EXECUTIVE SUMMARY

Background

With over one billion people in India, there is a need to increase food production to meet the demand of the burgeoning population. As rice is the staple food in most parts of India and there is a need to increase production of rice and productivity of land under rice cultivation. India has the largest acreage under rice at 43.97 million hectare with a production of 104.32 million tones and yield of 2372 kg/ha (Government of India, 2012).

In fact the rice research programme in India over the past 50 years has largely centred on shifting the yield frontier which contributed substantially to achieving food security through increased rice supplies (CRRI, 1996). Several studies indicated high payoffs to rice research in India *(Evenson & McKinsey, 1991); Evenson, 1993; Kumar & Rosegranht, 1994; Pingali et.al, 1997; Jha & Kumar, 1998 as quoted in Pingali & Hossain, 1999).* The rice output growth was 2.80 per cent per annum during 1966-99 with the highest rate of growth (4.00% per year) achieved during the 1980s. Yield improvement in rice was major sources of strong output growth, largely due to widespread adoption of modern rice varieties in favourable irrigated environments *(Baker & Herdt, 1985; David & Outsuka, 1994; Hossain, 1996; Pingali et.al 1997).* However, the sense of complacency in the demand-supply balance began disappearing in early 1990s, when it was observed that yield advances in rice drastically slowed down for the irrigated rice systems in India as well as in other Asian countries. The intensive rice growing states of Andhra Pradesh, Tamil Nadu, Punjab & Haryana, which performed significantly in terms of yield improvements until the 1980s, have been witnessing either a plateau or negative yield growth during the 1990s. The economically exploitable yield of existing High Yield Varieties (HYVs) of rice has almost reached the technical optimum in irrigated rice systems with the universal adoption of HYVs.

Among various approaches and options available policymakers and research managers considered development and use of hybrid rice technology in the late 1980s as a readily available option to shift upward and yield frontier in the irrigated environments in India. Further, the miraculous success of hybrid rice technology in China, which greatly contributed to the growth of rice production in that country *(Lin, 1994; Virmani et.al 1998),* triggered an interest in strengthening research efforts in some tropical countries in Asia including India in early 1990s.

Several international agencies like UNDP, FAO, ADB and International Rice Research Institute (IRRI) have generously supported the hybrid rice research and development at many national research institutions in tropical Asia including India in the early 1990s. India received nearly US $ 8 million in financial support from these external agencies between 1990 & 2000 for activities under the hybrid rice programme initiated in 1989 at the Directorate of Rice Research, Hyderabad. An additional to external funding with the Central Government through the ICAR and State Governments have invested huge capital and human resources for the development and supply of suitable hybrid rice technology for Indian farmers. The private sector participated in hybrid rice research programme and seed production in a big way in the early 1990s, expecting a huge seed business and a guaranteed seed market in view of rice being a widely cultivated crop in the country and the farmer not being able to keep hybrid seed from his/her own produce. Among about 130 private seed companies engaged in rice business across the country, 15 larger companies participated in hybrid rice seed production and distribution in early 1990s. **After four years of rigorous research (1989-93), the first hybrid rice was released in Andhra Pradesh in 1993-94 rabi season.** Subsequently, as a result of concerted efforts over a period of two decades since the inception of the National Programme on Hybrid Rice (1989), a total of 43 rice hybrids have been released for commercial cultivation in the country of which 27 as indicated in table No. 1.1 were developed by public sector institutions and 16 were developed by private sector *(Shoba Rani et. Al., 2010, p. 36).* In contrast, in China the initial phase of development of hybrid rice was solely a public sector affair.

At present hybrid rice is reported to be grown approximately 2 lakh hectares. Area under hybrid rice will further increase after heterotic hybrids suitable for high productivity areas of Punjab, Haryana, coastal region of Andhra Pradesh and shallow low land areas are identified and an effective transfer of technology is taken up vigorously in the target states (Viraktamat, 2010). Based on the quantity of hybrid seed sold in 2008, it is estimated that hybrid rice was cultivated on 0.15 m ha. The National Food Security Mission (NFSM) launched in 2007 envisioned an increase of 10 m. tons by the end of 11th Five Year Plan (2012). Of this hybrid rice is expected to contribute 3.4 mt if grown in 3.4 m ha (@ on tone advantage). The ultimate goal of the mission is to extend 20.00 per cent of the total rice area planted with hybrid rice. In an effort to enhance rice productivity, the present government has, in a policy shift, decided to encourage the cultivation of hybrid varieties by offering subsidies even in those cases where the seeds are not certified, but are truthfully labeled and notified. Under the NFSM, the approach is to bridge the yield gap in respect of rice through dissemination of improved technology and farm management practices. Added emphasis is being given for adoption of hybrid rice under the special scheme namely; **"Bringing Green Revolution to Eastern India (BGREI)."** The programme covers traditional rice growing areas such as Uttar Pradesh, Bihar, Jharkhand, West Bengal, Madhya Pradesh, Chattisgarh & Assam and these states account for 80.00 per cent of adoption. It is to be pointed out here that adoption of rice hybrids developed in India did not take place in the in green revolution areas where productivity plateau. The extent of adoption of hybrid rice in South India is very low (5.00%) and North-West India (Punjab, Haryana & Maharashtra account for 15.00 Per cent.

Moreover, Janaiah (2002) argues that in spite of huge capital and human resources invested over the past decade to develop and supply hybrid rice technology for Indian farmers, there has not been a noticeable impact on the sector. India has tried to emulate China's success story in the area of hybrid rice research and development, but Indian farmers have not readily accepted hybrid rice technology. If one looks at adoption of hybrid rice in different states the adoption, empirical

results found that the farmers have not adopted hybrid rice for various reasons. In spite of attempts over a decade to popularize hybrid rice in states like Andhra Pradesh, Tamil Nadu & Karnataka in south the adoption is very low *(Janaiah; 2003; Chengappa et.al; 2003 & Ramasamy et.al, 2003)*. The reasons for resistance to adopt hybrid rice in India are (a) shortage of hybrid rice in terms of quantity and quality, (b) poor hybrid rice grain formation, (c) yield, biotic stresses like bacterial and pest attack, (d) lack of market for hybrid rice because of consumer's preferences regarding grain quality, shape, colour and cooking quality, and; (e) high cost of hybrid seed. In fact, recently the Bihar Government paid Rs. 61 crore to farmers who cultivated hybrid rice because the grain formation did not occur in the seed and hence farmers incurred losses. Despite all above, a number of varieties, as staged in table No. 1.1, have been released by the Central Government and states as well to meet the demand of the farmers; the spread of these new varieties in place of traditional ones has not been examined adequately. In fact, there is no comprehensive study to record farm level experiences of hybrid rice, thus, the Ministry of Agriculture, Government of India has decided to assign the study entitled **"Spread of New Varieties of Hybrid Rice and their Impact on the Overall Production and Productivity"** to its Agro-Economic Research Centres in their respective states. Accordingly, this Centre has been undertaken the study in Bihar.

Objectives of the Study

i. *To indicate the extent of adoption and the level of participation by the different categories of farmers in the cultivation of hybrid rice.*
ii. *To assess the overall impact on rice production and productivity of hybrid rice cultivation.*
iii. *To study the economics of cultivation of hybrid rice varieties vis-à-vis inbred varieties.*
iv. *To identify factors determining the adoption of hybrid rice varieties.*
v. *To address various constraints and outline the prospects for increasing hybrid rice cultivation and finally*
vi. *To suggests policy measures for expansion of hybrid rice cultivation.*

Data Base and Methodology

This study is based on both secondary and primary data. Secondary data relating to area, production and yield of rice crop were collected from the Directorate of Agriculture, Government of Bihar. Secondary data were also obtained from the publications of Government of Bihar and Government of India. These are mainly Economic Survey of Bihar, Statistical Handbook of Bihar, Agricultural Statistics--- At a Glance: 2012 etc. To arrive at the trends in APY of rice secondary data were collected for the years from 1984-85 to 2009-10. Primary data is confined to the National Food Security Mission (NFSM) paddy districts (18 districts) of Bihar. Out of these 18 NFSM paddy districts, two (02) districts namely; Muzaffarpur and Gaya were selected on the basis of having higher concentration of hybrid seeds cultivation. From Muzaffarpur districts, two representative blocks namely; Minapur, Motipur & from Gaya district Aamas & Dumaria blocks were chosen following same criteria. Thereafter from each of the selected blocks, two villages namely; Shital Sema & Minapur from Minapur Block and Morsandi and Tajpur from Motipur Block and Mahua and Bazitpur from Aamas Block and Karhani and Bokaha from Dumaria Block were selected for in-depth enquiry. From each of the selected villages, lists of cultivating households growing hybrid rice varieties and inbred varieties were prepared separately and stratified according to farm size groups such as marginal (< 1 ha), small (1 to 2 ha), semi-medium (2 to 4 ha), medium (4 to10 ha) and large (10 ha & above). Due attention was given in the sample to accommodate the social composition of the villages. As regards the sample size is concerned, 40 hybrid rice growers from the list of hybrid rice growers and 10 inbred rice growers from the list of inbred rice growers were randomly chosen, making a total of 50 paddy growers from each of the sample district were selected. This way the total size of the sample is 100 paddy growers, equally spread over in two selected districts from the state (Bihar). The reference period of primary data was 2008-09 and 2009-10. Primary data was obtained by administering a duly structured schedule.

Major Findings

Followings are major findings of the study:

Out of the three rice growing seasons, winter (Aghani) is the most important season in Bihar in terms of area sown and production. In 2009-10 winter rice accounted for 36.99 per cent of total output and 80.93 per cent of total area cultivated under rice. The importance of winter rice output in total production has fallen from 91.41 per cent in 1984-85 to 36.99 per cent in 2009-10 while that of Boro rice has risen from 1.65 per cent in 1984-85 to 2.07 per cent in 2009-10 except a few years. Increase in the share of output in case of autumn rice (Bhadai) is due to increased in area from 6.94 per cent in 1984-85 to 88.61 per cent in 2007-08. However, it declined to 60.95 per cent in 2009-10. For summer rice, increased share in production is attributable to increase in both area and production. The relative importance of winter rice has also sharply fallen in terms of acreage planted and production. It is noted that average rice yield in Bihar increased to 1475 kg per hectare in 2006-07 except 2008-09 & 2009-10. These were 928 kg per hectare in 1987-88 and 1211 kg per ha in 1984-85, the period when rice crop of the state was yet to switch over to the hybrid technology. In case of summer rice, yield rate increased from 1406 kg per ha in 1984-85 to 2053 kg per ha in 1998-99, which again increased to 1736 kg per ha in 2009-10. For winter rice, yield level increased from 1098 kg per ha in 1984-85 to 1142 kg per ha in 2009-10 through 1555 kg per ha in 2006-07 whereas autumn rice recorded yield levels of 947 kg per ha in 2009-10 which was 1648 kg per ha in 2008-09 against 771 kg per ha in 1984-85. Above analysis showed that there has been overall increase in rice production during the period under study 1984-85 to 2009-10.

Total area under HYV rice has increased from 1401 thousand ha in 1994-95 to a peak of 1984 thousand ha in 1999-2K but it has fallen in subsequent years and reached to the level of 1691 thousand ha in 2009-10. But it has increased from 1401 thousand ha in 1994-95 to 1691 thousand ha in 2009-10, registering an increase of 20.70 per cent in area. In case of production almost similar pattern was observed. It increased from 2065 thousand MT in 1994-95 to 2203 thousand MT in 2009-10, accounting for an increase in production by 6.69 per cent during the period.

Compound Growth Rate (CGR) in area of total paddy on an aggregate level during the period-I (1984-85 to 1993-94) was estimated as 0.68 per cent per annum which decreased to -2.13 per cent per annum during the period – II (1994-95 to 2003-04). But thereafter it increased at the rate of 12.95 per cent per annum during the period – III (2004-05 to 2009-10). Thus, it clearly indicates that the area under total paddy on an aggregate level in the state of Bihar has increased significantly during the period – III (2004-05 to 2009-10). Compound Growth Rate of production of total paddy had recorded increase at the rate of 1.45 per cent per annum during period-I (1984-85 to 1993-94), and 15.93 per cent per annum during the period – III (2004-05 to 2009-10) except decrease in period – II (1994-95 to 2003-04) by 4.63 per cent per annum. Similarly, the CGR of productivity of total paddy had also increased at the rate of 0.77 per cent per annum during period – I (1984-85 to 1993-94) and 2.64 per cent per annum till during the period – III (2004-05 to 2009-10). But it has fallen by 0.97 per cent per annum during the period – II (1994-95 to 2003-04).

Co-efficient of variation on an aggregate in the area of total paddy was estimated to 10.10 per cent during the period of 1984-85 to 1993-94 which varied to 26.76 per cent till the period of 2004-05 to 2009-10. While, the coefficient of variation in production of total paddy had varied in increasing direction from 13.58 per cent in the period of 1984-85 to 1993-94 to 27.19 per cent till the period of 2004-05 to 2009-10. But the coefficient of variation in yield of total paddy was recorded to 16.38 per cent during 1984-85 to 1993-94, which increased to 20.25 per cent till the period of 2004-05 to 2009-10.

The compound growth rate in area of total HYV paddy was estimated as 2.11 per cent per annum during the period of 1994-95 to 2003-04 which increased to 3.08 per cent per annum during the period of 2004-05 to 2009-10. The compound growth rate in production of total HYV paddy had also increased at the rate of 4.08 per cent per annum during 1994-95 to 2003-04 to 8.38 per cent per annum till the period of 2004-05 to 2009-10.

The co-efficient of variation in total area of HYV paddy during the period of 1994-95 to 2003-04 was calculated to 11.93 per cent which decreased to 7.57 per cent during

the period of 2004-05 to 2009-10. The variation in total production was estimated to 18.01 per cent during the period of 1994-95 to 2003-04 which increased to 24.20 per cent during the period of 2004-05 to 2009-10. The variation in total productivity was recorded to be 8.94 per cent during the period of 1994-95 to 2003-04 which also increased to 18.68 per cent during the period of 2004 - 05 to 2009-10.

The table reveals that the share in area of HYV rice was 31.00 per cent in 1994-95, which touched to the level of 52.63 per cent in 2009-10. Similarly the share in production of HYV rice to total rice production in the year 1994-95 was 30.11 per cent, which doubled in the year 2009-10.

The agricultural economy of Bihar is largely dependent on marginal and small operational holdings, which accounts for 96.92 per cent, followed by semi-medium (2.56%), medium (0.50%) and large (0.02%). Besides, out of the total working population (33.88%), 77.35 per cent are engaged in agricultural activities (cultivators plus agricultural labourers) in the state.

Out of 80 adopters' farm household marginal and small farmer together account for 77.50 per cent followed by semi-medium (15%) and medium (7.50%). Similarly in case of non-adopters farm families, 70.00 per cent account for marginal and small farms, 20.00 per cent semi-medium and 10.00 per cent medium farms.

On an average there were 7.39 persons in a farm family constituting 62.66 per cent male and 37.24 per cent female. It was 7.43 persons among the adopters' farm households and 7.25 among the non-adopters farm households.

The average age of the head of family is largely in the category of 18 to 60 years (92%) at the overall level; however, it was a little bit higher among the adopters' category (92.50%), and that of 90.00 per cent among the non-adopter farm households.

The caste composition of households reveals that 60.00 per cent are belonged to other backward castes followed by general category of castes (30%) and scheduled castes (10%) on overall basis.

On the farms of sample hybrid adopters during kharif season of 2009-10, about 47.11 per cent of the Gross Cropped Area (GCA) was adopted by paddy, 13.09 per cent by maize and 11.46 per cent by other crops. While during 2010-11, 48.68 per cent was covered by kharif paddy crop, 12.53 per cent by kharif maize and 10.68 per cent by other crops.

The area under pulses, rabi maize and other crops was found a little higher in 2010-11 over 2009-10. The aggregate share of kharif crops of the GCA was almost 73.00 per cent plus among the non-adopters of hybrid rice during both years.

During the year 2009-10, the average area under rice was estimated at 0.82 ha (62.60%) of the average farm size. Out of which 0.71 ha (86.58%) was devoted on HYVs and 0.11 ha (13.42%) hybrid. Similarly in 2010-11, the average area under rice was estimated at 0.85 ha (64.88%) of the average farm size. Out of which 0.70 ha (82.36%) was devoted on HYVs and 0.15 ha (17.64%) on hybrid rice.

Out of 80 sample hybrid rice adopters, 49 (61.25%) have reported about the Extension Workers of State Department of Agriculture, more specifically the SMS and Kisan Salahkar (KS) followed by participation in training programme under SRI Technology (45%), progressive farmers (17%) and Krishi Vigyan Kendra (5%).

Majority of the sample hybrid adopters were received good quality of information from all the major sources of information except the progressive farmers.

During the year 2009-10, about 40.00 per cent of the sample hybrid adopters have received the seed from the district office of the department of agriculture on full subsidy, 32.50 per cent on partial subsidy and 27.50 per cent from local input dealers. While during the year 2010-11, 45.00 per cent of the hybrid adopters have obtained the seed from district office of the department of agriculture on full subsidy followed by 30.00 per cent from the government on partial subsidy and 25.00 per cent purchased from licensed local input dealers.

The percentage difference between the hybrid and HYVs rice was calculated at 58.98 per cent. During 2009-10, the percentage difference between the mean yields of

hybrid and HYVs rice was better than the percentage difference between the mean yields of hybrid and HYVs rice of 2010-11. On an average the yield gain was 58.98 per cent obtained by all sizes of farm in 2009-10, while that of 55.79 per cent in 2010-11.

Marginal farmers have been largely affected by costlier seeds (27.50%, small farmers by lack of irrigational facilities (23.75%), semi-medium farmers by lack of adequate training and information (6.25%) whereas medium farms by lack of irrigational facilities (3.75%) and lack of adequate training and information (3.75%) during the year 2009-10. While during the year 2010-11, marginal farmers largely reported for costlier seeds (28.75%), small farmers for lack of credit facilities (17.50%), semi-medium farmers for costlier seeds (6.25%) and lack of adequate training and information (6.25%) whereas medium farmers reported for lack of irrigational facilities (3.75%).

Seed rate (kg/ha) is significantly lower for the hybrid than for HYVs. The use of chemical fertilizer is also 25.97 per cent higher than that for HYVs. While in case of non-adopter of hybrid rice, it is higher by 23.96 per cent. Labour use is significantly higher for the hybrid than that for HYVs. However, more labour is used in transplanting of hybrid rice (25.14 days) as compared to HYVs (21.18 days). Among all the components of total cost, expenditure on human labour formed the single largest item accounted for 27.62 per cent and 33.64 per cent of the total cost for hybrid and inbred varieties respectively. The cost incurred on seed was next one which formed about 14.17 per cent of total cost for hybrids whereas that was calculated at 4.80 per cent for HYVs. Total cost of input was about 27.42 per cent higher for hybrids than that for HYVs. The total seed cost for hybrid rice was about 3.75 times higher than that for HYVs.

During 2010-11, the farmers growing hybrid rice received a gross return of Rs. 83719.18 per hectare while the gross return for inbred varieties was Rs. 54178.66. Thus, the gross return was 54.52 per cent higher in hybrid rice cultivation. However, the profit (net return) realized in hybrid and inbred rice was Rs. 59966.93 and Rs. 35538.10 per hectare respectively. Thus, the profit gain realized in hybrid rice production was Rs. 24428.83 per hectare or 68.74 per cent over inbred varieties of

rice. Consequently the benefit cost ratio was also higher in hybrid rice cultivation (3.52:1). Now, net return from hybrids over the reference periods has merely decreased from Rs. 60138.94 per hectare in 2009-10 to Rs. 59966.93 per hectare in 2010-11 accounting for 0.28 per cent decreased in 2010-11.

Hybrids have hulling, milling and head rice recovery ratio of 66.67 per cent, 63.16 per cent and 60.01 per cent respectively. The corresponding figures for HYVs were calculated at 70.58 per cent, 65.22 per cent and 61.86 per cent respectively whereas Non-adopter reporting hulling ratio (71.43%), milling ratio (66.66%) and head rice recovery ratio (65.21%).

On an overall average of size group 62.26 per cent and 42.89 per cent 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. 1240.28 per quintal and Rs. 1221.53 per quintal for hybrid and HYVs rice respectively.

Very little variation was found in quantity sold by the farmer for hybrid and HYVs because most of sample size was marginal and small farmer, they used their produce in large quantity as home consumption and remaining amount sold for purchasing agriculture inputs.

On overall size 63.01 per cent and 43.74 per cent were found to be sold in the market on an average price of Rs. 1242.63 and Rs. 1227.67 per quintal by adopters of hybrid rice and HYVs rice growers respectively while, non-adopters of hybrid sold their 42.44 per cent of total output in the market on an average rate of Rs. 1217.88 per quintal. 42.83 per cent and 43.33 per cent of their output were found to be sold in the market on an average price of Rs. 1816.80 per quintal and Rs. 1965.33 per quintal by adopters of hybrid and HYVs rice respectively while, non-adopters sold 44.06 per cent of their total produce in the market with on an average price of Rs. 1964.52 per quintal. 70.12 per cent and 46.12 per cent of their total produce were estimated to be sold in the market on an average price of Rs. 1821.87 per quintal and Rs. 1967.53 per quintal by adopters of hybrid and HYVs growers respectively; while non-adopters

sold their 53.64 per cent of total output in the market on an average price of Rs. 1965.64 per quintal.

Most of the hybrid adopters sold their greater proportion of paddy output immediately after the harvest in the month of November and December, although the marketing was spread over the month except April to October.

During the year 2010-11, in case of hybrid adopters, 21.19 per cent and 23.96 per cent of total annual sales of hybrid paddy occurred in the month of November and December respectively as against the corresponding proportions of 26.53 per cent and 35.16 per cent for HYVs respectively.

Most of the sample farmers both hybrid adopter and non adopters have not been able to received high prices and greater amount of sales in the month of November and December just after harvest the crops was mainly effected by the small land holders who compelled to sell their output to meet their bare requirement.

73.50 per cent of the sample farmers reported extension worker of the state department of the agriculture as their source of awareness about hybrid rice technology.

Demonstration of the hybrid rice for the extension of hybrid rice cultivation included PHB-71 as reported by 42.00 per cent having yield advantage of 72.00 per cent over HYVs, US-312 (35%) with 65.00 per cent yield advantage and PAC-835 (28%) with 58.00 per cent of yield advantage.

Usual source of seed for the farmers 68.00 per cent of total farmers reported government supply as source of seed. However, seeds available during planting time were reported by 39.50 per cent of the farmers and only 10.50 per cent of the farmers who reported availability of seeds at reasonable price.

Yield gain of (10-15%) more in hybrid rice production was reported by 15.50 per cent of the sample farmers. Yield received of (15-20%) more in hybrid rice was informed by 32.75 per cent of the respondent farmers and yield realized in hybrid rice higher

by 20.00 per cent and above as compared to inbred (HYVs) rice was reported by 43.50 per cent of the farmers.

A major proportion (85.50%) of the respondent farmers also noticed to have used recommended doses of the fertilizer input. There was some reasons concerned with sample farmers those who have not used fertilizer in recommended doses, reported lack of knowledge (44.25%) and financial constraint (55.75%) as the main reasons for non-adoption of recommended doses of the fertilizer.

Majority of the sample farmers 84.50 per cent know the correct way of using and doses of plant protection pesticides for general and hybrid rice. While, 79.50 per cent of the respondents reported know correct doses of pesticides for hybrid seed variety.

Most of the respondent farmers (71.50%) reported to be negative in responses of more requirement of credit for using hybrid seed one of those who require credit, 38.00 per cent of sample farmers reported that they get credit from the institutional sources.

One of the major problems notified by the adopters included poor cooking and keeping quality (78%), poor grain quality and as a result lack of market acceptance 88.50 per cent, traders not accepting hybrid rice grain lack of demand from millers and consumers 81.50 per cent and rice broken more after milling 52.00 per cent.

All the sample farmers (cent-per cent) reported that there was more yield gain in hybrid over the best popular inbred rice varieties (HYVs). Also hybrid rice production was considered to be more profitable as response by 74.50 per cent of the sample farmers. Almost 88.50 per cent of the sample farmers reported that grain quality of hybrid rice is poor as compared with the grain quality of the existing HYVs varieties of rice while about 56.25 per cent of the farmers said hybrid rice is not suitable for their taste.

About 38.00 per cent of sample non-adopters reported that they have not heard about new variety of hybrid rice while 62.00 per cent of the non adopting farmers viewed in favour of heard about some varieties of hybrid rice and as such varieties

are PHB-71 as reported by 59.68 per cent of the farmers corresponding to US-312 (62.45%) and PAC-835 (68.03%).

Majority 60.50 per cent informed that they have received suggestions from Agricultural Extension Officer (AEO) of the state department of agriculture followed by Village Level Worker (VLW) with 42.18 per cent and known from government demonstration 25.25 per cent.

According to non-adopting farmers, yield gain but less profitability of hybrid rice (66.50%) is major reasons for non-adopting of hybrid rice followed by seed is too costly 42.00 per cent and not heard of the government assistance for expansion of hybrid rice seed with 30.00 per cent responses. Government seed germination too low is reported by 26.00 per cent of sample respondents.

Policy Implications

On the basis of above findings and field level observations followings are the policy implications:

1. The cost of irrigation, seeds and pesticides were significantly higher in hybrid rice production than HYVs, which may be reduced by providing skill oriented training & incentivization programme to hybrid rice growers over HYV rice growers ***(Attn: Directorate of Agriculture, Government of Bihar).***
2. The access for hybrid rice technology was poor. So there is need to promote such technology by way of training, extension services, monitoring etc. ***(Attn: Directorate of Agriculture, Government of Bihar).***
3. Since most of the hybrid adopters sold their output just after harvesting causing them low returns, so hybrid adopters should be encouraged to process and sell husked paddy to make it more profitable. It requires proper storage facilities also **(*Attn: Directorate of Agriculture, Government of Bihar).***
4. Most of hybrid adopters reported about the quality of hybrid in terms of cooking and keeping was much poor. So there is need to improve the quality by promoting more scientific applications ***(Attn: SAUs, Government of Bihar).***
5. Adoption of hybrid paddy was found poor, which needs to be increased. ***(Attn: Directorate of Agriculture, Government of Bihar).***

6. Since efforts is required to encourage small & marginal farmers for adoption of hybrid rice. To popularize the same, distribution of rice minikits (hybrid rice kits) among them should be at larger scale ***(Attn: Directorate of Agriculture, Government of Bihar).***
7. Effective implementation and monitoring of NFSM (Rice) and BGREI Programme is need of hour to increase the rice area, production and yield in the state because of high potentiality of the region/state in terms of having rice based cropping system ***(Attn: Directorate of Agriculture, Government of Bihar).***

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