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Economic Viability Analysis of Super Seeder Machine Adoption in Wheat Cultivation: A Case Study in Haryana

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Abstract: There is a need to investigate the potential for conserving essential inputs through resource-conserving alternative technologies in agriculture, such as the super seeder technique and happy seeder, etc. The study focusses the economic viability of the super seeder machine used in wheat farming in Haryana. The blocks, villages, and respondents were chosen using a multi-stage random selection procedure. The study was conducted in the Karnal and Kaithal districts of Haryana in 2021-2022. Using conventional and super seeder paddy straw management techniques, a sample of 100 wheat-growing farmers was chosen. The viability of the machinery was assessed using the payback period and break-even point. The payback period was 2.08 years for wheat crop planting using the super seeder. The machine's net present value and benefit-cost ratio were assessed as Rs. 18718.03 and 1.52, respectively. The machine's break-even points and break-even hours were 50.01 ha and 81.50 hrs., respectively.

Key words: Economic viability, payback period, break-even point.

The technological improvements in Indian agriculture since the mid-sixties have brought about a revolutionary increase in agricultural production. Farm mechanization has helped bring about a significant improvement in agricultural productivity. Thus, there is a strong need for mechanization of agricultural operations. The factors that justify the strengthening of farm mechanization in the country can be numerous. The timeliness of operations has assumed greater significance in obtaining optimal yields from different crops, which has been possible through mechanization. For instance, wheat sowing in India is done up to the first fortnight of November. A delay beyond this period by every one week leads to about 0.37 t ha^{-1} decrease in the yield.

As of January 2022, 6755 custom hiring centers were operational in Haryana, where 31446 agricultural machines were available for crop residue management (Anonymous, 2023; NEWSNCR, 22 January 2022). In the fiscal years 2021-22, a total of 250 million rupees was allocated to facilitate the accessibility of agricultural machinery for farmers. The result was 30% improvement in crop residue management *vis a vis* previous year. Farmers have stopped burning stubble in the fields and are coming forward to take advantage of the crop residue management scheme (NEWSNCR, 25 January 2022). A single tractor-mounted super seeder which cuts and lifts the standing stubble, drills the wheat seeds into bare soil, and deposits the residue over the sown area as a mulch cover can work approximately 3 ha daily for 25-30 days during the rabi planting season (The Indian Express, 24 January 2020).

Agriculture mechanization is essential because it helps to increase the productivity of crops by enhancing the effectiveness and efficiency of the inputs used in crop production. By increasing the amount of power available to agriculture, more regions can be cultivated to produce more crops while preserving natural resources. Farmers may produce crops more effectively using less power by implementing modern, ecologically friendly technologies. Sustainable agricultural mechanization can make post-harvest, processing, and marketing operations and functions more effective, efficient, and environmentally friendly, which can have a substantial impact on the growth of value chains and food systems. The amount of mechanization should successfully and efficiently meet their needs.

One of the most extensively cultivated cereal crops worldwide is wheat (*Triticum aestivum* L.), and raising grain production is a crucial national objective to meet the country's continuously rising food needs. One of the key elements impacting wheat production is the sowing technique. The majority of farmers reported higher yields (21-23 q acre^{-1} or 2.49 t ha^{-1} while using a happy seeder, in comparison to that achieved using disc harrows or rotavators (16-18 q acre^{-1} or 39-44 q ha^{-1}) (Kirandeep *et al.*, 2020). Bishnoi *et al.*, 2023 report that the yields obtained with the super seeder and conventional approaches were 2.48 t ha^{-1} and 2.38 t ha^{-1}, respectively. Despite being a new technology, the super seeder has enabled farmers to achieve yields higher than zero-till drills and rotavators/ disc harrows. With a projected area of 2550 ha and a productivity of 4900 kg ha^{-1}, wheat is one of the most significant crops in Haryana (Economic Survey of Haryana, 2022-23). Under the rice-wheat cropping pattern, wheat would be sown using machines like the super seeder, happy seeder, zero drill, and others to ensure prompt operation, increasing crop production, and for the farmer's economic advantages. The wheat grain yield experiences a decline of approximately 1% for delay of each day after the optimum sowing date (Shah *et al.*, 2020). Timely sowing could open up opportunities for extra revenues through higher yield and optimum temperature at maturity.

Innovative solutions like the "super seeder" and other associated machinery have been created to effectively manage agricultural leftovers and reduce environmental impact in response to the rising cases of crop residue burning (paddy straw) of and pollution levels. These innovations are intended to develop a more dependable and environment friendly agricultural system to benefit farmers' and the environment. In past, adoption of these technique on farmers' fields has been hampered by factors such as high machinery costs, high hiring costs, and delays in subsidy payments (Bishnoi *et al.*, 2023). But there is need for a systematic study to assess the impact of super seeder technology in India, particularly in Haryana. The current investigation constitutes a groundbreaking effort in this direction. The primary objective of the current study is to assess the economic viability of employing conventional and super seeders and determine the benefit-cost ratio for determining if the super seeder technique is feasible.

Materials and Methods

Since the super seeder technology has mainly been practiced for wheat cultivation, the impact study was restricted to this crop only. The economic viability assessment of the super seeder machinery operations involved analyzing data gathered from Karnal and Kaithal districts of Haryana. These districts were selected based on their extensive cultivation of rice-wheat cropping patterns and the widespread adoption of super seeder machines for directly sowing wheat crops amidst paddy residue. The data collected encompassed initial machine investments, sowing expenses, maintenance costs, depreciation charges, diesel expenses, and sowing returns. Both fixed costs (such as interest on fixed costs and depreciation) and variable costs (including maintenance, fuel, labor, and operational expenses) were carefully calculated for these units. These costs were then compared to the returns generated from the operations to determine the overall economic viability.

To calculate the economic viability of a super seeder, we calculate the payback period, which was determined by subtracting the initial investment from the net return until the initial investment was repaid entirely. The shorter the payback period, the more feasible it is to invest in a super seeder. After that, we examine the break-even point for the machinery, which was the yearly utilization level at which the machine must be run to make the investment viable, known as the break-even point. The formulas used to calculate the economic viability for super seeder are as follows:

$$\text{Payback period} = \frac{\text{Initial investment}}{\text{Average annual net benefit}}$$

$$B(x) = \text{Fixed cost} + \text{Variable cost}$$

where, x = Break-even point (per hectare); B = Benefits (or the custom fee)

The above formula was used for calculating the net return from the machinery after that we calculate the payback period.

$$\text{Break-even point (ha)} = \frac{\text{Annual payback (Rs.)}}{\text{Annual monetary save against conventional sowing (Rs. ha}^{-1}\text{)}}$$

$$\text{Benefit cost ratio} = \frac{\text{Gross return}}{\text{Total operational cost}}$$

Gross return = Total area cultivated by machine x Custom hiring charges

Annual payback = Total revenue - Total cost

Annual monetary gain over conventional tillage = Preparatory tillage charges + sowing charges in conventional tillage - sowing charges in super seeder

Total monetary save = Annual monetary gain over conventional tillage x Total sowing in ha./year

Breakeven point (hours) = Breakeven point (ha) x total time required in sowing per ha.

Results and Discussion

The payback period, net present value, and break-even point value for the super seeder machine are presented in Table 1. The payback period is the period in which the initial investment is recovered. The break-even point is the point where fixed as well as variable costs are recovered at which there is no loss and no profit. The break-even point is essential in establishing the machine's helpful working lifespan. By calculating the break-even point, we can establish the number of hectares of land that must be sown and the number of hours of operation before the machine profits. The super seeder machine is also superior to the conventional technique because it reduces greenhouse gas emissions and places a higher priority on environmental safety than other factors. The conventional method burns paddy residue and requires at least four to six preparatory tillage operations for sowing of wheat crop, each of which uses a significant amount of fuel and results in pollution but in the super seeder technology residue mixed as in-situ management which improves the soil quality ultimately yield also increases over the conventional technique.

When comparing the economics of super seeder machines to conventional sowing techniques, it was discovered that the super seeder technique had a benefit-cost ratio of 1.52 for the wheat crop. The super seeder machine's break-even hectares and break-even hours for the wheat crop were determined to be 50.01 hectares and 81.50 hours, respectively. The break-even point is crucial in figuring out how long the machine will operate profitably. By figuring out the break-even point, we can figure out how many hectares of land need to be sown and how many hours the machine has to run in order to start making money. The super seeder machine has a net present value of Rs. 18718.03 and a payback period of 2.08 years. Similar findings were reported in the study by Kumar *et al*. (2019), which discovered that under reaper-cum-binder, the break-even (hours) was 260.90 and the break-even (hectares) was 99.17. The break-even hectares for reaper-cum-binder machines were 19.75, and the break-even hours for the wheat crop were 51.94 hours, and benefit-cost ratio of 2.08 as reported by Kumar *et al*. (2019).

Table 1. Payback period, net present value and break-even point value for the super seeder machine

1	Costs	Value (Rs.)
A	Fixed costs	
i	Initial cost with subsidy	125500.00
ii	Depreciation @ 10% per annum	9412.50
	Total of initial cost and depreciation	134912.50
iii	Interest on fixed cost @ 7% per annum	9443.87
	Total of initial cost, depreciation and interest on fixed cost	144356.37
	Total fixed costs without initial cost	18856.38
B	Variable costs	
i	Diesel consumption (liter ha^{-1}) @ Rs. 84/liter 21.61 L ha^{-1}	1815.45
ii	Labor cost (Rs. ha^{-1})	247.00
iii	Maintenance cost (Rs. ha^{-1})	370.50
	Total of diesel consumption, labor cost and maintenance cost (Rs. ha^{-1})	2432.95
iv	Interest on operational cost @ 7% per month ha^{-1}	14.19
	Total of diesel consumption, labor cost, maintenance cost and interest on operational cost (Rs. ha^{-1})	2447.00
C	Total costs*	21303.52
2	Returns	
i	Average sown area by one individual in the year (ha)	43.57
ii	Sowing charges (Rs. ha^{-1})	4421.32
iii	Average operational cost of sowing (Rs.)	106024.90
iv	Interest on average operational cost @ 7%	618.47
v	Total operational cost	106643.40
vi	Total cost (Rs.)*	125499.80
vii	Gross return	192674.70
viii	Net return	67174.94
3	Payback period	2.08
4	Net present value	18718.03
5	Break-even point/ha	50.00
6	Break-even point/hour	81.50
7	Benefit-cost ratio	1.52

*= In fixed costs, only depreciation charges and interest on fixed capital are included.

Super seeder machine is also superior to the conventional technique because it reduces greenhouse gas emissions. Environment safety is more important than others, and this technique is environmental friendly as compared to the conventional technique because in the conventional technique, paddy residue is burned, and at least 4-6 preparatory tillage operations in which fuel is used much more amount, which causes the pollutions but in the super seeder technology residue mixed as in-situ management which improves the soil quality ultimately yield also increases over the conventional technique.

The main environmental benefits are conservation of soil due to higher organic carbon contents (Chauhan *et al.*, 2002); and ground water conservation as it reduces irrigation water requirement (Malik *et al.*, 2004). It also helps in reducing greenhouse gas emissions due to reduction in diesel use (Sharma *et al.*, 2002). Most farmers said using a super seeder boosted production, reduced weeds, and saved money on cultivation costs and irrigation water.

This technology is also superior to the conventional technique because it reduces greenhouse gas emissions. Environmental safety is more important than other concerns, and this method is more environmentally friendly than the conventional method because it does not burn paddy residue and does not require as many preparatory tillage operations, which use much more fuel and result in pollution.

Economic analysis of the super seeder technique for wheat cultivation is an economical and attractive option for the farming community because this technology proved profitable in terms of return, cost, and time-saving compared to the conventional techniques of wheat sowing. The higher benefit-cost ratio (2.91) by the super seeder compared to the conventional technique (2.64) showed its importance (Bishnoi *et al*., 2023). Rice residue contains around 0.7% N, 0.23% P, and 1.75% K, and it is also an essential source of micronutrients such as Zinc and is rich in Silicon. Therefore, in-situ residue management protects the environment and soil health. Using a super seeder for the sowing of wheat results in significantly higher yield, gross returns, net returns, and B:C ratio of wheat. Super seeder with loose straw removal treatment was the most promising in yield, economically feasible, and environment friendly (Chaudhary *et al*., 2021).

Conclusion

Super seeder is the next version or modification of happy seeder in which some parts of the previous crop are left in the field, but in the case of the super seeder, there is no residue left between the wheat crops; all residues are mixed with the soil very well and decomposed by the time. The super seeder machine has a benefit-cost ratio of 1.52 for the wheat crop. The break-even hectares and break-even hours for the wheat crop for the super seeder machine were calculated to be 50.01 hectares and 81.50 hours, respectively. The super seeder machine has a net present value of Rs. 18718.03 and a payback period of 2.08 years. In conclusion, offer subsidized super seeders to farmers or provide affordable machinery through agricultural departments or cooperatives. Publish guidelines for farm operations, ensuring proper crop management and input quantities. Organize demonstrations and exhibitions to dispel doubts and misconceptions. Establish robust extension services for managing super seeders. Continue improving machinery for effective wheat seeding in no-till systems.

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