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Economic Effect of Custom Hiring Centres on Paddy (*Oryza sativa*) Cultivation in Haryana, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

To compare the economics and efficiency of resource use in paddy cultivation when using machinery hired from government-sponsored Custom Hiring Centres (CHCs) vis-à-vis private farm machinery providers. The study was carried out in the Kurukshetra district of Haryana during the agricultural year 2020-21. Selection of district was done based on the highest percentage change in farm power availability since the beginning of the Sub Mission on Agricultural Mechanization (SMAM). The data for the investigation were gathered from 80 paddy farmers (40 hiring farm machinery from the private farm machinery providers and 40 from the CHCs). The farmers who hired the machines from CHCs found 10.52 per cent reduction in the paddy operational costs when compared to the farmers who hired machinery from the private farm machine providers. Furthermore, the net returns of the farmers who hired from the CHCs were approximately 27.06

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percent higher. In case of the resource use efficiency, machine labour was discovered to be the most efficiently utilised resource under CHCs. In comparison to the private farm machinery providers, the study found that the CHCs help to improve returns and efficiency of utilisation of the farm machinery as a resource.

Keywords: Cost and returns; farm Mechanization; resource use efficiency.

1. INTRODUCTION

In the last 50 years, there have been many changes in Indian agriculture in terms of input use, from human labour, farm-sown seeds, bullock-pulled farm implements to high-quality hybrid seeds, chemical fertilisers, electric motor-run tube wells, and farm machinery [1]. With the passage of time, it has become increasingly important for farmers to use cutting-edge technology to get more from their land and remain in business. However, purchasing the farm machinery by individual farmers can be difficult due to the high cost of capital investment [2], and even wealthy farmers cannot afford all the machines, so hiring appears to be a much better option than purchasing all of them.

In an economy where agriculture accounts for approximately 20% of GDP and employs nearly half of the labour force, mechanisation has the potential to change the game in the Indian context [3]. To put it another way, farm mechanisation is critical for changing the economic picture of a developing country like India. However, the flip side of the coin is that mechanisation necessitates large capital investments, and with approximately 86% of farm holdings in the country being marginal and small [3], much investment at the individual farm level is neither affordable nor feasible. Large machinery, by definition expensive, can become unaffordable even for large farmers at times [4].

This gives rise to the concept of hiring farm machinery, which, while not novel, has the potential to address the issue of farm machinery availability, particularly for marginal and small farmers. Given all the advantages that mechanisation may offer, the Government of India (GoI) introduced the Sub Mission on Agricultural Mechanization (SMAM) in 2014 to increase the accessibility of farm equipment, particularly to small and marginal farmers, through government-sponsored Custom Hiring Centres (CHCs). The scheme's objective was to increase average farm power availability to 2 kw/ha. Through government backing, larger and more expensive machines were made available to farmers on a rental basis [5].

According to the Indian Council of Agricultural Research, paddy occupies one million hectares (mha) of the state's total arable land, making it the leading crop in Haryana. Furthermore, this is the crop with the one of the highest farm machinery requirements, so taking all of this into account, as well as the fact that timely and easily available farm machinery can play a significant role in changing the economic facet of the [6], a need was felt to evaluate the economic effect of increasing farm machine availability through custom hiring on paddy. Hence, with the aforementioned information in mind, the following research objectives were set forth: (i) to study the comparative economics of paddy cultivation based on mechanization sources and (ii) to work out resource use efficiency in paddy cultivation based on mechanization sources; where sources of mechanization were, *viz*. government sponsored CHCs and private local farm machinery providers.

2. MATERIALS AND METHODS

2.1 Study Area and Sampling Procedure

The study was conducted in Kurukshetra district in northern Haryana. Data were collected in agricultural year 2020-21. Kurukshetra district was purposively selected due to the highest percentage change in farm power availability since introduction of SMAM [5].

Further, two blocks Shahbad and Pipli were selected randomly. A total of four villages with two villages from each block were selected randomly. A separate list of farmers from the chosen villages, hiring farm machineries from government sponsored CHCs and private farm machinery providers were prepared.

At last, 20 farmers from each of four villages (10 hiring farm machinery from the private farm machinery providers and 10 from CHCs) were randomly interviewed using a pre tested

interview schedule. Thus, the total sample for the study constituted of 80 farmers.

2.2 Economics of Paddy Cultivation

The total cost of cultivation for each group of farmers was calculated as the sum of the total variable cost and fixed cost.

The total variable cost was calculated by the sum of the total operational cost (included both human labour and charges of machinery used) and total input cost (seed, irrigation, farm yard manure, fertilizers, and plant protection chemicals) were used. The Net returns were calculated by subtracting the total cost from the gross returns. B-C (Benefit-Cost) ratio was calculated as the ratio of gross returns to the total cost.

2.3 Resource use Efficiency

Cobb-Douglas production function was used to study the effect of inputs on paddy and wheat output and to further find out resource use efficiency. Following form of Cobb-Douglas production was utilized in current study to find out resource use efficiency.

$$Y=ax1^{b1}.x2^{b2}.x3^{b3}.x4^{b4}.x5^{b5}.x6^{b6}.U$$

Where,

Y=Gross returns (₹ /hectare)
a= constant
x1= Human labour (₹ /hectare)
x2= Irrigation (₹ /hectare)
x3= Seed (₹ /hectare)
x4= Machine labour ((₹ /hectare)
x5= Fertilizer (₹ /hectare)
x6= Plant protection chemicals (₹/hectare)
bi= (i=1 to 6) Regression coefficient of factor inputs
U= Random disturbance term

For simplification, it was converted from exponential to linearized form by applying log operation on both sides and was written as below:

$$LnY=lna+b1.lnX1+b2.lnX2+b3.lnX3+b4.lnX4+b5.lnx5+b6.lnX6+U$$

Where,

Ln= Natural logarithm,
a = Constant,
U= Error term,
bi $_{(i=\ 1to\ 6)}$= production elasticities of respective factor inputs

't' test was used to test the significance of regression coefficient (bi), using the following formula

$$t = \frac{bi}{s \cdot e \cdot bi}$$

Where,

bi= Regression coefficients of xi
s.e. bi= standard error of bi

2.3.1 Calculation of resource use efficiency

Resource use efficiency is the measure of whether a particular input at its market price has been efficiently allocated or not through its judicious use [7]. To find the allocative efficiency first, Marginal Value Product (MVP) was calculated which is additional output achieved by adding an additional unit of the input. To find out the MVP following formula based on geometric mean was utilized.

$$MVP = b_i \frac{\bar{Y}}{\bar{X}_i}$$

Where,

$b\bar{i}$= Regression coefficient of input i
$\bar{Y}$= Geometric mean of return
$\bar{X}i$= Geometric mean of input i

To compute the resource use efficiency, ratio of MVP to Marginal Factor Cost (MFC) was considered, a ratio of greater than one showed under-utilization while less than one suggested over-utilization of resources. Following are the decision criteria used to decide the resource use efficiency.

MVP/MFC < 1 or MVP-MFC < 0 shows over-utilization of resource/input and shows that optimality has been crossed

MVP/MFC > 1 or MVP-MFC > 0 shows under-utilization of resource/input and suggests that optimality has not been reached yet.

MVP/MFC = 1 or MVP-MFC = 0 shows optimal utilization of resource/input

Resource use is efficient when marginal value product is equal to input price which results in maximization of profit. Mathematically,

$$MVPi = Pi$$

Where,

Pi= price of a unit of input Xi
Any variation in MVP from input cost is viewed as inefficient resource utilisation. Greater the difference between MVP and price of input greater is resource use inefficiency. Since, all the inputs and outputs were expressed in monetary terms, the acquisition cost of the inputs was taken as one ₹. The criteria used here to assess the resource allocation efficiency are to test the MVPs against MFC [8]. To test the significance of these variations 't' test was used. Expression of t test used was given by

$$t = \frac{MVP - P_i}{S \cdot E \cdot of\ MVP}$$

Where,

MVPi is the marginal value product of ith input Pi is price or acquisition cost of input. The ratio of yield and associated input at geometric mean level was multiplied by the standard error of regression coefficients to determine the MVP's standard error.

3. RESULTS AND DISCUSSION

3.1 Comparative Economics of Paddy Cultivation

3.1.1 Comparative cost of paddy cultivation by sources of mechanization

Total cost of cultivation was ₹ 113631.18/ha under CHCs, the same was ₹ 117021.85/ha under private farm machinery providers as source of machinery. In the case of paddy cultivation with private machinery providers, the fixed cost was 63871.02/ha and with CHCs, it was 63359.94/ha, which was comparable to one another.

The total variable cost under private machine providers was ₹ 53149.87/ha and, it was ₹ 50271.25/ha under CHCs, which resulted in the variation in the cost of paddy cultivation. In aspects of variable costs, the total input cost of paddy cultivation under private machine providers was ₹ 24189.02/ha and the total input cost under CHCs was ₹ 24222.98/ha, which were comparable, while the operational costs of paddy cultivation under private sources (26826.67/ha) were higher than those of CHCs (24002.23/ha) (Table 1). The total operational cost of paddy cultivation under CHCs was 10.53 per cent lower than that of private machine providers, which explains why cultivation with CHCs as a mechanisation source is less expensive [9,10]

3.1.2 Comparative returns from paddy cultivation by sources of mechanization

In the context of paddy cultivation with private farm machinery providers production was 69.31 quintals/hectare providing a gross return of ₹ 131052.03 and under CHCs it was 69.98 quintals/hectare yielding a gross return of ₹ 132868.70 which was relatively higher than the former one. Improved yield can be credited to the fact that prompt availability of machines, as reported by farmers who hire from CHCs, does contribute to increased productivity. Net returns from paddy cultivation under CHCs were higher by 27.06 per cent. Benefit-cost ratio for paddy cultivation under CHCs was 1.17 as opposed to 1.12 for paddy cultivation under private farm machinery suppliers (Table 1). Decreased cultivation costs and increased returns can justify improved net returns and hence the B: C. The results were in line with the findings of Chinnappa *et al.* (2018) where net returns were found to be increased by 24 per cent under CHCs [10].

3.2 Resource use Efficiency in Paddy Cultivation by Sources of Mechanization

The coefficient of determination (R^2) from the regression analysis was found to be decent in both models with values of 0.75 (paddy cultivation under private farm machinery providers) and 0.77. (Paddy cultivation under CHCs). Furthermore, machine labour was one of the common variables that had a significant impact on the returns in both models. As a result, the models as a whole were satisfactory to compare effective resource utilisation based on different mechanisation sources. (Table 2).

Further resource use efficiency computation was performed by determining MVP and then determining the gap between MVP and MFC. In the case of paddy cultivation under CHCs, it was discovered that machine labour was the input with the highest resource utilisation efficiency. In the case of paddy cultivation under private farm machinery providers it was human labour

Table 1. Comparative analysis of cost and returns of paddy based on mechanization source

S No	Item	CHC (₹/ha)	Per cent to total cost	Private (₹/ha)	Per cent to total cost
1	**Total Operational Cost**	**24002.23**	**21.12**	**26826.67**	**22.92**
2	Total Input Cost	24222.98	21.32	24189.02	20.67
3	Total Variable Cost	50271.25	44.24	53149.87	45.42
4	Total Fixed Cost	63359.94	55.76	63871.02	54.58
5	**Total Cost**	**113631.18**	**100.00**	**117021.85**	**100.00**
6	Gross Returns	132868.70		131052.03	
7	Net Returns	19237.52		14028.90	
8	Yield (qtls)	69.98		69.31	
9	**B:C Ratio**	**1.17**		**1.12**	

Table 2. Regression analysis of paddy based on sources of mechanization

Variables	Production elasticities		Standard Error		t	
	PFMP	CHC	PFMP	CHC	PFMP	CHC
Intercept (a)	4.89	7.23	0.80	0.60	6.08	12.14
Human labour (b1)	0.11*	0.07**	0.03	0.03	3.21	2.47
Irrigation (b2)	0.21**	-0.06	0.08	0.05	2.64	-1.20
Seed (b3)	0.19*	0.13*	0.04	0.04	4.84	2.97
Machine Labour (b4)	0.17*	0.11*	0.05	0.01	3.18	8.59
Fertilizer (b5)	0.03	0.15*	0.03	0.05	0.91	3.05
PPC (b6)	0.06**	0.09**	0.03	0.05	2.10	2.03
R^2	0.75	0.77				
F Value	16.61	18.90				

PFMP- Private Farm Machinery Providers
CHC- Custom Hiring Centres
PPC - Plant Protection Chemicals
, ** and * Significant at 1 %, 5% and 10 % respectively*

Table 3. Resource use efficiency of paddy cultivation based on sources of mechanization

Variables	MVP		MFC		MVP-MFC		SE (MVP)		t	
	PFMP	CHC	PFMP	CHC	PFMP	CHC	PFMP	CHC	PFMP	CHC
Human labour (b1)	1.16	0.76	1.00	1.00	0.16^	-0.24	0.36	0.31	0.44	-0.80
Irrigation (b2)	2.92***	-0.89	1.00	1.00	1.92	-1.89	1.11	0.74	1.73	-2.55
Seed (b3)	18.66*	12.67*	1.00	1.00	17.66#	11.67#	3.86	4.26	4.58	2.74
Machine Labour (b4)	1.58	1.24***	1.00	1.00	0.58	0.24^	0.50	0.14	1.16	1.69
Fertilizer (b5)	0.54	2.68***	1.00	1.00	-0.46	1.68	0.60	0.88	-0.77	1.91
PPC (b6)	1.31	1.96	1.00	1.00	0.31	0.96	0.62	0.96	0.49	0.99

PFMP- Private Farm Machinery Providers
CHC- Custom Hiring Centres
, ** and * Significant at 1 %, 5% and 10 % respectively*
^ Highest resource use efficiency # least resource use efficiency
PPC - Plant Protection Chemicals
MVP- Marginal value product
MFC- Marginal Factor Cost

because of difference between MVP and MFC being closest to zero (Table 3). It can be justified by the fact that readily available farm machinery, particularly heavy machinery (such as laser land levellers) at reasonable prices does lead to efficient utilisation of machine labour as an input [11,12].

4. CONCLUSION

The study was done to find out the economic effect of CHCs on paddy cultivation in Haryana. From the study it was found that cost of cultivation under CHCs was lower. The lower cost was mainly because of low operational costs. Operational cost under CHCs were lower to the tune of 11 per cent. Further, timely, and easily available machines made sure that returns were better under CHCs. Also, machine as a resource was optimally utilised under CHCs. So, it can be concluded that CHCs do fulfil their purpose of improving farm power availability at reasonable rates.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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