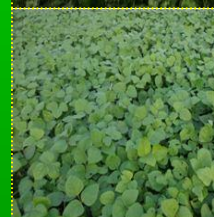
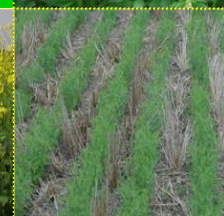


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Residue Handling Capacity of the Versatile Multi-crop Planter for Two-wheel Tractors

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Introduction

Crop residue retention is one of the core principles of conservation agriculture (CA). However, the level of retention and residue handling characteristics depend on household use of residue, crop type, residue type (loose or anchored), freshness (or weathering status), water content in residue, soil type, soil water content in the field, type of implements used to sow the next crop, disease of previous crops, height of residue, etc. Over the last decade, innovations made to a wide range of 2-wheel tractor (2WT) seeding implements now permit reliable seeding into minimally disturbed soil and moderate levels of crop residue. This provides a window of opportunity to develop CA cropping systems for small holder farmers in Asia and Africa, not only in terms of reduced soil disturbance but also with respect to biomass cover and crop rotation. The Versatile Multi-crop Planter (VMP) was designed as multi-functional and multi-crop 2WT-based planter for smallholders with capability for seed and fertilizer application in variable row spacing (Haque et al., 2011) but its capacity for residue handling using single-pass shallow-tillage (SPST), strip tillage (ST), zero tillage (ZT), bed planting (BP), and conventional tillage (CT) has not been systematically tested.

Materials and Methods

Since 2010, a total of seven VMPs were used to establish >4,000 on-farm and on-station trials and demonstration plots into various crop residue types and retention levels in different parts of Bangladesh. The soil moisture levels of the plots, where measured, ranged from 15 to 41 %. Data on tillage type used, residue type and height, and ease of operation were collected from 2,157 on-farm trials and farmers' demonstration plots where each year the VMPs were used to establish many crops (Table 1). The plot size was ranged from 112 to 1333 m². On-farm data were collected using structured questionnaires and 12 focus group discussions with farmers and service providers of VMP; on-station data were collected and analysed by Excel.

Results and Discussion

When crop residue accumulates on the rotary shaft and/or the furrow openers this lengthens the sowing operation due to the time required to clear the machine and there are also problems with seed and fertiliser placement which may affect crop establishment. Each tillage type available with the VMP has varying capacity to cope with the volume and height of residue retained from the previous crop.

Strip Tillage (ST): In total 1062 trials were conducted with various residue retention levels. In case of ST with sharp and straight rotary blades that aligned with furrow openers minimal residue accumulation occurred on the rotary shaft or furrow openers if the height of anchored residue was < 60 cm. (equivalent to 5.5 t of rice or wheat residue per ha). If loose and > 40 cm high, rice and wheat residue (up to 4.5 t/ha) accumulated on the rotary shaft and furrow openers especially if the residue was fresh and wet.

Bed Planting (BP): Out of 2,002 trials that retained rice, wheat, and mungbean residue (Table 2), only 16 trials used two tillage passes for forming and/or reshaping beds and planting crops in various levels of retained residue. In case of BP, 20 cm of any type of residue accumulated on furrow openers and needed to be cleaned by an operator quite often. Higher amounts of

residue retention and multiple tillage passes enhanced the residue accumulation on the rotary shaft and furrow openers, which was severe if loose and fresh residue was retained in the field.

Zero Tillage (ZT): Residue accumulation on furrow openers was observed if the height of residue was >20 cm; and was more severe with greater amounts of loose residue and tall anchored residue. Higher residue accumulation with furrow openers was observed even with very low retention (<0.4 t/ha) when the retained loose rice or wheat residue was >10 cm long.

Conventional Tillage (CT): Higher residue accumulation on the rotary shaft was observed when the retained anchored residue (Table 2) height was > 30 cm (equivalent to 3.37 t/ha) with 3-4 tillage passes to prepare land. Higher residue accumulation on the rotary shaft was observed even at very minimal retention (<0.4 t/ha) when the retained loose residue (Table 2) was > 30 cm long.

Table 1. Crop-wise residue retention and performance evaluation of VMP under different tillages options for sowing (n=includes the total number of on-farm trials plus farmers' demonstration plots).

Crop species	Tillage type				Total	% of total
	ST (n)	BP (n)	ZT (n)	CT (n)		
Rice	511	64	8	321	904	41.9
Wheat	232	20	-	203	455	21.1
Chickpea	27	13	-	8	48	2.2
Jute	66	24	12	159	261	12.1
Lentil	86	20	8	68	182	8.4
Maize	66	-	-	62	128	5.9
Mungbean	87	20	-	20	127	5.9
Mustard	26	4	-	22	52	2.4
Total:	1101	165	28	863	2157	100

Table 2. Height and weight of retained residue of rice, wheat, and mungbean into which following crops were sown using VMP under various tillage systems.

Crop and height (cm) of retained residue	Residue retained (mean of all (n) determinations)							
	Strip Tillage (ST)		Bed Planting (BP)		Zero Tillage (ZT)		Conven. Tillage (CT)	
	n	t/ha	n	t/ha	n	t/ha	n	t/ha
Rice, >50	27	4.8	27	4.4	27	4.5	27	4.6
Rice, 20- 50	267	3.1	20	3.1	8	2.8	253	3.2
Rice, <20	414	1.5	21	1.5	8	2.5	322	1.5
Wheat,>40	342	2.9	28	2.8	8	2.3	167	2.7
Mungbean,>30	12	2.8	12	2.8	-	-	12	2.8
Total:	1062	-	108	-	51	-	781	-

Reference

Haque ME, Bell RW, Islam AKMS, Sayre K, Hossain MM (2011) Versatile multi-crop planter for two-wheel tractors: an innovative option for smallholders. In: Gilkes, R.J., Nattaporn, Prakongkep (Eds.), 5th World Congress of Conservation Agriculture incorporating 3rd Farming Systems Design Conference. 26–29 September 2011, Brisbane, Australia. pp. 102-103.