Biological Forum – An International Journal **14(4a): 246-250(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Assessment and Evaluation of Zero Tillage Technology for Wheat Cultivation by using Seed Cum Fertilizer Seed Drill in Madhesh Province of Nepal

Ram Nath Jha[1*], Roshan Kumar Sah[1], Arbind Jha[1] and Lalan Kumar Singh[2]
[1]Agricultural Machinery Testing and Research Centre Nawalpur Sarlahi Nepal.
[2]Ministry of Land Management Agriculture and Cooperatives (MoLMAC), Madhesh Province, Janakpur, Nepal.

(Corresponding author: Ram Nath Jha)*
(Received 14 September 2022, Accepted 10 November, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Wheat is one of the major food crops of Nepal after rice and maize. Traditional methods of wheat cultivation are labor intensive, tedious, time taking, and demands huge amount of resources that increase the cost of cultivation, therefore farmers get less benefit from this practice. Nepalese agriculture is facing labor scarcity due to a lack of youth and skilled manpower who migrated to urban areas and the gulf countries in search of better opportunities. In order to address this issue, Agricultural Machinery Testing and Research Centre (AMTRC), Nawalpur, Sarlahi had conducted participatory research on zero tillage technologies for wheat cultivation in Mahottari districts during 2076/077 (2019/20) and 077/078 (2020/21). The research trials were carried out in four replications with three treatments *i.e.* zero tillage technology through seed cum fertilizer seed drill machine (T_1), one ploughing + one harrowing + seeding (T_2) and the third treatment was farmers' practice (T_3). For this purpose wheat variety, Gautam was selected and sown @120 kg/ha and fertilizer recommended @100:60:40 N: P_2O_5: K_2O kg/ha respectively. The average grain yield was recorded highest 1726 kg/ha and 3112 kg/ha by the use of seed cum fertilizer seed drill machine in first and second year respectively followed by farmers' practice with an average yield of 1675 kg/ha and 2925 kg/ha and lowest from the practice of one ploughing + one harrowing + seeding which produced 1530 kg/ha and 2655 kg/ha respectively in first and second year of experiment. Thus highest net return of Rs. 20707.38 /ha was obtained from the use of seed cum fertilizer seed drill machine which was 22.97 per cent more than farmers' practices. Thus, zero tillage technology through seed cum fertilizer seed drill machine method was found suitable for wheat cultivation for the benefit of the farmers.

Keywords: Wheat, Mechanization, Zero Tillage Technology, machine farming.

INTRODUCTION

Nepal is a small, land-locked mountainous country with diverse agroecologies. It is an agricultural country having 66 percent of people directly engaged in farming (FAO, 2019). Agriculture contributes to almost one-third of the national economy (NPC, 2017). Agricultural crop productivity in Nepal is the lowest among South Asian countries (FAO, 2018). Farming is still subsistence in nature and different agricultural crops are integrated with livestock. Rice, maize, wheat, millet, barley, and buckwheat are the major staple foods grown in the country. During the year 2074/075 the contribution of agriculture, forestry and fishery to gross domestic product was 27.59 percent which has been expected as 26.98 during the fiscal year of 2075/076 (MoF, 2019). The agricultural sector production during 2074/075 was increased by 2.7 percent which has been estimated as 5.1 percent in 2075/076 (MoF, 2019).

Wheat is the 3rd most important staple food crop of Nepal after rice and maize. Nepalese farmers grow wheat as a winter-season crop which covered a 7,11,067 ha area and produced 2,127,276 metric ton with total productivity of 3 ton/ha in fiscal year 2077/78 (2020/21). Similarly, it was grown in 7,07,505 ha area with total production of 2,185,289 metric ton in the year 2076/77(2019/20) (MoALD, 2022). The wheat production and productivity has also been influenced by climatic factors which have now a day known as impact due to climate change. Devkota and Phuyal (2015) found significant positive impact of the average and maximum temperature and significant negative impact of the minimum temperature on net revenue and wheat yield of terai region. Similarly, they also found the mixed impacts of precipitation on wheat production. This winter crop is grown from terai to mid-hills and high hills of the country. It is consumed in different forms like bread, chapatti, noodles, and biscuits, and therefore it has high demand in the food industries to make readymade food products. Wheat contributes about 20% of the total cereal production in Nepal. Over 60% of wheat is produced in the Terai (plain) region, though they are also produced in the mid hills and high hills regions of Nepal (Timsina *et al.*, 2018). The importance of wheat increases since it contains gluten, a protein which is an important properties that creates stickiness in the wheat flour. Though wheat has high importance in our food and agricultural system,

Nepalese farmer's obtain less benefit by growing this crop because of high cost of cultivation. In Nepal labor shortage has also created a sense of following mechanization in agriculture. In the recent years, agriculture sector in Nepal is facing acute labor shortage due to rapidly increasing labor outmigration, especially migration towards the golf countries in search of better employment opportunities The labor shortage in agriculture sector has increased the rural labor wage rates (Wang *et al.,* 2016; Wiggins and Keats 2014). Thus, it is necessary to develop and test a low-cost wheat cultivation technology that farmers could adopt and take maximum benefit from it.

Wheat cultivation demands tillage for field preparation which is high energy demanded operations and also needs high investments. Tillage is labor intensive and time taking job that farmers faces in recent days. Considering the high cost of energy, it is desirable to conserve energy in farming through efficient tillage operations which will require less energy and provide a satisfactory soil structure for crop emergence and growth. Thus selection of tillage system best suited to a particular situation is an important decision to be made by the growers (Keil *et al.,* 2020).

In Nepal there is increase in the uses of farm machinery, still it requires more for the augmentation of agricultural products. It has significant role in the commercialization of agriculture in Nepal under present context of labor scarcity. Marahatta *et al.* (2018) found higher yield of both rice and wheat (4106; 3042 kg/ha) in conservation agriculture than as compared to conventional agriculture (4106; 3022 kg/ha). The mechanization reduces cost of cultivation and increases yield than that of traditional farms. Rahaman *et al.* (2011) reported that the less number of labors per hectare is required to complete the production process by mechanized farm compared to traditional farms. The yield of wheat under mechanization (2.65 mt/ha) was higher than that of traditional farms (2.57 mt/ha) in Bangladesh. The study carried out by Yamin *et al.* (2011) revealed a good scope of increment in production of wheat by increasing and managing agricultural machines in Punjab-Pakistan. Cultural and economic constraints have hindered the widespread adoption of more expensive precision agriculture technologies like zero-till that have the capacity to improve labor and farm input efficiencies in wheat cultivation in Nepal (Mcdonald *et al*., 2018).

Farmers in hills are also interested in mechanization as there is a lack of manpower due to youth migration. Paudel *et al*. (2019) conducted an assessment which showed that farm size, on-farm wage rates, number of household members migrated, access to credit services, and association with cooperatives were the farm level attributes are positively associated with willingness to pay for mini-tillers. This study also revealed that farmers' average willingness to pay was 31 per cent lower than actual technology price. Network models, particularly Graphical Evaluation and Review Technique (GERT) networks are increasingly powerful tool for modeling the scheduling, planning, controlling, and analyzing of agricultural mechanization projects (Abdi *et al*., 2010). In a study conducted by Din and Khattak (2018) in Peshawar valley, Pakistan, found the per acre productivity of mechanized farmers a little bit greater than the non-mechanized farmers.

Agriculture mechanization is one of the key processes that will affect the future of small holder farming systems in Asian countries, including Nepal, where just 8 per cent of farmers use tractors, 26 per cent use iron plows, and more than 60 per cent of intercultural operations are managed by women (Kaur, 2017). Study carried out by GC *et al*. (2019) showed that light machinery is an essential part of Nepali farming system. Likewise, the presence of animal power, income per capita, per capita farm area, adaptation due to change in temperature, household size, farm area and income are significant determinants for total investment in farm mechanization. Pradhan *et al.* (2016) found much higher family income in tractor owned farms than bullock farms due to the higher income from off-farm activities in Sunsari district. Using geographical information system, they also observed that about 96.8 per cent of the total cultivated area can be covered using tractor, and 1.5 per cent can at least be served with power tillers. In the remaining 1.7 per cent area neither tractor nor power tiller can operate efficiently.

Delayed wheat sowing is one of the major factors responsible for low grain yield. Therefore, timely seedbed preparation practices are of paramount importance because of the opportunity to create the desirable structure that allows optimum crop production. The concept of zero tillage is becoming popular in recent years because it reduce production costs and carry out cultivation practices in time while eliminating the adverse effect of compaction in the field due to repeated machinery operations. Traditional method of seedbed preparation involves a chain of field operations such as ploughing, harrowing, clod crushing, soil packing which eventually cause severe soil compaction and increases production costs. Zero tillage by use of seed cum fertilizer seed drill machine (ZTD) system helps control soil erosion and continuous supply of fresh organic matter in the soil. It is time and labor saving technique mainly at the time of seeding. NWRP (2005) reported an average yield of 3412 kg/ha while Sah *et al.* (2007) reported highest grain yield of 3551 kg/ha of wheat cultivated by power tiller seed drill machine. In order to verify zero tillage technique it had carried out verification trial on zero tillage technique for wheat cultivation in farmers' field with the objectives of overcoming the problem of delayed planting, labor scarcity and poor crop establishment.

MATERIALS AND METHODS

An experiment was conducted to test and verify zero tillage technology in wheat cultivation in Gaushala, Mahottari, Nepal from 2076/77 to 2077/78. The trial followed randomized complete block design with three treatments and four replications. The three treatments were namely zero tillage technology through seed cum fertilizer seed drill machine (T_1), one ploughing + one harrowing + seeding (T_2) and farmers' practice (T_3) respectively. Farmer's practices was taken as control

trial. This experiment involved Gautam as a wheat variety with a seed rate of 120 kg/ha and was sown in a plot size of 30 × 30 meter square. Fertilizers N: P_2O_5: K_2O were recommended @100:60:40 kg/ha respectively. Wheat was sown in 2076.08.20 and 2077.08.21 in Gaushala and were harvested in 2076.12.20 and 2077.12.25 respectively. All agronomic packages were followed based on farmers practices and two irrigations were supplied during the crop period. Fields were frequently visited throughout the crop standing stage. Wheat yield was taken and the data were analyzed statistically through GenStat.

RESULTS AND DISCUSSION

The yield difference due to treatments were found non-significant in the first year of the experiment while it was significant ($p<0.1$) in the second year. The highest mean grain yield of 1726 kg/ha was obtained from the treatment with zero tillage technology through seed cum fertilizer seed drill machine followed by farmers' practice (1675 kg/ha) and lowest in one ploughing + one harrowing + seeding (1530 kg/ha) respectively in the 2076/77 (Table 1). During second year of the experiments, again the yield was obtained highest from the zero tillage technology through seed cum fertilizer seed drill machine treatment which recorded 3112 kg/ha followed by the farmers' practice (2925 kg/ha) and lowest yield obtained in one ploughing + one harrowing + seeding (2655 kg/ha) treatment (Table 2). Pooled analysis of 2076/077 and 2077/078 showed non-significant interaction between treatment and year while year and treatment as individual parameter was significant ($p>0.01$). The net return from zero tillage technology through seed cum fertilizer seed drill machine was highest in both of the years where in the first year Rs. 10314.50/ha (Table 3) and Rs. 31100.25/ha in second year (Table 4). Thus the average net return of the two years was Rs. 20707.38/ha followed by farmers practices which obtained Rs. 15950.50/ha (Table 5).

Cost incurred in fertilizer was highest in both of the years. This technique was mostly focused to reduce the cost of land preparation where in the first year it was 2.47 per cent in zero tillage technique of zero tillage technology through seed cum fertilizer seed drill machine while in farmers' practice it was 18.45 per cent in first year of the experiment. Similarly, in second year, the land preparation cost was 3.06 per cent in zero tillage technology through seed cum fertilizer seed drill machine treatment while it was 19.09 per cent in farmers' practice (Keil *et al.,* 2020). Gill (2006) has reported that zero tillage technology is cost saving technology with additional advantages such as better germination, better fertilization and seed placement, labor and time saving, less weed and more yield. Gupta *et al*. (2019) has reported that wheat sown by zero tillage technology that helped in advancing sowing time, reduced cost of cultivation in terms of land preparation (Rs. 3850/ha), saving in labour time (6-7 hr/ha), fuel (44 ltr/ha), environmental pollution (60%) as well as water-saving (33%).

Table 1: Mean grain yield of wheat grown under zero tillage technique at Gaushala, Mahottari, 2076/077.

Treatments		Mean grain yield (Kg/ha)				Mean
		R_1	R_2	R_3	R_4	
T_1	Zero tillage technology through seed cum fertilizer seed drill machine	1920	1590	2400	995	1726
T_2	One ploughing + One harrowing + Seeding	1800	1320	1980	1020	1530
T_3	Farmers' practice	1900	1500	2100	1200	1675
F test						NS
CV %						7.10

Table 2: Mean grain yield of wheat grown under zero tillage technique at Gaushala, Mahottari, 2077/078.

Treatments		Mean grain yield (Kg/ha)				Mean
		R_1	R_2	R_3	R_4	
T_1	Zero tillage technology through seed cum fertilizer seed drill machine	3210	2700	3390	3150	3112
T_2	One ploughing + One harrowing + Seeding	2670	2460	2730	2760	2655
T_3	Farmers' practice	3000	2700	2970	3030	2925
F test						**
CV %						3.63
LSD (0.01) kg/ha						275.90
Polled analysis (2062/063-2063/064):						
Year						**
Treatment						**
Treatment × year						Ns
CV %						4.90
LSD (0.01) kg/ha						1639.00

Table 3: Variable cost incurred in wheat cultivation of F/Y 2076/77.

Sr. No.	Operations/Materials	Cost incurred (Rs/ha)						Remarks
		Treatments						
		T_1	Percent	T_2	Percent	T_3	Per cent	
1.	Land Preparation & Seeding	371.50	2.47	2530.00	15.10	3270.00	18.45	
2.	Seed	2280.00	15.15	2280.00	13.61	2280.00	12.86	
3.	Fertilizers	8988.00	59.72	8988.00	53.63	8988.00	50.70	
4.	Irrigation	226.50	1.51	285.00	1.70	285.00	1.61	
5.	Harvesting & carrying	1390.00	9.24	1160.00	6.92	1240.00	6.99	
6.	Threshing, Drying and storage	1793.50	11.92	1515.00	9.04	1665.00	9.39	
	Total variable cost	15049.50	100.00	16758.00	100.00	17728.00	100.00	
	Gross return	25364.00		22320.00		24540.00		
	Net return	10314.50		5562.00		6812.00		

Table 4: Variable cost incurred in wheat cultivation of F/Y 2077/78.

Sr. No.	Operations/Materials	Cost incurred (Rs./ha)						Remarks
		Treatments						
		T_1	Percent	T_2	Percent	T_3	Percent	
1.	Land Preparation & Seeding	537.75	3.06	3142.50	16.00	3930.00	19.09	
2.	Seed	2748.00	15.62	2748.00	14.00	2748.00	13.35	
3.	Fertilizers	9600.00	54.58	9600.00	48.89	9600.00	46.63	
4.	Irrigation	238.67	1.36	297.00	1.51	297.00	1.44	
5.	Harvesting & carrying	1944.00	11.05	1728.00	8.80	1800.00	8.74	
6.	Threshing, Drying and storage	2519.33	14.32	2119.00	10.79	2211.00	10.74	
	Total variable cost	17587.75	100.00	19634.50	100.00	20586.00	100.00	
	Gross return	48688.00		41525.00		45675.00		
	Net return	31100.25		21890.50		25089.00		

Table 5: Mean value of Variable cost, Gross yield and Net return for the F/Y 2076/77 and 2077/78.

Sr. No.	Variable cost (Rs/ha)			Gross yield (Rs/ha)			Net return (Rs/ha)		
	2062/63	2063/64	Mean	2062/63	2063/64	Mean	2062/63	2063/64	Mean
T_1	15049.50	17587.75	16318.63	25364.00	48688.00	37026.00	10314.50	31100.25	20707
T_2	16758.00	19634.50	18196.25	22320.00	41525.00	31922.50	5562.00	21890.50	13726
T_3	17728.00	20586.00	19157.00	24540.00	45675.00	35107.50	6812.00	25089.00	15950

CONCLUSION

The zero tillage technology was most cost effective for wheat cultivation practices. Zero tillage by seed cum fertilizer seed drill machine was found the most economical because it saves labor, time, irrigation water, reduce cost of cultivation and increase net return per hectare to the farmers. Thus it is recommended to provide incentives to the farmers who want to purchase the zero tillage machines for wheat cultivation.

Conflict of Interest. None.

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How to cite this article: Ram Nath Jha, Roshan Kumar Sah, Arbind Jha and Lalan Kumar Singh (2022). Assessment and Evaluation of Zero Tillage Technology for Wheat Cultivation by using Seed Cum Fertilizer Seed Drill in Madhesh Province of Nepal. *Biological Forum – An International Journal*, *14*(4a): 246-250.