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Resource Use Efficiency in Hybrid and Inbred Rice Production in Uttarakhand

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Authors' contributions

This work was carried out in collaboration between all authors. Authors AP and HNS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author RSS managed the analyses of the study. Author AP managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Present study was conducted to evaluate resource use efficiency in hybrid and inbred rice cultivation in Udham Singh Nagar district of Uttarakhand, which was purposively selected. Three stage sampling technique was employed for constructing sampling plan. Probability proportion technique was followed to select respondents which make a sample size of 60 farmers comprising of 28 small, 17 medium and 15 large farmers from 4 villages. In this paper, we examined and compared resource use efficiency of hybrid and inbred rice varieties in study area. The results of study revealed that coefficient of multiple determinations (R^2), 80 per cent, variation in the yield of hybrid rice and inbred rice. Result shows that cultivation of hybrid rice seems more profitable than inbred rice of farmers in Uttarakhand. There should be concentrated effort made to expand area under hybrid rice cultivation.

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1. INTRODUCTION

Rice cultivation is an important constituent of hill agriculture because rice is staple food of Uttarakhand. It is a main crop of the state and grown in an area of about 2.94 lakh hectares (2010-11) accounting for over 54.00 percent of total area of cereal. The state having total production 5.50 lakh tones out of which plains and hills constitute about 3.72 (67.60 percent) and 1.78 (32.40 percent) lakh tones respectively. Average productivity of rice in the state is around 20.50 Qtl. per ha [1].

Agriculture is the main source of income for the families in India. Farms (arable land) cover half of the land and almost three-quarter of that land is used to grow the two major cereals rice and wheat. Rice (*Oryza sativa* L.) is the primary food for more than 3 billion people around the world and show one fourth of the global rice area (about 40 million ha) is rainfed lowlands of the humid and sub-humid tropics of South and South-east Asia and Africa. Worldwide, India stands first in rice area and second in rice production after China. India's annual rice production is around 85-89 million tons. It contributes 21.5 percent of global rice production. The population of our country has increased around 18 crore but production of rice increased by around 10 million tons in last decade [2].

Farmers are fail to get benefit of technologies and made allocative errors which showed that wider variation in yield, usually reflecting a corresponding variation in the management capacity of the farmers. This shows that considerable scope exists for raising productivity and income of the farmers by improving their efficiency [3].

The factors responsible for inefficiencies need to be identified and addressed properly for achieving a higher production in paddy. The launching of Hybrid variety in India has enhanced the importance of the study of efficiency in crop production. The concept of efficiency is vital to policy makers both at micro and macro levels. Policies related to land distribution, land ceilings, equal distribution of income agricultural education and extension services. Studies on resource use efficiency in paddy cultivation focus on the possibility of increasing the paddy yield while conserving the resources. In this paper, an attempt has been made to examine resource use efficiency from hybrid rice and inbred rice production among different size groups of farmers [4].

2. DATA AND METHODOLOGY

The present study was conducted in Udham Singh Nagar district of Uttarakhand which was selected purposively. Study was based on primary as well as secondary data. A three stage sampling technique was used for selection of the farmers. Out of seven blocks in the district, two blocks and from each block four villagers were selected randomly. The farmers were categorized into three group on the basis of land holding *i.e.* Small (<2 ha), Medium (2-4 ha) and Large (>4 ha) and probability proportion to size method was used to select farmer. Therefore, a sample of 60 hybrid rice growers was obtained which were 28, 17 and 15 on small, medium and large sized farms, respectively.

The resource use efficiency was calculated by using Cob Douglas production function [5].

Cob Douglas production function with its variable which was used given below-

$$Y = a X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} e$$

Where,

- Y = Yield in qtl per hectare
- X_1 = Seed (Kg per ha)
- X_2 = Expenditure on fertilizers in Rs per ha
- X_3 = Irrigation in number
- X_4 = Human labour in man days
- X_5 = Expenditure on machine power in Rs per ha
- X_6 = Expenditure on plant protection chemicals in Rs per ha
- e = Error term

b_1, b_2, b_3, b_4, b_5 and b_6 are the respective partial regression coefficients *i.e.* seed, expenditure on fertilizers, irrigation number, human labour, expenditure on machines and expenditure on plant protection chemicals respectively, (elasticity of production) of the explanatory variables.

3. RESULTS AND DISCUSSION

3.1 Resource Use Efficiency

The production elasticities of seed quantity showed that one percent increase in use of seed is positive and statistically significant increase in productivity of inbred rice by 0.45 percent, 1.23 percent, respectively on small, large size farm, but expected to significantly increase in productivity of inbred rice by 0.3117 percent in overall basis. Whereas, for hybrid rice the production elasticity of seed quantity indicates that one percent significant increase in the seed quantity will lead to increase in the hybrid rice yield by 2.93, 2.97 percent on medium size and large sized in hybrid rice grower.

The regression coefficient of expenditure on fertilizer was found to be positive and significant in all types of farmers, using inbred varieties. Production elasticity of expenditure on fertilizer show that one percent increase of use of expenditure on fertilizer will expected increase yield of inbred varieties by 1.40 per cent and 0.52 medium and large sized farms respectively, but production elasticity of expenditure on fertilizer was found to be positive in overall basis which means one percent increase in use of expenditure on fertilizer will leads to positive and significant productivity of inbred rice by 0.5033 percent. Whereas, the production elasticity of expenditures on fertilizers was also found to be positive in case of small, medium, large and overall basis size farms growing hybrid rice but was found positive and significant only at small and overall level and it will increasing the yield of hybrid rice by 0.3385 and 0.7216 percent respectively. The regression coefficient of irrigation water was found to be positive in all size of farms of growing inbred rice but found significant only in small and medium inbred rice grower by 0.19 and 0.38 per cent. Whereas, for hybrid rice only overall was significant, which indicates that one per cent increase in use of irrigation water results increase in yield of hybrid rice by 0.83 per cent.

The regression coefficient of human labour was found to be positive in all categories of farmers growing inbred rice but only overall basis found statistically significant. The regression coefficient of human labour was found to be positive in all cases of farmers growing hybrid rice. Production elasticity of human labour was statistically significant in case a small and medium size farm which indicates that one percent use of human labour will increase yield of hybrid rice by 0.0823 percent and 0.0754 percent, respectively.

Production elasticity of machine power was found to positive in all cases growing both inbred and hybrid rice. Production elasticity of machine power was statistically significant only in small size farms for inbred rice while for hybrid rice, it was statistically significant in case of large size farm and overall basis.

The regression coefficient of expenditure on plant protection chemicals was found to be positive in case of large and overall category of farmers but expenditure on plant protection chemicals was negative and significant for medium farms in inbred rice cultivators. Further, the production elasticity of expenditure on plant protection chemicals revealed that one percent increase in use of expenditure on plant protection chemicals will increase productivity of by 0.40 per cent on large size of farms in inbred rice and in case of medium farm regression coefficient of output for expenditure on plant protection chemical was negative and significant which implying that there will be decrease in the yield on increasing the use of the chemical. However, in case of hybrid rice cultivation it was significant and positive on large farms affect by 0.76 per cent while increase in expenditure on plant protection chemicals by one percent. A similar type of study was conducted on Kole land [6].

3.2 Marginal Value Product (MVP) to Marginal Input Cost (MIC) Ratios of Resources in Inbred and Hybrid Rice Production

MVP and MIC ratio of resources used in the cultivation of inbred and hybrid rice have presented in Table 2.

In case of inbred rice, on the overall basis MVP to MIC ratio of seed quantity (5.58), expenditure on fertilizer (3.10), irrigation water (12.25), human labour (4.71) and machine power (1.24) were more than one indicating that still there scope of higher utilization of these resources and which is turn would increase the gross income. This would help to maximization their profit in inbred rice cultivation, but the MVP to MIC ratio of expenditure on plant protection chemical was less than unity (-6.682) indicated excessive use of plant protection chemical. In case of hybrid rice, the MVP to MIC ratio of seed (21.67), machine power (4.63), expenditure on plant protection chemical (2.79), irrigation water (13.12), human labour (1.48) and expenditure on fertilizers (1.32) were more than one indicating

Table 1. Estimation of Cobb-Douglas production function for inbred and hybrid rice production

Category of farms	Inbred varieties				Hybrids			
	Small	**Medium**	**Large**	**Over all**	**Small**	**Medium**	**Large**	**Over all**
Number of farmers	**28**	**17**	**15**	**60**	**28**	**17**	**15**	**60**
Intercept	1.139918 (1.170626)	7.214825 (4.4119)	-0.89149 (2.08283)	6.3796** (2.7836)	-0.1739 (1.5237)	-6.1073** (2.3957)	1.3063 (2.7388)	-1.7105 (1.1502)
Seed quantity (kg/ ha) X_1	0.45298** (0.22429)	0.464154 (0.496425)	1.22628* (0.386179)	0.3117* (0.0980)	1.0690 (0.321)	2.9346** (1.2444)	2.9695* (0.7314)	2.3623* (0.7866)
Expenditure on fertilizer (Rs/ ha) X_2	0.19824 (0.098187)	1.401793** (0.456055)	0.524813* (0.13052)	0.5033** (0.2480)	0.3385* (0.1214)	0.0912 (0.1654)	0.1311 (0.1510)	0.7216* (0.1123)
Irrigation water (in number) X_3	0.193835** (0.093835)	0.380272** (0.160939)	0.004613 (0.102157)	0.0192 (0.1050)	0.0213 (0.0168)	0.0059 (0.0399)	0.0726 (0.0536)	0.8273** (0.3876)
Human labour (man days/ ha) X_4	0.464757 (0.244015)	0.26128 (0.21373)	0.06634 (0.165995)	0.2893** (0.1719)	0.0823*** (0.0448)	0.0754*** (0.0365)	0.0352 (0.0771)	0.0643 (0.05328)
Expenditure on machine power (Rs./ ha) X_5	0.122519* (0.061953)	0.04605 (0.065509)	0.207356 (0.245544)	0.1110 (0.1038)	0.3019 (0.2236)	0.0022 (0.1462)	1.1728** (0.4931)	1.3823** (0.2676)
Expenditure on plant protection chemical (Rs / ha) X_6	-0.04127 (0.146976)	-1.0742*** (0.693427)	0.40373** (0.173896)	0.0408 (0.1066)	0.0800 (0.1114)	-0.3456 (0.4171)	0.7558** (0.3343)	0.1723 (0.2876)
R^2	0.79	0.71	0.87	0.77	0.67	0.80	0.86	0.77

*Note: Figure in parenthesis indicating standard errors; *, **, and *** indicating 1, 5 and 10 percent level of significance*

Table 2. Marginal value product to Marginal input cost ratios of resources in inbred and hybrid rice production

Variables	Inbred rice								Hybrid rice							
	Small		Medium		Large		Over all		Small		Medium		Large		Over all	
	MVP (MIC)	Ratio	MVP (MIC)	Ratio	MVP (MIC)	Ratio	MVP (MIC)	Ratio	MVP (MIC)	Ratio	MVP (MIC)	Ratio	MVP (MIC)	Ratio	MVP (MIC)	Ratio
Seed quantity	277.50 (33.23)	8.35	614.93 (24.01)	25.61	1610.40 (40.50)	39.76	979.06 (21.48)	5.58	1058.08 (162.69)	6.50	3038.11 (148.06)	20.51	3224.54 (152.41)	21.15	2537.24 (117.05)	21.67
Expenditure on fertilizer	1.98 (1.00)	1.977	3.19 (1.00)	3.194	4.13 (1.00)	4.132	3.10 (1.00)	3.101	1.26 (1.00)	1.26	2.79 (1.00)	2.79	1.58 (1.00)	1.58	1.32 (1.00)	1.32
Irrigation water	1064.76 (109.44)	9.72	980.64 (113.50)	8.64	728.62 (100.50)	7.25	1258.68 (102.75)	12.25	1102.85 (118.72)	9.28	1001.99 (115.57)	8.67	1218.71 (108.04)	11.25	1169.74 (89.11)	13.12
Human labour	493.95 (180.50)	2.67	325.83 (175.60)	1.86	585.66 (170.25)	3.44	573.00 (121.75)	4.71	345.74 (178.22)	1.94	287.13 (169.90)	1.69	383.79 (164.72)	2.33	204.67 (137.62)	1.48
Machine power	0.39 (1.00)	0.39	0.76 (1.00)	0.76	4.11 (1.00)	4.11	1.24 (1.00)	1.24	4.12 (1.00)	4.12	0.03 (1.00)	0.03	1.29 (1.00)	1.29	4.63 (1.00)	4.63
Expenditure on plant protection	-3.08 (1.00)	-3.08	-7.386 (1.00)	-7.39	3.04 (1.00)	3.039	-6.682 (1.00)	-6.68	1.4254 (1.00)	1.42	-2.78 (1.00)	-2.78	4.97 (1.00)	4.97	2.79 (1.00)	2.79

Note: Figure in parenthesis indicates MIC

that still there is scope for higher utilization of these inputs and which is turn would increasing the gross income.

In case of inbred rice growing farmers on small farms, ratio of MVP to MIC for human labour (2.67), seed quantity (8.35), irrigation water (9.72) and expenditure on fertilizers (1.977) were more than one indicating that still there is scope for higher utilization of these inputs for increase gross income, but ratio of MVP to MIC of expenditure on plant protection chemical (-3.08) and machine power (0.39) was less than unity indicating excessive use of this inputs for the increasing the yield of inbred rice.

In case inbred rice growing farmers on medium farms, ratio of MVP to MIC for seed quantity (25.61), human labour (1.86), irrigation water (8.64) and expenditure on fertilizers (3.194) were more than one indicating that still there is scope for higher utilization of these inputs for increase gross income, but ratio of MVP to MIC expenditure on plant protection chemical (-7.386) and machine power (0.76) was less than unity indicating excessive use of this inputs for the increasing the yield of inbred rice.

For the large growing farmers of inbred rice, MVP to MIC ratio for seed quantity (39.76), expenditure on fertilizer (4.132), irrigation water (7.25), machine power (4.11), expenditure on plant protection chemical (3.039) and human labour (3.44) were more than one indicating that there is scope for higher utilization.

In other hand, on the farms of small hybrid rice growing farmer, ratio of MVP to MIC for seed quantity (6.50), irrigation water (9.28), human labour (1.94), machine power (4.12), expenditure on fertilizer (1.26) and expenditure on plant protection chemicals (1.42) were more than one show there is scope of utilization of these inputs which in turn would increase the gross income.

In other hand, medium hybrid rice growing farmer, ratio of MVP to MIC for seed quantity (20.51), human labour (1.69), irrigation water (8.67) and expenditure on fertilizer (1.26) and were more than one shows the there is scope of utilization of these inputs and which in turn would increase the gross income. But the MVP to MIC ratio for expenditure on plant protection chemical (-2.78) and machine power (0.03) presents excessive use of seed quantity.

For large farmers, MVP to MIC ratio for seed quantity (21.15), irrigation water (1.25), human labour (2.33), machine power (1.28), expenditure on fertilizer (1.58) and expenditure on plant protection chemical (4.97) was more than one revealed there is scope for higher utilization of the human labour which in turn would increase the gross income. Such type of study was conducted by Suresh and Reddy, 2006 and Senthil and Alagumani, 2005, [7,8] too and found the same result.

4. SUMMARY AND CONCLUSION

The level of rice production may not be sufficient to feed the ever increasing population in the future. The scope for expansion of area under rice has already been exhausted, the only way to increase the production by increasing the productivity of rice through modern technology. The hybrid rice may be potential technology to increase the average productivity level of rice in the country. Hybrid rice has potential to 20-30 per cent higher than the inbred rice within same maturity duration as reported in previous studies. In hybrid rice resource use efficiency of various resources and ratio of MVP and MIC is much better than inbred rice in Udham Singh Nagar district of Uttarakhand. In Inbred rice, MVP was negative for the plant protection chemical which reflects that marginal value of product were declining but farmers are still using chemicals. Therefore, National food security mission has accomplished its goal by using seeds of hybrid varieties. Due to under use of seeds, fertilizers and over use of plant protection measure is a need to optimize the resource so that increase profit and income of the farmer. There is a need to follow a strong extension programme in the area regarding improved cultivation practices of hybrid rice. The potential and efficiency of various production process which would ultimately benefit the producers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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