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Development and Modification of Conventional Seed-Cum-Fertilizer drill into broad bed furrow Machine

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Abstract
Traditional sowing methods have limitations and some crops are water stress crop. To overcoming those problems a tractor operated broad bed furrow machine was modified and evaluated. It has a three point hitch, two bottom ridges which forms the ridges and furrows with seedling either on the ridge, or in furrow as desired in a single operation. It can be used for sowing of both *Kharif* and *Rabi* crops with hallow soil cover over the seed. The machine was evaluated; actual seed application rate was obtained 58.97 kg/ha with fluted exposure was 18 mm and 88.46 kg/ha with fluted exposure was 27 mm. The actual fertilizer application rate was found 47.18 kg/ha with fluted exposure 9 mm. Field performance was evaluated by field capacity (ha/hr), field efficiency (%), Draft (kg). Fuel consumption was found to be 4 L/h and the cost of operation 453 Rs/h. Bulk density of the field (kg/m^3), moisture content (db) of the field at various depth 5 cm, 15 cm, 25 cm. The functional performance of different system of seed drill was satisfactory during field.

Keywords: Modified broad bed furrow machine, fabrication of ridger, design of ridger, field efficiency

Introduction
Traditional methods are used for sowing of crop like broadcasting, manually, opening furrows by a country plough and dropping seeds by hand, and dropping seeds in the furrow through bamboo/metal funnel attached to a country plough**.** Traditional sowing methods have following limitations like in manual seeding, it is not possible to achieved uniformity in distribution of seeds, poor control over depth of seed placement, labour requirement is high because two persons are required for dropping seed and fertilizer, it is necessary to swath high seed rates and bring the plant population to desired level by thinning. In Chhattisgarh traditional methods of sowing of water stress crop is adopted by farmers. Some farmers used seed drill for sowing for water stress crop, but due to improper drainage in the field, the yield of water stress crop reduced. Soybeans and other water stress crop need good surface drainage. Field surface smoothing and forming can improve the surface drainage of a field and should be done properly, (Verma *et al*., 2015) [8]. Broad bed planting of soybean is one method to plant on broad rows or beds improved drainage (Singh *et al*., 1999) [6]. It has also been reported that water stress crop sown on beds is more resistant to lodging than the crop sown on flat fields, (Shukla *et al*., 1999). The furrows are useful to drain out excessive rainwater during heavy storms and for storing rainwater in furrows for enriching soil moisture through percolation in case of deficit rainfall. The soil moisture thus stored sustains the crops during dry spells, (Singh *et al.,* 2011) [5]. The ridge bed seed cum fertilizer drill is used for sowing the less water requirement crops, because the water logging is directly affects the plant growth, (Shrivastav *et al.*, 2012) [4].

Modified Broad Bed furrow machine: Ridge and furrow system of planting offers a better alternative than flatbed sowing in dry land or rain fed as well as irrigated conditions. To meet the seedling requirement of *Kharif* and *Rabi* crops, a tractor drawn machine known as broad bed seed-cum-fertilizer drill has been developed; it is essential for obtaining an adequate stand with limited use of irrigation water or under rain fed conditions. It has got a seed metering attachment which is suitable for seed ranging in size from rapeseed to chickpea. The broad bed seed-cum-fertilizer drill can be used for sowing of both *Kharif* and *Rabi* crops with hallow soil cover over the seed. The advantages of sowing on broad bed seed-cum-fertilizer drill is that it makes the dry upper layer soil into ridges and sowing is done in furrows at appropriate depth. It also works efficiently even when the moisture is depth of 15-20 cm.

Materials and Methods

Design consideration

The existing ridger and seed-cum-fertilizer drill was modified to broad bed furrow machine as a functional and experimental unit. The design of machine components were based on the principles of operations, tested and compared with the conventional method, to give a correct shape in form of prototype. A new design will be initiated either to provide a machine for sowing the water stressed crop, if not existed or to provide an improved design to overcome problems/defects of existing practice of machines. If the forecast for the demand of such a machine is favorable the engineering design process may be initiated and should involve a few selected manufacturers and farmers as co-operators. Basic specifications of machine should be derived from agronomic and operational parameters, source of power, labour requirements and economic condition of farmers.

Development of ridger

The ridger is very important part of machine. Mild steel was used for making ridger. Before starting the work, drawing of ridger developed in the other parts of the country were procured and studied. The requirements of a ridger suiting to local soil and crop condition, cultivation practices and draught ability of local tractors were evaluated. In this view new ridger fulfilling the above requirements is designed. It has been designed with the following consideration: The machine should have depth stability, low cost machine so that small farmers can afford it, simplicity in construction, ease of operation and adjustment, suitable depth control mechanism.

Ridger dimensions and material

The dimensions of ridger are shown in the fig. 1 & 2 in this fig. side view and top view are represented. Material of proper strength was used for ridger to bear the desired load. M.S. Sheet 10 gauge thick plate, 16 mm and 25 mm diameter circular bar, angle iron and flat iron bar for developing component of the ridger. Table 1 given the specifications of the materials for different components of modified Broad bed furrow machine.

Table 1: Selection of material for broad bed furrow machine with weeder attachment

S. No.	Component	Material specification	Size (mm)
1.	Ridger	M.S. Sheet Circular bar Flat iron bar (W×T) Angle Iron Bush	3 mm thick 16 mm & 25 mm 50×24 & 40×5 50×50×5 18 mm diameter
2.	Sweep	Flat iron bar (W×T)	50×7
3.	Nut & Bolts	Mild steel (D×H)	12×100 6×80 9×60 12×60 9×200
4.	Washer	Mild steel	

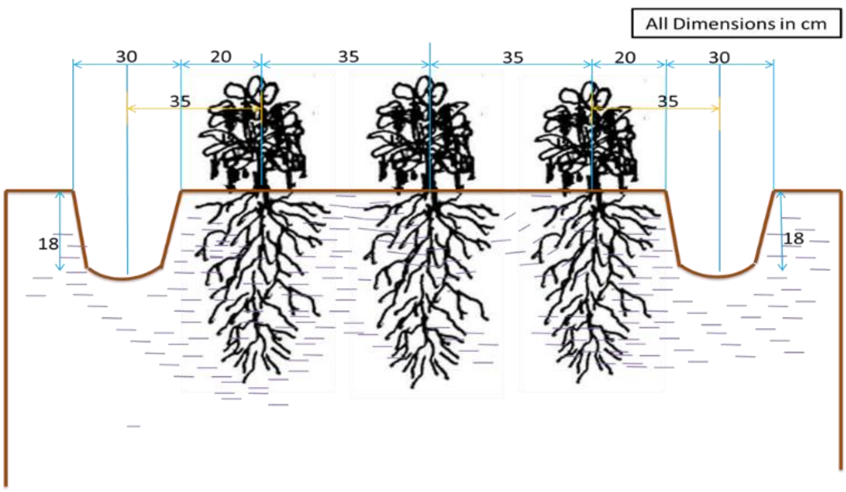

Fig 1: Theoretical consideration of working of machine

Theoretical consideration

Physical properties of soil

Bulk density: The bulk density was determined by dividing the weight of oven dried soil (at 105 ˚C for 24 h) sampled by volume it occupied and calculated by using the formula:

$$b_d = \frac{W_t}{L \times \left(\frac{\pi d^2}{4}\right)} \quad (1)$$

Where,

b_b = Bulk density of soil, kg/m^3;

W_t = Weight of sample, kg;

L = Length of cylinder, m; and

d = Diameter of cylinder, m.

All dimensions in mm

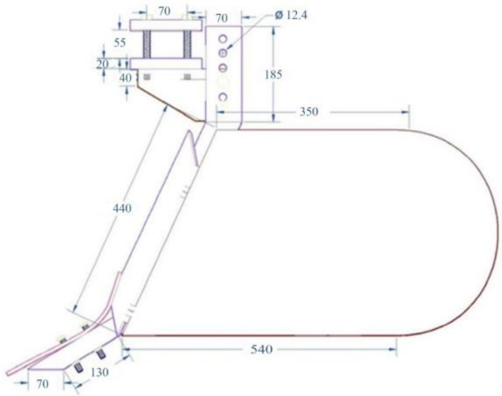

Fig 2: Side view of ridger

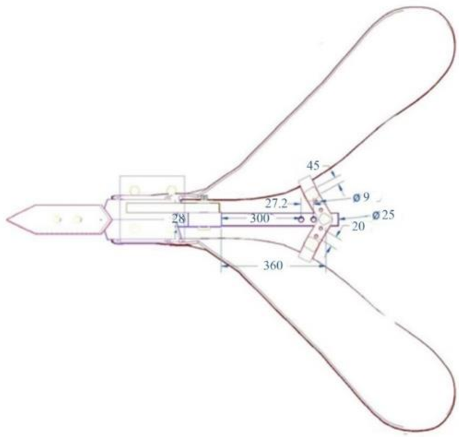

Fig 3: Top view of ridger

Moisture content: Moisture content (%) on dry basis of soil was measured by oven dry method:

$$M_c = \frac{W_2 - W_3}{W_3 - W_1} \times 100 \quad (2)$$

Where,
M_c = Moisture content of soil, % db
W_1 = Weight of crucible, g;
W_2 = Weight of crucible + wet soil, g;
W_3 = Weight of crucible + oven dried soil, g.

Field Performance

Speed of operation: The speed of operation was measured by recording the time required to cover 20 m distance in the field during operation. Speed of operation was determined by the following:

Speed (km/h) = 3.6 × distance travelled (m)/ time (s) (3)

Theoretical field capacity: The theoretical field capacity is the rate of field coverage that would be obtained if implement were performing its function 100% of the time at the rated speed and always covering 100% of its rated width (IS: 11531-1985)

$$TFC = \frac{W \times S}{10} \quad (4)$$

Where,
TFC = Theoretical field capacity, ha/h;
W = Theoretical width of implement, m and
S = Speed of operation, km/h.

Effective field capacity: The actual field capacity is the actual average rate of coverage by the implement. (IS: 11531-1985).

$$EFC = \frac{A}{T} \quad (5)$$

Where,
EFC = Effective field capacity, ha/h;
A = Actual area covered, ha and
T = Total time required to cover the area, h.

Field efficiency: The field efficiency is the ratio of effective field capacity to the theoretical field capacity and expressed in per cent.

$$\text{Field efficiency (\%)} = \frac{EFC}{TFC} \quad (6)$$

Where,
EFC = Effective field capacity (ha/h) and
TFC = Theoretical field capacity (ha/h).

Calculation of actual application rate of seed and fertilizer for field operation The actual manure application was determined by using eq^n 7 (Khurmi and Gupta 2005).

$$AR = \frac{Q \times 10{,}000}{W \times V} \quad (7)$$

Where,

AR	=	Application rate in kg/ha
Q	=	Seed or fertilizer delivery rate in kg/sec
W	=	Actual width of application in m
V	=	Forward travel speed in m/sec

Results and Discussion
The broad bed furrow machine was evaluated and tested on chickpea crop in the farm and result was successfully obtained. The weight of soil sample was found to be 1.802kg and the bulk density was obtained 1764.93 kg/m^3. The moisture content of soil sample is shown in Table 2. The method used for determining moisture content was oven drying method. Three samples were taken from the field.

Table 2: Moisture contain of field soil

S. No.	Depth of sample, (mm)	Moisture content, db (%)	Moisture content, wb (%)
1.	50	7.00	6.50
2.	150	16.00	13.70
3.	250	29.00	22.48

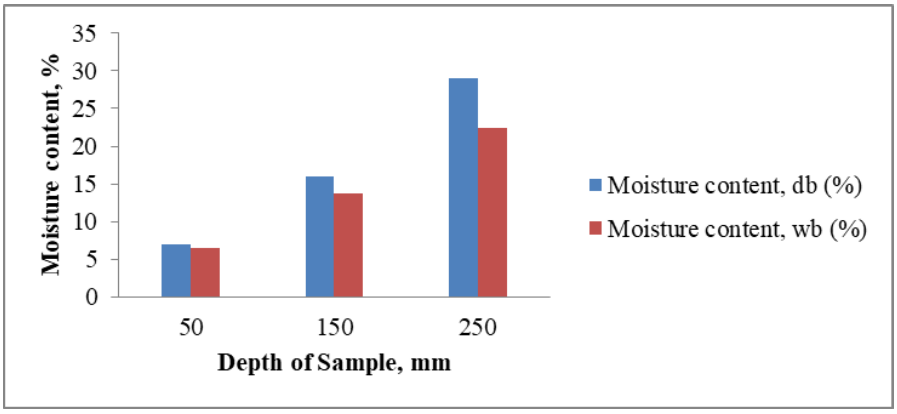

Fig 4: Moisture content at dry and wet basis of field soil

Calibration of machine
The machine was calibrated in laboratory. Chickpea and DAP was used for the calibration. The machine was lift up to height of about 80-90 mm above the ground level. Then the seed and fertilizer were put in to the seed box and fertilizer box respectively. The result was shown in table no 3.

Table: 3 Theoretical application rate of seed for modified broad bed furrow machine

S.No.	Opening (mm)	Seed delivered in 20 ground wheel revolution, kg	Dia. of ground wheel, m	Width of application, m	Application rate, (kg/ha)
1.	25	0.344	0.47	1.40	83.57
2.	35	0.420	0.47	1.40	102.03
3.	45	0.495	0.47	1.40	120.26

All dimensions in mm

Fig 5: Back view of modified broad bed furrow machine

Table 4: Theoretical application rate of fertilizer for modified broad bed furrow machine

S.No.	Opening (mm)	Seed delivered in 20 ground wheel revolution, kg	Dia. of ground wheel, m	Width of application, m	Application rate, (kg/ha)
1.	10	0.222	0.47	1.40	53.93
2.	15	0.278	0.47	1.40	67.78

Actual application rate for field operation

The actual application rate was determined in the field. The actual application rate of seed and fertilizer for modified broad bed furrow machine given in table 5 and 6.

Table 5: Actual application rate of seed for modified broad bed furrow machine

S.No.	Opening (mm)	Seed delivery rate, kg/sec	Actual width of application, m	Forward travel speed, m/s	Application rate, kg/ha
1.	20	0.009	1.40	1.09	58.97
2.	30	0.013	1.40	1.09	88.46

Tractor operated at a speed of 3.92 km/h and the width covered was 1.40 m so theoretical field capacity was calculated. Theoretical field capacity of machine was 0.54 ha/h the machine was tested in field. The size of the field was 0.1 ha. It was observed that the machine was operated at 3.92 km/h. the effective field capacity was found to be 0.38 ha/h. Field efficiency of the machine was calculated by using the eq^n. Field efficiency of the machine was 70%.

Table 6: Actual application rate of fertilizer for modified broad bed furrow machine

S.No.	Opening (mm)	Fertilizer delivery rate, kg/sec	Actual width of application, m	Forward travel speed, m/s	Application rate, kg/ha
1.	10	0.0072	1.40	1.09	47.18

Conclusions

A modified broad bed furrow machine with weeder attachment developed and fabricated successfully considering the standard design consideration such as functional requirements, mechanical considerations, agronomical requirements, economical consideration. Seed drill can be successfully used for sowing chickpea, pea, maize, soybean etc. There are very little damage of seed or we can say that no damage of seed during operations. Seed drill give fairly uniform row to row spacing. The performance of seed drill was also satisfactory in economical of view. Modified broad bed furrow machine can be used for small, medium and large seeds satisfactorily. No damage of seed was observed during field operation due to mechanical reason. The developed machine was tested both in Field as well as Laboratory as per BIS standard and found its performance satisfactory. The field capacity of Modified broad bed furrow machine is quite high (0.38 ha/h) and its field efficiency was impressive (70%).The actual application rate was 58.97 kg/ha and 88.46 kg/ha at 20 and 30 opening (mm) and for fertilizer 47.18 kg/ha at 10 opening. The cost of operation of modified broad bed furrow machine was found as Rs. 473/h and Rs.1279/ha. In view of the use of Modified broad bed furrow machine for different seeds was strongly recommended. It has a great edge over conventional seed drill.

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