

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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EXECUTIVE SUMMARY

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.

1.1. 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.

1.2. 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, Mehсуva 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.

1.3. 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 found 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 2010-11 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.

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) following 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 followed 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 less 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 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 varieties 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%).

1.4. 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)