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On-farm Evaluation of Zero Tillage Wheat in Dhanusha, Nepal

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Abstract: ***Field trials were conducted at two locations in Dhanusha, Nepal in winter season of 2016 at farmer's fields to evaluate performance of tillage and crop establishment methods on yield and economics in rice-wheat system. Four tillage and crop establishment methods; conventional tilled transplanted rice followed by conventional tilled wheat (CTTPR-CTW), conventional tilled transplanted rice followed by zero tilled wheat (CTTPR-ZTW), unpuddled transplanted rice followed by zero tilled wheat (UNTPR-ZTW), zero tilled direct seeded rice followed by zero tilled wheat (ZTDSR-ZTW) were evaluated. Tillage and crop establishment methods significantly influenced grain yield and net benefit. ZTDSR followed by ZTW had the highest grain yield and net benefit of 454.9 US $. The results showed that ZTDSR-ZTW could be a sustainable and economic option for rice-wheat system against CTTPR and CTW. However, future works are needed for faster dissemination of the resource conservation technology among the farmers. The technology also improves livelihoods of the people by conserving natural resources and mitigating labor shortage issues.***

Keywords: Resource conservation tillage, zero tillage, crop establishment, profitability

1. Introduction

Rice-wheat cropping systems occupy about 13.5 million hectares in South Asia (especially in the Indo-Gangetic Plains of India, Pakistan, Bangladesh, and Nepal), contribute 85 per cent to the region's cereal production, and feed about 20 per cent of the world population [1, 2). Wheat ranks the first position among the cereal crops world-wide covering an area of 220.1 million ha; with total annual production of 749.4 million ton [3].

In Nepal, wheat is the third most important cereal crop after rice and maize. In 2017, the area, production and productivity of wheat in Nepal was 0.7 million hectares, 1.8 million metric ton and 2.5 t/ha [4]. The productivity of wheat in Nepal is lower than our neighboring countries like China, India, Pakistan and Bangladesh. The yield potential of wheat has been improved over the past few decades. However, there is a room for improvement to increase the productivity of wheat.

Rice-Wheat system is one of Nepal's principal agricultural production systems and occupies about one fourth of the total cropped area, which provides food, income and employment to over 83% of the Nepalese. The traditional method of crop establishment involves excessive tillage and land preparation which is a pain staking, expensive and time-consuming task that further leads to poor plant stand and late planting [5, 6]. In this situation, resource conservation technologies such as zero tillage, reduced tillage and surface seeding provide a basket of options to alter crop yield and income of farmers. These technologies provide substantial savings in water, labor and other resources along with early crop establishment, drudgery reduction and environmental protection. Farmers, researchers, and other stakeholders gain a better understanding of the innovation, thereby encouraging its adoption.

With recent increases in fuel prices, tillage now accounts for a higher proportion of production costs than harvesting does [5]. Such systems have fueled interest in finding tillage systems that minimize negative impacts to the environment while sustaining economic crop productivity. More recently, conservation tillage (no tillage with residue retention) was identified in recent literature reviews [8]. In the context of scarcity of labor, mechanization is must for the sustainable cultivation of wheat. Thus, the performance study of zero tillage wheat, an already proven technology, was done in Dhanusha district of Nepal.

2. Materials and Methods

Farmers' field experiments were carried out five villages of Dhanusha district. The experiment was laid out in a Randomized Complete Block design and farmers were used as replications. Five farmers were participated at each location. The experiments were conducted in winter season of 2016. The experimental sites are shown in Fig 1. The experiments were conducted at five locations but the results of only two locations were considered in this paper. Farmer participatory research experiments on zero tillage rice and wheat were conducted in different farmers' field of Dhanusha district. Zero tillage technology Evaluation of zero tillage wheat against conventional tillage zero tillage (ZT) wheat was tested against farmer's conventional tillage practice (CT). GenStat (15th edition) statistical packages were used in analyzing experimental data for all the field experiments reported in this paper. All of the field experiments were conducted in low land fields that would have remained fallow in winter season because of excess soil moisture at planting time. Experimental sites were having higher clay percentage and poor drainage (internal and external) system which are typical characteristics of the low land fields in the area.

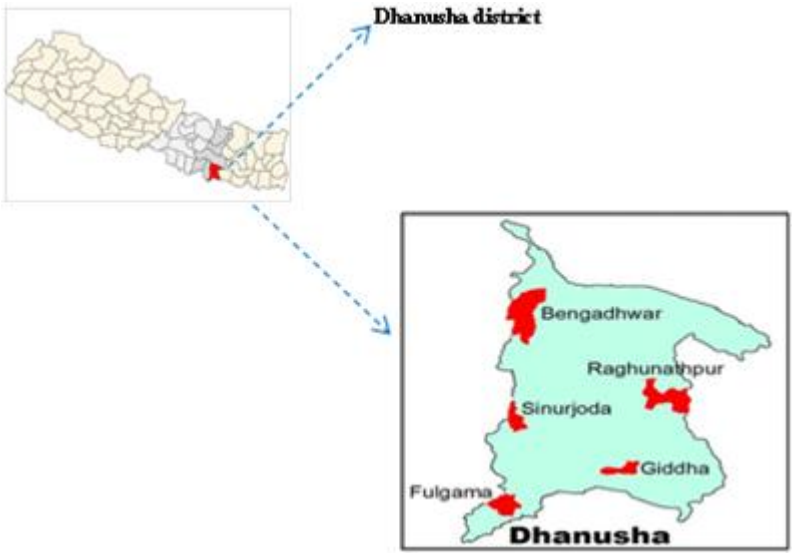

Figure 1: Experimental sites (red highlighted area) in Dhanusha district of Nepal

3. Results and Discussion

Performances of wheat under different crop establishment methods at different farmers' fields are presented in Tabble 1. Of the four crop establishment methods, conventional tillage transplanted rice (CTTPR) followed by zero tillage wheat (ZTW) outperformed at each location. The higher grain and straw yields were obtained in un-puddled transplanted rice-zero tillage wheat (CTTP-ZTW) as compared to other tillage systems. The highest net benefit was recorded in CTTPR-ZTW (454.9 US $).

The un-puddled rice followed by zero tillage wheat tillage system (CTTPR-ZTW) provided great reduction in the cost of cultivation, higher yield and benefit over farmers' conventional tillage at both the research sites. Our results are in conformity with the findings of previous research findings [6, 9, 10]. Similar results were reported by other authors [11, 12].

Table 1: Performance of wheat under different crop establishment methods at two locations of Dhanusha district in 2016

Location	Treatments*	Grain yield (t/ha)	Straw yield (t/ha)	Gross returns (US $)	Total cost (US $)	Net benefits (US $)
Giddha	CTTPR-CTW	3756	4210	1316.7	1080	236.7
Giddha	CTTPR-ZTW	3838	6620	1526.2	999.2	527
Giddha	ZTDSR-ZTW	3830	6490	1513.9	999.2	514.7
Giddha	UPTPR-ZTW	3842	6570	1523.3	999.2	524.1
Mean		**3817**	**5973**	**1470**	**1019.4**	**450.6**
Fulgamma	CTTPR-CTW	3835	6132	1487.3	1171.9	315.4
Fulgamma	CTTPR-ZTW	4040	6550	1573.9	1077	496.9
Fulgamma	ZTDSR-ZTW	3986	6484	1554.5	1077	477.5
Fulgamma	UPTPR-ZTW	4129	6891	1623.9	1077	546.9
Mean		**3998**	**6514**	**1559.9**	**1100.7**	**459.2**
Grand mean		**3907**	**6243.375**	**1515**	**1060.1**	**454.9**

*CTTPR = conventional tillage transplanted rice, CTW = conventional tillage wheat, ZTDSR = zero tillage direct seeded rice and ZTW = zero tillage wheat

Out-scaling of findings

In 2017 out-scaling activities were done with the continuation effort of field staff. Although, there were some obstacles for the expansion of more areas under this technology due to farmers' unawareness about the benefits of the technology. The technology was promoted in 38 farmers covering an area of 8.24 ha.

Table 2: Expansion of zero tillage wheat among farmers in Dhanusha district

Locations	No of farmers	Area(ha)	Crop
Sinurjoda	20	4.67	Wheat
Phulgama	4	0.66	Wheat
Giddha	8	2	Wheat
Ragunathpur	4	0.66	Wheat
Lalgarh	2	0.25	Wheat
Total	38	8.24	Wheat

4. Conclusion

The findings of this study suggests that alternative tillage and crop establishment methods evaluated in this study had significant effect on grain and straw yields over the conventional tillage in rice-wheat system and they also reduced significantly in production cost. However, there is a great challenge of awareness increase among the wider farming communities.

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