Resource conserving technology (RCT) in wheat: a promising better option in Samba district of Jammu and Kashmir

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ABSTRACT

Thirty frontline demonstrations each were conducted during rabi season of 2019-20 and 2020-21 to evaluate zero tillage for wheat sowing with an objective to improve farm productivity and efficiency in Samba district, J&K. The present study was conducted with the specific objective to analyze the economic impact of resource conservation technology (zero tillage) as compared to the conventional tillage practices on wheat cultivation in the district. The study revealed that there was significant impact of conservation practice; 17.66 per cent human labour, 54.63 per cent machine labour, 20 per cent seed cost and 33 per cent irrigation water were saved with zero tillage as compared to the conventional tillage method of wheat. There was a wide yield gap between the potential, demonstration and farmers' yields of wheat mainly due to the technology gaps. The average yield of demonstration plots was 24.50 and 26.90 q/ha as compared to 19.30 and 21.90 q/ha in farmers' plots in 2019-2020 and 2020-2021 respectively. On overall average basis, 25.70 per cent higher grain yield was recorded under demonstration plots as compared to the farmers' plots (26.20 q/ha). The technological yield gap varied to the extent of 23.10 to 25.50 q/ha. The net return in zero tillage of wheat production was higher by 27.42 per cent as compared to the conventional method. B-C ratio under zero tillage was 3.43 while under conventional method it was only 2.21. Therefore zero tillage was economically feasible. The yield gap analysis emphasizes the need to educate the farmers for adoption of the resource conservation technologies to revert the trend of wide extension gap.

Keywords: Zero tillage; broadcasting; technology gap, net return, B-C ratio; yield

INTRODUCTION

India is the second largest producer of wheat in the world with an average annual production of 80 million tonnes (Anon 2012). The rice-wheat rotation is the principal cropping system in south Asian countries that occupies about 13.5 million hectares in the Indo-Gangetic plains of which 10 million hectares are in India. This cropping system is also very prevalent in erstwhile state of Jammu and Kashmir. Wheat occupies 30,438 ha area and annual production is 20.27 q/ha in the Samba district. Delayed sowing due to the presence of crop residue reduces crop yield of 30 to 40 kg per ha per day (Baranwall 1995, Hobbs 1988) if crop is sown after mid-November. The delay of every successive day in planting beyond November third week decreases the grain yield progressively (Ali et al 2010, Irfaq et al 2005, Sharma 1992). In Samba district, many farmers grow late maturing, fine-grained basmati varieties of rice causing late sowing of wheat. The major challenge to wheat production in the union territory is enhancing of its productivity and profitability. Therefore to avoid delay in planting and reduce the cost of production, farmers have started adopting resource conserving technologies such as zero tillage and surface seeding in wheat production (Gupta and Seth 2007). The savings in input cost, fuel consumption and irrigation water use have been reported due to adoption of zero tillage in wheat cultivation (Malik et al 2003, Bhushan et al 2007). Farmers prefer this technology due to the farm labour shortage and rising fuel prices. To boost the production and productivity of wheat crop in the district, Krishi Vigyan Kendra (KVK), Samba, J&K conducted frontline demonstrations (FLDs) on zero tillage technology in wheat crop. The present study was undertaken with the objective of comparing the economics of wheat production with zero tillage and conventional method and quantifying the contribution of technology and inputs into the estimated productivity differences due to zero tillage.

MATERIAL and METHODS

Zero tillage has been interpreted as the process of planting wheat seed after the harvest of rice directly on untilled soil which had the rice crop residues. The conventional tillage refers to the intensive tillage with multiple passes of a tractor to accomplish land preparation for wheat sowing. Farmers in Samba district are rapidly adopting zero tillage technology for wheat cultivation.

For this study, thirty frontline demonstrations (FLDs) on wheat were conducted at farmers' fields in the district to assess its performance during rabi season for two consecutive years 2019-20 and 2020-2021. The area under each demonstration was 0.2 ha. In FLD plots, zero tillage technology practice was adopted whereas in the adjoining farmers' fields, crop was grown as per the practices followed by the farmers which served as control/local check.

The thirteen furrows tractor-mounted zero seed cum fertilizer drill was tested in laboratory before taking to actual field conditions. The seeds were passed through the grooves of the fluted roller to check the regularity of flow and damage. The line to line spacing of zero seed cum fertilizer drill was adjusted at 22.5 cm. The machine was calibrated for 80 kg/ha seed under normal conditions. The calibration for fertilizer per hectare was also done.

Calibration of zero seed cum fertilizer drill: The following steps were followed for calibration of zero seed cum fertilizer drill.

Determination of the nominal width (W) of drill (Sahay 2004):

$$W (m) = M \times S$$

where M= Number of furrow openers, S= Spacing between the openers in meters

To find out the length of a strip (L) having nominal width W necessary to cover 1/25 of a hectare:

$$L = 10{,}000/W \times 1/25 = 400/W \text{ meters}$$

To determine the number of revolutions (N) the ground wheel has to make to cover the length of the strip (L):

$$A = \pi \times D \times N = 10{,}000/w \times 1/25$$

where D= Diameter of ground wheel in meters

$$\text{or } N = 10{,}000/\pi \times D \times W \text{ rev/m}$$

The drill was jacked up so that the ground wheel turned freely. A mark was made on the drive wheel and a corresponding mark at a convenient place on the body of the drill to help in counting the revolutions of the drive wheel. Selected seeds and fertilizers were put in the respective hoppers. A sack or a container was placed under each boot for seeds and fertilizers. The rate control adjustment was set for the seeds and fertilizers for maximum drilling. The position was marked on the control for reference. The clutch or on-off adjustment was engaged for the hoppers and the drive wheel was rotated at the speed N:

$$N = 400/\pi \times D \times W \text{ rev/min}$$

The quantity of seed and fertilizer dropped was weighed in kg/ha and recorded on the data sheet. The process was repeated by suitably adjusting the rate control till desired rate of seed and fertilizer drop was obtained. All input and output parameters pertaining to the wheat production were based on average values of two years with a view to minimize seasonal fluctuations in the variables. The primary data on grain yield and farmers' practices were collected from the FLD beneficiaries and farmers of check plots through random crop 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 includeed 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 was taken on actual expenditure basis. The gross income included the total value of main crop and byproduct. Net income was calculated as the difference between gross income and cost of production.

Estimation of technology gap, extension gap and technology index: Technology gap referred to the difference between the potential yield and actual farm yield. The potential yield referred to that which was obtained in the experiment station. The yield was considered to be the absolute maximum production of the crop possible in the given environment which was attained by the best available methods and with the maximum inputs in trials on the experiment station in a given season. Demonstration yield was the yield obtained on the demonstration plots on the farmers' fields in the study area. The conditions on demonstration plots closely approximated the conditions on the cultivators' fields with respect to infrastructural facilities and environmental conditions. Actual yield referred to the yield realized by the farmers on their farms under their management practices. The data output was collected both in 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

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

Regular visits by KVK scientists to FLD plots were made so as to ensure timely application of critical inputs and to solve other crop related problems.

RESULTS and DISCUSSION

The machine was field evaluated at farmers' fields for raising the wheat crop after paddy in comparison to the conventional method of broadcasting. The primary data were collected during 2019-20 and 2020-21 from 30 farmers each year. All input and output parameters pertaining to the wheat production were based on average values of two years.

Sowing time: The results showed that zero tillage was the most time effective for 71.56 per cent over the conventional practice. The time taken with conventional practices and zero tillage method was 10.20 and 2.90 h/ha respectively (Table 1).

Depth of sowing: The depth of sowing of seed by zero till seed cum fertilizer drill was found to be 5 cm as compared to broadcasting method in which seed remained on top surface of the soil (Table 1).

Labour requirement: Labour requirement for sowing of wheat with zero tillage was much less as compared to the broadcasting method. The study showed that the zero tillage saved 17.66 per cent labour as compared to the farmers' practice (Table 1). Similar results were reported by Murumkar et al (2015)

Fuel requirement: Fuel used by the zero seed cum fertilizer drill was very less as compared to the broadcasting method. The fuel used by zero till seed cum fertilizer drill was 12.10 l/ha as compared to 34.90 l/ha in conventional method. Zero till seed cum fertilizer drill saved 65.33 per cent fuel as compared to the broadcasting method (Table 1).

Cost of irrigation and irrigation hour: The cost of irrigation was calculated by multiplying the time required to irrigate the farm with cost of electricity or diesel consumption per hour. The total time of irrigation was 2.25 per cent less as compared to the conventional method.

Cost of operation and cost of production: The cost of operation was Rs 3,800 and 1,250/ha in the conventional and zero tillage method respectively. Zero seed cum fertilizer drill saved 67.11 per cent cost of operation as compared to the broadcasting method. The cost of production was Rs 14,000 and 11,500/ha in the conventional and zero tillage method respectively (Table 1).

Grain yield: The grain yield was estimated by measuring the plot cutting yield. This was done by measuring the grain yield production per plot area under a particular method by harvesting of crop for each plot and measuring the yield in each method. In conventional and zero tillage method average yield was found to be 20.60 and 25.70 kg/ha respectively (Table 1). Benefit-cost ratio was 3.43 in zero till seed cum fertilizer drill whereas 2.21 in farmers' practice. Therefore yield of grain as well as benefit-cost ratio increased in the zero tillage method.

Technology yield gap: The technological gap varied to the extent of 23.10 to 25.50 q/ha (Table 2). The overall average technological gap was 24.30. The technology gap observed may be attributed to dissimilarity in the soil fertility status, agricultural practices and local climatic situation.

Table 1. Average field performance of different treatments for sowing of wheat after harvesting of paddy crop in the study period

Component	Conventional method	Zero tillage method	Per cent change
Sowing time (h/ha)	10.20	2.90	–71.56
Depth of sowing (cm)	Top surface of the soil	05	-
Seed requirement (kg/ha)	100	80	–20
Labour requirement (h/ha)	52.10	42.90	–17.66
Machine labour (h/ha)	10.80	4.90	–54.63
Fuel requirement (l/ha)	34.90	12.10	–65.33
Cost of operation (Rs/ha)	3800	1250	–67.11
Cost of production (Rs/ha)	14000	11500	–17.88
Grain yield (q/ha)	20.60	25.70	24.77
Net return (Rs/ha)	31000	39500	27.42
Benefit-cost ratio	2.21	3.43	-

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

Component	Year	
	2019-20	2020-21
Number of demonstrations	30	30
Area (ha)	6.00	6.00
Potential yield (q/ha)	50.00	50.00
Average yield of demonstration plots (q/ha)	24.50	26.90
Average yield of farmers' plots (q/ha)	19.30	21.90
Per cent increase over farmers' plots	26.90	22.83
Technology gap (q)	25.50	23.10
Extension gap (q)	5.20	5.00
Technology index	51.00	46.20

Extension yield gap: The extension yield gap during the study period varied to the extent of 5.00 to 5.20 q/ha (Table 2). The overall average extension gap was 5.10 q/ha which emphasized the need to educate the farmers through various extension means like FLDs for adoption of resource conservation technologies to regress the trend of wide extension gap. 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 faced in order to harness the yield potential of specific crop cultivars under demonstration plots.

Technology index: The technology index showed the feasibility of the evolved technology at the farmers' fields. The lower the value of technology index, the more is feasibility of the technology. Fluctuation in the technology index ranging between 46.20 and 51.00 per cent and overall average technology index observed as 48.60 per cent (Table 2) during the two years of FLDs may be attributed to the dissimilarity in soil fertility status, weather conditions (low or untimely rainfall) and insect pests and diseases.

These results are in conformity with the findings of Shashikumar (2015) in maize crop and Gaddi et al (2002) in cotton.

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

CONCLUSION

The study revealed that it was possible to save machine labour and irrigation water under the zero tillage than under the conventional method. Due to the resource saving, net return was significantly higher in zero tillage technology. Hence this technology is an important alternative to save scarce resources and enhance the net farm income. By adopting this technology, farmers could save scarce resources and reduce the cultivation costs. The availability of zero till seed drill needs to be accorded more attention to foster the adoption of zero tillage technology in wheat production.

The wheat sowing by zero seed cum fertilizer drill was found very encouraging besides a net saving of Rs 8,500/ha as compared to the farmers' method of wheat establishment. This could be mainly because of saving of fuel, labour and other inputs. The tractor operated zero seed cum fertilizer drill can be an acceptable machine for the farmers for sowing of wheat after paddy harvesting since it gives maximum plant population, requires less labour, reduces cost of cultivation and gives higher yield as compared to the farmers' practice. This has been proved to be more beneficial in terms of saving of number of operations required for wheat sowing, saving of tractor hours, saving of diesel fuel and reducing the incidence of weeds. Sowing with this technology has an advantage of better inter-culturing operations, management of insect pests and diseases and mechanical harvesting.

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