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POSTER ABSTRACTS

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Transplanted Rice in Conservation Agriculture- How is it Possible?

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INTRODUCTION

Significant progress has been achieved with developing conservation agriculture (CA) systems for direct-seeded rice production (Johansen et. al., 2012). However, for direct seeded rice (DSR), weed control remains a continuing problem for successful crop management. By contrast, the common perception is that, without full tillage and puddling of wet soil, rice cannot be transplanted and produce satisfactory grain yield. Hence it has been accepted that transplanted rice cannot be incorporated in CA cropping systems. Since 2008-09 (Haque, 2010), transplanted rice (*Oryza sativa* L.) has been grown in both monsoon (Aman) and cool - dry (Boro) seasons with minimum tillage unpuddled or fully puddled plots in more than 100 farmers' plots in different soils and agro climatic zones of Bangladesh. We have been experimenting for five years with transplanting of rice into unpuddled soil after minimum soil disturbance with or without residue retention to develop a rice establishment system compatible with a CA cropping sequence. In this paper we report on experiments in farmers' fields in Rajshahi district, north-west Bangladesh.

METHODS

Three types of single-pass minimum or reduced tillage {*viz*. 1. single pass shallow tillage (SPST, up to 5 cm deep full tillage); 2. bed formed (BP, newly-formed or reshaped of permanent 60 cm beds); 3. strip tillage (ST, 5-7 cm deep and 5-6 cm wide tilled zones were made)} were compared with traditional puddling (CT, land was prepared by 2-wheel tractor with 2-dry and 2-wet tillage passes). Except CT, all unpuddled land preparation were done in dry land with single tillage pass by VMP (Johansen et al., 2012), followed by the application of irrigation water to inundate the plots for 24 hrs. The recommended doses of basal fertilizers were hand broadcasted prior to transplanting of rice seedlings. The rice was grown with recommended agronomic management. Yield, yield-contributing characters, input use and economic data were collected and data was analyzed using MSTATC program. Two-three seedlings per hill were transplanted manually at the row and hill spacing of 20 cm in all tillage types except BP which was two rows of rice in each bed at the hill spacing of 20 cm.

Results and discussions

There was no difference in rice grain yields with sowing method during the first three seasons (Boro 2008-09, Aman 2009, and Boro 2009-10) in the farmers' field of Durgapur and Aman 2012 cropping seasons at Godagari site (Table 1). Higher grain yields were recorded in case of ST and CT which was significantly higher than BP in Aman 2011, Aman 2012, and Aman 2013 cropping seasons at Durgapur sites (Table 1). Significantly higher rice grain yield (6.00 t/ha) was attained from ST which was higher than CT during the Boro 2012-13 cropping season in 29 on-farm demonstration sites of Durgapur, Sadar-Thakurgaon, Gouripur, and Godagari Upazilas. Tillage cost for land preparation was significantly lower in all crops where single-pass minimum tillage was used (Haque et. al., 2013). Among all single-pass minimum tillage types, SPST systems demonstrated superior weed control but all used less fuel, machinery and labour and had higher net profit than full tillage and puddled transplanting. Minimum tillage unpuddled transplanting reduced the time taken for land preparation and crop establishment; and decreased the number of irrigation events required to wet up the soil (data not shown). The limited soil disturbance in strip tillage (ST), bed planting (BP) and single pass shallow tillage (SPST) did not hinder transplanting of rice.

Table 1. Rice grain yield (t/ha) in full tillage puddled and single-pass minimum tillage systems. Means followed by different letters in a row were significantly at P<0.05 by LSD; n=number of replications.

		Rice grain yield (t/ha)			
Cropping Season	Location	SPST	CT	BP	ST
Boro 2008-09 (n=8)	Farmers' Field, Durgapur	5.58	5.39	5.56	5.59
Aman 2009 (n=9)	Farmers' Field, Durgapur	4.08	3.39	4.07	3.94
Boro 2009-10 (n=10)	Farmers' Field, Durgapur	5.28	5.39	5.45	5.21
Aman 2011 (n=4)	Long-term trial, Durgapur	-	5.42[a]	4.71[b]	5.47[a]
Aman 2012 (n=4)	Long-term trial, Durgapur	-	8.12[a]	7.01[b]	8.26[a]
Boro 2012-13 (n=29)	On-farm Demonstration at Durgapur, Sadar-Thakurgaon, Gouripur, Godagari	-	5.74[b]	-	6.00[a]
Aman 2012 (n=4)	Long-term trial, Godagari	-	6.85	6.12	6.30
Aman 2013 (n=4)	Long-term trial, Durgapur	-	5.05[a]	3.97[b]	4.96[a]

CONCLUSION

Five-years of results have confirmed that the single-pass minimum tillage unpuddled transplanting is a feasible option for transplanting of rice. The minimum tillage unpuddled transplanting in both Aman and Boro seasons rice produced similar or significantly higher grain yield compared to full tillage and puddled transplanting. By using strip tillage on flat land or raised beds, it is possible to achieve minimum soil disturbance and crop residue retention. Our results demonstrate that the minimum tillage unpuddled rice transplanting can be adopted as an alternative to DSR. This opens up opportunities for the continuous application of CA practices in all crops of rice-based cropping sequences that common in the Eastern Indo-Gangetic plain.

ACKNOWLEDGEMENT

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Conservation Agriculture in Rice-Based Cropping Systems: Its Effect on Crop Performance

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Introduction:

Conservation agriculture (CA) systems are yet to be developed for the intensive rice-based cropping systems (3 crops in a year, comprising rice (*Oryza sativa* L.) plus additional cereal, legume and/or oilseed crops) that are common across the Eastern Indo-Gangetic Plain (EIGP). Farming systems in EIGP are characterized by two key edaphic influences, viz: puddling soil for transplanting rice, which destroys the soil structure through intensive tillage and; removal or burning of crop residues before sowing that limits the recycling of organic matter to soils. Neither of these practices is consistent with the full implementation of CA in the intensive rice-based cropping systems.

Implementing CA in the rice-based crop system is feasible using a novel unpuddled transplanting approach to establish rice. In this method of crop establishment (see Haque et al. these proceedings), a strip of soil is tilled (5-7 cm width and 7-10 cm depth) by rotating tines. The soil is flooded to allow the tilled strip to soften before seedlings are transplanted into the strip. Conservation agriculture practices for crops apart from rice are already developed in this region. The objective of the present study was to assess CA based on strip tillage (including unpuddled transplanting for rice) compared to conventional tillage in intensive cereal-dominant and legume-dominant crop rotations. Key questions were: how critical is it for increased residue retention to enable the CA system to be productive and; how long is the transition phase before the main benefits of CA for crop yield become apparent?

Material and methods:

Long term field experiments were carried out for 3 years (2010–11 to 2012–13) at two different agro-ecological zones and soil types in Bangladesh (Alluvial area-24°28 N, 88°46 E and High Barind Tract-24°31 N, 88°22 E) to evaluate the effects of tillage (strip tillage-ST, bed planting-BP and conventional tillage-CT) and residue management systems [high residue- (50 % previous cereal crop residue or 100 % of legume residue); low residue-(20 % previous cereal crop residue or 0 % (only root dry matter was retained in soil) legume residue)] on growth and yield of the three crops in the rotation: lentil (*Lens culinaris* Medik.) or wheat (*Triticum aestivum* L.) in the cool-dry season; mung bean (*Vigna mungo* L.) in the early wet season and transplanted rice in the main wet season. In the interests of brevity the bed planting results are not presented and neither are results for mung bean included in additive yields for the cereal-dominated rotation.

Results and discussion:

In both zones, with legume-dominated (lentil- mung bean- rice) and cereal-dominated rotations (wheat-mung bean- rice), minimum tillage (ST) initially decreased yield of the cool season crop in first year ($P<0.05$) but in the second year there was no difference with CT and in the third growing season in the sequence, cool season crop yields (lentil and wheat) were increased under ST ($P<0.05$) (data not shown). In the first growing season though there were no residue effect on yields but in the following year higher residue retention produced higher yield for both cool season crops ($P<0.05$). Over two years covering seven crops, the additive yield was comparable between ST and CT (Fig. 1). In the legume-dominant

rotation, high residue increased the cumulative straw dry matter (data not shown). By contrast, in the cereal-dominant rotation, cumulative straw dry matter increased with high residue retention under ST but not under CT (data not shown).

From these two experiments in different agro-ecological zones, we conclude that CA in rice-based intensive rotations on small holder farms seems feasible and there is no evidence of a yield penalty considering the 7 consecutive crops over 3 years. In the cool-dry season crops (lentil and wheat), crop yield was initially the same or less under ST, but by crop 7, yields in ST exceeded those in CT. This result suggests that minimum tillage and higher residue retention enhanced cool season crop yield in the intensive rice-based cropping systems of the EIGP but it takes 2-3 years to derive the main benefits for crop productivity. Further studies are examining the change in soil properties over the 3-year period after commencing minimum tillage.

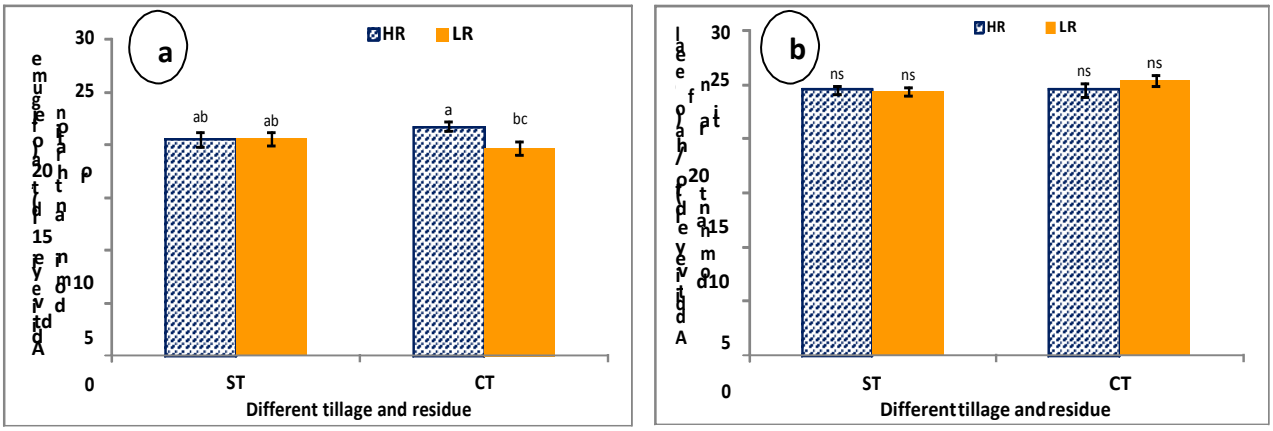

Figure 1. Additive yield of crops for the legume-dominant (a) and cereal-dominant rotations (b) at the Alluvial and High Barind Tract sites, respectively, Rajshahi, Bangladesh. ST-strip tillage; CT-conventional tillage; HR-high residue; LR-low residue. Values are means of four replicates ± standard error of mean. Values with the same letters are not different at $P < 0.05$ 'ns' indicate that the effect is not significant at $P < 0.05$

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Addressing the Problem of Crop Residue Through Adopting of Turbo Seeder in Rice-Wheat Cropping System of Central Punjab Pakistan

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Key words: zero tillage, turbo seeder, crop residue, wheat yield, water use efficiency

Introduction

Pakistan being an agricultural country grows rice and wheat as main food crops on major part of its area. Almost area of 1.7 million hectares is being cultivated under rice-wheat cropping system which ensures the food security to the people. Wheat and rice are among the major crops grown in Pakistan contributing 2.6 and 1% to GDP respectively (GOP-Economic Survey of Pakistan 2011-12).Wheat yield of Pakistan is far below than the potential yield level of many advanced countries. Farmers generally burn rice residue prior to wheat sowing as the cheap and easy option for residue management, but burning leads to losses of soil organic matter and nutrients (especially N, P, K, S and C), and creates environmental pollution (particulates and greenhouse gases) (Singh et al. 2007). The maintenance of crop residues on farmland is important from an agronomic stand point. It can lead to increased yields (Wilhelm et al., 2004). This shows that rice residue could be left in field for better wheat production which has the potential to reduce the fertilizer application in the field. The residue provides the nutrients to the crops and better soil physical structure. In rice-wheat cropping system of the Punjab, in combine-harvested rice fields most of the farmers burn the rice crop residue for good land preparation before sowing of wheat crop. This cause serious threat to atmosphere results in loss of Nitrogen about 25-35%, Phosphorus 40-50% and 60- 75% of Potassium. Rice crop residues have important economic value in terms of livestock feeding, raw material for industry and burning fuel for household and also good source of organic material.Tillage is one of the key operations in planting of crops and extensive tillage is contributing factor in increasing the total cost of production. In burnt rice residue fields zero tillage drill works very well. To avoid this loss there was a need either to modify the zero tillage drill or introduce new machinery for the management of crop residue in the rice harvested fields.

Material and Methods

To test the turbo seeder technology for wider adoption in Pakistan two improved version of TURBO seeders were imported from India through Rice-Wheat Consortium and were modified locally. The farmers participatory research trials were conducted under Lower Bari Doab Canal Improvement Project (LBDCIP) in the districts of Okara and Kasur the rice-wheat cropping area of Punjab during the year 2009-2012.The field experiments were laid out in a Randomized Complete Block Design(RCBD) with four replications having plot size one acre at each location. Before conducting the experiments fields were leveled with laser land leveler and soil samples were collected and analyzed before and after the experiments to test the soil fertility level. The crop was monitored on regular intervals and data were recorded at critical crop growth stages. Data were recorded in three replicates and for each replication observation was made from five one square meter sample areas. Agronomic parameters recorded include productive tiller/m^2, plant height (cm), weed density/m^2, 1000-grain weight (g) and grain yield t/ha. The recommended dose of fertilizers was added in all experimental sites in each treatment. Role of irrigation water, the salient component of irrigated agriculture was also taken under consideration. Equal amount of water was applied in each treatment. In tillage practices, various treatments i.e. T1 including sowing of wheat with TURBO seeder in residue, T2 (Zero tillage in partial crop residues), T3 Zero tillage recorded. The impact of conservation agriculture technologies was assessed in the with burnt residues and T4 (conventional sowing) were studied in detail. At the same time water use efficiency in all four practices and role of crop residue in enhancing the organic matter were also studied in experimental sites.

Results and Discussions

During 2009-10, in account of water conservation the highest value was recorded in turbo seeder planted wheat (33%) followed by Zero tillage planted wheat (20%). Similar trend was observed in the subsequent year 2010-11 but the only change was observed that the difference between 30% rice residue and 50% residue saved almost equal amount of water. The benefit-cost ratio was the major component used for evaluation of the options. Data revealed that sowing of wheat with TURBO seeder had significant impact in management of 4-5 tons of rice residue/ac in combine harvested rice fields. It was also observed that on an average 7% of wheat yield crop was increased. Moreover, soil organic matter was increased, one irrigation costing Rs.3800/ac was saved, and cost of weedicides Rs.1000/ac was also saved as compared with conventional sowing. Crop residue treatment in Zero-tillage soils sequestered significantly higher yield and reduces the cost of land preparation and energy saving. The crop residue management practices in wheat crop were impressive and have shown the potential to enhance the farmers' income to the considerable extent. As the yield of wheat increased due to this practice as observed by the experiments, the ultimate return also increased. The study suggests that turbo seeder technology is quite useful and potential for wide scale adoption in rice wheat cropping system in Pakistan.

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The Study of No-Till Farming System in the High Risk Agricultural Zones in the Southern Aral Sea, in Karakalpakstan

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Background

The main problems of agriculture in irrigated lands of the Southern Aral Sea area of Karakalpakstan are soil salinity, low organic content, the lack of water during the growing season, lack of arable equipments and tractors in the period of sowing crops. To solve these problems, it is necessary to use techniques to reduce the salinity of soil moisture conservation, increasing the content of organic matter in soil and saving material and labor resources. In this connection, zero tillage is the most relevant technology for arid conditions of Karakalpakstan.

Results

Soil cover with straw is a mandatory approach of zero tillage. Straw cover soil increases organic matter content of the soil, reduces salt accumulation in the rhizosphere , conserves soil moisture, protects the soil from wind and water erosion. Soil cover with straw and zero tillage in two years also activates biological processes in the soil. Qualitative study of the protease activity of the soil showed that under the cover at permanent use of zero tillage in two years was significantly higher than with conventional technology.

Saving material and labor resources in growing agricultural products is an important factor for achieving high economic efficiency. Zero treatment enabled to reduce fuel consumption in the cultivation of wheat by 59.9 percent, and in the cultivation of cotton by 91 percent.

But in our case there is a risk of yield reduction in the transition from traditional technology to zero tillage. In the first years of use of zero tillage yield is usually 0.5-1.0 tons / ha less than with traditional multiple processing. However despite this profitability is always higher, even at the minimum yield, as the cost of crop production at zero treatment is significantly lower than with conventional technology. It also should be noted that in the absence of plowing in our environment there is a risk of clogging perennial weeds such as alhagi, licorice, reeds and tamarisk quinoa , etc.

Applications and Implications for Conservation Agriculture

Our experiments showed that zero tillage is quite suitable for use in soil and climatic conditions of Karakalpakstan. Even in the early years of zero tillage can be recommended for sowing wheat, sunflower, soybeans, sesame , sorghum, maize. Advantages of zero tillage in our conditions is it can restore soil fertility, reduced salinity , water conservation for irrigation , saving manpower and diesel. However, due to lack of research in this area in the country is no scientific evidence-based recommendations. In this regard, we consider it necessary to expand scientific research on the effect of zero tillage on soil parameters on the conservation of water resources in terms of water shortage and reduce greenhouse gas emissions**.**

Experimental Approach.

Experiments were carried out on mid-loamy light gray soils of the Republic of Karakalpakstan. Soil parameters (soil moisture, salinity, texture, soil protease activity) by taking soil samples followed by laboratory analysis studied by conventional methods (Alexandrova , Naydenova , 1986), also by the

method of experimental work in field (Nikitenko , Ermakov , Bezuglova , Maslova .Mozgovoy , Saranin, Monakhov , 1982).
Surveys and observations, as well economic assessment carried out by the method of experimental work in field (Nikitenko , Ermakov , Bezuglova , Maslova , Mozgovoy, Saranin , Monakhov , 1982)

Results and Discussion
The results showed that soil moisture in the soil cover of straw 2-3 times higher as compared with uncovered soil. Soil cover with straw also reduces the accumulation of salts in the rhizosphere 1.5-4 times compared to uncovered soil. Soil cover with straw and no-till within two years of the permanent application also activates biological processes in the soil. Qualitative study of the protease activity of the soil showed that under the cover at permanent use of zero tillage was significantly higher than conventional technology.

Saving material and labor resources in growing agricultural products is an important factor for achieving high economic efficiency. Saving fuel for growing wheat by 59.9 percent, and in the cultivation of cotton to 91 percent lower than conventional treatment.

In the first years of application of zero tillage yield is usually less than 0.5-1.0 tons / ha than with conventional tillage . Thus, for example wheat yields with conventional technology was 2.3 tons / hectare and with zero technology 1,8 tons / ha. This is understandable, because the soil with no-till field has not yet reached the "cultivation " of the soil naturally. As studies scholars and practitioners in many countries, loose soil conditions at zero treatment is achieved only after five years of permanent applications. It also should be noted that in the absence of plowing in our environment there is a risk of clogging perennial weeds such as alhagi, licorice, reeds and tamarisk quinoa , etc. However, despite this zero tillage allows top receive crops at a minimum cost of material and labor resources and this is a major motivating force.

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