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Impact of improved varieties on farmers income: Insight from lower Shivalik hills

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ABSTRACT

High yielding varieties of cereal crops were the major contributors to India's Green Revolution in 1960s and till date these varieties have been largely contributing to India's bread basket. Uttarakhand is primarily an agricultural state although its share in the country's total area and production is negligible. In this paper the authors have attempted to measure the technical and economic efficiencies of improved varieties of paddy and wheat in lower Shivalik hills of Uttarakhand during 2017–20. Uttarakhand is primarily an agricultural state although its share in the country's total area and production is negligible. Economic efficiencies of the varieties were measured by benefit-cost ratio (BCR) and net return (NR). Technical efficiencies were measured by Box plot technique in R software. Kernal density plot was used to represent yield variation among the varieties. The findings revealed that PB 1121 paddy and HD 2967 wheat respectively were the best varieties in terms of technical efficiency (productivity) and economic efficiency (BCR and Net Return). Estimates of t-test also show the significant differences in BCR and net return between improved and local varieties. Thus, study shows that the positive impacts of improved varieties of the major crops have significantly contributed to productivity, farm income and livelihood in the lower Shivalik hills of Uttarakhand which, in turn, may provide prospective implications towards country's total production and food security.

Keywords: Benefit-cost ratio (BCR), Box plot technique, Impact on productivity, Kernal density, Net return (NR)

India is an agrarian country, where more than 50% of population is dependent on agriculture. According to the data provided by Department of Economics and Statistics (DES) the production of food grains for the year 2013–14 was 264 million tons which was more than that of 2012–13 (257 million tons). Adoption of improved varieties potentially helps the poor by augmenting producer's income and stimulating growth linkages in the economy which leads to food production, productivity, and food security. The agriculture sector of Uttarakhand is a vital sector that employs about 70% of the state's population eventhough it contributes only 17% to the state's gross domestic product (Watershed Management Directorate, Dehradun 2008). Since nearly 90% of the terrain of Uttarakhand is hilly, yield per ha isn't high. Foodgrain production of Uttarakhand has increased only by 0.06 million ton in almost a decade from 1.72 million tons in 2001 to 1.78 million tons in 2010 (Anonymous, PHD Chamber of Commerce and Industry 2011). The growth of grain production is pretty variable in different areas. As a result, the agriculture sector presents a combined picture. Instead of adequate natural resources for successful crop growth like fertile soil, 87 % irrigation water, the productivity was found not to reach a competitive level for various crops as compared to other parts of the lower Shivalik hills (i.e. Jammu region of J&K and Malwa region of Punjab) because of unavailability of improved planting materials (seed), poor access to modern technologies, poor productivity level leading to abysmally low marketable surplus in plains (Roy *et al*. 2016 and Roy *et al*. 2020). So, there have been serious efforts to introduce improved and remunerative varieties. Thus, the prime objective of this study is to analyse the efficiency of improved varieties of major food crops (paddy, wheat) with respect to technical as well as economic parameters, i.e. BCR, net return and yield. Findings provide justification of expenditure incurred on adoption of these varieties for enhancing productivity and farm income.

MATERIALS AND METHODS

Uttarakhand is primarily an agricultural state although its share in the country's total area and production is negligible. From review of literature and secondary sources

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of information, it was found that the major crops which are grown in the hills include wheat, paddy, *mandua*, *ramdana* and potato, whereas in the plains (lower Shivalik hills) the most important crops are wheat and paddy (DAC&FW 2019). Considering the above facts, the study was purposively carried out in the lower Shivalik hills of Uttarakhand during 2017–20. The delineated map shows, i.e. Jammu region of J&K and Malwa region of Punjab, parts of Haridwar, Udham Singh Nagar (Rudrapur), Champawar of Uttarakhand comes under lower Shivalik hills (Yadav *et al.* 2015, Roy *et al,* 2020). Technologies which were demonstrated and popularized for the last 10 years were considered as improved technologies, i.e. varieties (National Food Security Mission 2019). A list of improved and local varieties of major crops, i.e. paddy, wheat have been prepared. A list of improved varieties of paddy and wheat crops which were most prevalent and adopted after 2010 were enlisted with discussion with KVK staff and State Department of Agriculture. Among the listed varieties, six varieties (i.e. three improved varieties (in rice- PB 1121, PS 5, Pant Sugandh Dhan 21 and Wheat- HD 2967, HD 3086, HD 3059 and three local varieties (in rice- Sarbati Pant Dhan 3, Pant Sugandh Dhan 15 and in wheat-PBW 226, PBW 292, HD 550) from each crop were selected randomly without replacement method by using lottery method.

A multistage random sampling was used to select the area and the sample for the study. Initially, three districts (Haridwar, Udham Singh Nagar, and southern plain of Nainital) were identified. Here the criterion used was the presence of plains and adequate irrigation facilities. In the second stage, blocks from three districts were enlisted. Among the enlisted blocks, all five blocks of Haridwar, all seven blocks of Udham Singh Nagar, and only two blocks in the southern part of Nainital had irrigation facilities. In the third stage, 50% blocks had been selected by adopting Fisher randomization technique. Hence, three blocks from Haridwar, four blocks from Udham Singh Nagar, and one southern block from Nainital district were chosen for the study. In fourth stage, three villages from each of the eight selected blocks with more probability value were selected. A total of 24 villages from eight blocks of three districts have been selected for the final study. A total of 360 farmers were served as respondents for this study. Net return was attained by subtracting the total costs endured from the gross returns obtained. Benefit cost ratio was obtained by dividing the gross income by total cost. T-test has been adopted to find out significance difference of improved and local varieties, if any. Box plot technique is a technique of graphically

Table 1 Comparative benefit-cost ratio (BCR) analysis of crop varieties (N=360)

		Farmers' category				
		Small (1-2 ha)	Medium (2-4 ha)	Semi-medium (4-10 ha)	Average	Total average
Rice varieties						
Improved	Pusa 1121	2.84	2.87	2.87	2.86	2.76
	PS 5	2.66	2.74	2.89	2.76	
	PS Dhan 21	2.66	2.64	2.68	2.66	
	Total avg	2.72	2.75	2.81		2.76
Local	Sarbati	1.61	1.65	1.66	1.64	1.95
	Pant 3		2.15	2.05	2.10	
	Pant 15	2.15	1.95	2.22	2.11	
	Total Avg	1.88	1.92	1.98		1.93
t-statistics		6.71**	42.84**	22.87**		
P (T<=t) two-tail		0.00	0.00	0.00		
Wheat varieties						
Improved	HD 2967	2.30	2.41	2.47	2.39	2.19
	HD 3086	2.35	2.36	2.39	2.37	
	HD 3059	1.76	1.84	1.88	1.82	
	Total avg	2.13	2.20	2.24		2.19
Local	PBW 226	1.77	1.80	1.86	1.81	1.79
	PBW 292	1.86	1.81	1.86	1.84	
	HD 550		1.73		1.73	
	Total avg	1.81	1.78	1.86		1.82
t-statistic		7.61**	42.84**	5.41**		
P(T<=t) two-tail		0.003	0.00	0.00		

**Significance 1%

depicting groups of numerical data through their quartiles. Kernel density depicts the dispersion of yield among the selected varieties. The peak of density plot helped to exhibit where values were concentrated. Band width represented the density of values among the farmers for particular variety.

RESULTS AND DISCUSSION

Data (Table 1) shows the BCR values of improved and local paddy varieties. BCR in case of Pusa 1121 was 2.86:1, whereas BCRs were 2.76:1 and 2.66:1 for PS 5 and Pant Sugandh Dhan 21, respectively. No such variations had been found in BCRs values among improved varieties. Farmers who used local varieties, results revealed a different picture. In case of Pant 3 and Pant 15, BCR were 2.10:1 and 2.11:1 respectively, whereas for Sarbati, BCR was found to be 1.65:1 which was much lower. But interaction with the farmers explored that Sarbati was one of the popular and also the oldest variety. Bold grain size and good taste lead preference of the consumer for growing Sarbati, instead of low market price. The result of t-test also confirms significant differences in BCR among the different categories of farmers. No small farmers had used Pant 3 (local variety) now-a-days. The t-test statistics 6.71 implies significant differences of BCR among the small farmers using improved and local varieties. Similarly, t-test values of 42.84 and 22.87 indicated significant differences in BCR among medium and semi-medium farmers (1% level). Further, small farmers adopting improved paddy varieties got BCR of 2.72:1, whereas it was 2.75:1 and 2.81:1 for medium and semi-medium farmers, respectively. Similarly, it represents BCR values of improved and local wheat varieties. It was found that HD 2967 has the highest BCR values (2.39:1) compared to HD 3086 and HD 3059. In HD 3086, BCR was 2.37:1, whereas it was 1.59:1 in case of HD 3059.

Small farmers who adopted improved varieties has BCR value of 2.13:1, whereas BRC values were 2.20:1 and 2.24:1 for medium and semi-medium farmers. In contrast, BCR value was highest (1.84:1) in PBW 292 among the other local wheat varieties, i.e. 1:81:1 (PBW 226) and 1.73:1 (HD 550). But BCR was highest (1.86:1) for semi-medium farmers. In fact, HD 550 variety was not used by small and semi-medium farmers in that area.The t-test results also show the significant differences (1% level) among the farmers who adopted improved varieties. Estimates of t-test indicated positive and significant differences among the farmers who adopted improved and local varieties. The t-test values of 34.98 and 13.15 among the medium and semi-medium farmers showed that more revenue can be obtained in case of adoption of improved varieties. Comparable finding had been accounted by Mohamed *et al*. (2014).They reported that divulged adoption of improved varieties of wheat had more BCR than the local varieties of wheat. The finding was conversely with the finding of Ahirwar *et al*. (2015). They announced that the advantage cost proportion was to be most for small farmers (1:2.027) when contrasted with medium (1:1.918) and large farmers (1:1.899).

The Box plot technique has been adopted to find out the yield variations between improved and local varieties (Fig 1). The same procedure had been adopted in the study conducted by Arora *et al*. (2019) for evaluation of recommended maize production technology in khadi area in Farmer FIRST Programme.

The graph showed that among the improved paddy varieties, PB 1121 had a yield variation of 52–57 q/ha. Similarly, on an average, yield varied from 52–56 q/ha and 52–53 q/ha in case PS 5 and Pant Sugandh Dhan 21, respectively. The end of Whiskers represents the minimum and maximum yield variations which varied from 47-60 q/ha in case of PB 1121 and PS 5. In case of Pant Sugandh Dhan 21, it varied from 49-60 q/ha. In contrast, for local varieties (Sarbati and Pant Dhan 3), it was 45 q/ha. Pant Sugandh Dhan 15 had yield variation of 38-45 q/ha which was relatively quite lower compared to other selected varieties. Data (Fig 1), represented the minimum, average and maximum yield of improved and local wheat varieties. HD 2967 got an average yield 60-68 q/ha, whereas it was 60 q/ha for HD 3086 and HD 3059. The end of Whiskers range indicated that minimum and maximum yield of HD 2967 were 57 q/ha and 74 q/ha.

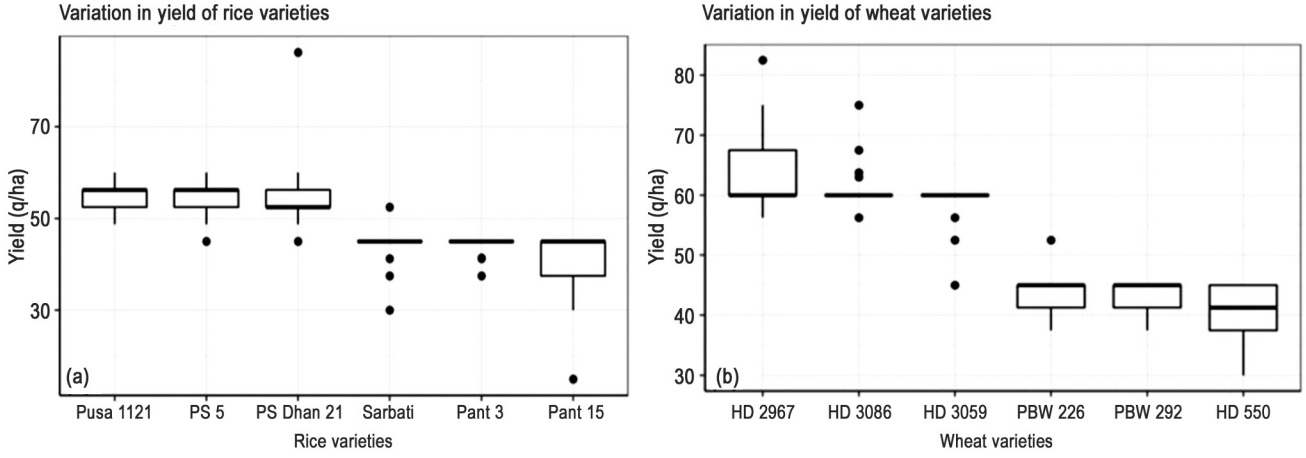

Fig 1 Yield estimation of rice (a), wheat (b) varieties.

Table 2 Comparative analysis of net return of crop varieties (N=360)

		Farmers' category				
		Small (1-2 ha)	Medium (2-4 ha)	Semi medium (4-10 ha)	Average	Total average
Rice varieties						
Improved	Pusa 1121	114079.18	109232.95	109914.12	111075.4	107663.2
	PS 5	102577.30	107861.4	115973.67	108804.1	
	PS Dhan 21	102604.48	102660.7	104064.74	103110	
	Total avg	106420.3	106585	109984.2		107663.2
Local	Sarbati	38331.49	37434.92	36787.20	37517.87	58793.23
	Pant 3		71878.47	64238.13	68058.30	
	Pant 15	73301.13	64070.74	75038.70	70803.52	
	Total avg	55816.31	64070.74	75038.70		64975.25
t- statistics		35.41***	22.87**	2.37***		
P (T<=t) two-tail		0.00	0.00	0.19		
Wheat varieties						
Improved	HD 2967	76052.68	81959.59	84773.53	80928.60	78007.46
	HD 3086	78952.97	77510.84	79846.28	78770.03	
	HD 3059	75493.33	71765.24	75712.67	74323.75	
	Total avg	76832.99	77078.56	80110.83		78007.46
Local	PBW 226	45202.97	46787.78	50372.83	47454.52	46076.09
	PBW 292	49989.02	46582.40	49419.13	48663.51	
	HD 550		42110.23		42110.23	
	Total avg	47595.99	45160.14	49895.98		46076.09
t-statistics		7.61**	42.48***	4.16**		
P (T<=t) two-tail		0.03	0.00	0.02		

Significance 5%, * Significance 1%

Kernel density depicted the dispersion of yield among the selected varieties. The peak of density plot helped to exhibit where values were concentrated. Band width represented the density of values among the farmers for particular variety.

From the data, it was found that for Pusa 1121, dispersion of yield ranged between 48-60 q/ha, and maximum yield concentrated ranged between 50-54 q/ha. Similarly, for PS 5 and Pant Sugandh Dhan 21, maximum yields concentrated were 50-55 q/ha and 52-55 q/ha, respectively. In contrast for local varieties yield dispersion had been presented in similar way. In case of Sarbati, maximum yield was between 43-48 q/ha, whereas it was 42-45 q/ha and 43-45 q/ha per ha, respectively for Pant Dhan 3 and Pant Sugandh Dhan 15. From the data, it was found that for HD 2967, dispersion of yield ranged between 58-72 q/ha and maximum yield between 60-63 q/ha. Similarly, for HD 3086 and HD 3059, maximum yield ranged between 60-62 q/ha and 55-60 q/ha. On the other hand, for local variety PBW 226 and PBW 292, maximum ranged between 42-45 q/ha. Similarly, for variety HD 550, it was 40 q/ha. It can be said that the improved varieties of wheat have more yield as compared to the local ones.

Table 2 shows the net return of improved and local paddy varieties in absolute terms. Net return in case of Pusa 1121 was ₹ 111075.40, whereas it was ₹ 108804.10 and ₹ 103110 for PS 5 and Pant Sugandh Dhan 21, respectively. Net return was less for Sarbati among the all local varieties. A related study was directed by Awotide *et al*. (2016) which reported that improved rice varieties could prompt a lot of wanted increment in profitability, guaranteed national and food security and could likewise be away out of the threat of provincial neediness in Nigeria. They also reported that adoption of new cassava varieties upgraded the rural household health.

Data (Table 2) showed that in case of wheat, net return was maximum (₹80928.60) in HD 2967, whereas it was ₹78770 and ₹74323.75 for HD 3086 and HD 3059, respectively. Highest net return was found PBW 292 (₹48663.51) among the selected local wheat varieties. A similar result was announced by Verma *et al*. (2016). T test results represented that there was significant difference in net return in absolute term between improved and local varieties.

The study showed that the PB 1121 variety of paddy

and HD 2967 variety of wheat are the best economically, speaking in terms of net return and BCR and also technically in terms of productivity. This variety of paddy showed better results compared to other varieties for its quality, grain recovery and good taste. All these varieties of crops were also the most profitable varieties for the region resulting in more farm income and ensuring livelihood security. Creating awareness through extensive demonstrations for its adoption at a larger scale among the dominant small farmers is what is now called for. The alignment of farmer-oriented government policies and infrastructural supports for the promotion of such economically potential varieties are advocated for augmenting a sustainable farm production and income; thereby improving livelihood of the farming communities.

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