Comparative study on different sowing methods of wheat crop in sub-tropical zone of Samba district, Jammu and Kashmir

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 Received: 18.01.2025/Accepted: 06.03.2025

ABSTRACT

This study evaluated the impact of different wheat sowing techniques (zero tillage, super seeder and conventional broadcasting) on yield and profitability in the rice-wheat cropping system of Samba district, Jammu and Kashmir. Field demonstrations were conducted over two years, comparing the three methods. Results showed that zero tillage and super seeder significantly improved efficiency, yield and profitability compared to conventional broadcasting. Super seeder achieved the highest grain yield (37.60 q/ha) and net return (Rs 59,800/ha) followed by zero tillage (28.70 q/ha and Rs 43,600/ha respectively). Both technologies reduced labour, fuel and operational costs. Technological and extension gaps were analyzed, highlighting the need for enhanced farmer education and technology adoption. Farmers adopting zero tillage and super seeder expressed willingness to continue, despite challenges like high input costs and climatic variations. The study concluded that these modern sowing techniques offer substantial benefits for enhancing wheat production in the region.

Keywords: Wheat; super seeder; zero till seed cum fertilizer drill; broadcasting; yield

INTRODUCTION

Wheat (*Triticum aestivum* L) is one of the most widely grown cereal crops in the world. The area under wheat is increasing every year being the most important food grain and staple food of Indians especially in northern parts of the country. India produced 113.29 million tonnes of wheat over an area of 31.83 million ha with yield of 3,559 kg per ha in 2023-24 (Anon 2024). India is the world's second-largest wheat producer, accounting for 14 per cent of global wheat production (Anon 2021).

The rice-wheat cropping system (RWCS) plays a vital role in global food security as it provides staple foods to the world's population (Lalik et al 2014, Banjara et al 2021a). The RWCS is extensively cultivated and is the most technologically advanced system in the world. In Asia, 13.5 million hectares are grown, with 57 per cent of it being in south Asia (Ladha et al 2009). Furthermore, more than 85 per cent of the RWCS practiced in south Asia is distributed in the Indo-Gangetic plains (Banjara et al 2021b). This cropping system is also very prevalent in Himachal Pradesh and Jammu and Kashmir, especially the Jammu region.

Looking into the future, towards 2030 and beyond, the challenge of feeding India's growing population is going to be a major task (Gulati et al 2023). It is necessary to implement appropriate agricultural mechanization to perform agricultural operations so as to increase productivity, reduce costs and maximize agricultural income (Cupial and Kowalczyk 2020). There was 23.0 and 24.0 per cent decrease in grain yield of wheat for the late sown when compared with normal sowing on 28 November in first year and second year respectively (Verma et al 2022). This loss can be saved through early and fast seeding of wheat using

tractor drawn super seeder and zero tillage compared to conventional method. The selection of suitable sowing methods plays an important role. It maintains plant population, proper depth at which seed is placed in the soil and proper spacing between rows and plants (Anon 2019).

In sub-tropical zone of Samba district, Jammu and Kashmir, wheat is sown through broadcasting on a large area after rice harvesting. Technique of sowing is one of the important factors which compensate the low tillering in wheat, to give the best plant distribution in the field and to save the labour in controlling weeds within ridges or rows (Kabesh et al 2009). Wheat is sown through broadcasting on a large area after rice harvesting. Broadcasting not only requires higher seed rate but also leads to poor yield (Tanveer et al 2003). The crop sown by drilling after tillage reduced more grain yield as compared to drilled with zero tillage and broadcasted after tillage (Bakhsh et al 2020). Sowing of wheat crop in system of wheat intensification method with proper spacing is recommended for receiving higher growth and yield of wheat than in broadcasting and line sowing method (Santhosh and Mehera 2022).

Mishra et al (2022) reported that wheat sown under system of wheat intensification at 22 cm × 22 cm spacing was better than line sowing at 26 cm and broadcasting methods in terms of grain yield. However, it was not economical than line sowing due to higher cost incurred in labour. Therefore, mechanization in system of wheat intensification should be developed in order to replace required manual power and get higher profit. Singh and Chaturvedi (2023) confirmed that line sown method of sowing was significantly superior over broadcasting method of sowing in terms of plant height, number of tillers per hill, number of leaves per plant, length of spike, number of grains per spike, test weight, grain yield, straw yield, harvest index, gross return and net return.

Manan and Sharma (2017) reported that in Kapurthala district of Punjab, zero till seed drill was getting popularity because intensive tillage was not necessary for wheat crop in paddy-wheat rotation and there was sufficient scope to reduce tillage operations for seed bed preparation of wheat crop. Zero tillage is a conservation technology that has the potential of saving time, energy and inputs for small farmers (Singh et al 2012).

The objective of the present study was to investigate the effect of different sowing techniques on the yield of wheat. Three major sowing techniques were applied. These were super seeder, zero seed cum fertilizer drill and broadcasting. The main function of the super seeder machine is to plough standing paddy stubble in soil and sow wheat seed simultaneously in a single operation after the harvesting of the paddy with combine harvester having super-SMS attachment. Zero tillage is a minimum tillage practice in which the crop is sown directly into soil and not tilled since the harvest of the previous crop. Broadcasting method is a method of seeding that involves scattering of seed. The seeds are spread uniformly and are then covered with planking.

MATERIAL and METHODS

The experiment was conducted at farmers' fields in Raguchak, Chachwal, Challyari, Paloora, Kotli Matkalian, Khor Salarian, Rakh Barothian and Harsath villages of Samba district of Jammu and Kashmir during rabi season of 2022-23 and 2023-24. Conventional rice-wheat rotation has been followed in this area for a long time. A field survey was conducted in selected villages to collect desired information. The primary data were collected from 20 farmers each who used super seeder, zero tillage technology and conventional farming from the same villages per year. The area under each demonstration was 0.2 ha. Regular visits by Krishi Vigyan Kendra scientists to frontline demonstrations (FLDs) were made so as to ensure timely application of critical inputs and to solve other crop related problems. The schedules were developed to collect necessary information regarding hired human labour, machines used, seeds, fertilizers, irrigation and plant production measures. All input and output parameters pertaining to wheat production were based on two years average values with a view to minimize seasonal fluctuations in the variables. Data were analyzed using percentage, benefit-cost ratio and partial budget analysis techniques. The extension activities like field days and Kisan Goshthis were also organized at the demonstration sites to provide opportunities for other farmers of the area to see the technology adopted. The primary data on grain yield and farmers' practices were collected from the FLD beneficiary and farmers of check plots through random crop cut methodology followed by personal interviews so that further research and extension activities could be improved. The cost concept was considered for the estimation of cost of wheat production. The cost was taken into account to

calculate net income and benefit-cost ratio. The cost included all direct expenses paid in cash for crop production such as hired human labour, seeds, fertilizers, plant protection measures, overhead charges and input value of family labour.

The cost of human labour and diesel were taken on actual expenditure basis. Gross income included the total value of main crop and by-products. Net income was calculated as the difference between gross income and cost of production. Total cost, cross return, return over total cost (net return) and benefit-cost ratio were calculated as under:

Total cost = Total variable cost + Total fixed cost

Gross return = Main product value + By-product value

Return over total cost (net return) = Gross return – Total cost

Benefit-cost ratio = Gross return/Total cost

Performance of technology with performance indicators such as sowing time and operational energy, depth of sowing, labour requirement, population of established plants per unit area, fuel requirement, cost of operation, cost of production and grain yield were taken in to account.

Estimation of technology gap, extension gap and technology index

The data were collected both from FLDs as well as control plots and finally the extension gap, technology gap and technology index were worked out (Samui et al 2000) as given below:

Technology gap = Potential yield – Demonstration yield

Extension gap = Demonstration yield – Farmers' yield

$$\text{Technology index (\%)} = \frac{\text{Technology gap}}{\text{Potential yield}} \times 100$$

RESULTS and DISCUSSION

Data given in Table 1 depict that zero tillage and super seeder were 81.0 and 54.6 per cent more time effective and 65.2 and 50.6 per cent more energy-effective respectively over the conventional practice. Zero tillage and super seeder required 37.0 and 42.0 man hours per ha respectively as compared to 49.0 man hours per ha in conventional method. Fuel requirement in case of zero tillage and super seeder was 11.90 and 13.70 l per ha respectively as compared to 35.40 l per ha in case of conventional method. Cost of operation was also lower while using zero tillage (Rs 6.500) and super seeder (Rs 8,600), whereas, it was Rs 11,500 in conventional method. The cost of production was Rs 21,600 in zero tillage, 24,100 in super seeder and Rs 23,000 in conventional method. The grain yield was 28.70, 37.60 and 24.30 q per ha in zero tillage, super seeder and conventional method respectively. Higher net return of Rs 43,600 and 59,800 was recorded in zero tillage and super seeder respectively as compared to Rs 37,000 in conventional method. Similar trend was observed in case of benefit-cost ratio which was 2.70, 3.65 and 2.15 in zero tillage, super seeder and conventional method respectively.

The technology yield gap of zero tillage and super seeder was 21.30 and 12.40 q per ha respectively (Table 2). This technology gap could be due to agricultural practices adopted and local climatic conditions. The extension yield gap of zero tillage and super seeder was 4.40 and 13.30 q per ha respectively which emphasized the need to educate the farmers through various extension means like FLDs for adoption of resource conservation technologies. Generally, the technological gap appears even if the FLDs are conducted under the close supervision of farm scientists on the farmers' fields. This may be attributed mainly to the lack of irrigation infrastructure, untimely rainfall, variation in soil fertility, cultivation on marginal lands, non-congenial weather conditions and local specific crop management problems.

The technology index shows the feasibility of the evolved technology at the farmers' fields. Lower the value of technology index, more is the feasibility of technology. Fluctuation in the zero tillage and super seeder technology was 42.60 and 24.80 respectively (Table 2) during the two years of FLDs that may be attributed to the dissimilarity in the soil fertility status, weather conditions (low or untimely rainfall) and insect pests and diseases.

Feedback was also recorded by interviewing the farmers about low productivity of wheat. As per the farmers, the high cost of seed, fertilizers and machines, lack of awareness about balanced doses of fertilizers, less or untimely rainfall etc were the main reasons. Farmers, who had adopted zero tillage and super seeder machines in wheat production, were interested to continue with these methods.

Table 1. Field performance of different treatments for wheat sowing after harvesting of paddy crop

Component	Treatment		
	Conventional method	Zero tillage	Super seeder
Sowing time (hours/ha)	10.80	3.30 (81.0)	4.90 (54.6)
Operational energy (MJ/ha)	1,976.11	687.59 (65.2)	975.43 (50.6)
Depth of sowing (cm)	Top surface of the soil	5	8
Labour requirement (man hours/ha)	49.0	37.0	42.0
Fuel requirement (l/ha)	35.40	11.90	13.70
Cost of operation (Rs/ha)	11,500	6,500	8,600
Cost of production (Rs/ha)	23,000	21,600	24,100
Grain yield (q/ha)	24.30	28.70	37.60
Net return (Rs/ha)	37,000	43,600	59,800
Benefit-cost ratio	2.15	2.70	3.65

Table 2. Technology gap, extension gap and technology index in wheat crop production

Component	Treatment		
	Conventional method	Zero tillage	Super seeder
Area covered (ha)	4.00	4.00	4.00
Potential yield (q/ha)	50.00	50.00	50.00
Average yield (q/ha)	24.30	28.70	37.60
Per cent increase in resource conservation over farmers' plots	-	18.11	54.73
Technology yield gap (q)	-	21.30	12.40
Extension yield gap (q)	-	4.40	13.30
Technology index	-	42.60	24.80

In a study conducted in Ferozepur, Punjab, Gautam and Aulakh (2022) obtained higher grain yield by PAU Happy seeder (54.45 q/ha) sowing method as compared to broadcasting + mulcher (51.85 q/ha), Super seeder (49.15 q/ha) and zero drill (45.95 q/ha). The benefit-cost ratio was higher in case of PAU Happy seeder (3.71:1) as compared to broadcasting + mulcher (3.51:1), zero drill (2.76:1) and super seeder (2.38:1). Higher net return was obtained using PAU Happy seeder (Rs 1,20,602.50/ha) as compared to broadcasting + mulcher (1,09,548.75/ha), super seeder (95,236.25/ha) and zero drill (93,055.00/ha).

Iqbal et al (2017) evaluated Happy seeder zero tillage (HSZT) technology with conventional method (CM) of sowing of wheat and showed that HSZT produced maximum germination count, 1000-grain weight, yield, net income and benefit-cost ratio. HSZT was a good option for growers of rice tract as it ensured timely sowing of wheat crop in a single pass. HSZT not only ensured maximum yield but also saved fuel and energy; hence it was a most economical practice.

Kirandeep et al (2020) reported that most of the wheat farmers got higher yields (21-23 q/acre) using Happy seeder. The lowest yield was obtained from the use of rotavators/disc harrows (16-18 q/acre). Super seeder helped the farmers in getting yields higher than zero till drill and rotavators/disc harrows.

In a study conducted in Nepal, Ansari et al (2023) examined the impact of farm mechanization on wheat productivity (mainly super seeder, rotavators or farmers' practice and zero till seed cum fertilizer drill). The highest yield of 3,426.9 kg per ha was obtained where super seeder was used for wheat cultivation followed by farmers' practice of 3,061.8 kg per ha. The lowest yield of 2,484.4 kg per ha was obtained where zero till seed cum fertilizer drill was used. The yield using super seeder was 11.14 per cent higher and cost of production was 2.78 per cent lower than farmers' practice. The highest benefit-cost ratio (2.44) was found in using super seeder as compared to zero-till seed cum fertilizer drill (1.39) and farmers' practice (0.2).

Raju et al (2012) analyzed the comparative economics of zero tillage and conventional methods of rice and wheat cultivation in Haryana state. In case of wheat, both yield and net return were significantly higher in zero tillage by 5.54 and 24.72 per cent respectively. Similarly, use of human labour, machine labour and irrigation were saved by 13.93, 45.88 and 15.98 per cent respectively in zero tillage than conventional method of wheat production. Zero tillage technology enabled farmers to increase returns and save crucial input costs.

Latif et al (2024) evaluated four wheat sowing techniques viz conventional tillage/broadcasting method, Happy seeder, ridge sowing and super seeder in Gujranwala zone, Pakistan As compared to conventional tillage/broadcasting method the super seeder was estimated as resource conservation technique regarding sowing time (62.50%), irrigation time (7.69%), seed cost (14%), fertilizer cost (10.81%) and fuel cost (58.33%). An increased wheat yield (13.11%) was recorded with super seeder (3,450 kg/ha) as compared to conventional tillage/broadcasting method (3,050 kg/ha) in rice-wheat cropping system. The super seeder conserved soil moisture, increased soil organic matter, bettered soil tilth and enhanced fertilizer uptake efficiency, which ultimately increased the yield over the other comparative wheat sowing techniques.

Hashim et al (2022) revealed that the demonstrated technologies under frontline demonstrations resulted in an augmented mean yield of 4.73 tonnes per ha having an edge of 18.22 per cent higher yield over farmers' practice of 4.01 tonnes per ha. Induction of demonstration technology recorded a mean technology gap of 1.79 tonnes per ha, extension gap of 0.72 tonnes per ha and technology index of 27.41 tonnes per ha. The FLDs recorded an additional return of Rs 18,350.72 and 15,221.25 per ha with B-C ratio of 1.44 and 1.58 for demonstration and 0.78 and 1.06 for local check during 2017-18 and 2018-19 respectively.

CONCLUSION

Present study evaluated the impact of different wheat sowing techniques – zero tillage, super seeder and conventional broadcasting, on wheat yield and profitability in the Samba district of Jammu and Kashmir. The results demonstrated that both zero tillage and super seeder methods significantly outperformed conventional broadcasting. Zero tillage and super seeder techniques were more time- and energy-efficient, requiring less labour, fuel and operational costs. Super seeder showed the highest grain yield (37.60 q/ha) and net return (Rs 59,800/ha) followed by zero tillage (28.70 q/ha and Rs 43,600/ha respectively), compared to conventional broadcasting (24.30 q/ha and Rs 37,000/ha respectively). Super seeder had the highest benefit-cost ratio (3.65), indicating a greater return on investment. Technological gap was observed for both zero tillage and super seeder, suggesting potential for further yield improvement with optimal management practices. Extension gap highlighted the need for increased farmer education and technology adoption through extension activities. The technology index indicated the feasibility of zero tillage and super seeder, with lower indices suggesting higher feasibility. The study concluded that adopting zero tillage and super seeder technologies offers significant advantages in terms of efficiency, yield and profitability compared to conventional broadcasting. These technologies are recommended for widespread adoption in the region to improve wheat productivity and farmer income.

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