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Economics of Production and Resource Use Efficiency Wheat Cultivation in Hardoi District of Uttar Pradesh

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ABSTRACT

The study focuses on economic analysis of wheat production in the Hardoi District of Uttar Pradesh. The study is carried out to determine resource use efficiency of Wheat production in the study area. Production data were collected from 100 farmers randomly from five village areas of Kothawan block for Hardoi district of Uttar Pradesh. In this study, the overall average productivity and gross return of wheat was recorded 28.52 q/ha and Rs 36,306 respectively. The farm size group wise productivity of wheat was 27.85 q/ha obtained in marginal size group followed by 28.95 q/ha and 30.35 q/ha in small and medium size farm, respectively. Gross income obtained in small size group was 36073 followed by 35000 in medium and 38900 minimum in large size group. The lead functional form was the cobb Douglas log function which produced R^2 of 0.93, 0.94 and 0.94 in marginal, small and medium farm group. MVP value of various input used in wheat crop grown in Kothawan block revealed that in case of wheat, only manure and fertilizer showed MVP less than unit which means that these resources were overused, so their use should be reduced. Other than manure and fertilizer, all the resources showed MVP more than unit which stated that these resources were still under use and their use can be increased to raise the profit.

Keywords Production, Resource use efficiency, MVP. Wheat cultivation Grow return.

INTRODUCTION

Wheat (*Triticum aestivum* L.) growing, like rice farming, is widely popular all over the world. Wheat is referred to as the "King of Cereals." Wheat is cultivated on 222.6 million hectares in 122 countries, generating 716.1 million tonnes with a productivity of 3.21 tonnes per hectare (DES, Ministry of Agriculture) (2017-18). The global wheat production in the marketing year 2019/2020 was around 765 million metric tonnes. In comparison to the previous marketing year, this represented an increase of over 30 million tonnes. According to the Agriculture Ministry of Food Grain Output, India ranked second

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in the world wheat production in 2018-2019, with 283.37 million tonnes produced (2019-20). Wheat consumption is rising, with estimates ranging from 105 to 109 million tonnes by 2020. China, the United States, India, and France are all major wheat producers. Wheat is grown on around 239 million hectares around the world, with a total yield of 425.5 million tonnes of wheat grains. India is ranked fourth in terms of both area and production (Ahirwar *et al.* 2015).

The country has sold wheat to the rest of the world for a total of Rs 439.16 crores/61.84 million dollars in the year 2019-20. This is a lot of money. In India, wheat is grown on 23.61 million hectares and makes 44.25 million tonnes of grains each year. Wheat is grown mostly in the states of Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, Rajasthan Bihar, Maharashtra, and Gujarat in the country (Gurjar and Varghese 2005). Uttar Pradesh is the state that contributes the most land and production, but Punjab is the state that has the highest average productivity. Haryana is in third place. When wheat is grown in Gujarat, it covers about 6 to 7 million hectares of land. Of this, about 75% to 80% is irrigated wheat, and the rest of the land is used for rain-fed wheat. People grew it on 6.94 million acres in the year 1997-98. It made 16.47 million tonnes of grains. This means that India is the world's biggest producer of milk. It's also the second-biggest producer of rice, wheat and sugarcane. India is also a big producer of fruit and cotton. It is also one of the world's top producers of spices, fish, poultry, livestock, plants, and other foods. Wheat is a good source of carbs (Pandey and Rai 2019). Globally, it is the main source of vegetable protein in human food. It has a protein content of about 13%, which is high compared to other major cereals, but it isn't very good at providing essential amino acids. (Singh and Chandra 2002).

In feed mills, wheat is the main source of raw material. Bread cake and biscuits are made with wheat. Pasta and spaghetti semovita are made with wheat, as well as pasta and macaroni (Raghuvanshi *et al.* 1999). After harvesting wheat, the grain is taken away from the stalks and chaff, which are left behind. Hardoi is also a wheat-growing area in the state of UP. Over 343069 hectares, there were 1062320 metric tonnes of wheat grown in the district in the year 2019-20. The yield was 39.95 q/ha. Productivity of wheat in Hardoi district is very low compared to the national level, which means that there is still a lot of room to improve this ratio in the district. This is one of the main goals of this paper are:

To study of farm structure, cropping pattern and crop intensity on sample farms;
To analyses cost of cultivation, cost of production and input-output relationship production of wheat crop on sample farms;
To estimate resources, use efficiency of wheat on sample farms and to find out major constraints of production and
suggest suitable measure to overcome them.

MATERIALS AND METHODS

Data collection

This empirical investigation of resource use efficiency has made extensive use of primary data. The schedules that have been pre-structured and pre-tested have been used to gather the farmers from the community. The population sample was drawn using a multi-stage stratified random sampling technique. By selecting the Hardoi district on purpose, the sampling process has begun.

First, a list of each of the 19 blocks in Uttar Pradesh's Hardoi district was created, along with an average ranking for wheat farming. Block Kothawan, which has the most wheat-growing land, was specifically chosen for this investigation. Thereafter, a list of all the villages in the Kothawan block was created and placed in ascending order of the area planted with crops. From these lists a sample of 100 respondents were drawn following the proportionate allocation to the different categories. Under marginal farmers category 60, small famers 23 and medium farmers 17 have occurred out of hundred samples.

Period of enquiry

The data pertained to agriculture year 2020-2021 estimation of costs and returns.

Cost A_1 : It includes costs and kind expenses actually incurred by cultivators which are as follows:

(i) Wage of hired human labor
(ii) Charges for bullock labor
(iii) Hired labor charges of implements and machinery
(iv) Cost incurred on manures and fertilizers
(v) Seeds
(vi) Plant protection chemicals
(vii) Irrigation charges
(viii) Land revenue
(ix) Depreciation and
(x) Repair charges on farm assets.

Cost A_2: Cost A_1 + Rent paid for leased in land.
Cost B_1: Cost A_2 + Interest on owned fixed capital assets.
Cost B_2: Cost B_1 + Rental value of owned land.
Cost C_1: Cost B_1 + Imputed value of family labor.
Cost C_2: Cost B_2 + Imputed value of family labor.
Cost C_3: Cost C_2 + 10% of cost C_2 (managerial cost)
Gross income = Value of total output.
Net income = It is computed by deducting cost C_3 from gross income.

Regression analysis

Production function analysis was carried out to examine the productivity and efficiency of different resources of the sample farms. Multiple regression analysis was done to examine the cost-benefit relationship and productivity of farms. Different types of production functions were explored, out of them only Cobb-Douglas production function was found best fit for analysis (Yadav *et al.*2013).

The mathematical form of Cobb- Douglas production function is given below:

$$Y = ax1^{b1} \times 2^{b2} \ldots\ldots\ldots\ldots\ldots\ldots X\, k^{bk}\, e^{\mu}$$

Where;
Y = Dependent variable (output values in Rs / ha)
X_i = I^{th} independent variable (input values in Rs /ha)
X_1 =Labor (Rs /ha.)
X_2= seed (Rs/ha)
X_3=Manure and fertilizer (Rs/ha)
X_4= Irrigation (Rs/ha)
a = Constant
b_i = Production elasticity with respect to X_i
e = Error term or disturbance term
μ = Random variables

The value of the constant (a) and coefficient (b_i) in respect of the independent variables in the function have been estimated by using the method of least squares.

Estimation of marginal value product

The marginal value product of input was estimated by taking partial derivatives of returns with respect to the input concerned, at the geometric mean level of inputs (Srivastava *et al*. 2015 and Singh *et al*. 2018).

Where, (*MVP*) $b_i = \dfrac{b_i\, \bar{y}}{x_i}$

b_i = Production elasticity with respect to X_i
$\bar{y}$ = Geometric mean of y (output values in Rs/ha)
X_i= Geometric mean of X_i
(MVP) = Marginal value product of i^{th} impact

RESULTS AND DISCUSSION

Structure of farm

The study on the structure of sample farms are of significant importance as these influence the resource use pattern on farms. The structure of farm family highlights overall condition within and around the farms such as size of holding, cropping pattern and intensity of cropping. The characters existing on sample farms are discussed in following manner.

Average size of holding

The study covers a sample of 100 farmers, which divided in three size groups namely marginal (below 1 ha), small (1-2ha) and medium (2-4ha) with respect to cropped area. The average size of holding on various groups of sample farms presented in Table 1. It is evident from the table that the average size of holdings in study area were 0.53, 1.48 and 2.23 hectares in marginal, small and medium farm groups, respectively. Whereas overall size of holding size was 1.041 hectares. It is clear from the data that net cultivated area of sample farms 31.9, 34.2 and 38 hectares falls under marginal, small and medium categories, respectively. It concluded that medium farmers were cultivating maximum area followed by

Table 1. Average size of holding on sample farms under different size group.

Sl. No.	Size of farm	Number of farmers	Net cultivated area (ha)	Average size of holding (ha)
1	Marginal (Below -1 ha)	60	31.9 (30.64)	0.53
2	Small (1-2 ha)	23	34.2 (32.85)	1.48
3	Medium (2-4 ha)	17	38 (36.51)	2.23
	Overall	100	104.1 (100)	1.041

Note : Figures in parenthesis indicated the percentage of net cultivated area.

small and marginal categories of farmers.

Cropping pattern

Cropping pattern shows the area devoted to the various crop during the given period, conventionally in single year It indicates the yearly sequence and spatial arrangement of crops followed in a particular area. The cropping pattern followed by the sample farms on marginal, small and medium farms are presented in Table 2. It revealed that among the various crops grown at the selected medium sample farm, Paddy has covered the maximum area i.e., 1.94 ha 42.0% of total cropped area, Wheat was found as first important crop covering an area of 2.05 ha, 44.4% of total cropped area followed by, Maize 0.4, moong 0.27, sugarcane 0.02, vegetables 0.03 each, Chari 0.14, 3.0 ha percent pea 0.02 mustard 0.08 and per cent, respectively. Oil crops have also been allotted a considerable area in existing cropping pattern as *rabi* crop (Mustard) were sown in 0.8 % of total cropped area of medium farm. Similarly at medium sample farm, major area.

Cropping intensity

Cropping intensity is a measure of land use intensity based on the number of crops cultivated in a given field over the course of a year. The following formula was used to calculate it (Kushwaha *et al.* 2018),

Table 2. Cropping pattern under different size group of sample farms (area in hectare).

Crop grown	Average size of farm groups Marginal	Small	Medium	Overall average
Paddy	0.50 (43.1)	1.22 (38.1)	1.94 (42.0)	0.91 (41.0)
Sugarcane	0.01 (0.9)	0.21 (6.6)	0.02 (0.4)	0.06 (2.6)
Maize	0.01 (0.9)	0.05 (1.6)	0.04 (0.9)	0.02 (1.1)
Wheat	0.49 (42.2)	1.19 (37.2)	2.05 (44.4)	0.92 (41.3)
Mustard	0.01 (0.9)	0.09 (2.8)	0.08 (1.7)	0.04 (1.8)
Pea	0.01 (0.9)	0.01 (0.3)	0.02 (0.4)	0.01 (0.5)
Potato	-	-	0.03 (0.6)	0.01 (0.2)
Chari	0.04 (3.4)	0.14 (4.4)	0.14 (3.0)	0.08 (3.6)
Moong/Urd	0.06 (5.2)	0.25 (7.8)	0.27 (5.8)	0.14 (6.3)
Vegetable	0.03 (2.6)	0.04 (1.3)	0.03 (0.6)	0.03 (1.5)
Gross cropped area	1.16 (100)	3.2 (100)	4.62 (100)	2.22 (100)

Note :Figures in parenthesis indicated the percentage of net cultivated area.

$$\text{Cropping intensity} = \frac{\text{Total cropped area}}{\text{Cropping intensity}} \times 100$$

It has been computed for all size groups of farms and is presented in Table 3. The maximum cropping intensity was observed to be 218% in case of marginal farm followed by small and medium farms to 216 and 207%, respectively with an average of 213%.

Structure of costs and income

The different costs concept like cost A_1, A_2, B_1, B_2

Table 3. Cropping intensity of different size group of sample farms.

Farm groups	No. of farms	Average size of holding	Gross cropped area (ha)	Cropping intensity (%)
Marginal (below1 ha)	60	0.53	1.16	218
Small (1-2ha)	23	1.48	3.2	216
Medium (2-4ha)	17	2.23	4.62	207
All farms	100	1.04	2.22	213

Table 4. Per hectare costs of different inputs used in wheat crop on different size group of sample Farm: (Rs in per ha).

Sl. No.	Particulars	Size group of farms Marginal	Small	Medium	Overall average
1	Family labor	1623.5 (4.95)	890.25 (2.75)	552.86 (1.60)	1261.8 (3.90)
2	Hired labor	796.5 (2.43)	1519.75 (4.70)	1787.14 (5.16)	1095.5 (3.39)
3	Total human labor	2420 (7.38)	2410 (4.45)	2340 (6.75)	2357.3 (7.29)
4	Machinery charge	2065.25 (6.30)	2085.32 (6.45)	2034.25 (5.87)	2023.9 (6.26)
5	Seed	3500 (10.67)	3100 (9.67)	3032 (8.75)	3267.8 (10.11)
6	Manure and fertilizer	4950 (15.09)	5155 (15.94)	5950 (17.17)	5048.2 (15.62)
7	Irrigation	3860 (11.77)	3557 (11.00)	4100 (11.83)	3749.1 (11.60)
8	Threshing	1180.25 (3.60)	715.15 (2.21)	725.25 (2.09)	981.4 (3.04)
9	Combine	690.25 (2.10)	1218.74 (3.77)	2154.25 (6.22)	1017.6 (3.15)
10	Plant protection	520.25 (1.59)	480.23 (1.49)	456.26 (1.32)	491.0 (1.52)
11	Interest on working capital	210.26 (0.64)	190.25 (0.59)	165.25 (0.48)	194.7 (0.60)
12	Rental value of land	10000 (30.49)	10000 (30.93)	10000 (28.85)	9800.0 (30.33)
13	Interest on fixed capital	420.24 (1.28)	480.32 (1.49)	452.38 (1.31)	430.5 (1.33)
14	Sub total	29816.5 (90.91)	29392.01 (90.91)	31409.64 (90.91)	29361.5 (90.91)
15	Managerial cost @ 10% of Sub total	2981.65 (9.09)	2939.20 (9.09)	3140.96 (9.09)	2936.7 (9.09)
	Grand total	32798.15 (100)	32331.21 (100)	34550.6 (100)	32297.7 (100)

Note : Figures in parenthesis indicate the percentage to the per hectare investment.

,$C_1$and C_2 were considered for the analysis of the data. Similarly, the various income measures such as gross income, net income, farm business income, family labor income and farm investment income were also calculated for the sample farms. The costs of production of wheat (Rs /quintal) and input: Output relationship has also been worked out on the basis of different costs.

Figures in parenthesis indicate the percentage to the total cropped area was covered by wheat crop: Medium (44.4%) of total cropped area followed by small (37.2%) and marginal (42.2%). It may be concluded that wheat and paddy were considered as main food crops having I" and 11 place in cropping pattern.

Cost of cultivation of wheat

The per hectare cost on various input factors in wheat production was worked out and its details presented in the Table 4. This table indicated that on an average per hectare cost of cultivation of wheat was found Rs 32314.2. The cost of cultivation was experiential on marginal farm (Rs. 32798.15) followed by small farm (Rs 32331.21) and medium farm (Rs 34660.6).

The total cost on marginal farm was maximum due to heavy outflow on irrigation and human labor. The study further open that in case of small farm, cost incurred on irrigation was (11.60%) followed by human labour (4.45%) and medium farm cost incurred on irrigation (11.83% and tractor charge (5.87%).

The further distribution of the costs on overall farm average showed the maximum expenditure on irrigation i.e. (11.60%) followed by human labour charge (3.92%). The expenditure on overall, tractors charges, manures and fertilizers, seed to 6.30, 15.09 and 10.67% respectively.

Measures of costs and returns of wheat crop in study area

The costs and income per hectare from the cultivation of wheat crop on different categories of farms were worked out and presented in Table 5. It is depicted from the table that, overall, the total cost of cultivation (C_1) computed to Rs 32548.14 per hectare which was maximum to Rs 35802.95 on marginal farm followed by small, medium farms to Rs 35024.32 and Rs 49888.91, respectively.

As far as the income measure are concerned, it observed from the table that the gross income per hectare was maximum to Rs 36073.00 on marginal farm followed by small and medium farms to Rs. 35000.00 and Rs 38900.00 respectively. Whereas, overall gross income calculated to Rs 36306.80. Other income measures like net income, farm income, and family labor income were also worked out and presented in the table showing same trend as gross income. As size of farm increases, the various measures of income decreases.

Table 5. Per hectare costs and income from the production of wheat crop on different size group of farms Rs in per ha.

Sl. No.	Particulars	Size group of farms			
		Marginal	Small	Medium	All farm average
1	Cost A_1/A_2	17772.76	18021.44	20404.40	18277.34
2	Cost B_1	20924.64	18501.00	20856.78	20335.67
3	Cost B_2	30924.64	28501.00	30856.78	30355.67
4	Cost C_1	22548.14	19391.25	21409.64	21628.51
5	Cost C_2	32548.14	29391.25	31409.64	31628.51
6	Cost C_3	35802.95	32330.00	34550.60	34791.27
7	Gross income	36073.00	35000.00	38900.00	36306.00
8	Net income	3524.86	5608.75	7490.35	4678.28
9	Family labour income	5148.36	6499.00	8043.22	5951.13
10	Farm business income	18300.24	16978.56	18495.6	18029.46
11	Yield (q/ha)	27.85	28.95	30.35	28.52
12	Cost of production	1350.51	1255.30	1220.75	1306.53
13		Input- output ratio			
(i)	On the basis of A_1/A_2	1:2.02	1:1.94	1:1.90	1:1.98
(ii)	On the basis of B_1	1:1.72	1:1.89	1:1.86	1:0.22
(iii)	On the basis of B_2	1:1.16	1:1.22	1:1.26	1:0.19
(iv)	On the basis of C_1	1:1.59	1:1.80	1:1.81	1:0.83
(v)	On the basis of C_2	1:1.10	1:1.19	1:1.28	1:0.00
(vi)	On the basis of C_3	1:1.00	1:1.08	1:1.12	1:1.37

It displayed in the table that cost of production per quintal on the basis of cost C, was highest to Rs 1220.75 on medium farm followed by marginal and small farms corresponding to Rs1350.51 and Rs1255.30, respectively. Where overall it was Rs 1306.55 per quintal.

The input-output analysis was also done on the basis of cost A, to cost C_2. It varied from 1:2.02 to 1:1.00 in case of marginal farm size group. 1: 1.94 to l:1.08 on small farm and 1:1.90 to 1:1.12 on medium farm size group. The overall the input: Output ratio on the basis of various costs varied from 1:1.98 to 1:1.37.

Resource use efficiency

The Cobb - Douglas production function was applied to find out the efficiency of various resources used in the production of wheat. The value of elasticity of production, standard error, co-efficient of multiple determinations and return to scale for wheat production on different size group of farms presented in Table 6. The high value of R^2 of the fitted function

Table 6. Resource use efficiency estimator of wheat on different size of sample farms in the study area.

Size group of sample farmer (ha)	Production elasticities				Sum of elastic-ities	R^2
	X_1	X_2	X_3	X_4		
Marginal	0.0982*	0.4429**	0.1968*	0.0821**	0.8202	0.93
Small	0.4739**	0.0963*	0.0209*	0.2429	0.8342	0.94
Medium	0.3690*	0.1488*	0.1892	0.1272	0.8343	0.94

Note: Figures in parenthesis denoted standard error of respective variable
** significant at 1% level
* significance at 5% level
X_1, X_2, X_3, and X_4 denotes for labor, seed, manure and fertilizer, irrigation respectively.

Table 7. Marginal value productivity (MVP) of included factors of production process in wheat production.

Size group of farms	Marginal value productivity of input/factors			
	X_1	X_2	X_3	X_4
Marginal	1.46	4.56	1.43	0.76
Small	6.88	1.08	0.14	2.39
Medium	6.13	1.91	1.23	1.20

indicated that sufficient and large proportion of the total variation in the depended variable is explained by the input included in the function. The table further indicated that four variables viz., labor, seed, manure fertilizer, irrigation jointly explained 0.9496, 0.9319, and 0.9477% variation of the dependent variable on small, marginal and medium farms, respectively.

Marginal value productivity (MVP)

In case of all these categories of farms and all the variables were positive value of MVP to factor costs Table 7. Indicated that there is further scope to increase the investment on all the factors to realize more return than the costs.

CONCLUSION

The sample of 100 farmers of selected block were considered to study and resulted average size of holding as 0.53, 1.48 and 2.23 hectare in respect of marginal, small and medium farms, respectively. On overall farms per farm investment to total assets on farm building, implements and machineries and livestock accounted for 65.64, 22.87 and 7.23% respectively. Cropping pattern of the sample farm for wheat per cent area to gross cultivated area showed increasing trend with increasing size of farms. Per farm area for wheat 0.49, 1.19 and 2.05 hectare under marginal, small and medium farm, respectively. Cropping intensity observed as 218.00, 216.00 and 207.00% for marginal, small and medium farms, respectively. Intensity of cropping showed decreasing trend with increasing size of farms except medium farms. In case of wheat, highest cost of cultivation was observed under marginal size of sample farms mainly due to higher irrigation charge.

Average, cost of cultivation was worked out to Rs 32297.70 maximum cost incurred in the wheat crop due to irrigation having overall share of 11.60%. The gross income per hectare was observed maximum under marginal farms (Rs 36073.00) followed by small farms (Rs 35000.00) and medium farms (Rs 38900.00). The gross income per hectare was highest on marginal farms due to intensive cultivation and more use of human labour and no. of irrigation on these farms for higher productivity on these farms was associated with better management by farmers, timely cultural operations through family labors. On overall average, gross income was Rs 36306.80, whereas, net income was Rs 13235.84 per hectare. An overall average, farm business income and family labor income were worked out to Rs 34296.75, Rs 22720.87 per hectare, respectively.

Cost of production per quintal of wheat was computed to Rs 1350.51, Rs 1255.30, and Rs 1220.75 on medium, small, and marginal farms, respectively. Input-output ratio related to cost C, was highest on marginal farms (1:1.09) followed by small farms (1:1.08), and medium farms (1:1.05). Under marginal and small farms, the elasticity of production with respect to plant protection and seeds were statistically significant. Under medium farms, irrigation, plant protection was found statistically significant. In case of wheat, returns, to scale marginal, small and medium, size of sample farms characterized by decreasing returns to scale. Out of total variation in dependent variables explained by independent variables which were found significant, labor, seed, manure and fertilizers, irrigation were found significant at 5% and 1% level of significance. The wheat crop R^2 was found to be 0.93 which means that 0.94% of the variation in the yield was explained by independent variables which were found significant in terms of marginal farms. MVP value of various input used in wheat crop grown in Kothawan block revealed that in case of wheat, only manure and fertilizer showed MVP less than unit which means that these resources were overused, so their use should be reduced. Other than manure and fertilizer, all the resources showed MVP more than unit which stated that these resources were still under use and their use can be increased to raise the profit.

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