Farmer Participatory Refinements and Adoption of CRIDA Bullock Drawn Planter in Latur District of Maharashtra

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ABSTRACT: Three-row multi-crop bullock drawn planter developed by Central Research Institute for Dryland Agriculture, Hyderabad was tested, refined and demonstrated for sowing soybean and other dryland crops on farmers' field during 2008-13. Its performance evaluation was carried out with conventional sowing by bullock drawn *tifan*. Based on farmers feedback and on-field observations; refinements such as scrapper on ground wheel, boot with seed and fertilizer delivery pipes, fluted roller type fertilizer agitator and increased hole size on fertilizer controlling lever were incorporated in the planter. Field tests showed that the refined planter performed well for sowing soybean, soybean + pigeonpea, chickpea, sorghum and groundnut crops in the district. The field capacity of the planter was 2 ha/day with an average field efficiency of 75% and an average sized bullock could easily pulled it. The planter saved 9-27% seed, 63-75% labour and increased crop yield by 11-20% as compared to conventional sowing by bullock drawn *tifan*.

Key words: Farmer participatory**,** refinements, CRIDA planter, adoption

Sowing is a critical operation for any successful crop production. The aim of sowing is to establish a plant population whose spacing contributes to the maximum return per unit area. Hence, optimizing the density of plants is a prime importance, and this requires precision in terms of seed metering and distribution by the seeding machine. The objective of seed metering is to accurate and uniform seeding that causes no damage to the seed. Seed distribution refers to the planting of seeds according to a predetermined pattern (Colombino *et al*., 1989). This should take into account the requirement for equidistant spacing between seeds. The depth at which they are planted should be adjusted to provide them the best moisture conditions (Kumar, 1989). It is therefore, important to take into account the components of the drill and the possibilities of their adjustment.

Animal power is the major source of farm power in Latur district of Maharashtra State. Hence, all the conventional methods of sowing are primarily linked with animal power. Dryland crops are generally sown by traditional method, using a hand metering wooden or plastic bowl mounted on a wooden or MS frame called "*tifan"* or "*dufan*". In this method, farmers normally use higher seed rate than desired to achieve required plant stand. This results in inadequate and non-uniform plant stand. This practice not only results in higher seed cost but also lower the crop yield. Apart from this, conventional system requires skilled labour to meter seed and fertilizers. The traditional system has the limitations of uneven depth of seed placement, slow ground coverage and high labour requirement (Awadhwal & Babu, 1994). The availability of easy to use multi-crop planter for small scale farmers can alleviate these problems substantially, and can also help to maintain timely seeding and reduce the farmers' drudgery. Considering the limitations of conventional crop sowing method and precision needs of the crop sowing, CRIDA three-row bullock drawn multi-crop planter developed by Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad was tested, evaluated and adopted on the farmers' field in Latur District (Mayande *et al.*, 2004).

Materials and Methods

The CRIDA three-row bullock drawn planter developed by CRIDA, Hyderabad was tested on farmers' field for sowing soybean, soybean + pigeonpea intercropping, chickpea, sorghum and groundnut crops.

Description of the CRIDA three-row bullock drawn planter

CRIDA three-row bullock drawn planter consists of a main frame, hopper box, three furrow openers, a drive wheel, a pair of guide or transport wheels, seed metering plates, seed tubes and other accessories (Figure 1). The frame consists of a square bar, formed by joining two angle irons and a beam made of iron pipe. The angle of the beam to the ground can be adjusted to eliminate the effect of height of bullocks on the working angle of the implement. The hopper box has two compartments; each for seed and granular fertilizer. The seed compartment is divided into three subsections each for individual furrow opener. These three seed boxes have an inclined plate metering mechanism. Seeds of the same or different crops can be simultaneously metered from individual subsections, thus facilitates sowing of intercrops. The appropriate seed plates are selected as per the crop to be sown. The fertilizer section is also divided into three sub-sections. Each section has holes at the bottom centre for fertilizer delivery. Fertilizer moves through this orifice at bottom by gravity and is facilitated by zigzag rubber agitator fixed on shaft. The furrow openers are mounted on main frame with 'U' clamps and their spacing can be adjusted

by lateral shifting of furrow openers according to the row spacing requirement of the crop to be sown. The spouts of the metering mechanisms and furrow openers are connected by plastic tubes. Seed discharged from metering plates passes through the plastic tube and subsequently get placed into the soil. The depth of seed placement is adjusted by moving the axles of depth wheels up and down, in relation to the furrow openers. The drive wheel provides power to the seed and fertilizer metering mechanism through a set of chain and sprocket connected to seed and fertilizer shafts. A lever connected to drive wheel is used to lift ground drive wheel and to stop seed dropping during transport and especially at turnings in the field.

Fig. 1 : CRIDA 03-row bullock drawn planter (Curtsy: CRIDA, Hyderabad)

Farmers' participation

Farmers were trained on the attachment, adjustments and operation of the CRIDA bullock drawn planter. Simple refinements were incorporated to match local field conditions in such a way that it did not affect on the cost of planter and could be easily fabricated in local workshop in the village.

Farmers' feedback: The planter was operated under supervision of KVK experts by beneficiary farmers and field observations were recorded. Many visiting farmers observed the performance of the planter in the field and registered their feedback on performance through participatory sessions organized at each test site. The problems reported by farmers were put in their order of importance. Strategies to solve these problems, pointed out by the farmers were also recorded. Feedback received through participatory sessions with the farmers, on-field problems observed during operation of the planter and possible solutions discussed are summarized in Table 1.

Table 1 : Problems identified, possible cause and refinement incorporated in the planter

Working part of the planter	Problems identified	Causes	Refinements discussed with farmers
Guide or depth control wheel	Depth adjustment by 50 mm interval	Adequate seeding depth adjustment not available with present axle of wheel	Increase number of holes on the axle of wheel at equidistance of 50 mm to get holes at 25 mm interval
	-Sticking of soil on wheel causes uneven depth of sowing especially during kharif	Vertisols with high moisture condition in the field soil	Use of scrapper to remove/avoid soil build up on ground wheel
	-Considerable time loss in removing the soil on ground wheel		
Seed and fertilizer tubes	Clogging of seed & fertilizer tubes at delivery ends especially during kharif	Hanging type seed and fertilizer tubes	Use of boot with seed and fertilizer delivery pipes
Fertilizer controlling lever	-Uneven and Less fertilizer delivery	Delivery hole size	Increase hole size on fertilizer controlling lever by 2 to 5 mm to meet required fertilizer quantity
	-Less scope for fertilizer lever adjustment		
Fertilizer agitator	Fertilizer agitator worn out earlier	Agitator made of rubber	Use of MS fluted roller type agitator

Test Parameters

The test performance of the seed and fertilizer metering units include uniformity of seed droppings, plant spacing, field performance, field capacity and labour requirement.

Performance of seed metering mechanism: The seed metering mechanism was tested in the laboratory and field. The planter was set with suitable plates (Table 2) for crops to be sown and operated over a given distance. The planter unit was run with its furrow openers fitted, such that they simply slid on the ground and seeds were dropped onto the soil surface (Awadhwal & Babu, 1994). For each crop the number of seeds dropped and the spacing between them were measured.

Table 2 : Seed metering plates used for sowing different crops

Crop	Number of cells on seed metering plate	Cell Diameter, mm	Thickness of seed metering plate/ depth of cell, mm
Soybean	23	8.0	5.8
Pigeon pea	12	6.5	5.0
Sorghum	12	4.5	4.5
Chickpea	12	8.0	6.0
Groundnut	12	10.0	7.0

Field performance: Appropriate metering plates (Table 2) were used for sowing soybean, soybean + pigeonpea (4:2) intercrop, chickpea, sorghum and groundnut crops. Observations were taken to determine field capacity and forward speed of the planter. At 25 days after sowing plant to plant spacing in a 10 m row length was recorded from each test plot and derived plant population.

Intra row variation in placement of seeds

It was evaluated based on the actual plant to plant spacing achieved. The data measured were used to calculate the following indices of planter performance.

***Mean seed spacing*:** Mean seed spacing (S) is the mean of total number of spacing measured.

$$S = \frac{1}{N}\sum_{i=1}^{N} x_i$$

Where, N is the total number of spacing measured; x_i is the distance between plants

Miss Index: The missing percentage is represented by an index called the Miss Index (MI) which is the percentage of spacing's greater than 1.5 times the set spacing (X) (Katchman and Smith, 1995 and Bracy *et al.,* 1999).

$$MI = \frac{n_1}{N}$$

Where, n_1 = number of spacing > 1.5 X.

Multiple Index: The multiple (more than one seed) percentage is represented by Multiple Index (DI) which is the percentage of spacings that are less than or equal to half of the set spacing (X) (Katchman and Smith, 1995).

$$DI = \frac{n_2}{N}$$

Where, n_2 = number of spacing ≤ 0.5 X.

***Good spacing range*:** This spacing range was derived from information on the effects of plant to plant spacing variation on the grain yield (Soman *et al.*, 1987; Wade, 1990; Wanjura, 1980).

Good spacing range = 0.25 to 1.75 times the recommended ideal spacing

Results and Discussion

Refinement of the planter

Based on feedback received through participatory sessions with the farmers and on-field problems observed during operation of the planter the following refinements were incorporated in the planter.

***Scrapper welding and holes drilled on the brace/arm of depth wheel*:** The holes were drilled at 25 mm interval on the brace of depth control wheel. This allowed farmers to adjust the depth of planter operation by 25 mm interval (Figure 2). To remove the soils build on ground wheel, especially in kharif season, a MS plate of 70 x 50 x 5 mm size was welded on the side arm of depth wheels, as shown in Figure 2. The scrapper works at any depth of operation of the planter.

***Boot with seed and fertilizer delivery pipes*:** Two MS pipes of 120 x 50 mm size were cut at 60^0 angle from the bottom and welded on the back side of furrow opener at 50 mm vertical distance from the tip of furrow opener as shown in Figure 3. The seed and fertilizer tubes were inserted in these pipes at the delivery end. This refinement reduced the seed and fertilizer clogging considerably especially in kharif season.

***Fertilizer agitator*:** Fertilizer agitator made of rubber was worn out and did not work satisfactorily continuously for two seasons. Therefore, it was replaced with the fluted roller type agitator having four grooves (Figure 4). It was observed and reported by farmers that it worked satisfactorily and delivered the fertilizer evenly as compared to rubber agitator.

***Fertilizer controlling lever*:** To meet the farmers' requirement to sow 125-150 kg fertilizer per ha and provide better scope for adjusting fertilizer rate, the hole size on the fertilizer control lever was increased from 10 mm to 12 mm (Figure 5). This facilitated the adjustment of the lever and delivered 130 ± 15 kg fertilizer per ha as in conventional system.

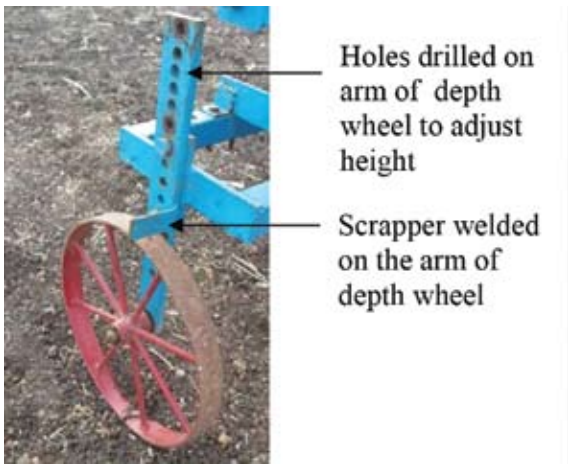

Fig. 2 : Holes drilled and scrapper welded on the brace/arm of ground wheel

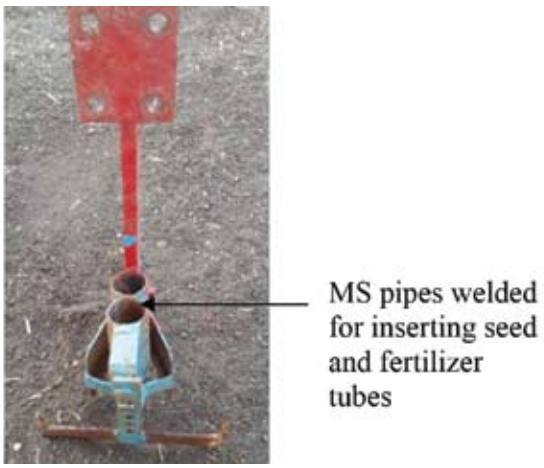

Fig. 3 : Boot with seed and fertilizer delivery pipes

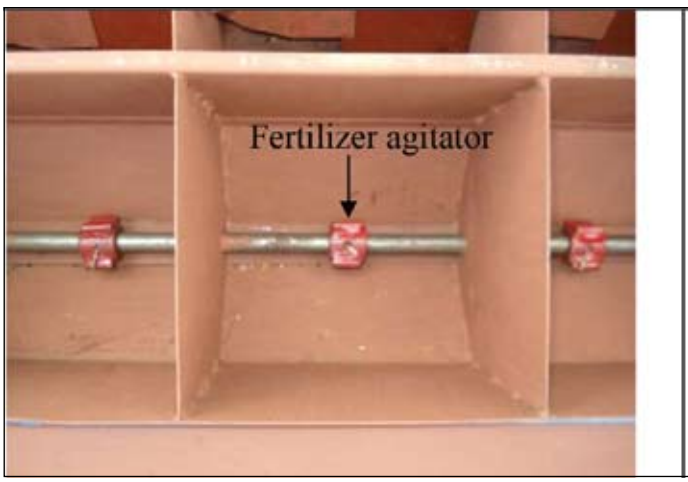

Fig. 4 : Refined fertilizer agitator fitted on fertilizer shaft

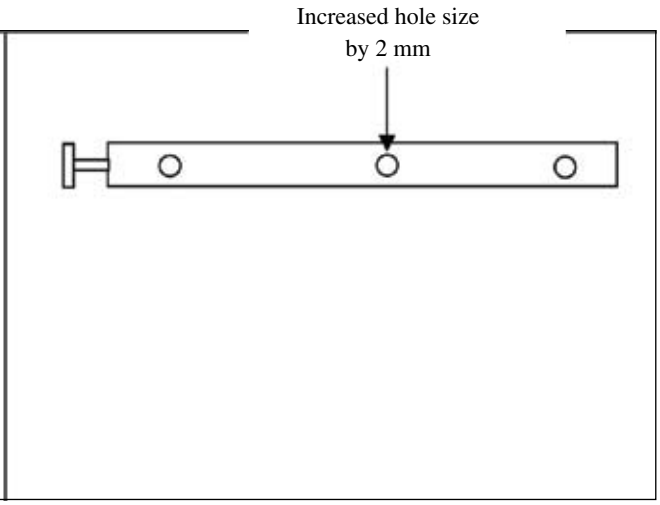

Fig. 5 : Fertilizer control lever

Seed metering test

The results of seed metering tests, average number of seeds dropped per meter row length and seed damage for different crops are given in Table 3. It was observed that inter-row variation in seed spacing was less than 2% in all crops. About 1.2% of TAG 24 seeds of groundnut seeds suffered from partial injury from bruising during metering. There was no visible damage occurred to the seeds of other crops.

Table 3 : Seed metering performance of CRIDA bullock drawn planter

Crop	Variety	100 seed mass (g)	Number of seeds/m row length	Seed damage, %
Soybean	JS-335, MAUS-71, DS-228	10.2	23.5 (± 3.33)	0.0
Pigeonpea	BSMR 736, BSMR 853	11.3	12.26 (± 3.02)	0.0
Sorghum	Local, Parbhani moti	3.4	12.48 (± 4.83)	0.0
Chickpea	Vijay	16.6	12.22 (± 2.75)	0.05
Groundnut	TAG-24	24.8	11.40 (± 2.50)	1.2

Field performance

Plant population: The plant population of different crops achieved using CRIDA bullock drawn planter is given in Table 4.

Table 4 : Plant stand of crops sown with CRIDA three-row bullock drawn planter

Crop	Number of rows in a single pass	Row spacing, cm	Mean plant stand in 25 m^2 area	Plant population achieved ('000/ha)
Soybean	3	45	1110.5 (± 18.3)	444
Soybean + pigeonpea *	2 + 1	45	728.4 (± 14.6) 168.9 (± 20.2)	308 69
Sorghum	3	45	468.2 (± 18.5)	187
Chickpea	3	45	457.6 (± 23.8)	220
Groundnut	3	30	628.7 (± 21.9)	262

* Two rows of pigeonpea were intercropped with four rows of soybean

***Mean plant spacing*:** The mean values of the soybean, pigeonpea, chickpea, sorghum and groundnut plant spacing measured at 25 days after sowing were 4.7, 11.2, 11.6, 11.9 and 12.4 cm, respectively with CRIDA bullock drawn planter (Table 5). Hence, the seed spacing is within the range of the optimal seed spacing of 5 cm for soybean and 10 cm for pigeonpea, chickpea, sorghum and groundnut.

***Miss index*:** The average miss index measured along the planted row was in the range of 15.1 to 27.6 cm for all the crops tested (Table 5). The maximum miss index (27.6) was recorded in groundnut against minimum (15.1) with pigeonpea. This variation in the miss index could be due to number of factors including jumping of seeds in the furrow, germination of planted seeds and clogging of seeds along the boot.

***Multiple index*:** The average maximum multiple index 19.2% was recorded with pigeonpea against 8.9% with the groundnut of the total crops tested (Table 5). The lowest multiple index with groundnut might be attributed due to uneven size of seeds, which allowed to pick up and deliver two seeds in a cell of the metering plate sown of the same crop and variety. This can be rectified by cleaning and grading of seeds before the sowing.

Table 5 : Plant spacing performance of crops sown by CRIDA three-row bullock drawn planter

Variables	Crop				
	Soybean	Pigeon pea	Chickpea	Sorghum	Groundnut
Mean plant spacing, cm	4.7 (± 2.8)	11.2 (± 3.1)	11.6 (± 4.1)	11.9 (± 3.3)	12.4 (± 2.6)
Missing index	23.5	15.1	19.2	21.9	27.6
Multiple index	13.0	19.2	13.8	11.8	8.9
Good spacing range	77.6	86.2	83.5	83.4	74.2

***Good spacing range*:** The good spacing range for all the crop sown was in the range of 74.2 to 86.2% and more than 75% of the spacing of all crops tested were in the good spacing range. In groundnut low proportions of the plant spacing were in the good spacing range (74.2%). This could be because groundnut was sown in late rabi season, when there was considerable variation in the soil moisture at seeding depth. This could have reduced the germination.

Field performance

The details of comparative field performance of CRIDA 3-row planter and conventional drill is given in Table 6. The actual field capacity of the CRIDA bullock drawn planter was found to be 0.33 ha/h for soybean as against 0.27 ha/h with conventional drill for crop sowing at 45 cm row-to-row distance. The field capacity of the CRIDA bullock drawn planter was 20-28% more than conventional drill '*tifan*'. The labour requirement for sowing 1 ha was in the range of 4-6 man-h for CRIDA planter as against 11-18 man-h for conventional sowing by '*tifan*'. The conventional method required two persons for metering seeds and fertilizers each and three labourers for intercrop sowing. Thus, the CRIDA planter reduced the labour requirement by 63-75% as compared to '*tifan*'.

The CRIDA planter saves 19.8, 16.9, 27.2, 17.6 and 9% seeds of soybean, pigeonpea, sorghum, chickpea and groundnut as compared to conventional sowing. Thus, CRIDA planter saves 9-27% seeds as compared to conventional drill. The use of CRIDA planter enhanced the yield of soybean, pigeonpea, sorghum,chickpea and groundnut by 18.2, 19.9, 15, 11.6 and 14.6 % as compared to conventional sowing by *tifan*.

The beneficiary farmer reported that the CRIDA planter was easy to operate and draft of the planter did not overload the bullocks during operation. Also, the average sized pair of bullock could easily operate the planter.

Table 6 : Field performance of CRIDA bullock drawn planter with conventional sowing

Variables	Crop									
	Soybean		Soybean + pigeon-pea (4:2)		Sorghum		Chickpea		Groundnut	
	CP	CD	CP	CD	CP	CD	CP	CD	CP	CD
Villages	Mahapur, Lodga, Bhosa, Sirsi, Pangaon, Sugaon Mamdapur, Murambi Chincholirao		Sirsi, Sugaon, Chincholirao		Bhosa, Chincholirao		Bhosa, Sirsi, Shivni, Chincholirao		Bhosa, Sirsi	
Year	2008-09, 2009-10, 2010-11, 2011-12, 2012-13		2009-10, 2010-11, 2011-12, 2012-13		2008-09, 2011-12, 2012-13		2008-09, 2009-10, 2011-12, 2012-13		2008-09, 2010-11	
Number of farmer	30	26	13	11	16	13	27	22	05	03
Total Area, ha	29.2	10.4	10.2	5.4	8.4	9	22.2	11.0	4.2	1.2
Row spacing, cm	45	45	45	45	45	45	45	45	30	30
Average depth of operation, cm	5.7	6.7	5.6	6.8	7.2	8.1	7.1	8.3	7.4	9.0
Width of operation, cm	135	135	135	135	135	135	135	135	90	90
Speed of operation, km/h	2.7	2.5	2.7	2.4	2.5	2.2	2.6	2.3	2.4	2.1
Field capacity, ha/h	0.33	0.27	0.32	0.28	0.30	0.25	0.30	0.24	0.22	0.18
Field efficiency, %	76.8	62.2	74.1	58.6	71.1	57.2	71.2	51.5	78.7	58.2
Labour requirement, man-h/ha	4	10.8	4.1	16.5	4.3	12.3	4.2	13.0	6.0	18.1
Seed rate, kg/ha	58.2	72.6	39.3 (S) 7.8 (PP)	50.5 (S) 10.6(PP)	9.1	12.5	40.2	48.8	98.3	108.0
yield, q/ha	20.8±3.2*	17.6±3.1	13.9± 2.8 16.9±2.2	11.7±2.9 14.1±2.3	17.6±2.6	15.3±2.3	17.3±3.4	15.5±3.0	16.5±2.5	14.4±2.3

CP= CRIDA planter, CD= Conventional drill (*tifan*); S- Soybean, PP- Pigeonpea, * Mean ± SD

Conclusions

The overall performance of the refined CRIDA three-row bullock drawn planter is very satisfactory. It requires 4-6 h to sow 1 ha area and a pair of medium sized bullocks easily pull it. The planter saves seed and labour requirement considerably and covers more area as compared to the conventional seed drill. The planter is able to place 65% plants at optimum spacing. The accuracy of plant spacing can be improved by using graded seeds for planting. There is need to improve the fertilizer metering system of the planter for regular release. The planter is adopted by farmers in the district and are using successfully for sowing soybean, pigeonpea, greengram, blackgram, sorghum, chickpea, groundnut, maize and onion crops.

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