ACTA SCIENTIFIC AGRICULTURE (ISSN: 2581-365X)

Volume 3 Issue 1 January 2019

Research Article

Comparative Study of Input Use, Productivity and Profitability of Improved and Hybrid Rice in Kapilvastu, Nepal

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Received: December 04, 2018; **Published:** December 14, 2018

Abstract

The study was conducted in Yashodhara rural municipality of Kapilvastu district to compare the input use, productivity and profitability of improved and hybrid rice. Altogether 60 samples were taken; 30 each from improved and hybrid rice growers. Interview schedule was prepared, and selected household were interviewed. Data entry and analysis was done using SPSS and MS Excel. The analysis showed that in nursery stage, the quantity of seed used was significantly higher for improved rice (47.8 ± 0.8 kg/ha) than hybrid rice (15.5 ± 0.3 kg/ha) whereas the quantity of DAP used was significantly higher in hybrid rice (21.7 ± 0.4 kg/ha) than improved rice (20.3 ± 0 kg/ha) however other inputs were not significantly different ($P > 0.05$).In 'transplanting-harvesting' stage, labor used in improved rice (75.7 ± 0.2 man days/ha) was significantly higher than in hybrid rice (68.8 ± 0.3 man days/ha) whereas organic manure (1786.7 ± 109.8 kg/ha), urea (261.3 ± 3.7 kg/ha) and machinery used (7 ± 0.1 hour/ha) in hybrid rice was significantly higher than organic manure (1368.5 ± 129.1 kg/ha), urea (185.5 ± 3.3 kg/ha) and machinery used (6 ± 0.1 hour/ha) in improved rice however other inputs were not significantly different ($P > 0.05$). The productivity of hybrid rice (4.3 ± 0 ton/ha) was found to be significantly higher than improved rice (3.4 ± 0 ton/ha). BCR of hybrid rice (1.3) was found significantly higher than BCR of improved rice (1.2).

Keywords: Hybrid Rice; Improved Rice; Input Use; Productivity; Profitability

Introduction

Agriculture is the mainstay of Nepalese economy. Agriculture contributed 28.89% of the total GDP of the country [1]. Rice is the most important food crop of Nepal accounting for half of the cropped area and food production. In Nepal improved or open pollinated varieties (OPVs), hybrids and local varieties of rice are grown. A total of 270 rice varieties are grown in different ecological regions of Nepal of which improved varieties occupy 82%, local varieties occupy 10.2% and hybrids occupy 7.4% of rice cultivated area [2]. Out of the 80 varieties released (number 62) and registered (number 18) in Nepal till 2014, 63 are improved and 17 are hybrids.

Improved rice still dominates the area under rice but in recent years area under hybrid rice is increasing. This may be due to the stagnant yield and low productivity of improved rice. It was noted from the research that hybrid rice has the potential to significantly increase rice yields, often to the range of 15-30% relative to local or even modern high yielding varieties [3]. After the unveiling of the profitability and the impacts of hybrids in assuring the food security there has been a surge of registration of hybrids in Nepal. As of 2014, there were nearly 300 hybrids notified out which 17 notified hybrids are of rice crop [3]. Most of the hybrid seeds come from India and few from China. Farmers cultivate hybrid rice based on their own practices and are unaware of the technicalities of hybrid rice cultivation.

Food insecurity is often linked with the decreased rice production because rice contributes more than 50% of grain requirement and more than 30% of calorie intake. 33 out of 75 districts were found to be food insecure [4]. In past few decades the increase in production of rice is not satisfactory and the pressure of population growth is ever increasing. Increase in yield of Rice in Terai which is the bread basket of Nepal was 1.77 during 1991-2012 compared to 1.78 during 1974-1990 and the increase in area under rice cultivation was 0.07 in 1991-2012 compared to 0.15 in

1974-1990 [5]. It is evident that the increase in yield is static and the increase in area under rice cultivation is in decreasing side. This is a serious situation and demands concern of the stakeholders.

Nepal is a net importer of rice. In 2012/13 Nepal imported rice amounting Rs 9.23 billion or 259,045 tons [5]. The rise in prices has also resulted in the low purchasing power of the people of Himalayan districts making them vulnerable to food insecurity. Therefore, it is vital to increase the production and productivity of rice through a certain technology in order to address the present demand and to improve the income and livelihood of farmers of Nepal. But the present varieties used by the farmers (improved rice) cannot provide such breakthrough because they require more seed rate and labor but still gives low yield. At the same time the resource use efficiency, productivity and profitability of hybrid rice is also not known.

Rice is the principal food crop of Nepal and same is the case with Kapilvastu district. Most of the farmers of Kapilvastu cultivate improved varieties such as Ram dhan, Sava manisha, Kalanamak, Sabitri, Radha-4, etc. In year 2016/17 the rice cultivated area was 70560 ha and production was 158230 Mt with productivity of 2.24 ton/ha [6]. The productivity of rice in Kapilvastu is significantly lower which will be unable to feed the growing population in near future. Therefore there is a need of a technology that will radically increase the rice production in the district and hybrid rice is that technology. Hybrid rice provides substantial yield advantages over conventional rice or improved rice.

The inputs use, and the productivity of improved rice is known and studied but there has been very little study about the input use pattern and productivity analysis of hybrid rice. The profitability of adoption of hybrid rice is dependent on how input use pattern is altered and how much significant the productivity is [7]. This study aims to find out productivity, profitability and the difference in inputs use between the hybrid and the improved varieties of rice. The comparative study of input use, productivity and profitability between hybrid and improved rice is thus essential to find out which one is better and for the diffusion of better rice varieties to other areas of Nepal.

Methodology

The study was conducted at Baidauli and Rangapur village under Yasodhara rural municipality of Kapilvastu district of Nepal. It lies between Latitude 27° 25' to 27° 84' due North and Longitude 82°75' to 83°14' due East and is 90-824 meter above sea level. The area was purposively selected as hybrid rice along with improved rice is popularly cultivated in this area. 60 samples, 30 each cultivating improved and hybrid rice were selected randomly for the study.

The primary data were collected using Focus Group Discussion (FGD), Key Informant Interview (KII) and interview schedule. Secondary data were collected through relevant books, journal articles, DADO report and MoAD reports. The collected data were compiled, tabulated and analyzed using MS-Excel and SPSS. Descriptive and inferential tools of statistics were used.

Gross margin

Gross margin is the value of output by producer, which is computed at the farm gate price minus total variable cost.

Gross margin = Gross return - Total variable cost

Where, Gross return= Price × total quantity marketed

Total variable cost = Summation of cost incurred in all the variable items

Benefit cost analysis

Benefit cost analysis was done after calculating the total cost and gross return from the rice cultivation. Cost of production was calculated by summing the variable cost items in the production process. For calculating gross return, income from product sale was accounted. Therefore, the benefit cost analysis was carried out by using formula:

B/C ratio= Gross Return

Total cost

t test

Two tailed independent sample t test was used to compare the means between improved and hybrid rice about the amount of inputs used, cost of inputs, cost of production, days to maturity and productivity. The t- value was calculated by using following formula.

$$t\ value = \frac{\bar{x}_1 - \bar{x}_2}{sp(1 + n_1 + n_2)^{1/2}}$$

where,

¯x_1 = Mean of first sample

¯x_2=Mean of second sample

n_1 = Sample size (i.e., number of observations) of first sample

n_2 = Sample size (i.e., number of observations) of second sample

sp = Pooled standard deviation

The variables were tested at 0.05% level of significance. Mean values with different superscript letters in the same row indicate significant difference between the variables ($P < 0.05$).

Results and Discussion

Socio-demographic characteristics of the respondents

Household characteristics

It was found in the study area that the average age of the household head in the family members was 45.0 years and 47.4 years respectively for improved and hybrid rice growers. The average family size cultivated area and farming experience was slightly higher for hybrid rice growers than improved rice growers as shown in the table 1. It showed the higher adoption of hybrid rice technology by experienced farmers.

Variables	Improved	Hybrid
Age of HH head (years)	45.0 ± 13.5	47.4 ± 14.0
Family size	7.6 ± 3.0	7.8 ± 3.0
Cultivated area (ha)	1.43 ± 0.84	1.58 ± 1.1
Farming experience	14.3 ± 6.8	15.03 ± 1.1

Table 1: Household characteristics of improved and hybrid rice growers of Kapilvastu, Nepal (2018).

Education level

Figure 1 shows the poor educational status of the study area. About 30 percent both of improved and hybrid rice growers were illiterate and only 3.3 percent of them acquired university level education. Farmers acquiring secondary education and higher secondary education were mostly involved in improved rice cultivation while most of the farmers with primary education are involved in hybrid rice cultivation.

Input use

The inputs considered are seed, organic manure, chemical fertilizers, irrigation water, pesticide, labor and machinery used. The inputs used by improved and hybrid rice in nursery stage and 'transplanting-harvesting' stage was compared and analyzed by using t test. The results are discussed below.

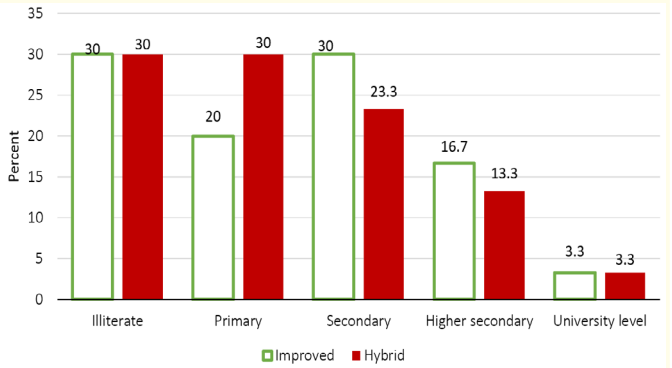

Figure 1: Education level of improved and hybrid rice growers in Kapilvastu, Nepal (2018).

The input use parameters in the nursery stage of rice are presented in table 2.

Parameter	Improved	Hybrid
Seed (kg)	47.8 ± 0.8^a	15.5 ± 0.3^b
Organic manure (kg)	172.3 ± 6.7^a	186.7 ± 8^a
Urea (kg)	11.4 ± 0.3^a	12 ± 0.4^a
DAP (kg)	20.3 ± 0^b	21.7 ± 0.4^a
MOP (kg)	3.2 ± 0^a	3 ± 0.1^a
Herbicide (ml)	28.5 ± 0.8^a	30.3 ± 0.^{6}a
Irrigation (hr)	0.4 ± 0^a	0.5 ± 0^a
Labor (man days/ha)	0.9 ± 0^a	0.9 ± 0^a
Machinery (hour/ha)	0.5 ± 0^a	0.5 ± 0^a

Table 2: Input use parameters of improved and hybrid rice during Nursery stage (Mean ± SD) in Kapilvastu, Nepal (2018).

*Mean values with different superscript letters in the same row were significantly different ($P < 0.05$)

Organic manure, urea, muriate of potash (MOP), herbicide, irrigation, labor and machinery were not significantly different ($P > 0.05$) between improved and hybrid rice while quantity of seed and DAP were significantly different ($P < 0.05$) between improved and hybrid rice. The quantity of seed used was significantly higher for improved rice (47.8 ± 0.8 kg/ha) than hybrid rice (15.5 ± 0.3 kg/ha). It may be due to the fact that farmers are aware about less seed rate requirement of hybrid rice. Similarly, the quantity of DAP used was significantly higher in hybrid rice (21.7 ± 0.4 kg/ha) than improved rice (20.3 ± 0 kg/ha).

The input use parameters in the 'transplanting-harvesting' stage is presented in table 3.

Parameter	Improved	Hybrid
Organic manure (kg)	**1368.5 ± 129.1^b**	**1786.7 ± 109.8^a**
Urea (kg)	**185.5 ± 3.3^b**	**261.3 ± 3.7^a**
DAP (kg)	93.3 ± 1.4^a	96.8 ± 1.7^a
MOP (kg)	47.1 ± 2^a	51.1 ± 1.8^a
Insecticide (ml)	397.5 ± 6.4^a	410.4 ± 5.1^a
Herbicide (ml)	205.3 ± 3.9^a	212.5 ± 3.1^a
Irrigation (hr)	60 ± 1.3^a	62.2 ± 0.9^a
Labor (man days/ha)	**75.7 ± 0.2^a**	**68.8 ± 0.3^b**
Machinery (hour/ha)	**6 ± 0.1^b**	**7 ± 0.1^a**

Table 3: Input use parameters of improved and hybrid rice during 'Transplanting-Harvesting' stage in Kapilvastu, Nepal (2018).

*Mean values with different superscript letters in the same row were significantly different ($P < 0.05$)

DAP, MOP, insecticide, herbicide and irrigation were not significantly different ($P > 0.05$) between improved and hybrid rice. Organic manure, urea, labor and machinery were found significantly different ($P < 0.05$) between improved and hybrid rice. Labor used in improved rice (75.7 ± 0.2 man days/ha) was significantly higher than in hybrid rice (68.8 ± 0.3 man days/ha). It may be due to lower seeding rates and higher use of machinery in hybrid rice cultivation. Organic manure used in hybrid rice (1786.7 ± 109.8 kg/ha) was significantly higher than improved rice (1368.5 ± 129.1 kg/ha). It might be because of the perception of farmers that hybrid rice requires higher nutrients than improved rice. Similarly, urea used in hybrid rice (261.3 ± 3.7 kg/ha) was significantly higher than improved rice (185.5 ± 3.3 kg/ha). Hybrid rice growers used higher amount of urea because they expected a higher yield in response to higher urea dose from hybrid rice. Likewise, machinery used in hybrid rice (7 ± 0.1 hr/ha) was significantly higher than improved rice (6 ± 0.1 hr/ha). It may be due to higher spacing of hybrid rice and availability of tractors and combined harvester easily in the study area.

In present study, seed requirement for hybrid rice was 15.5 kg/ha compared to 47.8 kg/ha for improved rice. Similarly, in their study, Azad*., et al.* (2015) found that seed requirement of hybrid rice was 15 kg/ha compared to 66 kg/ha of improved rice [8]. In present research, organic manure and Urea requirement for hybrid rice was higher by 30.56% and 40.86% respectively than improved rice while DAP and MOP requirement for hybrid rice was slightly higher (3.75% and 8.5%) than improved rice. It was reported in the research that Organic manures used for hybrids was nearly 71% higher than that of improved varieties while chemical fertilizer used for hybrid was only 12% higher than improved varieties [9]. It was found that the amount of insecticide and herbicide used in hybrid was higher by only 3.51% and 3.67% respectively than improved rice and it was non-significant. It indicates that problem of insect infestation and weed competition in hybrid rice is similar to improved rice. The biotic stress resistance of hybrid rice is determined by the resistance of their parental lines and evaluating whether this resistance was dominant or recessive [10]. In the present research, hybrid rice cultivation required 9.12% less labor than improved rice. The research reported that hybrid rice uses 4% less labor than improved rice [7].

Days to maturity and productivity

The result for the days to maturity and productivity of improved and hybrid rice is shown in table 4. Days to maturity and productivity were significantly different ($P < 0.05$) between improved and hybrid rice. The days to maturity for improved rice (148.03 ± 1 days) was found significantly higher than hybrid rice (122.27 ± 0.8). The productivity of hybrid rice (4.3 ± 0 ton/ha) was found to be significantly higher than improved rice (3.4 ± 0 ton/ha). Productivity of hybrid rice was 26.5% higher than improved rice. Hybrid rice yields 20-30% more than the improved rice with adequate management [11].

Economics of production

Average cost of production of inputs

Successful rice cultivation requires higher amount of different inputs along with proper care and management. The production cost involves the cost of seed, organic manure, chemical fertilizers, herbicide, irrigation, labor and machinery. In the study area, human labor was one of the major attributing items among all variable items and was computed in term of man per day. Human labor was required for performing different operations such as nursery bed preparation, land preparation, fertilizer application, pesticides application, irrigation, weeding, harvesting, storage etc. The chemical fertilizer cost was calculated by summing up the cost of urea, DAP and MOP. All the costs are presented in Nepalese rupees and are on per hectare basis.

Average cost of production of improved and hybrid rice production is shown in table 5.

Parameter	Improved	Hybrid
Seed	3809.9 ± 67.^{3}b	5484.5 ± 91.7^{a}
Organic manure	2231.2 ± 181^{b}	2960 ± 162.9^{a}
Chemical fertilizer	11743.7 ± 145.9^{b}	13868.6 ± 134.6^{a}
Insecticide	477.04 ± 7.7^{a}	492.52 ± 6.2^{a}
Herbicide	4588.7 ± 74.4^{b}	4856 ± 65.4^{a}
Irrigation	6318.9 ± 171.5^{a}	6264.87 ± 94.9^{a}
Labour	30658.7 ± 91.3^{a}	27920 ± 129.2^{b}
Machinery	12813.7 ± 278^{b}	14199.7 ± 305.1^{a}

Table 5: Average cost(inRs) of production of different inputs in Kapilvastu, Nepal (2018).

*Mean values with different superscript letters in the same row were significantly different (P < 0.05)

The cost for insecticide and irrigation was not significantly different (P > 0.05) between improved and hybrid rice. The cost for labor, seed, organic manure, chemical fertilizer, herbicide and machinery was found significantly different (P < 0.05) between improved and hybrid rice. The cost of labor in improved rice (Rs 30658.7 ± 91.3) was significantly higher than hybrid rice (Rs 27920 ± 129.2). The cost for seed (Rs 5484.5 ± 91.7), organic manure (Rs 2960 ± 162.9), chemical fertilizer (Rs 13868.6 ± 134.6), herbicide (Rs 4856 ± 65.4) and machinery (Rs 14199.7 ± 305.1) for hybrid rice was found significantly higher than the cost of seed (Rs 3809.9 ± 67.3), organic manure (Rs 2231.2 ± 181), chemical fertilizer (Rs 11743.7 ± 145.9), herbicide (Rs 4588.7 ± 74.4) and machinery (Rs 12813.7 ± 278) for improved rice. The cost of seed for hybrid rice was higher because of the expensive market price of hybrid seeds. The cost of other items for hybrid rice was higher because hybrid rice required higher amount of those inputs than improved rice.

Item wise cost of production

The highest cost of production was occupied by labor cost. The labor cost for improved rice (42.21%) was seen higher than hybrid rice (36.74%) which may be because of lower seed rate of hybrid rice. For hybrid rice, the cost of machinery (18.69%) and cost of chemical fertilizer (18.25%) was found higher than the cost of machinery (17.64%) and chemical fertilizer (16.17%) of improved rice. The cost of seed for hybrid rice (7.22%) is greater than improved rice (5.24%) which is obviously due to higher market price of hybrid seeds. The cost for organic manure (3.90%), insecticide (0.65%), herbicide (8.24%) and irrigation (8.24%) of hybrid rice was found similar to the cost of organic manure (3.07%), insecticide (0.66%), herbicide (6.32%) and irrigation (8.7%) of improved rice.

Type of rice	Seed	Organic manure	Chemical fertilizer	Insecticide	Herbicide	Irrigation	Labor	Machinery
Improved	5.24%	3.07%	16.17%	0.66%	6.32%	8.7%	42.21%	17.64%
Hybrid	7.22%	3.90%	18.25%	0.65%	6.39%	8.24%	36.74%	18.69%

Table 6: Item wise cost of production of improved and hybrid rice production in Kapilvastu, Nepal (2018).

Economic indicator of improved and hybrid rice production

Economic indicator of improved and hybrid rice production is shown in table 7.

Parameter	Improved	Hybrid
Total variable cost (Rs)	72641.8 ± 482.8^{b}	75986.2 ± 395.7^{a}
Cost per quintal (Rs)	2146.8 ± 26.7^{a}	1757.3 ± 11^{b}
Farm gate price (Rs)	25.8 ± 0.1^{a}	22.9 ± 0.1^{b}
Gross returns (Rs)	87413 ± 790.7^{b}	98860 ± 590.3^{a}
Gross margin (Rs)	14771.2 ± 943.6^{b}	22873.8 ± 556.1^{a}
BCR	1.2 ± 0^{b}	1.3 ± 0^{a}

Table 7: Economic indicators of improved and hybrid rice production in Kapilvastu, Nepal (2018).

*Mean values with different superscript letters in the same row were significantly different (P < 0.05)

Total variable cost, cost per quintal, farm gate price, gross returns, gross margin and BCR all were significantly different (P < 0.05) between improved and hybrid rice. Cost per quintal (Rs 2146.8) and farm gate price (Rs 25.8) of improved rice were significantly higher than cost per quintal (Rs 1757.3) and farm gate price (Rs 22.9) of hybrid rice. Total variable cost (Rs 75986.2), gross returns (Rs 98860), gross margin (Rs 22873.8) and BCR (1.3) of hybrid rice were significantly higher than total variable cost (Rs 72641.8), gross returns (Rs 87413), gross margin (Rs 14771.2) and BCR (1.20) of improved rice. In the similar research, it was found out that average cost of production of rice in Nepal was Rs 60000 with gross returns of Rs 80000, Gross margin of Rs 20000 and BCR of 1.33 in year 2013/14 [12].

The results indicate that the cost of production of hybrid rice is only marginally higher (4.6%) than improved rice. It was noted that additional cost of production for hybrids averages 5% with a range of 1% to 18% across countries [13]. In present research, hybrid rice has 54.85% higher gross margin than improved rice. Also, The BCR of hybrid rice (1.3) is higher than improved rice (1.2). Thus, cultivation of hybrid rice is more profitable than improved rice. It was reported in a research that the marginal returns of hybrid over inbred averages about 27%, ranging from 23% to 119% across countries and the benefit-cost ratio of hybrids (1.7) is only marginally higher than that of inbred (1.6) [13].

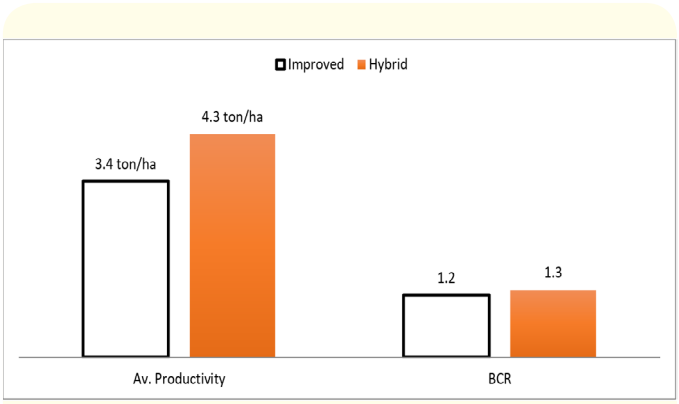

Figure 2: Comparison of improved and hybrid rice in terms of productivity and profitability.

Conclusion

In the nursery stage, the amount of seeds required was significantly higher for improved rice than hybrid rice whereas the amount of DAP required was significantly higher for hybrid rice than improved rice. In 'transplanting to harvesting stage' amount of labor required was significantly higher for improved rice whereas the amount of organic manure, urea and machinery required was significantly higher for hybrid rice. The productivity of hybrid rice was found significantly higher than improved rice. Total variable cost, gross returns and BCR of hybrid rice was significantly higher than improved rice. The higher gross returns of hybrid rice is offset by lower grain price however the cultivation of hybrid rice is profitable than improved rice.

It is concluded from the study that hybrid rice has higher productivity and is more profitable than improved rice. The use of hybrid rice ensures less labor and is thus helpful in places where labor is scarce. The inputs used by hybrid rice are higher than improved rice and therefore careful management of inputs and other agronomic practices would certainly ensure resource use efficiency thereby increasing productivity of rice. Thus, increased adoption of hybrid rice technology is necessary to increase the stagnant yield and benefit the farmers economically.

Bibliography

1. MoAD. Krishi Diary. GoN, MoAD, Agriculture Information and Communication Centre, Hariharbhawan, Lalitpur (2018).

2. Virmani SS and Donald LS. "Hybrid Rice". In Advances in Agronomy 57 (1996): 377-462.

3. Mallick RN. "Rice in Nepal". KalaPrakasan. Kathmandu, Nepal (1981).

4. CDD and ASoN. Rice science and Technology in Nepal (MN Paudel, DR Bhandari, MP Khanal, BK Joshi, P Acharya and KH Ghimire, eds). Crop Development Directorate (CDD), Hariharbhawan and Agronomy society of Nepal (ASoN), Khumaltar (2017): 976.

5. Joshi GR and Pandey S. "Farmers' perceptions and adoption of modern rice varieties in Nepal". *Quarterly Journal of International Agriculture* 45.2 (2006): 171.

6. DADO, Kapilvastu. Yearly agricultural development program and statistical book 2072/73. Taulihawa, Kapilvastu: District Agriculture Development Office (2016).

7. Lin JY. "Impact of hybrid rice on input demand and productivity". *Agricultural Economics* 10.2 (1994): 153-164.

8. Azad MAS., *et al*. Hybrid Rice: Economic Assessment of a Promising Technology for Sustainable Food Grain Production in Bangladesh (2015).

9. Husain MM., *et al*. "Hybrid Rice Adoption in Bangladesh: A Socioeconomic Assessment of farmers' Experiences". *Research Monograph* 18 (2001): 1-50.

10. Pandey P and Tiwari DK. "Modern techniques and agronomic packages for hybrid rice cultivation in India". *AAB* 4.1 (1994): 17-21.

11. IRRI, Hybrid Rice. In Proceedings of the International Symposium on Hybrid Rice. Hunan, China 1986 (1988): 6-10.

12. Bhandari NB., *et al*. "Cost, production and price spread of cereal crops in Nepal: A time series analysis2071/2072 (2014/2015)". (2015).

13. Xie F and Hardy B. Accelerating hybrid rice development. Los Baños (Philippines): International Rice Research Institute (2009): 698.

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