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Enhancing Productivity and Profitability in Wheat through Rotavator in Eastern Uttar Pradesh, India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The rice-wheat cropping system of the Indo-Gangetic region acts as the backbone of Indian agriculture feeding and providing livelihood to millions. Resource conservation technologies (RCTs) like rotavator has several positive effects such as early sowing of wheat, reducing land preparation time and cost, increasing soil organic content by incorporating the paddy stubbles, higher profits etc. The rotavator adopters in the study area earned an incremental net income of Rs. 7664.95 per ha and also the total cost of cultivation was reduced by Rs 1379.86 per ha. On an investment of Re one, the rotavator adopters earn a return of Rs. 0.81 whereas the non-adopters earn only Rs. 0.56. Adoption of this RCT offers several economic benefits to the respondents thus, making them economically better off than the non-adopters. The main reason for adopting the technology is the early sowing of wheat, which directly leads to better grain quality and quantity. Despite so many benefits, there are a few constraints in the adoption of rotavator, the major ones being the high custom hiring charges, non-availability of the machine on time or hire basis and high purchasing cost of the machine. Rotavator has the potential to play a significant role in boosting wheat production nationwide by overcoming constraints.

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1. INTRODUCTION

The rice-wheat cropping system is the backbone of Indian agriculture which extends over the Indo-Gangetic region covering nearly 14 million ha of area [1,2] and provides food and livelihood to millions [3]. Uttar Pradesh contributes to 32.7 percent of the country's total wheat production (GOI, 2022). In Uttar Pradesh, wheat is grown over an area of 9.2 million ha, of which eastern Uttar Pradesh (5.24 million ha) produces the highest [4]. For years the rice-wheat cropping system has been the way of life ensuring food and economic security, but the system is hard hit by the agricultural intensification process comprising of intensive tillage, mono-cropping and overuse of chemicals affecting the soil health, depleting the natural resource base, and raising climate vulnerabilities [5,6] thus, jeopardizing the future crop production potential. Resource conservation technology (RCT), an element of conservation agriculture is an effective approach to resist the negative effects of conventional agricultural practices. The adoption of RCTs enables the farmers to bridge the gap between paddy harvesting and wheat sowing, which directly boosts the quality and quantity of the produce.

Eastern Uttar Pradesh is geographically a significant wheat-producing region as it produces 57 percent of the state's total wheat production [4]. Of the several RCTs introduced in this Indo-Gangetic region of Eastern Uttar Pradesh, the rotavator is one of the most significant ones. Rotavator assists in early seedbed preparation, reducing the land preparation time for wheat sowing immediately after paddy harvesting. Compared to conventional tillage methods using a cultivator and harrow, the rotavator swiftly mixes and incorporates the paddy stubbles in the soil and requires low energy for the tillage operations thus, benefiting the farmers economically and environmentally. Rotavator in comparison to conventional tillage by cultivator saves time by 30-35 percent and reduces cost by 20-25 percent [7]. Farmers of Uttar Pradesh use the rotavator machine to mix the wheat seeds and fertilizers in the soil without any prior land preparation [8], leading to time-saving, cost reduction, and fuel savings. Rotavator is versatile in nature as they can be used in any type of soil [8].

Keeping in view the above advantages of the rotavator the present study was conducted in the Mirzapur and Chandauli districts of Uttar Pradesh to evaluate the economic impact of the RCT in Eastern Uttar Pradesh. The study was focused on testing the economic viability of the rotavator machine for wheat growers.

2. METHODOLOGY

2.1 Data and Source of Data

To conduct the present study primary data was collected through a pre-tested schedule from the rotavator adopters and non-adopters. The schedule was formulated to collect data regarding the quantity of inputs used, costs involved in the use of different machinery, total yield, market price of inputs and outputs etc. The data was collected for the period of 2021-22.

2.2 Sampling Procedure

Wheat is the second most important staple cereal crop that feeds millions of Indians and was purposively taken considering its importance in the food basket of India. Uttar Pradesh is the largest wheat-producer was also purposively selected for the study. In Uttar Pradesh, the eastern region holds the record of highest production which led to the selection of districts Chandauli and Mirzapur. The blocks were selected based on the criteria of maximum adoption and lowest/no adoption of the rotavator. In Chandauli district, block Chandauli was selected as adopter and Sakaldiah block was selected as non-adopter block whereas, in Mirzapur, Sikhar was opted as adopter and Narayanpur as non-adopter blocks respectively. Four villages from each block were randomly selected from the list of adopter and non-adopter villages. 10 farmers in each village were randomly selected for the interview. A total sample size of 160 farmers was taken under study, of which 80 were adopters and 80 were non-adopters.

2.3 Analytical Tools

2.3.1 Cost of cultivation

Cost concept developed by the Commission for Agricultural Costs and Prices (CACP) was used to estimate the cost of cultivation of wheat [9] under rotavator and conventional tillage. The costs were calculated as:

Cost A_1 = wages of human labour + charges of implements and machinery + costs incurred on seed + cost incurred on fertilizers + cost incurred on plant protection chemicals + irrigation charges + interest on working capital + land revenue + miscellaneous expenses
Cost B_1 = Cost A_1 + interest on the value of owned fixed capital assets (excluding land)
Cost B_2 = Cost B_1 + Rental value of owned land.
Cost C_1 = Cost B_1 + rental value of owned land (net of land revenue) and rent paid for leased-in land
Cost C_2 = Cost C_1 + imputed value of family labour
Cost C_3 = Cost C_2 + 10 percent of cost C_2 as account for managerial input of the farmer

2.3.2 Income measures

The return over different cost concepts is measured under income measures. These measures include:

Gross farm income = average yield per ha (kg) × average price per kg (Rs.)
Returns over variable cost = Gross income – Cost A_1
Farm business income = Gross income – Cost A_2
Family labour income = Gross income – Cost B_2
Net income = Gross income – Cost C_2
Returns to Management = Gross income – cost C_3
Farm investment income = Farm business income - imputed value of family labour
Net return per rupee of investment = $\frac{\text{Net Return (Rs.)}}{\text{Total Cost (Rs.)}}$

2.3.3 Economic benefit

The economic surplus model given by Alston et al. [10] was applied to calculate the economic benefits of the rotavator. The model is given below:

$$\triangle CS = P_0\, Q_0\, Z\, (1+0.5\, Z\eta)$$

$$\triangle PS = P_0\, Q_0\, (K-Z)\, (1+0.5\, Z\eta)$$

$$\triangle TS = \triangle CS + \triangle PS = PQ\, K\, (1+0.5\, Z\eta)$$

Where,

P_0 = Base price of the commodity
Q_0 = Base quantity
η = absolute value of the price elasticity of demand
$Z = K \frac{\varepsilon}{\varepsilon + \eta}$; or the proportionate price reduction in the market where ε is the elasticity of supply
K = proportionate reduction in cost of production
$\triangle$CS = Change in consumer Surplus
$\triangle$ PS = Change in producer Surplus
$\triangle$ TS = Change in total economic surplus

2.3.4 Garett's ranking

Garrett's ranking technique was used to rank the reasons for adoption by adopters and constraints faced by the non-adopters, the ranks assigned by the respondents were converted into a percentage position which was then transformed into Garrett's score based on Garrett's table [11].

$$\text{Percentage position} = \frac{100\,(R_{ij}-0.5)}{N_j}$$

Where,

R_{ij} = Rank given for the i^{th} item by the j^{th} respondent
N_j = Number of items ranked by the j^{th} respondent

3. RESULTS AND DISCUSSION

3.1 Socio-Economic Profile

The socio-economic profile of the respondents is represented in Table 1. The average landholding size was higher among adopters (1.79 ha) in comparison to non-adopters (1.09 ha) indicating that the majority of farmers fall under the small landholding size category. The average age of respondents (50.7 years) in the adopter category was lower than non-adopters (57.5 years). Farmers of both categories are literate up to primary level. The major occupation of all the respondents was crop production. The average number of family members for adopters and non-adopters was 7.42 and 7.78 persons per family.

At an average, the adopters had a farming experience of 19.32 years whereas the non-adopters had a little more farming experience (*i.e.* 21.5 years). The average farm income per annum of rotavator adopters (Rs. 168410) was higher than the non-adopters (Rs. 1411413). In a year, an adopter respondent spends around Rs. 129600 as consumption expenditure whereas the amount is a bit higher in the case of non-adopters (*i.e.* Rs. 132375). The major source of irrigation for both categories was canal irrigation. The major soil type prevalent in the area under study was loam and sandy loam. The major source of information for the farmers in the area was the informal sources such as farmers of the same village or neighbouring village, private dealers etc. The farmers in this region mainly follow the rice-wheat cropping pattern indicating the absence of crop rotation in the study area.

3.2 Economics of Wheat Cultivation

Different costs incurred in wheat cultivation by both adopters and non-adopters are listed in Table 2. Per ha total variable cost incurred by adopters and non-adopters was Rs 23681.82 and Rs 24915.82. The variable cost accounts for 63.7 and 64.4 per cent of total cost for adopters and non-adopters respectively. The total cost of wheat cultivation per ha (*i.e.* Cost C_3) was Rs. 37149.39 and Rs. 38667.23 respectively. The cost of machine labour was lower in rotavator tillage (*i.e.* Rs. 1713.46) than non-adopters (Rs. 2080.74). Rotavator improves the soil texture which reduces the quantity of seed and fertilizers thus, reducing the costs incurred on them.

The contribution of seed and fertilizer was 11 and 15.2 per cent for adopters and 11.8 and 15.4 per cent for non-adopters respectively. Even though the irrigation water was not charged based on the quantity, the amount of water used for irrigation by the rotavator (2268 m^3/ha) was less as compared to conventional tillage (2592 m^3/ha). Non-adopters do not spend a penny on plant protection chemicals due to low or negligible incidence of pest or weed, but in contradiction rotavator adopters face major pest problems thus, incorporating the costs of plant protection chemicals (Rs. 433.62).

The yield and returns from wheat cultivation is represented in Table 3. Per hectare wheat grain and by-product (*bhusa*) obtained by rotavator adopters was 28.17 and 18.9 quintals respectively, whereas 25.17 quintals of wheat grain and 16.85 quintals of by-product were obtained by non-adopters. Higher yields were direct results of the adoption of rotavator. The gross income earned by adopters (Rs 61279) was higher for adopters in comparison to non-adopters (Rs 54994.61). Higher returns and lower cost of cultivation resulted in comparatively higher net return per rupee of investment for rotavator adopters which was 0.81, which indicates that on an investment of Re one, the adopters earn a net return of Rs. 0.81 while the net return earned by non-adopters is Rs. 0.56. The incremental net income received by adopters was Rs. 7664.95 per ha.

3.3 Economic Benefits

Various economic benefits experienced by rotavator adopters are represented in Table 4. The per hectare increment in total income due to yield benefits was Rs 6285.09. The total economic benefit was due to a reduction in the cost of human labour, machine labour, seed, fertilizer, harvesting, and diesel saving and due to an increment in yield, it was Rs. 7952.1 per ha. The adoption of rotavator reduced the cost of inputs such as seed and fertilizers by Rs 460.65 and Rs 325.61 per ha. According to the rotavator adopters, diesel consumption reduces by 4 lt /ha amounting to Rs 360 per ha. Thus, rotavator not only benefits the farmers economically but also have environmental benefits.

3.4 Reasons for Adoption of Rotavator

The major reasons that inspired our adopters to adopt the rotavator are tabulated in Table 5. These are also the conditions that could motivate our non-adopters to adopt the technology. The prime reason for the adoption of rotavator was early sowing of wheat as the technology bridges the gap between paddy harvesting and wheat sowing by incorporating the paddy stubbles during land preparation. Reduction in land preparation cost due to a reduction in machine labour is the second cause for adoption followed by an increment in net income and increased crop yields. Other conditions that promoted the widespread of adoption of the technology in the region were reduction in irrigation water use, reduction in cost of cultivation and improvement in soil health.

3.5 Constraints in Adoption of Rotavator

Rotavator is an economic boon to the farmers, but still, there are causes that hinder its complete adoption, the constraints are ranked below in Table 6. The major constraint that restricts the adoption was high custom hiring charges which directly increase the cost of cultivation. Secondly, the reason that obstructs the adoption was non-availability of the rotavator machine on time or on hire basis, this majorly occurs due to the availability of less number of machines in a village and the demand for the machines during the wheat sowing time is higher. High cost of rotavator compels the farmer to be dependent on custom hiring only and thus hinders the full adoption of the technology. The other constraints are lack of financial support, no surety of profits, weed incidence and lack of knowledge about the technology. Overcoming these hurdles will lead to better adoption rates thus, benefiting the farmers both economically as well as environmentally.

Table 1. Socio-economic profile of respondents

Particulars	Units	Adopters (n=80)		Non-adopters (n=80)	
		Mean	Standard deviation	Mean	Standard deviation
Landholding size	Hectare	1.79	1.5	1.09	0.91
Age	Years	50.7	14.5	57.5	12.8
Education	Code	2.18	0.71	1.97	0.88
Occupation	Code	1.67	0.82	1.98	1.08
Family size	Number	7.42	3.14	7.78	3.97
Farming experience	Years	19.32	10.37	21.5	12.8
Farm income	INR/annum	168410	167543.4	141141.3	117887.3
Consumption expenditure	INR/annum	129600	91118.03	132375	113688.2

Note: Code for Education: 1- Illiterate, 2- Up to 7th class, 3-8th -12th class, 4- Graduation and above
Code for occupation: 1- Crop production, 2-crop production + service, 3-crop production + business, 4- crop production + livestock

Table 2. Cost of cultivation of wheat incurred by adopters and non-adopters (Rs. /ha)

Particulars	Adopters (n=80)		Non-adopters (n=80)	
	Amount	% total cost (C_3)	Amount	% total cost (C_3)
Wages of human labour				
a) Hired	2711.20	7.3	2949.47	7.6
b) Family	440.35	1.2	586.21	1.5
Cost of machine labour	1713.46	4.3	2080.74	5.4
Cost incurred on manures	90	0.2	131.4	0.3
Cost incurred on seeds	4086.55	11.0	4547.2	11.8
Cost incurred on fertilizers	5052.94	15.2	5954.8	15.4
a) Urea	1317.72	3.5	1494.93	3.9
b) DAP	3273.51	8.8	3416.57	8.8
c) Zinc	1037.96	2.8	1043.3	2.7
Cost incurred on plant protection chemicals	433.62	1.2	0	0.0
Irrigation charges	150	0.4	150	0.4
Harvesting and threshing	7954.8	21.4	8057.76	20.8
Land revenue	87.5	0.2	87.5	0.2
Depreciation on farm machinery, equipment, farm building etc.	220	0.6	220	0.6
Interest on working capital (@3%)	705.5	1.9	736.95	1.9
Interest on owned fixed capital assets excluding land (@10%)	650	1.7	650	1.7
Rental value of owned land	9000	24.2	9000	23.3
Cost A_1	23681.82	63.7	24915.82	64.4
Cost A_2	23681.82	63.7	24915.82	64.4
Cost B_1	24331.82	65.5	25565.82	66.1
Cost B_2	33331.82	89.7	34565.82	89.4
Cost C_1	24772.17	66.7	26152.03	67.6
Cost C_2	33772.17	90.9	35152.03	90.9
Cost C_3	37149.39	100.0	38667.23	100.0

Table 3. Yield and returns from wheat cultivation by adopter and non-adopters

Particulars	Adopters	Non-adopters
Main product produced (Qt./ha)	28.17	25.17
By-product produced (Qt./ha)	18.9	16.85
Return from main product (Rs. /ha)	55650.04	49719.95
Return from by-product (Rs. /ha)	5629.68	5274.66
Gross income (Rs. /ha)	61279.7	54994.61
Net return/Net income (Rs. /ha)	27507.53	19842.58
Returns over variable cost (Rs. /ha)	37597.88	30078.79
Farm business income (Rs. /ha)	37597.88	30078.79
Family labour income (Rs. /ha)	27947.88	20428.79
Returns to Management (Rs. /ha)	24130.31	16327.38
Farm investment income (Rs. /ha)	36709.04	38081.02
Net return per rupee of investment	0.81	0.56

Table 4. Economic benefits of rotavator adoption (Rs. /ha)

Particulars	Amount (Rs. /ha)
Due to reduction in the cost of labour	384.13
Due to reduction in the cost of machine labour	467.28
Due to reduction in the cost of seed	460.65
Due to reduction in cost of fertilizer	325.61
Due to the reduction in cost of plant protection chemicals	-433.62
Due to the reduction in cost of harvesting	102.96
Due to yield benefits (main & by-product)	6285.09
Due to diesel saving (@ Rs. 90/Lt)	360
Total economic benefits	7952.1

Table 5. Reasons for the adoption of rotavator

Reasons	Garett score	Rank
Early sowing of wheat	44.82	1
Reduction in land preparation cost	40.05	2
Increment in net income	39.08	3
Enhanced crop yield	38.94	4
Reduction in irrigation water use	38.89	5
Reduction in cost of cultivation	35.42	6
Improvement in soil health	34.21	7

Table 6. Constraints in adoption of rotavator

Reasons	Garett score	Rank
Custom hiring of rotavator machine is high	48.11	1
Non-availability of rotavator machine on hire or on time basis	47.81	2
High cost of rotavator machine	46.2	3
Lack of financial support	42.78	4
Not sure of profit	36.96	5
Weed problem	30.9	6
Lack of knowledge about the technology	24.84	7

4. SUMMARY AND CONCLUSION

Of the several resource conservation technologies popular in Eastern Uttar Pradesh, rotavator is one of the prominent ones. Rotavator plays a key role in the early sowing of wheat and also improves soil health by swiftly mixing and incorporating the paddy stubbles in the soil increasing the organic content of the soil. Analysis of the economics of wheat cultivation by rotavator clearly indicates that adopters received a higher net income than conventional tillage practitioners. The net return per rupee of investment was higher in adopters (0.81) than in non-adopters (0.56). The total costs incurred by adopters were lower than the non-adopters. Reduction in costs and yield benefits resulted in economic benefits of a sum total of Rs 7952.1 per ha. The major reasons that drive the adoption of rotavator were early sowing of wheat, reduction in land preparation cost and increment in net income. Despite several economic benefits, there are a few constraints that hinder the complete adoption of the technology: high custom hiring charges, non-availability of rotavator machine on time or hire basis and high cost of rotavator machine. To enhance the benefits of rotavator the above constraints need to be addressed by either increasing the number of machines at block level for custom hiring purpose this would directly reduce the hiring charges, government can also provide the machines for purchase on subsidy to increase the adoption rate.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Alam MK, Biswas WK, Bell RW. Greenhouse gas implications of novel and conventional rice production technologies in the Eastern-Gangetic plains. Journal of Cleaner Prouction. 2016;112(5):3977–3987.
2. Mishra JS, Poonia SP, Kumar R, Dubey R, Kumar V, Mondal S, et al. An impact of agronomic practices of sustainable rice-wheat crop intensification on food security, economic adaptability, and environmental mitigation across eastern indo-gangetic plains. Field Crops Research. 2021;267: 108164.
3. Kumar V, Jat HS, Sharma PC, Gathala MK, Malik RK, Kamboj BR, et al. Can productivity and profitability be enhanced in intensively managed cereal systems while reducing the environmental footprint of production? Assessing sustainable intensification options in the breadbasket of India. Agriculture, Ecosystems & Environment. 2018;252:132-147.
4. Singh A. A Statistical study of trends of wheat production in districts of eastern Uttar Pradesh, India. International Journal of Current Microbiology and Applied Sciences. 2020;9(4):158-166.
5. Mandal VP, Rehman S, Ahmed R, et al. Land suitability assessment for optimal cropping sequences in Katihar district of Bihar, India using GIS and AHP. Spatial Information Research. 2020;28(5):589–599.
6. Rani M, Joshi H, Kumar K, et al. Climate change scenario of hydro-chemical analysis and mapping spatio-temporal changes in water chemistry of water springs in Kumaun Himalaya. Environment, Development and Sustainability. 2021;23:4659–4674.
7. Agri Farming (n.d.). Rotavator uses in Agriculture, Advantages of Rotavator. Available:https://www.agrifarming.in/rotavator-uses-in-agriculture-advantages-of-rotavator
8. Singh OP, Singh R, Lakra K, Srivastava AK, Singh PK. Problems and prospects of rotavator use in Etah district of Uttar Pradesh. Trends in Biosciences. 2017;10(6):1415-1421.
9. Rao VM. "The making of agricultural price policy: A review of CACP reports". Journal of Indian School of Political Economy. 2001;13(1):1-28.
10. Alston JM, Norton GW, Pardey PG. Science under scarcity: Principles and practice for agricultural research evaluation and priority setting, Cornell University Press, Ithaca; 1995.
11. Decisions ISP. Application of Henry Garrett ranking method to determine dominant factors influencing smartphone purchase decisions of customers. Jour of Adv Research in Dynamical & Control Systems. 2019;11(6):213-18.

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