.22	5.88	0.13	3.41
Arhar	0.08	1.70	0.05	1.12	0.16	4.28	0.09	2.36
Other	0.02	0.40	0.02	0.34	0.10	2.67	0.08	2.10
Sub total	**4.42**	**100.00**	**4.51**	**100.00**	**3.79**	**100.00**	**3.86**	**100.00**
%	**(49.04)**		**(49.07)**		**(48.90)**		**(48.60)**	
Rabi								
Wheat	3.34	72.69	3.27	69.69	2.53	63.94	2.68	65.71
Gram	0.75	16.33	0.87	18.56	0.90	22.76	0.93	22.89
Masoor	0.34	7.43	0.33	6.97	0.38	9.51	0.32	7.93
Pea	0.09	1.95	0.14	3.05	0.09	2.25	0.10	2.48
Other	0.07	1.60	0.08	1.73	0.06	1.53	0.04	0.99
Sub total	**4.60**	**100.00**	**4.69**	**100.00**	**3.96**	**100.00**	**4.08**	**100.00**
%	**(50.96)**		**(50.93)**		**(51.10)**		**(51.40)**	
Grand total	**9.02**		**9.20**		**7.74**		**7.94**	

The situation have somewhat changed in the year 2010-11, the area of hybrid rice adopters under hybrid rice increased slightly from 37.63 per cent (2009-10) to 41.03 per cent (2010-11), while the area under soybean (27.58%) decreased slightly. But in case of non adopters the area under HYVs of paddy and soybean increased slightly and area under other crops decreased.

In Rabi season wheat and gram were observe as major crops of the grown by the adopters and non adopters both in approximately 70 and 20 per cent area during both the years. The slight variation was observed in the area of wheat and gram of adopter farmers. The area under wheat decreased slight from 72.69% (2009-10) to 69.69% (2010-11) while, area under gram increased from 16.33 per cent (2009-10) to 18.56 per cent (2010-11). In case of non adopters area under wheat crops increased from 63.94 per cent (2009-10) to 65.71 per cent (2010-11), but an area under gram remain same in both the years. It is to observe that adopters prefer cereals followed by pulses crop rotation in place of cereal followed by cereal crop rotation in the area under study. As regards to other Rabi crops slight change in area was noticed in the cultivator's fields.

3.4 Extent of adoption of hybrid rice technology

The data related to extension of adoption of hybrid rice technology by the adopters of hybrid rice during the years 2009-10 and 2010-11 is presented in Table 3.4. It is observed from the data that area under HYVs rice was found to be decreased in the year 2010-11 as compared to the year 2009-10 from 0.27 ha to 0.18 ha (marginal), 0.52 ha to 0.53 ha (small), 0.80 ha to 0.80 ha (semi – medium), 1.64 ha to 1.57 ha (medium), and 2.59 ha to 2.93 ha (large). The area under hybrid rice was found to be increased in the year 2010-11 as compared to the year 2009-10 from 0.40 ha to 0.51 ha (marginal), 0.82 ha to 0.86 ha (small), 0.94 ha to 1.06 ha (semi medium), 1.90 ha to 2.52 ha (medium) and 4.26 ha to 4.31 ha (large). At overall level average size of holding was found to be 4.31.The area under hybrid rice increased from 1.66 ha (2009-10) to 1.85 ha (2010-11), while the area under HYVs of rice increased from 1.17 ha to 1.20 ha (2010-11) in area under study.

Table 3.4: The extent of adoption of hybrid rice technology by farm size

(For hybrid adopters only)

Farm size classes	2009-10						2010-11					
	Average farm size	Average rice area	Average rice area under		Percent of rice area under		Average farm size (ha)	Average rice area (ha)	Average rice area (ha) under		Percent of rice area under	
			HYVs	Hybrid	HYVs	Hybrid			HYVs	Hybrid	HYVs	Hybrid
Marginal (Below 1ha)	0.70	0.67	0.27	0.40	4.56	4.86	0.70	0.68	0.18	0.51	2.95	5.46
Small (1 – 2 ha)	1.49	1.34	0.52	0.82	8.91	9.80	1.49	1.39	0.53	0.86	8.85	9.28
Semi medium (2 – 4 ha)	2.42	1.75	0.80	0.94	13.79	11.32	2.42	1.86	0.80	1.06	13.28	11.48
Medium (4 – 10 ha)	4.81	3.54	1.64	1.90	28.23	22.80	4.81	4.09	1.57	2.52	26.13	27.19
Large (10 ha and above)	12.16	6.86	2.59	4.26	44.51	51.22	12.16	7.24	2.93	4.31	48.79	46.59
Average	**4.31**	**2.83**	**1.17**	**1.66**	**100.0**	**100.0**	**4.31**	**3.05**	**1.20**	**1.85**	**100.0**	**100.0**

3.5 Farmers accessing source of information

The majority of the adopters of hybrid rice reported that extension worker of the Department of Farmers Welfare and Agriculture Development (85%) was the one of the main sources of information on hybrid rice for dissemination of technology (Table 3.5) followed by Krishi Vigyan Kendra (60%), input dealer (46.25%) and radio (40%). The Front Line Demonstration program conducted by

Govt. (33.75%), television (33.75%), news papers (20%) participating in training programme organized by the Govt. (18.75%) and progressive farmers (13.75%), output buyers, food processor, credit agency NGO / private agency were the other sources of information on hybrid rice technology in the study area.

Table 3.5: Farmers accessing source of information on hybrid rice technology **(**For Hybrid adopters only)

Sources	Number of farmers reporting	Percent of farmers reporting
Frontline demonstration programme conducted by government	27	33.75
Participation in training programme organized by the government	15	18.75
Krishi Vigyan Kendra	48	60
Extension worker of state department of agriculture	68	85
Television	27	33.75
Radio	32	40
Newspaper	16	20
Input dealer	37	46.25
Progressive farmer	11	13.75
Private agency/ NGO	1.0	1.25
Output buyers/food processor	3.0	3.75
Credit agency	2.0	2.5
Others	0.0	0.0

Table 3.6: Farmers reporting quality of information received among those accessing the source **(**For hybrid adopters only)

Source	Hybrid adopters reporting quality of information received		
	Good	Satisfactory	Poor
Participation in training programme conducted by the government	14 (51.85)	9.0 (33.33)	4.0 (14.81)
Participation in demonstration Programme organized by the government	9.0 (56.25)	5.0 (31.25)	2.0 (12.50)
Extension worker of state department of agriculture	21 (30.88)	34 (50.00)	13 (19.12)
Krishi Vigyan Kendra	12 (25.00)	28 (58.33)	8.0 (16.67)

Note: Figures in brackets indicate percentages

Regarding the quality of information received from the major sources was found at satisfactory level. The majority (50%) of the respondent reported that extension worker of the State Department of Agriculture works at satisfactory level, while 25.00 per cent and 8.00 per cent of the respondents reported that information recovered was of good poor quality respectively. (Table 3. 6)

3.6: Determinations of participations in Hybrid Rice Cultivation

An attempt has also been made to analyses the Determinations of participations in Hybrid Rice Cultivation. Logit analysis has been used by taken age, education, hh size, no of worker in the family, farm size, as independent variables over the adoption level (dependent variable) and the result obtained are presented in Table 3.7.

Table 3.7: Determinations of participations in Hybrid Rice Cultivation

S.No.	Variables	b	Std. Error	z
a	Constant	1.38	1.40	0.99
X_1	Age (in year)	-0.005	0.02	-0.24
X_2	Education (numbers of years of schooling)	0.13	0.19	0.70
X_3	HH size (in numbers)	0.03	0.12	0.24
X_4	Size of worker (in numbers.)	-0.13	0.26	-0.52
X_5	Farm size (in ha)	-0.23	0.20	-1.13
X_6	Irrigated land (in ha)	0.27	0.23	1.17

It is observed from the data that none of the independent variables considered in the model has yielded a significant relationship with the dependent variable. However, the signs of Z-statistics are as expected, and indicate the directions of relationship between the dependent and independent variables. Age, farm-size, and no. of workers shown negative relationship (i.e. higher is the age/farm-size/workers, the lower is the probability of adopting hybrid varieties of rice). Education, household size and irrigation availability shown positive relationship (i.e. higher the education/HH size/irrigation, the higher is the probability of adopting hybrid rice). On the whole, the model fails to identify factors that influence decision in adopting hybrid rice cultivation. This further pointed out that there might be some other factors at work influencing a decision regarding adoption of hybrid varieties of rice.

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CHAPTER – IV

IMPACT OF HYBRID RICE CULTIVATION ON OVERALL PRODUCTION OF RICE

This chapter deals with the farmers accessing sources of information of seed for hybrid rice cultivation, yield performance of hybrid rice and HYVs. yield gain of hybrid rice over inbred rice varieties and factors affecting the yield of hybrid rice.

4.1 Adoption of Recommended Package of Practices in Rice Cultivation

As regards to the adoption of recommended package of practices in rice cultivation, out of the total farmers who took participation in training program conducted by the government only 22.5% farmers adopted full package of recommended technology in cultivation of hybrid rice.

Table 4.1: Farmers reporting adopted recommended package of practices in rice cultivation (Percent of farmers reporting)

Source of information	Hybrid Adopters		Non-Adopters
	Hybrid Rice	HYV Rice	HYV Rice
Participation in training programme conducted by the government	22.5	16.25	26.25
Participation in demonstration Programme organized by the government	15	10	20
Extension worker of state department of agriculture	57.5	47.5	38.75
Krishi Vigyan Kendra	45	52.5	42.5

While, 16.25% HYVs 26.25 % of hybrid rice adopters and non adopters adopted recommended package of practices technology of rice respectively. (Table 4.1)

4.2 Sources of Seed for Hybrid Rice Cultivation

The data on sources of seed for hybrid rice in the year 2009-10 and 2010-11are presented in Table 4.2. It is observed from the data that the majority of adopter depended on private sector in both the years (2009-10) and (2010-11) followed by public sector on partial subsidy and public sector on full subsidy.

The mean yield of hybrid rice over the HYVs of rice has been found to be increased by about 40% across all the categories of farmers (Fig 4.1).

Table: 4.2: Farmers accessing sources of seed for Hybrid rice cultivation

(For hybrid adopters only)

Sources of seed	2009-10		2010-11	
	Number of farmers reporting	Percent of farmers reporting	Number of farmers reporting	Percent of farmers reporting
Public on full subsidy	11	13.75	13	16.25
Public on partial subsidy	23	28.75	15	18.75
Private	46	57.5	52	65
Total	**80**	**100**	**80**	**100**

The maximum yield was found to be increased in small, medium and semi medium farmers in both the years i.e. 2009-10 and 2010-11 (Table 4.3)

Table-4.3: Mean yield levels of hybrids and HYVs of rice by farm size on sample farms

(Hybrid adopters only)

Farm size classes (ha)	2009-10			2010-11		
	Mean yield (Kg/ha)		Percent difference	Mean yield (Kg/ha)		Percent difference
	Hybrid	HYVs		Hybrid	HYVs	
Marginal (Below 1ha)	4260.75	2587.62	39.27	4223.7	2434.71	42.36
Small (1 – 2 ha)	5047.22	2696.3	46.58	4929.82	2787.57	43.45
Semi medium (2 – 4 ha)	5238.39	3135.15	40.15	5851.55	3081.62	47.34
Medium (4 – 10 ha)	5371.43	2937.4	45.31	5533.3	3250.84	41.25
Large (10 ha and above)	4982.51	2819.41	43.41	5053	3034.42	39.95
All sizes	**4980.06**	**2835.18**	**43.07**	**5118.27**	**2917.83**	**42.99**

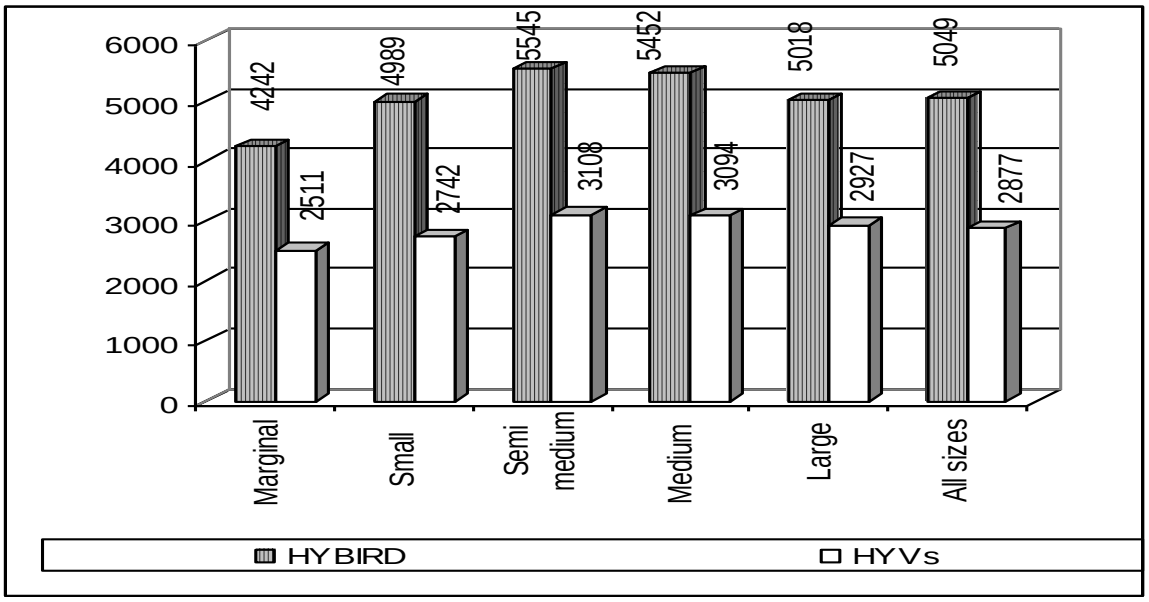

Fig. 4.1: Main yield (Kg/ha) of Hybrid Rice over the HYVs rice (Biannual Average up to 2011)

4.3 Factors affecting yield of Paddy

In the adopter of hybrid rice farms, all the factors of production were found to be positive except expenses on bullock labour, which was negative and significant. The expenses on seed (0.152***), chemical fertilizer (0.082***), human labour (0.243***) were positive and highly significant, which reveals that

if all things remains constant and at the present level of technological adoption an additional expense of Rs. 1/- each on seed, chemical fertilizer and human labour will be able to increase the yield of hybrid rice up to 0.152, 0.082 and 0.243 kg/ha respectively. The expenses on manures, pesticides, machine labour were found to be positive but non significant, which shows the need to provide extra attention while using these crucial inputs at their farms. There is also a need to provide skill oriented training and demonstration to them at their field. The coefficient of multiple regressions was found to be 0.568. Hence, the fitted function is good fit and able to explain 56.80 per cent variability in the yield of hybrid rice.

Table 4.4: Factor affecting yield of Rice (Rs/ha)

S. No	Independent Variable	Adopter			Non Adopter		
		b	Std. Error	t	b	Std. Error	t
1	Constant	1.862***	0.239	7.793	2.154	1.449	1.487
2	Seed	0.152***	0.041	3.690	0.134	0.163	0.822
3	Manure	0.005	0.004	1.091	0.012	0.015	0.818
4	Chemical fertilizer	0.082***	0.023	3.594	0.181**	0.075	2.396
5	Pesticide	0.007	0.009	0.735	0.002	0.015	0.107
6	Irrigation	0.005	0.004	1.308	0.024*	0.013	1.845
7	Human labour	0.243***	0.053	4.568	0.440***	0.149	2.951
8	Bullock labour	-0.015*	0.008	-1.722	-0.402	0.260	-1.543
9	Machine labour	0.002	0.012	0.159	-0.406	0.261	-1.556

R2 = 0.568 (Adopter), R2 = 0.797 (Non adopter)

*** Level of Significance 1%

** Level of Significance 5%

*Level of Significance 10%

As regards to non adopter of hybrid rice growing HYVs of rice, all the factors of production were found to be positive except expenses on bullock (-0.402) and machine (-0.406) labour. The expenses on fertilizer (0.181**), irrigation (0.24*) and human labour (0.440***) were positive and significant whereas expenses on seed (0.134), manures (0.012), pesticides (0.002) were positive but non significant. Hence, there is need to replace the seed of HYVs by hybrid seed and provide skill oriented training regarding package and practices of hybrid as well as HYVs of rice at farmers' fields as the majority of farmers reported that they had lack of knowledge of recommended package of practices. The fitted function is found to be good fit as it is able to explain 79.7% variability of selected independent variables in the yield of HYVs.

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CHAPTER – V

COMPARATIVE ECONOMICS OF HYBRID AND INBRED RICE CULTIVATION

This chapter deals with the input use pattern, operation wise labour absorption including women labour, cost of input incurred and economic return obtained by adopters over non adopters of hybrid rice technology in the area under study.

5.1 Input Use Pattern

The input use pattern of cultivation of hybrid and inbred rice related to hybrid rice growers and non adopter of hybrid rice presented in Table 5.1. It is observed from the data that adopter of hybrid rice over the HYVs of rice cultivators (adopter) and non adopter has been found to be used less quantity of seed, manures and bullock labour. While they found to be used more quantity of chemical fertilizer, number of sprays of pesticides, number of irrigations and human labour in cultivation of hybrid rice in the area under study.

Table 5.1: Input Use Pattern of Cultivation of Hybrid and Inbred Rice (2010-11)

Inputs	Hybrid Adopters		Non-adopters
	Hybrid	HYVs	HYVs
Seed (kg/ha)	15.19	53.62	61.51
Manure (tonne/ha)	1.35	2.14	1.83
Chemical fertilizer (kg/ha)	311.50	278.68	271.25
Pesticide (no. of sprays)	1.08	0.67	0.80
Irrigation (no. of application)	1.29	0.63	0.95
Human labor (days/ha)	90.12	83.28	80.11
Bullock labor (days/ha)	0.30	0.17	0.34

5.2 Comparison of Costs and Returns for Hybrid and Inbred Rice

The comparison of cost and return between hybrid rice and inbred rice in the year 2009-10 and 2010-11 has been presented in Table 5.2 & 5.3. It is observed from the data that in the year 2009-10 hired human charges was found to the main component of the total cost followed by machine charges, seed chemical fertilizer, manures, insecticide, pesticide and irrigation both in the adopter of hybrid rice as well as inbred rice. In cultivation of hybrid rice, expenses on seed, manures, chemical fertilizer, machine labor, hired labor, etc. were found higher than the inbred rice.

Table 5.2: Comparison of Costs and Returns for Hybrid and Inbred Rice (2009-10)

(Rs. /ha)

S. No	Particulars	Hybrid Adopters		Non-adopters	Percent increase Over HYVs	
		Hybrid	HYVs	HYVs	Adopter	Non adopter
A.	**Costs**					
1	Seed (both farm produced and purchased)	2818.12	1230.45	1310.05	56.34	53.51
2	Manure (owned and purchased)	775.53	895.06	880.5	-15.41	-13.54
3	Chemical fertilizers	2320.37	2055.24	1795.33	11.43	22.63
4	Insecticides & Pesticides	715.59	602.77	579.6	15.77	19.00
5	Irrigation charges (both owned and hired)	972.98	582.93	738.49	40.09	24.10
6	Machinery charges	4680.99	4400.99	4205.88	5.98	10.15
7	Hired human labour charges	5972.29	4695.01	4835.13	21.39	19.04
8	Bullock labour (owned and hired)	83.33	74.01	170.42	11.18	-104.51
9	Total cost	18339.2	14536.5	14515.4	20.74	20.85
10	Unit cost of production (Rs. Per Kg.)	3.01	3.89	4.62	-29.24	-53.49
B.	**Returns**					
1	Yield of paddy (qtl/ha)	49.8	28.35	23.7	43.07	52.41
2	Market price (Rs./qtl)	1016.27	1038.27	1088.57	-2.16	-7.11
3	Value of grain yield (Rs./ha)	50610.9	29436.7	25803.99	41.84	49.01
4	Value of straw yield (qtl/ha)	48	50	51	-4.17	-6.25
5	Total value of the produce (gross return)	53970.9	32936.7	29373.99	38.97	45.57
6	Net return (5 – 9)	35631.6	18400.2	14858.59	48.36	58.30
7	Benefit cost ratio:	2.94	2.27	2.02	22.79	31.29

The total cost of cultivation of rice (HYVs) was found Rs. 14536.46/-ha (in case of adopter of hybrid rice but also cultivated HYVs, hybrid rice adopter) and Rs. 14515.40/ ha (non adopter) while in case of hybrid rice it was found Rs. 18339.21/-ha which was about 20 per cent higher than the HYVs of rice.

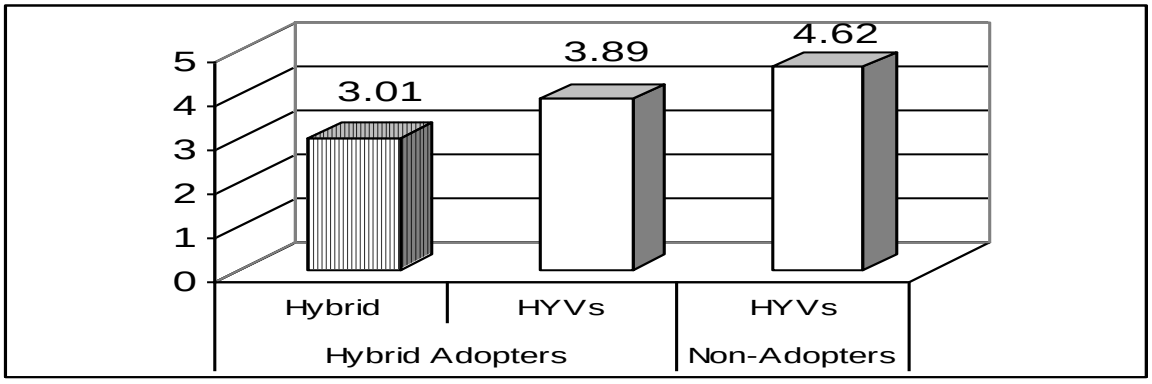

Fig. 5.1: Cost of Production (Rs. /q) of Hybrid Rice over HYVs Rice at Adopter and Non Adopter Farms.

The cost of production of hybrid rice was found 29.24 per cent lower (from Rs. 3.89/-Kg to Rs. 3.01/-Kg) as compared to inbred rice in the farms of hybrid rice adopter 52.41 per cent lower (from Rs. 4.62/-Kg to Rs. 3.01/-Kg) at

non adopter of hybrid rice farm in the year 2009-10. (Fig. 5.1) This was due to the 43.07 per cent and 52.41 per cent higher production of hybrid rice (49.80q/ha.) as compared to inbred rice respectively in adopter of hybrid rice farm and non adopter of hybrid rice farms, respectively.

The net returns from hybrid rice (Rs. 35631.64) was found to be 48.36 per cent and 58.30 per cent more as compared to inbred rice in the fields of hybrid rice adopter (18400.18/ ha) and non adopter farms Rs (14858.59/ha). The benefit cost ratio of hybrid rice cultivation (2.94) was also found higher as compared to inbred rice at hybrid rice adopter (2.27) and non adopter (2.02) farmers' fields. Thus the cultivation of hybrid rice was found to be profitable over HYVs rice cultivation is the study area. The observations on expenditure and returns in cultivation of rice in the year 2010-11 were found to be same as 2009-10 with minor variation.

Table 5.3: Comparison of Costs and Returns for Hybrid and Inbred Rice (2010-11)

(Rs. /ha)

S. No.	Particulars	Hybrid Adopters		Non-adopters	Percent increase Over HYVs	
		Hybrid	HYVs	HYVs	Adopter	Non adopter
A.	**Costs**					
1	Seed (both farm produced and purchased)	2884.14	1506.91	1548.55	47.75	46.31
2	Manure (owned and purchased)	516.31	1008.71	842.33	-95.37	-63.14
3	Chemical fertilizers	311.5	278.68	271.25	10.54	12.92
4	Insecticides & Pesticides	739.41	694.12	687.82	6.13	6.98
5	Irrigation charges (both owned and hired)	934.42	753.95	785.19	19.31	15.97
6	Machinery charges	5048.39	4475.67	4316.46	11.34	14.50
7	Hired human labour charges	6043.9	4710.96	5294.81	22.05	12.39
8	Bullock labour (owned and hired)	91.11	49.97	100.77	45.15	-10.60
9	Total cost	16569.2	13479	13847.19	18.65	16.43
10	Unit cost of production (Rs. Per Kg.)	2.5	3.22	3.96	-28.80	-58.40
B.	**Returns**					
1	Yield of paddy (qtl/ha)	51.18	29.18	25.24	42.99	50.68
2	Market price (Rs./qtl)	1102.21	1120.11	1165.71	-1.62	-5.76
3	Value of grain yield (Rs./ha)	56414.3	32682.8	29426.03	42.07	47.84
4	Value of straw yield (qtl/ha)	47	51	48	-8.51	-2.13
5	Total value of the produce (gross return)	60174.3	36762.8	33266.03	38.91	44.72
6	Net return	43605.1	23283.9	19418.84	46.60	55.47
7	Benefit cost ratio:	3.63	2.73	2.4	24.79	33.88

5.3 Operation-wise Human Labour Use

The cultivation of hybrid rice provided employment of 90.12 human labour days (Table 5.4). Out of which 60.44 days were hired labour and 29.68 days were family labour, while the cultivation of HYVs provided employment of 83.28 days out of which 36.1 days of family labour. The percentage of female labour used to the total labour was 49.79% in hybrid rice and 47.85% in HYVs rice.

Table 5.4: Operation-wise Human Labour Use in Hybrid and HYV Rice 2010-11

(For hybrid adopters only)

Type of operations	Hybrid rice			HYV Rice		
	Family labour (days/ha)	Hired labour (days/ha)	Total labour (days/ha)	Family labour (days/ha)	Hired labour (days/ha)	Total labour (days/ha)
Ploughing	1.32	1.05	2.37	1.40	1.04	2.44
Uprooting of seedlings	2.65	4.56	7.20	3.38	3.39	6.78
Transplantation of seedlings	6.70	28.40	35.10	7.27	22.28	29.55
a) Single seedlings per hill	0.00	0.00	0.00	0.00	0.00	0.00
b) Multiple seedlings per hill	0.00	0.00	0.00	0.00	0.00	0.00
Manu ring	0.88	0.63	1.51	0.69	0.28	0.97
Application of chemical fertilizer	1.20	1.04	2.24	1.47	1.35	2.83
Spraying plant protection chemicals	1.21	1.09	2.31	1.38	1.03	2.42
Weeding	2.84	5.43	8.27	3.16	6.13	9.30
Irrigation	0.65	0.88	1.53	0.49	0.26	0.75
Harvesting	9.52	14.94	24.45	13.89	9.33	23.22
Post-harvesting	2.71	2.42	5.13	3.04	2.01	5.05
All operations	**29.68**	**60.44**	**90.12**	**36.17**	**47.11**	**83.28**

In hybrid rice, the highest labour (days/ha) was found to be engaged in transplanting of seedlings (35) followed by harvesting (24.45), weeding (8.27), uprooting of seedlings (7.2), spraying of plant protection chemicals (2.31) and ploughing of land for field preparation (2.37%) application of chemical fertilizers (2.24) operations (Fig 5.2) while in HYVs of rice cultivation the highest labour were found to be used in transplanting of seedlings (29.55) followed harvesting (23.22), weeding (9.30), uprooting of seedlings (6.78), spraying of plant protection chemicals (2.42), application of chemical fertilizers (2.83) and ploughing of land for field preparation (2.44) operations by spraying of plant protection chemical and harvesting. (Fig 5.3)

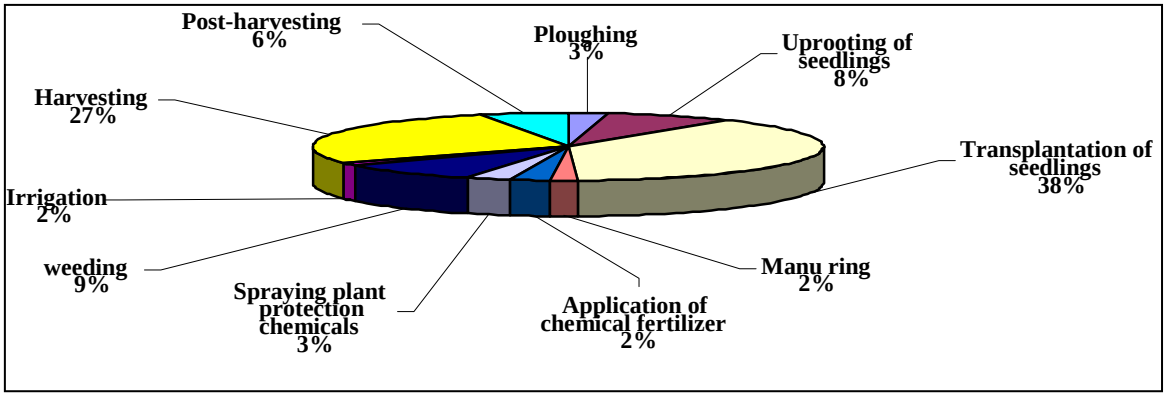

Fig. 5.2: Operation-wise Human Labour Use in Hybrid Rice: 2010-11

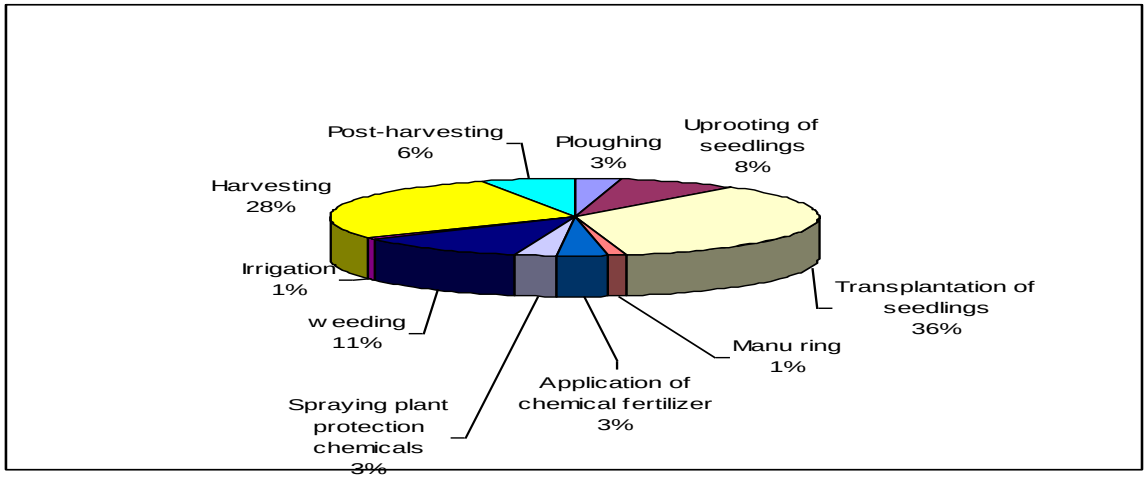

Fig. 5.3: Operation-wise Human Labour Use in HYV Rice: 2010-11.

Table 5.5: Female Labour Use per hectare (2010-11) (For hybrid adopters only)

Type of operations	Hybrid rice			HYV Rice		
	Family labour (days/ha)	Hired labour (days/ha)	Total labour (days/ha)	Family labour (days/ha)	Hired labour (days/ha)	Total labour (days/ha)
Ploughing	0.13	2.37	5.70	0.07	2.44	2.99
Uprooting of seedlings	3.35	7.20	46.58	3.00	6.78	44.24
Transplantation of seedlings	19.99	35.10	56.95	15.76	29.55	53.35
a) Single seedlings per hill	0.00	0.00	0.00	0.00	0.00	0.00
b) Multiple seedlings per hill	0.00	0.00	0.00	0.00	0.00	0.00
Manu ring	0.26	1.51	17.41	0.28	0.97	29.03
Application of chemical fertilizer	0.43	2.24	19.00	0.57	2.83	20.26
Spraying plant protection chemicals	0.47	2.31	20.18	0.58	2.42	24.14
weeding	4.86	8.27	58.73	4.85	9.30	52.18
Irrigation	0.26	1.53	16.74	0.14	0.75	18.06
Harvesting	12.80	24.45	52.33	12.42	23.22	53.50
Post-harvesting	2.32	5.13	45.26	2.18	5.05	43.09
All operations	**44.87**	**90.12**	**49.79**	**39.85**	**83.28**	**47.85**

Women played an important role in cultivation of rice whether it was hybrid or HYVs. They devoted approximate 50 per cent share in total labour used

in cultivation of rice (Table 5.5). They were found to be devoted themselves in all operations of cultivation of rice in the field. The maximum women labour found to be engaged themselves in transportation and uprooting of seedling, harvesting of crop, weeding and post harvest operations.

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CHAPTER – VI

GRAIN QUALITY CONSIDERATIONS AND THE ASPECT OF MARKETING

The chapter deals with the grain quality consideration and the different aspect of marketing including output and sale of paddy, and seasonal flow of sale of unhusked and husked rice of hybrid and inbred rice by the adopter and non adopter of rice technology.

6.1 Output and Sale of Rice

In this subhead the output and sale of rice related to unhusked and husked rice in different categories of land holding for the years 2009-10 & 2010 -11 has been considered for the study

6.1.1 Unhusked Rice

The output and sale of paddy (unhusked) in different categories of land holding is presented for the year 2009-10 & 2010-11 is dealt in detail in this sub head.

6.1.1.1 Unhusked Rice (2009-10)

The output and sale of paddy (unhusked) in different categories of land holding is presented for the year 2009-10 in Table 6.1. It is observed from the data that on overall average size group 84.80% and 75.22% of total output have been sold by adopters of hybrid and HYVs rice respectively in the market and rice growers received a price of Rs. 1014.7/q and 1068.19/q hybrid and HYVs respectively. Very little variation was found in quantity sold by the farmers for hybrid and HYVs because in the study area Government bodies are active and buy all the portion of rice from the farmers at Minimum Support Price just after the harvest of crop. As regards to different size of farms, not much variation was found in quantity sold by the farmers for hybrid. It ranged between 82.64% (marginal) to 91.49% (semi medium) and price received range from Rs. 988/q (marginal) to Rs.1066/q (semi medium).

As regard to non adopters are concerned, overall average farmers sold only 68.19% of total output in the market at an average price of Rs. 1098.83/q

which ranged between 55.10% (marginal) to 74.95% (large) at the price of Rs. 1040/q (marginal) to Rs.1143.33/q (semi medium).

Table 6.1: Output and sale of paddy (unhusked) by size groups of land holdings (2009-10)

Size group (Ha)	Crop	Hybrid Adopters				Hybrid Non-adopters			
		Output quantity (qtl) per farm	Sale quantity (qtl) per farm	% of Output sold	Average price received	Output quantity (qtl) per farm	Sale quantity (qtl) per farm	% of Output sold	Average price received
Below 1ha	Hybrid	14.40	11.90	82.64	988.00				
		(10.00)	**(9.00)**						
	HYVs	20.75	12.25	59.04	1022.50	24.50	13.50	55.10	1040
		(4.00)	**(4.00)**			**(2.00)**	**(2.00)**		
1 – 2	Hybrid	43.50	35.14	80.79	996.43	0.00	0.00	0.00	
		(14.00)	**(14.00)**						
	HYVs	20.36	14.91	73.21	1004.55	38.33	22.33	58.26	1103.33
		(11.00)	**(11.00)**			**(3.00)**	**(3.00)**		
2 – 4	Hybrid	50.92	46.58	91.49	1066.25	0.00	0.00	0.00	
		(12.00)	**(12.00)**						
	HYVs	29.92	18.64	62.29	1081.82	50.00	32.33	64.67	1143.33
		(11.00)	**(11.00)**			**(3.00)**	**(3.00)**		
4 – 10	Hybrid	105.62	89.23	84.49	996.15	0.00	0.00	0.00	
		(13.00)	**(13.00)**						
	HYVs	75.64	58.64	77.52	1101.36	102.00	70.50	69.12	1135
		(11.00)	**(11.00)**			**(2.00)**	**(2.00)**		
10 ha and above	Hybrid	219.60	185.20	84.34	1024.00	0.00	0.00	0.00	
		(15.00)	**(15.00)**						
	HYVs	88.31	72.31	81.88	1130.77	115.75	86.75	74.95	1072.5
		(13.00)	**(13.00)**			**(4.00)**	**(4.00)**		
All Sizes	Hybrid	86.81	73.61	84.80	1014.17	0.00	0.00	0.00	
		(64.00)	**(63.00)**						
	HYVs	46.99	35.35	75.22	1068.20	66.12	45.08	68.19	1098.83
		(50.00)	**(50.00)**			**(14.00)**	**(14.00)**		

Note: Figures in brackets indicate number of farms

6.1.1.1 Unhusked Rice (2010-11)

The output and sale of rice (unhusked) in different size of farms in the year 2010-11 was also observed and presented in Table 6.2. It is observed from the data that on overall size 87.71% and 75.59% were found to be sold in the market on an average price of Rs. 1075.48/-q and Rs. 1141.91/q by adopters of hybrid rice and HYVs growers respectively, while non adopters sold their 68.97% of total output in the market on an average rate of Rs. 1125.83/q. The quantity sold in different size of farm was found to be similar and ranged from 74.46 % (small) to 91.11 % (semi medium) with respect to hybrid adopter respondents, 68.18 % (marginal) to 81.13 % (small) with respect to adopter cultivated HYVs rice and 47.25 % (small) to 76.73 % (semi medium) with respect to non adopter respondents.

Table 6.2: Output and sale of paddy (unhusked) by size groups of land holdings (2010-11)

Size group (Ha)	Crop	Hybrid Adopters				Hybrid Non-adopters			
		Output quantity (qtl) per farm	Sale quantity (qtl) per farm	% of Output sold	Average price received	Output quantity (qtl) per farm	Sale quantity (qtl) per farm	% of Output sold	Average price received
Below 1ha	Hybrid	21.10	16.80	79.62	1036.50				
		(10.00)	**(8.00)**						
	HYVs	13.20	9.00	68.18	1153.33	23.25	11.75	50.54	1051.25
		(5.00)	**(5.00)**			**(4.00)**	**(3.00)**		
1 – 2	Hybrid	43.07	32.07	74.46	1066.43				
		(12.00)	**(11.00)**						
	HYVs	26.33	21.36	81.13	1103.18	30.33	14.33	47.25	1086.67
		(9.00)	**(9.00)**			**(3.00)**	**(3.00)**		
2 – 4	Hybrid	63.25	51.08	80.76	1094.17				
		(12.00)	**(12.00)**						
	HYVs	30.42	23.80	78.25	1180.00	68.50	43.50	63.50	1132.5
		(12.00)	**(12.00)**			**(3.00)**	**(3.00)**		
4 – 10	Hybrid	154.92	141.15	91.11	1082.31				
		(13.00)	**(13.00)**						
	HYVs	64.27	48.36	75.25	1127.27	101.00	77.50	76.73	1167.5
		(11.00)	**(11.00)**			**(3.00)**	**(3.00)**		
10 ha and above	Hybrid	221.87	201.13	90.66	1098.00				
		(15.00)	**(15.00)**						
	HYVs	109.38	81.62	74.61	1145.77	125.75	93.50	74.35	1191.25
		(13.00)	**(13.00)**			**(4.00)**	**(4.00)**		
All Sizes	Hybrid	100.84	88.45	87.71	1075.48				
		(62.00)	**(59.00)**						
	HYVs	48.72	36.83	75.59	1141.91	69.77	48.12	68.97	1125.83
		(50.00)	**(50.00)**			**(17.00)**	**(16.00)**		

Note: Figures in brackets indicate number of farms

The price of output was also found to be similar in all the categories of farms ranged from Rs. 1036.50/q (marginal) to Rs. 1098/q (large) with respect to adopter of hybrid rice, Rs. 1103.18/q (small) to Rs. 1180 /q (semi medium) at hybrid adopter farmers cultivated HYVs rice and Rs. 1051.25/q (marginal) to Rs. 1191.25/q (large) at non adopter farms.

6.1.2 Husked Rice

The output and sale of paddy (husked) in different categories of land holding is presented for the year 2009-10 & 2010-11 and dealt in detail in this sub head.

6.1.2.1 Husked Rice (2009-10)

The output and sale of rice (husked) in different size of farms in the year 2009-10 was also observed and presented in Table 6.3. It is observed from the data that 71.48% and 45.61% were found to be sold in the market on an average

price of Rs. 1307.02 /- and Rs. 1500.00 /q by adopters of hybrid rice and HYVs respectively While, non adopters sold their 46.25 % of total output in the market on an average rate of Rs. 1450/q.

Table 6.3: Output and sale of paddy (Husked) by size groups of land holdings (2009-10)

Size group (Ha)	Crop	Hybrid Adopters				Hybrid Non-adopters			
		Output quantity (qtl) per farm	Sale quantity (qtl) per farm	% of Output sold	Average price received	Output quantity (qtl) per farm	Sale quantity (qtl) per farm	% of Output sold	Average price received
Below 1ha	Hybrid	14.20	4.89	34.44	1298.00				
		(6.00)	**(4.00)**						
	HYVs	4.75	1.23	25.89	1400.00	3.12	0.00	0.00	0.00
		(2.00)	**(2.00)**			**(2.00)**	**(2.00)**		
1 – 2	Hybrid	14.50	6.12	42.21	1257.50				
		(2.00)	**(2.00)**						
	HYVs	0.00	0.00	0.00	0.00	9.50	2.11	22.21	1450
		( )	( )			**(1.00)**	**(1.00)**		
2 – 4	Hybrid	26.25	20.11	76.61	1346.25				
		(4.00)	**(4.00)**						
	HYVs	11.25	5.13	45.60	1550.00	23.50	11.50	48.94	1400
		(2.00)	**(2.00)**			**(1.00)**	**(1.00)**		
4 – 10	Hybrid	32.33	25.34	78.37	1333.33				
		(3.00)	**(3.00)**						
	HYVs	10.00	4.67	46.70	1600.00	25.50	14.89	58.39	1500
		(3.00)	**(3.00)**			**(2.00)**	**(2.00)**		
10 ha and above	Hybrid	41.50	35.60	85.78	1300.00				
		(1.00)	**(1.00)**						
	HYVs	15.50	7.90	50.97	1450.00	0.00	0.00	0.00	0.00
		(1.00)	**(1.00)**			**0.00**	**0.00**		
All Sizes	Hybrid	25.76	18.41	71.48	1307.02				
		(16.00)	**(14.00)**						
	HYVs	8.30	3.79	45.61	1500.00	12.32	5.70	46.25	1450.00
		(8.00)	**(8.00)**			**(6.00)**	**(6.00)**		

Note: Figures in brackets indicate number of farms

The quantity sold in different size of farm was found to be similar and ranged from 34.44 % (marginal) to 85.18 % (large) with respect to hybrid adopter respondents, 0.00% (marginal) to 50.97 % (large) with respect to adopters cultivated HYVs rice and 0.00% (marginal and large) to 58.39% (semi medium) with respect to non adopter respondents. The price of output was also fond to be similar in all the categories of farms ranged from Rs. 1257.50 /q (small) to Rs. 1346.25 /q (semi-medium) with respect to adopter, Rs. 1400.00 /q (semi medium) to Rs. 1600/q (medium) at hybrid adopter farmers cultivated HYVs rice and Rs. 1400.00 /q (semi medium) to Rs. 1500.00/q (medium) at non adopter farms.

Table 6.4: Output and sale of paddy (Husked) by size groups of land holdings (2010-11)

Size group (Ha)	Crop	Hybrid Adopters				Hybrid Non-adopters			
		Output quantity (qtl) per farm	Sale quantity (qtl) per farm	% of Output sold	Average price received	Output quantity (qtl) per farm	Sale quantity (qtl) per farm	% of Output sold	Average price received
Below 1ha	Hybrid	10.20	4.40	43.14	1360.00				
		(5.00)	**(4.00)**						
	HYVs	4.25	0.89	20.94	1500.00	5.50	0.00	0.00	0.00
		(2.00)	**(2.00)**			**(2.00)**	**0.00**		
1 – 2	Hybrid	24.50	9.20	37.55	1317.50				
		(2.00)	**(2.00)**						
	HYVs	0.00	0.00	0.00	0.00	11.00	2.00	18.18	1500
		0.00	**0.00**			**(1.00)**	**(1.00)**		
2 – 4	Hybrid	32.50	20.32	62.52	1462.50				
		(4.00)	**(4.00)**						
	HYVs	19.00	8.90	46.84	1500.00	24.50	11.46	46.78	1450
		(1.00)	**(1.00)**			**(2.00)**	**(2.00)**		
4 – 10	Hybrid	45.50	33.43	73.47	1415.00				
		(2.00)	**(2.00)**						
	HYVs	22.67	13.44	59.29	1516.67	41.50	23.98	57.78	1650
		(3.00)	**(3.00)**			**(2.00)**	**(2.00)**		
10 ha and above	Hybrid	87.50	71.30	81.49	1500.00				
		(2.00)	**(2.00)**						
	HYVs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		0.00	**0.00**			**0.00**	**0.00**		
All Sizes	Hybrid	40.04	27.73	69.26	1411.00				
		(15.00)	**(14.00)**						
	HYVs	9.18	4.65	50.59	1505.56	16.50	7.49	45.38	1533.33
		(6.00)	**(6.00)**			**(7.00)**	**(5.00)**		

Note: Figures in brackets indicate number of farms

6.1.2.1 Husked Rice (2010-11)

The output and sale of rice (husked) in different size of farms in the year 2010-11 was also observed and presented in Table 6.4. It is observed from the data that 69.26 % and 50.59 % were found to be sold in the market on an average prize of Rs. 1411.00 /- and Rs. 1505.56 /q by adopter of hybrid rice and HYVs growers respectively, while non adopters sold their 45.38% of total output in the market on an average rate of Rs. 1533.33/-. The quantity sold in different size of farm was found to be similar and ranged from 43.14 % (marginal) to 81.49 % (large) with respect to hybrid adopter respondents, 20.94 % (marginal) to 59.29% (medium) with respect to adopter cultivated HYVs rice and 0.00% (marginal) to 57.78 % (medium) with respect to non adopter respondents. The price of output was also found to be similar in all the categories of farms ranged from Rs. 1317.50/q (small) to Rs. 1500.00/q (large) with respect to adopter, Rs. 1500.00/q (Semi medium) to Rs. 1516.67/q (medium) at hybrid adopter farmers cultivated

HYVs rice and Rs. 1450.00/q (semi medium) to Rs. 1650.00/q (medium) at non adopter farms.

6.2 Seasonal Flow of Marketing (Sales)

The seasonal flow of marketing (sales) of paddy (unhusked & husked) for the year 2009-10 and 2010-11 has been taken in to consideration for the study.

6.2.1 Seasonal Flow of Marketing (Sales) for Unhusked Rice

The seasonal flow of marketing (sales) of paddy (unhusked) for the year 2009-10 & 2010-11 is dealt in this sub head.

6.2.1.1 Seasonal Flow of Marketing (Sales) for Unhusked Rice for 2009-10

The seasonal flow of marketing (sales) of paddy (unhusked) for the year 2009-10 is presented in Table 6.5.

Table 6.5: Seasonal flow of marketing (sales) of paddy (unhusked) (2009-10)

(Sales quantity in qtl.)

Month	Adopters		Non-Adopters
	Hybrid	HYVs	HYVs
January	8.01	5.78	7.61
	10.04	**14.14**	**15.69**
February	0	3.21	3.9
	0.00	**7.85**	**8.04**
March	0	2.6	1.99
	0.00	**6.36**	**4.10**
April	0	1.97	2.8
	0.00	**4.82**	**5.77**
May	0	3.1	2.6
	0.00	**7.58**	**5.36**
June	0	2.6	3.1
	0.00	**6.36**	**6.39**
July	3	1.67	2.2
	3.76	**4.09**	**4.54**
August	0	1.54	1.29
	0.00	**3.77**	**2.66**
September	0	0.8	1.01
	0.00	**1.96**	**2.08**
October	0	1.12	2.08
	0.00	**2.74**	**4.29**
November	16.39	6.7	8.9
	20.54	**16.39**	**18.35**
December	52.41	9.78	11.02
	65.67	**23.93**	**22.72**
Total	79.81	40.88	48.50

Note: Figures in bold indicate percentages of total sales

It is observed from the data that maximum quantity of the hybrid rice has been found to be sold in the months of December (65.67%) following by November (20.54%), January (10.04%) and July (3.76). About 96% of the total

hybrid rice has been sold by the adopter hybrid growers just after the harvest of the crop, HYVs rice growers sold their produce of rice in all the months of year, here also the maximum quantity sold in December (23.93) fallowing by November (16.39%), January (14.14%) but only 55% of the rice has been found to be sold in this harvest period. The remained portion (45%) was found to be sold in other months of the year. The same result has been observed for non adopter farmers. Their maximum quantity has been found to be sold in the peak period i.e. just after the harvest of rice. They sold them 56% of marketed surplus in these months and rests were found to be sold in different months of year.

6.2.1.1 Seasonal Flow of Marketing (Sales) for Unhusked Rice for 2010-11

The seasonal flow of marketing (sales) of paddy (unhusked) for the year 2010-11 is presented in Table 6.6.

Table – 6.6: Seasonal flow of marketing (sales) of paddy (unhusked) (2010-11)

(Sales quantity in qtl.)

Month	Adopters		Non-Adopters
	Hybrid	HYVs	HYVs
January	10.78	6.21	8.04
	11.17	**14.90**	**16.24**
February	1.07	2.98	3.93
	1.11	**7.15**	**7.94**
March	0.00	2.78	2.10
	0.00	**6.67**	**4.24**
April	0.00	1.36	1.92
	0.00	**3.26**	**3.88**
May	0.00	3.54	2.10
	0.00	**8.49**	**4.24**
June	0.00	2.11	2.04
	0.00	**5.06**	**4.12**
July	3.00	2.07	3.02
	3.11	**4.97**	**6.10**
August	0.00	1.23	1.60
	0.00	**2.95**	**3.23**
September	0.00	0.78	1.20
	0.00	**1.87**	**2.42**
October	0.00	1.32	2.15
	0.00	**3.17**	**4.34**
November	18.34	7.09	8.34
	19.00	**17.01**	**16.85**
December	63.34	10.21	13.06
	65.61	**24.50**	**26.38**
Total	96.54	41.68	49.50

Note: Figures in bold indicate percentages of total sales

It is observed from the data that maximum quantity of the hybrid rice has been found to sold in the months of December (65.67%), November (19.00%) and January (11.17 %). About 96% the total hybrid rice has been sold by the

adopter hybrid growers just after the harvest of the crop, HYVs rice growers sold their produce of rice in all the months of year, here also the maximum quantity sold in December (24.50%) November (10.21 %) and January (14.90 %) but only 50% of the rice has been found to be sold in this harvest period. The remained portion (50%) was found to be sold in other months of the year. The same result has been observed for non adopter farmers. Their maximum quantity has also been found to sold in the peak period i.e. just after the harvest of rice. They sold 60% of marketed surplus in these months i.e. November, December and January and rests were found to be distributed in different months of year.

6.3 Grain Traits of Hybrid Vs HYVs Rice

The grain traits of hybrid rice vis a vis HYVs rice has been presented in Table 6.7 & 6.8 respectively in case of adopters and non adopters.

Table 6.7: Grain quality traits of Hybrid rice vis-a-vis HYVs 2009-2010

Grain quality traits	Adopters		Non-Adopters
	Hybrid	HYVs	HYVs
Hulling ratio	71.87	75.83	75.6
Milling ratio	64.13	65.17	65.4
Head rice recovery ratio	56.54	56.80	57.05

Table 6.8: Grain quality traits of Hybrid rice vis-a-vis HYVs 2010-2011

Grain quality traits	Adopters		Non-Adopters
	Hybrid	HYVs	HYVs
Hulling ratio	72.73	76.67	76.80
Milling ratio	64.27	65.33	65.20
Head rice recovery ratio	56.54	56.80	57.05

It is observed from the data shown in table 6.7 that hulling ratio was found to be 71.87 and 75.83 in case of adopter of hybrid and HYVs respectively, while it was found 75.60 in case of non-adopter growing HYVs. The milling ratio and head rice recovery ratio were found to be 64.13 & 56.54 and 65.17 & 56.80 in case of adopter of hybrid and HYVs respectively, while it was 65.20 & 57.05 in case of non-adopter growing HYVs. The similar results with slight variations were observed for the year 2010-11 (Table 6.8). It is clear from above observations that the HYVs have greater hulling, milling and head rice recovery ratio as compared to hybrid rice.

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CHAPTER – VII

PROBLEMS AND PROSPECTS FOR INCREASING HYBRID RICE CULTIVATION

This chapter deals with the problem and prospects for increasing hybrid rice cultivation in the area under study. The perception of farmers' regarding cultivation of hybrid rice, fertilizer pesticide, credit and their overall perception are considered during course of investigation. The experiences of non adopter are also a part of the chapter.

7.1 Farmers awareness about hybrid rice technology

All the selected farmers were found to use hybrid seed due to higher production per unit of area as compared to HYVs rice and the rate of hybrid and HYVs of rice were found to be almost equal. The majority of sample farmers reported that the seed of hybrid rice was easily available to them (78.8%) from the Department of Agriculture and retailer of local market. The majority of them also reported that they were got good quality of hybrid seed (61.3%) at a reasonable price (61.3%) and they were satisfied from the quality of seed. Cent percent farmers reported that hybrid seed gave better results than the inbred seed. The majority of farmers (42.5) reported that yield increases up to 5-10%, while 32.5% and 25.0% reported yield increased up to 10-15% and 15-20% respectively. All the HHs used to purchase seed of hybrid rice every year. All the respondents also reported that the adoption of hybrid seed did not prevent the traditional practice of saving and exchange of seed. The majority of hybrid seed adopter further reported that they replaced the variety of hybrid seed after 3 years or more (67.5%), while 25.5%, 8.7% and 1.3% reported that they replaced it every 3 years every, alternate year and every year respectively.

Table 7.1: Questions related to Hybrid Adopting Farmers' access to Hybrid Seed input

S. No.	Particulars	Answers	% of farmers reporting
1	Have you used hybrid seed?	Yes	100.0
		No	0.0
2	If yes, why used -	Reason 1	0.0
		Reason 2	0.0
3	Is the hybrid seed easily available?	Yes	78.8
		No	21.3
4	What is the usual source of your seeds?	Source 1	Agriculture Dept.
		Source 2	Retail shops
5	Are the quality hybrid seeds available in your area?	Yes	61.3
		No	38.8
6	If yes, do you get seeds (a) during planting time and (b) at a reasonable price	Available during planting time	61.3
		Available at reasonable price	0.0
7	Are you satisfied with quality of seed?	Yes	63.8
		No	36.3
8	If no, reasons there for (poor germination etc.)	Reason 1	
		Reason 2	
9	Are you convinced that hybrid seed yield better results than the inbred seeds?	Yes	100.0
		No	0.0
10	If yes, indicate the percentage of yield increase.	5-10%	42.5
		10-15%	32.5
		15-20%	25.0
11	If Hybrid seeds bring lesser yields, indicate the percentage of yield loss due to hybrid rice.	5-10%	0.0
		10-15%	0.0
		15-20%	0.0
12	Do you purchase new seeds of hybrid varieties every crop season/year?	Yes	100.0
		No	0.0
13	Do you feel that adoption of hybrid seeds prevented traditional practice of saving and exchanging of seeds?	Yes	100.0
		No	0.0
14	How often do you replace hybrid seed varieties?	replacing every year	1.3
		replacing every alternative year	8.8
		replacing every 3 years	22.5
		replacing after 3 years or more	67.5

7.2 Problems faced by the farmers in input accessibility, production and marketing

The problems faced by the farmers in inputs viz. fertilizer insecticide pesticide and credit are considered in this subhead. The problem related to marketing and extension is also considered in the study.

7.2.1 Fertilizer

All the hybrid rice growers of the study area reported that they were used chemical fertilizer in cultivation of hybrid rice, while only 41.25% of them reported that they received information from any source regarding to use and dose of fertilizer, but only 31.25% of sample respondents applied recommended dose of fertilizer in the cultivation of hybrid rice, the remaining (68.75%) were not able to apply it due to non availability of desired fertilizers at the time of

application and its higher rate. Cooperative Societies are the main sources of fertilizer fallowed by market. The 77.5% of sample farmers reported that the cultivation of hybrid rice required more fertilizer as compared to inbred rice. (Table 7.2)

Table 7.2: Questions related to Hybrid Adopting Farmers access to Fertilizer input and its use

S. No.	Particulars	Answers	% of farmers reporting
1	Have you used chemical fertilizer?	Yes	100
		No	0.0
2	Whether received information from any source regarding what to use and the required doses?	Yes	41.25
		No	58.75
3	If yes, have you applied recommended doses of fertilizer?	Yes	31.25
		No	68.75
4	If not, state reasons there for	Reason 1	fertilizer not available timely
		Reason 2	fertilizer costly
5	If fertilizer not used at all what are the reasons	Reason 1	
		Reason 2	
6	Is fertilizer easily available?	Yes	47.5
		No	52.5
7	If yes, the source where it is available	Source 1	Society
		Source 2	Market
8	Do you feel that hybrid seeds require more fertilizer than inbred seeds	Yes	77.5
		No	22.5

7.2.2 Insecticide and Pesticide

The majority of hybrid rice adopter reported that the attack of pest and diseases was found less as compared to hybrid rice (63.75%) and only 31.25% of respondent applied pesticide to control pest in their field. All of them reported that the pesticides are easily available in the market, but majority of them did not know the correct way and proper dose of pesticides for plant protection. (Table 7.3)

The majority of adopter also reported that hybrid rice varieties are more susceptible to pest and diseases but respondent (76.25%) don't know the correct dose of pesticide for these hybrid seed varieties and felt that the cultivation is highly sensitive to crop management practices and use of key inputs and time bound operations (78.75%).The majority (90%) of them also reported that the yield loss was found to be more in hybrid rice as compared to inbred rice.

Table 7.3: Questions related to Hybrid Adopting Farmers access to Pesticide input and its use

S. No.	Particulars	Answers	% of farmers reporting
1	Whether hybrid rice crop or any other variety of rice crops was attacked with pests and diseases?	Yes	36.25
		No	63.75
2	If yes, which variety (Hybrid/HYVs) with area	Hybrid (area)	
		HYVs (area)	
3	Have you applied pesticides?	Yes	31.25
		No	68.75
4	If not, why not used?	Reason 1	
		Reason 2	
5	Is the pesticide easily available?	Yes	100
		No	0.0
6	Do you know the correct way of using and doses of plant protection pesticides?	Yes	22.5
		No	77.5
7	Do you feel that hybrid rice varieties are more susceptible to pests and diseases?	Yes	36.25
		No	63.75
8	Do you know the correct does of pesticides for hybrid seed varieties?	Yes	23.75
		No	76.25
9	Do you feel that hybrid rice cultivation is highly sensitive to crop management practices - use of key inputs and time bound operations?	Yes	78.75
		No	21.25
10	Do you feel that the extent of yield loss due to pests and diseases for inbred variety is lower as compared to hybrids	Yes	90
		No	10

7.2.3 Credit

The majority of respondents reported that hybrid rice cultivation required more credit as compared to HYVs rice (83.75%). They (86.75%) also reported about easy availability of institutional credit from cooperative credit societies and branches of commercial banks, but there is a need for lees documentation work for getting crop loan. (Table 7.4)

Table 7.4: Questions related to Hybrid Adopting Farmers' access to credit

S. No.	Particulars	Answers	% of farmers reporting
1	Do you require more credit for using hybrid seed?	Yes-1	83.75
		No-2	16.25
2	Do you get required credit from the Co. Credit Society or any other institutional sources?	Yes-1	86.25
		No-2	13.75
3	If yes, which source	Source-1	Co operative society
		Source-2	Commercial Bank
4	If not, what are the problems in getting credit	Problem-1	More Documentation
		Problem-2	Brokers Charges

7.2.4 Marketing

All the hybrid rice adopter reported that they did not face problem in selling the produce in the market. Government used to buy the entire produce at Minimum Support Price through cooperative societies.

Table 7.5: Questions related to Hybrid Adopters' Perception about Marketing of Hybrid Rice

S. No.	Particulars	Answers	% of farmers reporting
1	Do you face problems in marketing of hybrid rice produce?	Yes	0.0
		No	100
2	If yes, state the nature of the problem faced	i. Lower market price	0.0
		ii. Poor cooking and keeping quality	0.0
		iii. Lower head – rice recovery (percentage of clean rice after milling)	0.0
		iv. More broken rice after milling	0.0
		v. Lack of consumer demand for hybrid rice grain	0.0
		vi. Poor grain quality and as a result lack of market acceptance	0.0
		vii.Traders not accepting hybrid rice grain lack of demand from millers and consumers	0.0

7.2.5 Extension activities

The State Agriculture Department was found to be a primary source of extension of to hybrid rice technology. The majority of farmers (72.5%) reported that Front Line Demonstration programmes were organized in their area by the field workers to create awareness among them and 33.75 per cent of them were found to be participated in that programme. The 42.5 per cent farmers reported that State Department officers also organized training programme for them and 67.6% of them reported that they were participated in these training programme.

Table 7.6: Questions related to Hybrid Adopters' Awareness about Hybrid Rice Technology

S. No.	Particulars	Answers	% of farmers reporting
1	How has he become aware about hybrid rice technology?	Source – 1	Tanning & demonstration of Hybrid rice technology
		Source – 2	hybrid seed easily available , low rate and good quality
2	Whether front line demonstration programme is organized in your area by the Government to create awareness about the hybrid rice technology?	Yes	72.5
		No	27.5
3	If yes have you participated in the programme?	Yes	33.75
		No	66.25
4	Name the hybrids demonstrated and indicate the extent of yield advantage as demonstrated.	Hybrid – 1	
		Yield advantage (%)	10
		Hybrid – 2	
		Yield advantage (%)	5
5	Whether the government organized training programmes for farmers?	Yes	42.5
		No	57.5
6	If yes, had he participated?	Yes	67.6
		No	32.4
7	If participated mention the number of training programmes participated and their duration.	Trainings participated	2
		Numbers	23
		Duration	1 day

7.3 Farmers' overall perception of hybrid rice cultivation

The farmers' overall perception of hybrid rice cultivation was observed for adopter and non adopter of hybrid rice technology

7.3.1 Adopter of Hybrid Rice

The farmers reported that they got better yield gain from cultivation of hybrid rice over inbred rice. The production of hybrid rice was also found profitable over inbred rice even the qualities of grain was found poor (70%), no taste (3.75%), poor cooking quality (15%) and stickers of cooked rice (11.25%). The majority of them (88.75%) also reported that grain was found to be acceptable to traders and retailer. The majorities of them (83.75%) also reported that hybrid rice technology was found to be economically viable in the area and due to high yield as reported by 59 per cent of farmers and price are equal to the

HYVs of rice farmers sown their interest to cultivation of hybrid rice in the future also.

Table 7.7: Hybrid Adopting Farmers' overall Perception about Hybrid Rice Cultivation

S. No.	Particulars	Answers	% of farmers reporting
1	Is there any yield gain from cultivation of hybrids over the best popular inbred rice varieties?	Yes	100
		No	0.0
2	Is hybrid rice production profitable?	Yes	100
		No	0.0
3	Do consumers perceive hybrid as inferior to inbreed in respect of grain quality?	Hybrids inferior in respect of	100
		a) Poor grain quality	70
		b) No taste	3.75
		c) Poor cooking quality	15
		d) Stickiness of cooked rice	11.25
4	Is hybrid rice grain acceptable to traders and millers?	Yes	88.75
		No	11.25
5	Is he convinced with the economic viability of hybrid rice cultivation?	Yes	83.75
		No	16.25
6	It no, reasons therefore	Reason – 1	
		Reason – 2	
7	Do you like to continue cultivating of hybrid rice?	Yes	97.5
		No	2.5
8	If yes, reasons for continuing hybrid rice production	Reasons for continuing hybrid rice cultivation	
		a) Expecting to get new hybrids with better quality in the near future	41.0
		b) Higher yield of hybrid rice	59.0

7.3.2 Non Adopter of Hybrid Rice

The majority of non adopter of hybrid rice reported that they have heard about the new hybrid verities of hybrid rice (75%) viz, KRH2, 6444, 9090, DRH775, JRH-5, VS-312 and RH10 and Govt. Hybrid rice promotion programme (80%), (Table 7.8). The majority of them (75%) reported that they have seen standing Hybrid rice crop in their area. They have reported that the Rural Agricultural Extension Officer (63.64%) and relatives (27.27%) were suggested them to grow Hybrid rice seed at their field and 65% of them were convinced with their suggestions and will grow these varieties in next year.

The 35% of non adopters were not convinced to grow the Hybrid rice seed in this year due to non availability of seed in time (66.67%), non availability of pure hybrid seed (33.33%),

Table 7.8: Questions related to Reasons for non-adoption of hybrid rice (reaction of non-participants)

S. No.	Particulars	Answers	% of farmers reporting
1	Have you heard of any of the new hybrid varieties of rice? (Yes-1, No-2)		75
2	If yes, what are they? (name them)		KRH2, 6444, 9090, DRH775, JRH-5, US 312, RH 10
3	Have you heard of the Govts. Hybrid rice promotion programme? (Yes-1, No-2)		80
4	Have you seen any standing rice crop of hybrid variety in your area? (Yes-1, No-2)		75
5	Did anybody suggest you to grow this variety? (Yes-1, No-2)		55
6	If yes, state who suggested?	a) V.L.W	0.00
		b) BDO	0.00
		c) RAEO	63.64
		d) Relative	27.27
		e) Other cultivators	9.09
		f) Known from government demonstration	45.45
		g) Others (Specify)	0.00
7	Will you be growing this variety next year?	Yes	35.00
		No	65.00
8	What are the reasons for your not using this year?	i. Not heard of the variety	25.00
		ii. Not heard of the Govt. assistance for expansion of hybrid rice seeds.	20.00
		iii . Non-availability of seed	15.00
		a. Not at all	0.00
		b. Not in time	66.67
		c. Pure hybrid seed not available	33.33
		iv. Seed is too costly	20.00
		v. Seed available, but at too far a distance	0.00
		vi. Pre-treatment of seed is necessary and have never done it before.	0.00
		vii. Govt. Seed germination rate too low	30.00
		viii. Not convinced that the seed is of high quality	20.00
		ix. Not convinced that its yield is sufficiently high	25.00
		x. Lower yield for hybrid than for inbred	0.00
		xi.Yield gain but lower profitability of Hybrid rice	10.00
		xii. Variety too coarse	20.00
		xiii. Higher risks	25.00
		xiv. Will fetch lower price as compared to inbred variety	5.00
		xv. Needs too much of fertilizers	35.00
		xvi. Soil type not suitable	0.00
		xvii. Not insects pests and disease resistant.	35.00
		xviii. The extent of yield loss due to pests and diseases is higher for hybrids.	30.00
		xix. Needs more water	15.00
		xx. Fodder quality not good	0.00
		xxi. Credit – not available in time	5.00
		xxii. Credit not at all available	15.00
		xxiii. Restrictions on disposal i.e. should be sold to a particular agency	0.00
		xxiv. Any other (Specify)	0.00
9	Are you ready to accept new hybrid rice varieties in future considering superior grain quality and higher yield potential?	Yes	100.00
		No	0.00
10	If no, reasons therefore.	Reasons – 1	
		Reasons – 2	

low germination of seed provided by Govt. (20%) not convinced that its yield is sufficiently higher than HYVs (25%), higher risk (25%) variety too coarse seed of high quality (20%), high cost of seed (20%), and not heard of Govt. assistance for expansion of hybrid rice seed (20%). It is a good sign for NFSM programme for rice that all of the non adopters are now ready to accept new hybrid rice varieties in future considering superior grain quality and higher yield potential (100%).

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CHAPTER VIII

SUMMARY AND POLICY RECOMMENDATIONS

The background, objectives, database and methodology of the study are dealt in this chapter. Major findings along with policy implications are also explained in detail.

8.1 Background

Rice is the most important cereal crop in India in terms of area occupied, production and consumption as a principal food and occupies a prominent place in Indian agriculture. India produces 98.09 million tonnes of rice (2009-10). It is cultivated over an area of 41.92 million hectares which account for 23.25 per cent of the gross cropped area and 37.08 per cent of the area sown to that food-grain. It is the staple food for more than 60 per cent of Indian population and it accounts for 43 per cent of total food grain production and 46 per cent of total cereal production. To meet out the demand of increasing population and to maintain food self-sufficiency, the present production level of 99.18 million tons needs to be increased up to 120 million tons by the year 2020. This increase in production has to be achieved in the back drop of declining and deteriorating resources such as land, water, labour and other inputs and without adversely affecting the environment. The erratic monsoon pattern like the one witnessed during 2009 puts additional pressure to fill the food grain deficit (Viraktamath *et al.*, 2010).

Over the last four decades, the country witnessed an impressive growth in rice production due to the adoption of semi dwarf high yielding varieties coupled with the adoption of intensive input based management practices. However, in recent years the growth in production has decelerated from 4 per cent during 1980s' to 1.7 per cent during 1990s'. This deceleration is largely on account of slowing down in the growth of yield from 3.6 per cent during the 1980s to 1.3 per cent during the 1990s. Plateauing trend in the yield of High Yielding Varieties (HYVs), declining and degrading natural resources like land and water and acute shortage of labour make the task of increasing rice production quite challenging. The current situation necessitates looking for some innovative technologies to boost rice production.

The achievements so far in respect of raising yields and reducing variability in the unfavourable agro-climatic regions are not comparable with those realized for the favourable environments. The limited spread of the green revolution can be explained partly by the nature of available technology itself and partly by the uneven development of infrastructure, physical as well as institutional which is pre-requisite for the adoption of improved practices. Against such a background it is necessary to examine the needed changes in agricultural research strategy to boost up agricultural production in the light of emerging agro-climatic and socio-economic challenges. Redressal of crop regional imbalances in growth, imparting stability to agricultural output and bringing the benefits of agricultural research technology to the resource poor farmers are the three major concerns.

The spread of the newer varieties replacing the older varieties need to be closely monitored to take advantage of the superior characters of these newer varieties released by various research Institutions. This will help to break the yield plateau that has been experiencing in rice crop in the recent past and to increase the production and productivity of the crop. Though a number of steps are being taken by the Government to popularize these varieties like Frontline Demonstration, mini kit supply, organizing training programmes (1-21days) for farmers, farm women, seed growers, seed production personnel of public and private seed agencies, extension functionaries of state departments of agriculture, officials of state agricultural universities and NGOs, there is no concrete data to prove that the newer varieties of rice are spreading faster and replacing the older ones. Therefore, Present study has been conducted to assess the actual spreading of these newer varieties in terms of area with simultaneous reduction in the area under older varieties for rice crop and the increases in the average yield/ha. This will help the Government to draw a plan for augmenting the spread of the superior newer varieties in place of the age old varieties.

8.2 Objectives of the study

1. To determine the extent of adoption and the level of participation by the different categories of farmers in the cultivation of hybrid rice.
2. To assess the overall impact on rice production and productivity of hybrid rice cultivation.

3. To study the economics of cultivation of hybrid rice varieties vis-a-vis inbred varieties.
4. To identify factors determining the adoption of hybrid rice varieties.
5. To address various constraints and outline the prospects for increasing hybrid rice cultivation and finally
6. To suggests policy measures for expansion of hybrid rice cultivation.

8.3 Database and methodology

The study is based on both secondary and primary data. Secondary data relating to area, production and productivity of rice obtained from government publications viz. various issued of Madhya Pradesh agriculture statistics, Land Record Office of Gwalior Madhya Pradesh and web sites like www.agricoop.nic.in, www.mpkrishi.org, www.dacnet.nic.in were used to arrive at the trends in area, production and productivity. For the sake of comparison, it is usual to compare the performance of rice in the pre-introduction period of hybrid rice with that in post-introduction period as a whole. Keeping in mind that the first hybrid was developed and released for commercial cultivation in India in 1994, the study period was thus divided into three sub-periods viz. 1984-85 to 1993-94, 1994-95 to 2003-04 and 2004-05 to 2009-10. The period-I viz. 1984-85 to 1993-94 refers to the pre-introduction period of hybrid rice while other two period's viz. period-II & III correspond to post-introduction periods considering the base year (The average of first three years) and the current year (The average of last three years). Besides, official data regarding the activities undertaken by the government to popularize hybrid varieties like Frontline Demonstrations, Mini kit Supply, and Organizing Training Programme etc. were incorporated and analyzed in the study.

Primary survey was confined to the National Food Security Mission (NFSM) districts in Madhya Pradesh. The two districts i.e. Rewa and Mandla having relatively higher concentration of area under rice cultivation within the group of NFSM districts were chosen for the present study. Two representative blocks namely Rewa & Raipur karchuliyan from Rewa district and Mandla & Nainpur blocks from Mandla district were selected for the investigation. Within each block two villages namely Padokher and Atriya, Mehsuva and Gorgaon 164

were selected from Rewa and Raipur Karchuliyan development blocks respectively. In case of Mandla district Semarkhapa and Padami, Tuiapani and Rewada were selected from Mandla and Nainpur development blocks respectively for the study

In each village a complete list of cultivating households growing hybrid rice varieties and inbred varieties were prepared and stratified according to four standard land size groups such as marginal (less than 1 hectare), small (1 to 2 hectares), medium (2 to 4 hectares) and large (more than 4 hectares) including SC, ST and women farmers. In each district, 40 hybrid rice growers from the list of hybrid rice growing cultivators were drawn at random from different land size groups on the basis of their proportion in the universe. In addition to this sample, 10 inbred variety (traditional HYVs) rice growers but non-adopters of hybrid rice were selected randomly from the different land size groups amongst inbred rice growing cultivators following the same procedure. Thus, altogether, 50 rice growing cultivators were selected from each selected district. In all, 100 rice growing cultivators equally spread over two selected districts constituted the size of the sample in the study.

For the primary survey, the reference years were 2009-10. Accordingly, Kharif seasons for the rice crop covered in the study. Primary data were obtained by administering a structured schedule/questionnaire provided by the Coordinator, Agro-Economic Research Centre Visva-Bharati, Santiniketan West Bengal.

A simple tabular analysis was done to analyze the farm level data in ascertaining the farm level spread and impact of hybrid rice technology. In order to identify the factors affecting the yield of rice, yield response function separately for hybrid and inbred rice was estimated using Log linear models. Eight independent variables (Age, Education, Household size, Size of worker, Land ownership dummy, Farm size, Access to Source of information, Size of irrigated land) were found to be regressed upon the dependent variable yield per hectare of rice. The explanatory variables includes seed (kg/ha), manure (Rs./ha), fertilizer (Rs/ha), irrigation (number of irrigation/ha), human labour (man days/ha), machinery labour (hrs/ha), plant protection Chemicals (Rs./ha). In finding out the determinants of participation in hybrid rice cultivation, Logit

Model was used to drawn conclusion. For secondary data obtained from the official publications, the equation of the exponential curve was used to measure the growth in area, production and productivity of the crop. In measuring the instability in crop production, the co-efficient of variation technique was used for interpretation of tabulated data.

8.4 Major findings

The major findings of the study are as under:

The trend of rice in three different periods of the study i.e. period I (1985-1994), period II (1995-2004) and Period III (2005-2011) in Madhya Pradesh and its composition with comparison to India has been analyzed results showed that the share of Madhya Pradesh to area of rice in India was found to be decreased from 3.76 to 3.61 and 3.91 to 3.78 per cent in period I and period III, respectively, while it increased from 3.69 to 4.01 per cent in period II. The area of rice in M.P. shown increasing trend at the rate of 0.013 and 0.017 million ha per year in period I and II respectively while in Period III it shown decreasing trend at the rate of 0.0143 million ha per year.

The production of rice in M.P. showed increasing at the rate of 0.02, 0.025 and 0.034 million t per year with increase in production from 0.75 to 1.31, 1.42 to 1.87 and 1.29 to 1.77 million t in period I, II and III respectively. Period III performed better as compared to the period I and II because increased production could be achieved from decreasing area in period III.

The productivity of rice in M.P. showed increasing trend at the rate of 17.937, 1.712 and 31.692 kg/ ha per year and productivity increased from 493 to 854, 900 to 978 and 804 to 1167 kg/ha in the period I, II and III respectively. The drastic increase in the productivity in period III may be due to the adoption of hybrid rice technology by the farmers in this period showing superiority of hybrid rice over HYVs.

The linear and compound growth rates of area of rice in Madhya Pradesh were worked out as 0.00, 1.05 and -0.86 per cent (linear) and 0.01, 1.06 and -0.87 per cent per year (compound) as against of 0.57, -0.03 and 0.02 per cent (linear)

and 0.53, -0.04 and 0.01 per cent per year (compound) in India for the periods I, II and III respectively.

The share of Madhya Pradesh to production of rice in India was found to be increased from 1.67 to 1.75, 1.62 to 1.89 and 1.63 to 1.66 per cent in period I, II and III, respectively. The analysis revealed 10.73, 17.73 and 7.48 per cent of relative change with an annual fluctuation of 18.89, 23.44 and 12.78 per cent in the State as against 24.69, 5.47 and 5.71 per cent of relative change with annual fluctuation of 11.74, 7.49 and 5.76 per cent in India in period I, II and III respectively.

The linear and compound growth rate of production of rice in Madhya Pradesh were determined as 2.46, 1.87 and 2.28 per cent (linear) and 2.81, 1.21 and 2.27 per cent per year (compound) as against of 3.42, 0.68 and 1.43 per cent (linear) and 3.51, 0.62 and 1.48 per cent per year (compound) in India for the periods I, II and III respectively.

The difference in average productivity of rice between India and Madhya Pradesh ranges from 701 to 1129, 967 to 1287 and 1057 to 1349 kg/ha in the period I, II and III respectively. Analysis showed 12.50, -1.03 and 11.37 per cent of relative change with an annual fluctuation of 18.07, 17.03 and 13.38 per cent in the State as against 21.23, 5.55 and 5.25 per cent of relative change with annual fluctuation of 9.58, 5.56 and 3.88 per cent in India in period I, II and III respectively.

The annual linear and compound growth rate of productivity of rice in Madhya Pradesh were worked out as 2.44, -0.21 and 3.36 per cent (linear) and 2.80, -0.50 and 3.32 per cent per year (compound) as against of 2.89, 0.69 and 1.44 per cent (linear) and 2.96, 0.65 and 1.47 per cent per year (compound) in India for the periods I, II and III respectively.

The NFSM districts cover only 49.41 percent of total rice area of M.P. The maximum area was found to be in Rewa district (16.17%) and minimum in Panna district (6.79%). The productivity of rice was found to be higher in other districts (1227.15 kg/ha) as compared to State (1010.67 kg/ha) and total NFSM districts (705.37 kg/ha).

The 50 per cent districts of the State (25 districts) contributed 97.47 per cent while remaining 50 per cent districts (25 districts) contributed only 2.53 per cent of total rice area of Madhya Pradesh. The highest area (15.18%) and production (20.53%) was found in Balaghat district while highest productivity (2330.33 kg/ha) was observed in Gwalior district of Madhya Pradesh. The area and production of rice in Madhya Pradesh was found to be 1641 million ha and 1570.87 million tonnes respectively in the triennium ending of the year 2010.

The following findings were observed on the basis of primary data recorded in the area under study during the year 2009-10 and 2010-11:

The majority of adopter respondents (80) were male (96.28%), comes under the age group of 16-60 years (90%), educated up to secondary (52.50 %) followed by graduate (15%), primary (12.50%), illiterate (10.0%) and above graduate (6.24%) categories. The majority of non adopters (20) were found to be educated up to secondary level (55%) followed by illiterate (20%), up to graduate level (15%) and up to primary (10%), Hence, it is clear that adopters of hybrid rice technology are more educated than the non adopters.

The majority of adopters 57.5, 16.25, 13.75 and 12.50 per cent and non adopters 60, 25, 10 and 5 per cent belonged to OBC, General, SC and ST categories, respectively.

Self employed farming was found to be main occupation of the head of the family in adopters (73.75%) and non adopters (65%). The 11.25 per cent adopters and 20 per cent non adopters were found to be worked as agricultural labour in the study area.

The average size of operational land holding of adopters and non adopters was found to be 4.73 ha and 4.09 ha, ownership land holding was 4.29 ha and 3.66 ha and land under irrigation was 98.39 & 93.39 per cent was found in the above categories, respectively.

Hybrid rice (37.63%), followed by soybean (28.37%), HYV paddy (27.63%) were found to be main crops cultivated by adopter in Kharif season, while HYV paddy (60.44%), soybean (26.73%) were the major crops grown by the non adopter of hybrid rice farmers in the year 2009-10.

The situation have somewhat changed in the year 2010-11, the area of hybrid rice adopters under hybrid rice increased slightly from 37.63 per cent (2009-10) to 41.03 per cent (2010-11), while the area under soybean (27.58%) decreased slightly. But in case of non adopters the area under HYVs of paddy and soybean increased slightly and area under other crops decreased.

In Rabi season wheat and gram were observe as major crops grown by the adopters and non adopters both in approximately 70 and 20 per cent area during both the years. The slight variation was observed in the area of wheat and gram of adopter farmers. The area under wheat decreased slightly from 72.69% (2009-10) to 69.69% (2010-11) while, area under gram increased from 16.33 per cent (2009-10) to 18.56 per cent (2010-11). In case of non adopters area under wheat crops increased from 63.94 per cent (2009-10) to 65.71 per cent (2010-11), but an area under gram remain same in both the years. It is to observe that adopters prefer cereals followed by pulses crop rotation in place of cereal followed by cereal crop rotation in the area under study. As regards to other Rabi crops slight change in area was noticed in the cultivator's fields.

The area under HYVs of rice was found to be decreased in the year 2010-11 as compared to the year 2009-10 from 0.27 ha to 0.18 ha (marginal), 0.52 ha to 0.53 ha (small), 0.80 ha to 0.80 ha (semi –medium), 1.64 ha to 1.57 ha (medium) and 2.59 ha to 2.93 ha (large). The area under hybrid rice was found to be increased in the year 2010-11 as compared to the year 2009-10 from 0.40 ha to 0.51 ha (marginal), 0.82 ha to 0.86 ha (small), 0.94 ha to 1.06 ha (semi medium), 1.90 ha to 2.52 ha (medium) and 4.26 ha to 4.31 ha (large). At overall level average size of holding was found to be 4.31 ha. The area under hybrid rice increased from 1.66 ha (2009-10) to 1.85 ha (2010-11), while the area under HYVs of rice increased from 1.17 ha to 1.20 ha (2010-11) in area under study.

The majority (85%) of adopters of hybrid rice reported that extension workers of the Department of Farmers Welfare and Agriculture Development were the one of the main source of information on hybrid rice for dissemination of technology followed by Krishi Vigyan Kendra (60%), input dealer (46.25%) and radio (40%). The Front Line Demonstration program conducted by Govt. (33.75%), television (33.75%), news papers (20%) participation in training

programme organized by the Govt. (18.75%) and progressive farmers (13.75%), output buyers food processors credit agency, NGO / private agency were found to be the other sources of information on hybrid rice technology.

The majority (50%) of the respondents reported that extension workers of the State Department of Agriculture worked at satisfactory level in respect dissemination of quality information while 25 and 8 per cent of the respondents reported that information received was of good and poor quality, respectively.

Logit analysis has been performed to analyse the determinants of participations in hybrid rice cultivation and found that none of the independent variables considered in the model has yielded a significant relationship with the dependent variable. However, the signs of Z-statistics are as expected and indicate the direction of relationship between the dependent and independent variables. Age, farm-size, and no. of workers shown negative relationship (i.e. higher is the age/farm-size/workers, the lower is the probability of adopting hybrid varieties of rice). Education, household size and irrigation availability shown positive relationship (i.e. higher the education/hh size/irrigation, the higher is the probability of adopting hybrid rice). On the whole, the model fails to identify factors that influence decision in adopting hybrid rice cultivation. This further pointed out that there might be some other factors at work influencing a decision regarding adoption of hybrid varieties of rice.

As regards adoption of recommended package of practices in rice cultivation is concerned, it was recorded that hybrid rice adopters reported to adopt recommended package of practices of hybrid rice cultivation after receiving information through various sources such as extension worker of the state department of agriculture, KVKs, participation in training and demonstration programmes organized by the government were found to be 57.5, 45, 22.5 and 15 per cent, respectively, in case of hybrid rice adopters cultivating HYV of rice the percentage of respondents were adopt full package of practices were found to be 47.5, 52.5, 16.25 and 10, respectively and in case of non adopters it was observed as 38.75, 42.5, 26.25 and 20 per cent respectively.

The majority (57.5 & 65%) of adopter depended on private sector in both the years (2009-10) and (2010-11), respectively followed by public sector on partial subsidy and public sector on full subsidy. The mean yield of hybrid rice

over the HYVs of rice had been found to be increased by about 40% across all the categories of farmers.

In the adopter of hybrid rice farms, all the factors of production were found to be positive except expenses on bullock labour, which was negative and significant. The expenses on seed (0.152***), chemical fertilizer (0.082***), human labour (0.243***) were positive and highly significant, which reveals that if all things remains constant and at the present level of technological adoption an additional expense of Rs. 1/- each on seed, chemical fertilizer and human labour will be able to increase the yield of hybrid rice up to 0.152, 0.082 and 0.243 kg/ha respectively. The expenses on manures, pesticides, machine labour were found to be positive but non significant, which shows the need to provide extra attention while using these crucial inputs at their farms. There is also a need to provide skill oriented training and demonstration to them at their field. The coefficient of multiple regressions was found to be 0.568. Hence, the fitted function is good fit and able to explain 56.80 per cent variability in the yield of hybrid rice.

As regards to non adopter of hybrid rice growing HYVs of rice, all the factors of production were found to be positive except expenses on bullock (-0.402) and machine (-0.406) labour. The expenses on fertilizer (0.181**), irrigation (0.24*) and human labour (0.440***) were positive and significant whereas expenses on seed (0.134), manures (0.012), pesticides (0.002) were positive but non significant. Hence, there is need to replace the seed of HYVs by hybrid seed and provide skill oriented training regarding package and practices of hybrid as well as HYVs of rice at farmers' fields as the majority of farmers reported that they had lack of knowledge of recommended package of practices. The fitted function is found to be good fit as it is able to explain 79.7% variability of selected independent variables in the yield of HYVs.

The adopter of hybrid rice over the HYVs of rice cultivators (adopter and non adopter) had been found to use less quantity of seed, manures and bullock labour and more quantity of chemical fertilizer, number of sprays of pesticides, number of irrigations and human labour in cultivation of hybrid rice in the area under study.

The comparison of cost and return between hybrid rice and inbred rice in the year 2009-10 showed that hired human charges was found to be main component of the total cost followed by machine charges, seed chemical fertilizer, manures, insecticide, pesticide and irrigation both in the adopter of hybrid rice as well as inbred rice. In cultivation of hybrid rice, expenses on seed, manures, chemical fertilizer, machine labour, hired labour, etc. were found higher than the inbred rice. The total cost of cultivation of rice (HYVs) was found Rs. 14536.46/-ha (in case of adopter of hybrid rice but also cultivated HYVs, hybrid rice adopter) and Rs. 14515.40/ ha (non adopter) while in case of hybrid rice it was found Rs. 18339.21/-ha which was about 20 per cent higher than the HYVs of rice.

The cost of production of hybrid rice was found 29.24 per cent lower (from Rs. 3.89/-Kg to Rs. 3.01/-Kg) as compared to inbred rice in the farms of hybrid rice adopter 52.41 per cent lower (from Rs. 4.62/-Kg to Rs. 3.01/-Kg) at non adopter of hybrid rice farm in the year 2009-10. This was due to the 43.07 per cent and 52.41 per cent higher production of hybrid rice (49.80q/ha.) as compared to inbred rice respectively in adopter of hybrid rice farm and non adopter of hybrid rice farms, respectively.

The net returns from hybrid rice (Rs. 35631.64) was found to be 48.36 per cent and 58.30 per cent more as compared to inbred rice in the fields of hybrid rice adopter (18400.18/ ha) and non adopter farms Rs (14858.59/ha). The benefit cost ratio of hybrid rice cultivation (2.94) was also found higher as compared to inbred rice at hybrid rice adopter (2.27) and non adopter (2.02) farmers' fields.

The cultivation of hybrid rice provided employment to 90.12 human labour days per hectare, out of which 60.44 days were hired labour and 29.68 days were family labour while the cultivation of HYVs provided employment to 83.28 days per hectare, out of which 36.1 days were family labour. The percentages of female labour used to the total labourers engaged were 49.79 and 47.85 per cent in case of hybrid and HYVs rice, respectively.

In hybrid rice, the highest labour (days/ha) was found to be engaged in transplanting of seedlings (35) followed by harvesting (24.45), weeding (8.27), uprooting of seedlings (7.2), spraying of plant protection chemicals (2.31) and ploughing of land for field preparation (2.37) application of chemical fertilizers

(2.24) operations while in HYVs of rice cultivation the highest labour were found to be used in transplanting of seedlings (29.55) followed by harvesting (23.22), weeding (9.30), uprooting of seedlings (6.78), spraying of plant protection chemicals (2.42), application of chemical fertilizers (2.83) and ploughing of land for field preparation (2.44) operations.

In the year 2009-10, overall average size group 84.80% and 75.22% of total output (unhusked rice) have been found to be sold in the market and rice growers received a price of Rs. 1014.7/q and 1068.19/q by adopters of hybrid and HYVs rice respectively. Very little variation was found in quantity sold by the farmers for hybrid and HYVs because in the study area Government bodies are active and buy all the portion of rice from the farmers at Minimum Support Price just after the harvest of crop. As regards to different size of farms, not much variation was found in quantity sold by the farmers for hybrid. It ranged between 82.64% (marginal) to 91.49% (semi medium) and price received range from Rs. 988/q (marginal) to Rs.1066/q (semi medium).

As regard to non adopters are concerned, overall average farmers sold only 68.19% of total output in the market at an average price of Rs. 1098.83/q which ranged between 55.10% (marginal) to 74.95% (large) at the price of Rs. 1040/q (marginal) to Rs.1143.33/q (semi medium).

In the year 2010-11 unhusked rice on overall size 87.71% and 75.59% respondents were found to be sold in the market on an average price of Rs. 1075.48/-q and Rs. 1141.91/q by adopters of hybrid rice and HYVs growers respectively, while non adopters sold their 68.97% of total output in the market on an average rate of Rs. 1125.83/q. The quantity sold in different size of farm was found to be similar and ranged from 74.46 % (small) to 91.11 % (semi medium) with respect to hybrid adopter respondents, 68.18 % (marginal) to 81.13 % (small) with respect to adopter cultivated HYVs rice and 47.25 % (small) to 76.73 % (semi medium) with respect to non adopter respondents.

The price of output was also found to be similar in all the categories of farms ranged from Rs. 1036.50/q (marginal) to Rs. 1098/q (large) with respect to adopter of hybrid rice, Rs. 1103.18/q (small) to Rs. 1180 /q (semi medium) at

hybrid adopter farmers cultivated HYVs rice and Rs. 1051.25/q (marginal) to Rs. 1191.25/q (large) at non adopter farms.

The output and sale of rice (husked) at overall level showed 71.48% and 45.61% were found to be sold in the market on an average prize of Rs. 1307.02 /- and Rs. 1500.00 /q by adopters of hybrid rice and HYVs respectively While, non adopters sold their 46.25 % of total output in the market on an average rate of Rs. 1450/q. The quantity sold in different size of farm was found to be similar and ranged from 34.44 % (marginal) to 85.18 % (large) with respect to hybrid adopter respondents, 0.00% (marginal) to 50.97 % (large) with respect to adopters cultivated HYVs rice and 0.00% (marginal and large) to 58.39% (semi medium) with respect to non adopter respondents. The price of output was also fond to be similar in all the categories of farms ranged from Rs. 1257.50 /q (small) to Rs. 1346.25 /q (semi-medium) with respect to adopter, Rs. 1400.00 /q (semi medium) to Rs. 1600/q (medium) at hybrid adopter farmers cultivated HYVs rice and Rs. 1400.00 /q (semi medium) to Rs. 1500.00/q (medium) at non adopter farms.

The 69.26 % and 50.59 % output and sale of rice (husked) in different size of farms in the year 2010-11were found to be sold in the market on an average prize of Rs. 1411.00 /- and Rs. 1505.56 /q by adopter of hybrid rice and HYVs growers respectively, while non adopters sold their 45.38% of total output in the market on an average rate of Rs. 1533.33/-. The quantity sold in different size of farm was found to be similar and ranged from 43.14 % (marginal) to 81.49 % (large) with respect to hybrid adopter respondents, 20.94 % (marginal) to 59.29% (medium) with respect to adopter cultivated HYVs rice and 0.00% (marginal) to 57.78 % (medium) with respect to non adopter respondents. The price of output was also found to be similar in all the categories of farms ranged from Rs. 1317.50/q (small) to Rs. 1500.00/q (large) with respect to adopter, Rs. 1500.00/q (Semi medium) to Rs. 1516.67/q (medium) at hybrid adopter farmers cultivated HYVs rice and Rs. 1450.00/q (semi medium) to Rs. 1650.00/q (medium) at non adopter farms.

The maximum quantity of the hybrid rice has been found to be sold in the months of December (65.67%) following by November (20.54%), January (10.04%) and July (3.76). About 96% of the total hybrid rice has been sold by the

adopter hybrid growers just after the harvest of the crop, HYVs rice growers sold their produce of rice in all the months of year, here also the maximum quantity sold in December (23.93) fallowing by November (16.39%), January (14.14%) but only 55% of the rice has been found to be sold in this harvest period. The remained portion (45%) was found to be sold in other months of the year. The same result has been observed for non adopter farmers. Their maximum quantity has been found to be sold in the peak period i.e. just after the harvest of rice. They sold them 56% of marketed surplus in these months and rests were found to be sold in different months of year.

The hulling milling ratio was found to be about 36:64 for adopters and non adopters of hybrid rice or HYVs rice showed that only 64% of the rice whether it is hybrid or inbred processed in mills in the area under study. The head rice recovery ratio was found to almost same hybrid as well as HYVs rice in both the years of the study.

The majority of sample farmers reported that the seed of hybrid rice was easily available to them (78.8%) from the Department of Agriculture and retailer of local market. The majority of them also reported that they were got good quality of hybrid seed (61.3%) at a reasonable price (61.3%) and they were satisfied from the quality of seed. Cent percent farmers reported that hybrid seed gave better results than the inbred seed. The majority of farmers (42.5) reported that yield increases up to 5-10%, while 32.5% and 25.0% reported yield increased up to 10-15% and 15-20% respectively all the used to purchase seed of hybrid rice every year. All the respondents also reported that the adoption of hybrid seed did not prevent the traditional practice of saving and exchange of seed. The majority of hybrid seed adopter further reported that they replaced the variety of hybrid seed after 3 years or more (67.5%), while 25.5%, 8.7% and 1.3% reported that they replaced it every 3 years every, alternate year and every year respectively.

All the hybrid rice growers of the study area reported that they were used chemical fertilizer in cultivation of hybrid rice, while only 41.25% of them reported that they received information from any source regarding to use and dose of fertilizer, but only 31.25% of sample respondents applied recommended

dose of fertilizer in the cultivation of hybrid rice, the remaining (68.75%) were not able to apply it due to non availability of desired fertilizers at the time of application and its higher rate. Cooperative Societies are the main sources of fertilizer fallowed by market. The 77.5% of sample farmers reported that the cultivation of hybrid rice required more fertilizer as compared to inbred rice.

The majority of hybrid rice adopter reported that the attack of pest and diseases was found less as compared to hybrid rice (63.75%) and only 31.25% of respondent applied pesticide to control pest in their field. The majority of adopter also reported that hybrid rice varieties are more susceptible to pest and diseases but respondent (76.25%) don't know the correct dose of pesticide for these hybrid seed varieties and felt that the cultivation is highly sensitive to crop management practices and use of key inputs and time bound operations (78.75%).The majority (90%) of them also reported that the yield loss was found to be more in hybrid rice as compared to inbred rice.

The majority of respondents reported that hybrid rice cultivation required more credit as compared to HYVs rice (83.75%). They (86.75%) also reported about easy availability of institutional credit from cooperative credit societies and branches of commercial banks, but there is a need for lees documentation work for getting crop loan. Government used to buy the entire produce at Minimum Support Price through cooperative societies.

The State Agriculture Department was found to be a primary source of extension of to hybrid rice technology. The majority of farmers (72.5%) reported that Front Line Demonstration programmes were organized in their area by the field workers to create awareness among them and 33.75 per cent of them were found to be participated in that programme. The 42.5 per cent farmers reported that State Department officers also organized training programme for them and 67.6% of them reported that they were participated in these training programme.

The farmers reported that they got better yield gain from cultivation of hybrid rice over inbred rice. The production of hybrid rice was also found profitable over inbred rice even the qualities of grain was found poor (70%), no taste (3.75%), poor cooking quality (15%) and stickers of cooked rice (11.25%). The majority of them (88.75%) also reported that grain was found to be

acceptable to traders and retailer. The majorities of them (83.75%) also reported that hybrid rice technology was found to be economically viable in the area and due to high yield as reported by 59 per cent of farmers and price are equal to the HYVs of rice farmers sown their interest to cultivation of hybrid rice in the future also.

The majority of non adopter of hybrid rice reported that they have heard about the new hybrid verities of hybrid rice (75%) viz. KRH2, 6444, 9090, DRH775, JRH-5, VS-312 and RH10 and Govt. Hybrid rice promotion programme (80%). The majority of them (75%) reported that they have seen standing Hybrid rice crop in their area. They have reported that the Rural Agricultural Extension Officer (63.64%) and relatives (27.27%) were suggested them to grow Hybrid rice seed at their field and 65% of them were convinced with their suggestions and will grow these varieties in next year.

The 35% of non adopters were not convinced to grow the Hybrid rice seed in this year due to non availability of seed in time (66.67%), non availability of pure hybrid seed (33.33%), low germination of seed provided by Govt. (20%) not convinced that its yield is sufficiently higher than HYVs (25%), higher risk (25%) variety too coarse seed of high quality (20%), high cost of seed (20%), and not heard of Govt. assistance for expansion of hybrid rice seed (20%),. It is a good sign for NFSM programme for rice that all of the non adopters are now ready to accept new hybrid rice varieties in future considering superior grain quality and higher yield potential (100%).

8.5 Policy Implications

On the basis of above findings the following policy implications are as under:

1. The advent of new hybrids of rice leads to manifold increase in its production, but the yield gap is still wide as compared to its yield potential. It should be reduced by providing skill oriented training and by conducting more method and result demonstration. (Action: Department of Farmers Welfare and Agriculture Development Madhya Pradesh/KVKs/ and SAUs)
2. Feeding teeming population in declining area sent the caution signal against the complacency in the future food security at national, regional and house hold level. Rice is a choice crop of the millions of poor and small farmers not only

for income but also for house hold food security. This will be done with effective implementation of production programme e.g. NFSM and BGREI (Action: Ministry of Agriculture and Cooperation State/Central Govt)

3. The replacement of HYVs by hybrids is found very low and needs to be given priority as it was found that the cultivation of hybrid rice found to be more profitable as compared to HYVs. This will definitely increase the productivity of the crop, income of the farmers, which bring the desirable changes in the standard of living of the farming community. (Action: Department of Farmers Welfare and Agriculture Development Madhya Pradesh)
4. Programmes like BGREI (Bringing Green Revolution in Eastern India) must be implemented for hybrid rice in the areas where rice is being grown. (Action: Department of Farmers Welfare and Agriculture Development Madhya Pradesh)
5. Efforts should be made to encourage the progressive farmers and officers of KVKs to popularise hybrid rice through training and other incentives. (Action: Department of Farmers Welfare and Agriculture Development Madhya Pradesh)
6. The emphasis should be given to conduct more number of demonstrations on the fields of marginal and small farmers. (Action: Department of Farmers Welfare and Agriculture Development Madhya Pradesh/KVKs/ and SAUs)
7. There is need to replace the seed of HYVs by hybrid seed and provide skill oriented training regarding package and practices of hybrid as well as HYVs of rice at farmers' fields as the majority of farmers reported that they had lack of knowledge of recommended package of practices. (Action: Department of Farmers Welfare and Agriculture Development Madhya Pradesh/KVKs/ and SAUs)
8. Government must provide subsidy to the hybrid rice growers in purchasing inputs and provide incentives in purchasing hybrid rice at MSP. (Action: Ministry of Agriculture and Cooperation State/Central Govt)
9. As the district-wise data related to different parameters of production of hybrid rice has not been available in land record office, Gwalior (M.P.) and in the department of Farmers' Welfare and Agriculture Development, Bhopal. Hence efforts should be made sure for the availability of the same for the research

workers for further research and other activities. (Action: Directorate of Economics & Statistics Madhya Pradesh Bhopal)

10. Access to information must be increased through government agencies or KVKs, as the result of the study shows that the majority of the farmers were found to be dependent on input dealers for their requirement of seed and technical knowhow. Hence, seed developed by government agencies must be in adequate quantity and should be made available at the time of sowing at grass root level on regular basis for its wide adoption. (Action: Department of Farmers Welfare and Agriculture Development Madhya Pradesh/KVKs/ and SAUs)
11. As the result of the study shows that the maximum quantity (96%) of hybrid rice has been sold just after the harvest of the crop in the month of November, December and January at non remunerative prices due to lack of storage facilities at house hold level and unable to fetch the remunerative prices. Hence there is need to provide storage facilities at grass root level. This will not only stop the wastage of precious staple food rice but also stabilises the prices in long run. (Action: Department of Farmers Welfare and Agriculture Development Madhya Pradesh/KVKs/ and SAUs)

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Important Websites: 1. Directorate of Rice Research, Rajendra Nagar, Hydrabad

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