

Appropriate mechanization

for resource conservation in rainfed agriculture

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Rainfed agriculture is challenged by climate variability, erratic rainfall, low or lack of soil moisture during crop establishment and crop growing season which are the major problems faced in dryland agriculture. In rainfed regions, deficit soil moisture and low water-holding capacity of soils limit crop productivity. Various technologies were developed for in situ moisture conservation by ICAR-Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad. Broad bed and furrow planter, raised-bed planter and paired-row planter developed by CRIDA enabled farmer's to make seed bed suitable for in situ moisture conservation and also for minimizing soil erosion. This mechanisation has a positive impact on soil fertility, water conservation and weed control in rainfed agriculture as well as on-farm income through higher output per unit area due to increased productivity.

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RAINFED agriculture is constrained by moisture stress during crop growing season. Primarily good seed bed configuration is needed for better *in situ* moisture conservation. If the field is not well prepared, it results in formation of cloddy seed-bed due to which sowing becomes difficult. The productivity of rainfed crops can be improved through *in situ* soil moisture conservation. In recent times, in addition to long dry spells, the rainfed crops are also being affected by high intensity rainfall events/wet spells in short time. There is a need for suitable seed-bed configuration for better establishment of rainfed crops. ICAR-Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad, Telangana developed many *in situ* moisture conservation technologies. To overcome energy requirement and reduce the drudgery involved in manual sowing, ICAR-CRIDA developed broad-bed furrow planter, raised-bed planter and paired-row planter which fulfil the requirement of seed bed configuration.

Variable width raised-bed planter

Generally, raised-bed planting is practised in areas with poor drainage and compacted soil conditions. It improves soil aeration by allowing the soil to dry faster. Also, the structure of bed and furrow exposes more surface water infiltration into the soil surface. It also facilitates better runoff during heavy rainfall as water-

logging becomes a major constraint in crop production. However, normal raised bed planters do not have the compatibility with all the cropping systems. A tractor operated variable width raised-bed planter was designed and developed to suit the crop geometry of major rainfed crops such as pigeonpea, maize, castor, cotton and sorghum. The main idea is to conserve as much rain water as possible in an optimized way by making furrows with well structured ridgers. Raised beds are made above natural terrain of land such that planting area is raised above the soil level forming a bed for planting of one, two or three rows of crops. The raised-bed planter mainly consist of two ridgers which makes furrows and a shaper making the compact raised bed of trapezoidal shape. The ridger makes a furrow of 35–40 cm width and 16–20 cm depth as per the soil conditions. The wings of ridgers were specially designed, so that the top soil disturbance was minimized to reduce the germination loss which is a common phenomenon in rainfed soils. The bed shaping frame was made adjustable for 60, 80, 100 and 120 cm to suit the different crop row requirements. This machine was fabricated to suit the tractor track, so that the weeding and other operations could be done easily by running the tractor tyres in furrows to keep the bed configuration intact without disturbance.

The performance of CRIDA-raised bed planter was



CRIDA variable width raised bed planter cum herbicide applicator

demonstrated on farmers' fields in the villages adopted under NICRA (National Innovations in Climate Resilient Agriculture). The results indicated an increase in soil moisture content by 20% over the conventional method after 5 days of rainfall. The crops also could withstand initial dry spells of 10 days more than the crops sown on flat beds. In addition, the bed consistency was significant. The yield increase was 15–25% in castor and pigeonpea, respectively when compared to the conventional planter.

Broad bed furrow planter

Four row CRIDA-broad bed furrow (BBF) planter is specifically designed for soil and water conservation. The main feature of the BBF planter is to have a bed between the furrows at the ground level with moderate consistency. This helps in *in situ* conservation of rain water on farm level during the season apart from sowing the seed and placing the fertilizer at proper depth and placement. The broad furrows formed by the planter help in conserving the rainwater and also act as drainage channels to drain out the excess water during excess rainfall events.

It consists of a rigid frame with three-point hitch mounting arrangement. Four tyres are fixed on the frame with dimensions of 2500 mm × 400 mm. The ridger

wings are adjustable to form a broad furrow of 35–45 cm wide according to crop geometry needs and the depth of conservation furrow can be made at 20–35 cm as per the soil conditions. The narrow-headed furrow opener opens a small seed furrow on top of the ridge and the seed falls into the furrow at proper depth based on the tractor hydraulic depth control. The depth of seed furrow varies from 25–60 mm. The fertilizer will be delivered into the furrow through pocket wheel mechanism. It forms two furrows during the tractor forward operation and the first ridger runs in the second furrow during its return to maintain the symmetry in formation of furrows and ridges based on the crop geometry requirement. The planter can be operated by 35 hp and above 35 hp tractors. BBF technology is very popular in Maharashtra and Madhya Pradesh for sowing of soybean. The yield increase was 15–20% due to BBF planting in maize, soybean, sorghum and pigeonpea when compared to the conventional system. The planter also widely used in Maharashtra for direct sowing of onion due to which the cost of operation reduced significantly, compared to the conventional transplanting system.

Four rows CRIDA-BBF planter is widely adopted by the farmers in Maharashtra, Chhattisgarh, Telangana and Andhra Pradesh. Further, it is thought that additional attachment of pesticide and weedicide sprayer could reduce number of operations in turn saving the cost of cultivation. Many of the farmers where pre-emergence herbicide application is being practiced show keen interest for such modification. Keeping the farmers' interest in view, modifications over existing BBF planter have been made by Vasantrao Naik Marathwada Krishi Vidhyapeeth (VNMKV), Parbhani (Maharashtra) in collaboration with ICAR-CRIDA. The newly developed BBF planter was refined to make 5 rows at a time. The frame length was increased from 2.25–2.73 m. The distance between extreme tyne and ridger was adjusted at 45 cm for crop sowing. Further, to address the problem of lateral seepage of water in broad bed, one additional small ridger has been attached after third furrow opener from left. An adjustable seed covering device was also attached for proper placement of soil over seed at appropriate pressure. An additional PTO (power take-off) operated weedicide spraying unit (6



Four-row CRIDA-BBF planter



Five-row BBF planter in operation

nozzle) can be attached. This is four in one BBF planter which accomplishes bed making, sowing and fertilizer application, seed covering and weedicide application. The newly developed five row BBF planter can be recommended for soybean, red gram, cotton, maize and sorghum. The specification of five row BBF planter-cum-sprayer are given in Table 1.

Table 1. Specification of 5 row BBF planter cum sprayer

Particular	Dimensions/number/details
Overall dimension (mm)	L-2207, W-2730, H- 868
Frame dimensions (mm)	L-2730, W-480
Weight (kg)	350
Sowing mechanism	Inclined Plate Metering
Tynes	05
Furrow openers/Ridger	02
Supporting wheels	Nil
Drive wheel	01
Transmission mechanism	Chain and Sprocket
Tractor power	35 hp and above
Spraying attachment	PTO operated HTP pump (on demand)
No. of nozzle	6

Sowing of intercropping systems with 5 row BBF planter

Intercropping of cereal and pulse crops, as a risk coping mechanism, is traditionally practised particularly by small and marginal farmers in rainfed areas in India for minimizing drought impact. In strip cropping systems, mechanical operations like sowing, intra row weeding, top dressing, relay sowing, mechanical harvesting becomes easy. A simple alteration of spacing in 2:1 intercropping system, a strip cropping system (4:4) can be developed which can provide 22% increase in yield in pigeonpea + sorghum strip row intercropping systems (4:4 replacement series).

Paired-row planter

The *in situ* moisture conservation practice through formation of conservation furrow at 30–35 DAS is recommended. To capitalize the initial rainfall in wide row crops, a paired-row planter was developed at ICAR-CRIDA. The planter sows the seed in rows spaced uniformly apart, making *in-situ* moisture conservation furrows in between the two rows. This planter has four tynes to sow in pairs which have adjustable rows with different spacing apart and adjustment of spacing between each pair of rows. The seed rate is controlled mechanically through ground wheel drive which in turn rotates the inclined plate through a set of bevel gears. Moreover, crop wise specially designed inclined plates are available which help to achieve high precision index. Sowing with CRIDA-paired row planter helps to complete the operation in time to utilize the available



Sowing of pigeonpea + sorghum strip cropping system with 5-row BBF planter

soil moisture as well as conserve the initial rain water. Further, the spacing between the rows helps free movement of tractor or bullocks for weeding and inter-cultivation operation without any crop damage. The planter is suitable for sowing of bold and very small size seeds which otherwise cannot be satisfactorily sown by conventional seed drills. The planter is also suitable for sowing of intercrops. The performance of paired-row planter for sowing of pigeonpea was good (Table 2).

Table 2. Performance of paired row planter for sowing of pigeonpea

Particular	Details
Seed rate (kg/ha)	6–7
Average depth of sowing (mm)	20–40
Average furrow width (cm)	45, 60
Average germination % per 10 m length	90–95
Fuel consumption (litre/h)	4–4.5
Time lost per turn (sec)	15–20
Theoretical field capacity (ha/h)	0.55
Actual field capacity (ha/h)	0.45

SUMMARY

In rainfed agriculture, timely and precision agricultural operations are very important particularly for *in situ* moisture conservation and sowing/planting of crops. These are needed for good crop establishment and performance, to mitigate dry spells and higher productivity of rainfed crops. For this purpose, farm mechanization with appropriate implements are needed. CRIDA has developed very efficient implements with multiple operations like BBF, planter-cum-sprayer etc. It has reduced the risk of crop failure as a result of drought or floods and helped the farmers save time and money that they can further invest on some other activities. These implements have been made available in various states through private industries and government schemes.

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