

## DEVELOPMENT AND EVALUATION OF MANUALLY OPERATED SEED DRILL FOR BAJRA CROP

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**Abstract:** Pearl millet (*Pennisetum glaucum*) is a major cereal crop grown in the semi-arid regions of Asia and Africa. It is cultivated on about 26 million ha in Asia and Africa. Of this, more than 40% of the area is in Asia, where India is a major producer of this crop with about 10 million ha and an average productivity of 870 kg/ha (Agricultural statistics, 2006). Thus, Pearl millet is an important crop for the state of Gujarat.

Bajra is sown by animal/tractor drawn seed drill or manually. Tractor drawn seed drills are suitable for medium or big farms with high seed rate. Draft animals are not only becoming costly but they are diminishing also. More than 75 % of Indian farmers belong to small and marginal category and doing all operations manually. Manual sowing is a highly labour intensive, tedious, time consuming and not technically suitable. Farmers are sowing by broad casting or 'Kera' method for bajra crop. In this method seed rate too high, for economic growth of plant thinning is required. Therefore, a manually operated two row seed drill was developed.

The developed seed drill was tested for its quality parameters, seed rate, seed damage, seed distribution, seed spacing, labour requirement, energy requirement, theoretical field capacity, actual field capacity, field efficiency, and cost of operation. In the laboratory test, the seed rate, seed spacing and coefficient of uniformity of the developed seed drill unit-1, unit-2 and unit-3 were found as 3.08, 4.95, 7.78 kg/ha, 19.50, 14.83 and 10.95 cm, 76.92 %, 98.56 % and 73.00 % respectively. During field test, draft was found 18 kg, average speed 1.65 km/hr. The theoretical field capacity, actual field capacity and field efficiency of the developed seed drill was found as 0.148 ha/h, 0.138 ha/h and 80.51 % respectively.

**Keywords:** Bajra, sowing method, seed drill.

## INTRODUCTION

Pearl millet (*Pennisetum glaucum*) is a major cereal crop grown in the semi-arid regions of Asia and Africa. It is cultivated on about 26 million ha in Asia and Africa. Of this, more than 40% of the area is in Asia, where India is a major producer of this crop with about 10 million ha and an average productivity of 870 kg/ha (Agricultural statistics, 2006).

*Received Nov 24, 2016 \* Published Dec 2, 2016 \* www.ijset.net*

Different sources of power like human power, animal power and mechanical power are utilized for sowing the millet seed in the field. Germination of seed was uniform and two days quicker with the use of seed drill as compared with “Kera” (dropping of seeds in furrows manually) and “Pora” (dropping of seeds through a funnel and tube attached behind a desi plough). The use of seed drill gave an increase of 12.50 to 32.00 % in the yield over traditional methods (Sirohi, 1980). However, Farmers are not satisfied with these methods due to the uncertainty in the seed rate and not maintaining the proper spacing between the seeds in row. Low cost manually operated multi crop seed drill with cup feed metering mechanism can help farmers as to solve the problem of line sowing of seeds particularly for the small and marginal farmers to enhance production and productivity (Ghosal and Pradhan, 2013).

Tractor operated seed drills/ planters are suitable for big farmer and big field and keeping bullocks is becoming more costly now a day so, a study on “Development of a manually operated seed drill for bajra (*Pennisetumglaucum*) crop” was taken.

## MATERIALS AND METHODS

Manually operated double row pull type seed drill was developed and evaluated for its performance is tested on farm as well as laboratory.

### Physical Properties of Bajra (*Pennisetumglaucum*) Seed

Physical properties of seed were measured to decide the dimensions of the seed drill.

**a) Size:** Size of 15 numbers of seeds in terms of equivalent diameter ( $D_e$ ) was determined with the help of measurement length (l), width (b) and thickness (t).

$$D_e = (l b t)^{1/3}$$

**b) Sphericity:** The sphericity of bajra seeds ( $\emptyset$ ) was calculated by using the following relationship (Mohsenin, 1980).

$$\emptyset = \frac{(l b t)^{\frac{1}{3}}}{l}$$

**c) Bulk density:** The seeds were filled in a 268.47cc capacity cylinder without undue pressure and its weight was measured on an electronic balance meter having least count of 0.1 g. Ratio of weight per unit volume gives bulk density.

**d) Angle of repose:** The seeds were allowed to fall from a height until maximum height was reached and the height of seed heap was noted. Angle of repose was measured by:

$$\theta = \tan^{-1} \left( \frac{h}{r} \right)$$

Where,

$\theta$  = Angle of repose (degree);  $h$  = Height of pile (mm); and  $r$  = Radius of pile (mm)

### **Design of Seed Metering Device for Bajra**

The component of seed drill is Ground wheel, Seed metering and holding device and Handle and design of these are as:

#### **a) Ground wheel**

There are two ground wheels. They are fabricated from mild steel bar of 12 mm diameter and 130 mm length. The diameter of each ground wheel was kept 380 mm and diameter of inner flat circle is 120 mm. The periphery of ground wheel is 1195 mm. Means, in 20 revolution 24 m distance travels by seed drill. (Shown in Fig1)

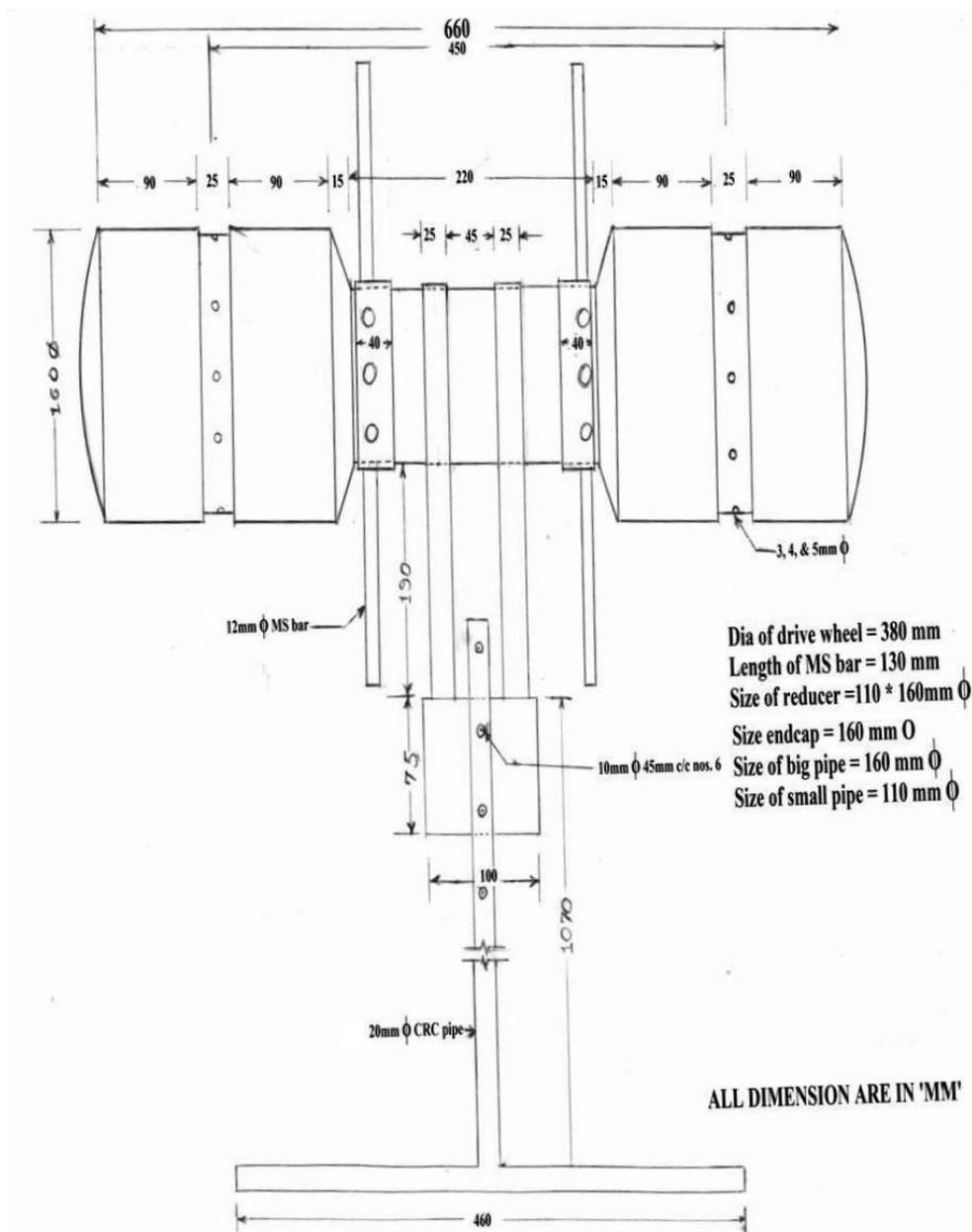
#### **b) Seed metering and seed holding device**

In designing and development of the manually operated pull type two row pearl millet seed drill, seed drill consists of 110mm and 160mm PVC pipes, two PVC reducers and two PVC end cap. Pipes are used as a seed holding device. Unit 1, Unit 2 and Unit 3 have 3 mm, 4 mm and 5 mm holes size respectively created on bigger pipes. On periphery of big pipe equal distance 8 holes are created.

The distance between two holes was calculated on bases of recommended seed spacing. Bajra sowing row to row spacing is 45 cm and seed to seed spacing is 15 cm. The overall capacity of the seed holding device was kept 8.5 kg of bajra seeds. As per recommended by JAU seed rate for bajra is 3.75 kg/ha. So that volume of the seed holding device was determined on the bases of average bulk density of the bajra seeds.

$$\text{Volume of hopper} = \frac{\text{Capacity of the hopper}}{\text{Bulk density of bajara seeds}} = \frac{8.5}{896.86} = 0.00948 \text{ m}^3$$

The seed hopper was designed and developed for the volume of 0.00948 m<sup>3</sup>.



**Fig. 1 Sketch diagram of manually operated seed drill**

### c) Handle

It is fabricated from the CRC pipe of 1450 mm length and 20 mm outer diameter. Width of handle is 460 mm. Pipe holding device consist of 380 mm flat iron. Total all over length of handle is 1300 mm  $\pm$  110 mm adjustable.

### Performance Evaluation of the Developed Pull Type Bajra Seed Drill

In order to evaluate the performance of a bajra seed drill, it is essential to test it with respect to laboratory test and field test was done. Observations taken under laboratory tests were:

a) Calibration of seed rate at full,  $\frac{3}{4}$ , and  $\frac{1}{2}$  capacity of seed holding device was measured. Also the mechanical damage to seed, seed distribution test, and seed uniformity test were done in the laboratory test.

b) Mechanical damage is ratio of damaged seeds after metering to the total seed feeded to meter.

c) Seed distribution test was conducted to study the variation in number of seed in the furrow. During calibration test, number of seeds discharged in 20 revolution of drive wheel was collected.

d) Seed uniformity test:

The spacing between two consecutive seeds was measured for a length of 5 m run in each row. The average value was found out and the coefficient of uniformity was calculated by following formula.

$$\text{Coefficient of uniformity (\%)} = \left(1 - \frac{\sum |X - \bar{X}|}{N \bar{X}}\right) \times 100$$

Where,

X = Spacing between two consecutive seed (cm);

$\bar{X}$  = Theoretical spacing (cm); and

N = No. of seeds.

In order to field test, the draft measurement by dynamometer and field efficiency was measured.

## RESULTS AND DISCUSSION

This chapter describes the experimental testing and functional performance in the field. It includes the result of laboratory tests and field tests.

### Physical properties of bajra seeds

Observations for physical properties of bajra seeds are as Table 1.

**Table 1: Physical properties of Bajra seeds (GHB-558)**

Sr. No.	Name of physical property	Minimum	Maximum	Average	
1	Size	Length, mm	2.95	3.70	3.28
		Width, mm	2.42	3.21	3.006
		Thickness, mm	2.42	3.21	3.006
		Equivalent diameter, mm	2.42	3.21	3.006
2	Sphericity	0.86	0.96	0.93	
3	Bulk density, g/cc	0.895	0.897	0.896	
4	Angle of repose, degree	26.50 <sup>0</sup>	26.65 <sup>0</sup>	26.56 <sup>0</sup>	

**Table 2: Calibration of bajra seed drill**

Rate Setting	Test No.	Weight of Seed from all Furrow Openers in kg/ha		
		Unit 1 (3 mm hole size)	Unit 2 (4 mm hole size)	Unit 3 (5 mm hole size)
Hopper Fully filled	1	4.00	6.66	8.88
	2	3.55	6.66	9.77
	3	3.55	5.77	9.33
	Average	3.70	6.36	9.66
Hopper filled with $\frac{3}{4}$	1	3.11	4.88	7.55
	2	3.11	4.44	7.11
	3	3.33	4.44	7.55
	Average	3.18	4.58	7.42
Hopper filled with $\frac{1}{2}$	1	2.22	4.00	6.36
	2	2.22	3.77	6.66
	3	2.66	4.00	5.77
	Average	2.36	3.92	6.26

### Performance Evaluation of Bajra Seed Drill

The developed pull type bajra seed drill was tested for the performance in laboratory tests and field tests. The results of these tests are as:

#### Laboratory tests

##### a) Calibration of seed drill:

Standard calibration procedure was followed as per the test code IS:6316:1993 provided. Calibration results of the seed drill by 20 revolutions to the drive wheel is shown in Table 2.

##### b) Mechanical damage:

There no mechanical damage was found in observation.

##### c) Seed distribution test:

Due to the 20 revolution of drive wheel, the average number of seed discharge from the furrow opener by the developed unit 1, unit 2 and unit 3 was counted as 175, 230 and 335 respectively.

d) Seed uniformity test was obtained by coefficient of uniformity. Coefficient of uniformity was measured by comparison of recommended spacing 15 cm between two seed holes to the spacing between two seeds dropped from seed drill. The result is as Table 3.

**Table 3: Testing of seed uniformity**

Metering Device	Test Plot No.	Average Spacing between two consecutive seeds (cm)	Coefficient of uniformity (%)
3 mm hole size metering device	1	14.90	99.33
	2	28.60	52.44
	3	15	100
	<b>Average</b>	<b>19.50</b>	<b>76.92</b>
4 mm hole size metering device	1	14.70	98.00
	2	14.96	99.70
	3	14.85	99.00
	<b>Average</b>	<b>14.83</b>	<b>98.86</b>
5 mm hole size metering device	1	9.92	66.13
	2	11.83	78.86
	3	11.10	74.00
	<b>Average</b>	<b>10.95</b>	<b>73.00</b>

### 3.2.2 Field tests

a) Draft measurement through dynamometer resulted that, average pull of seed drill was observed 21 kg. Therefore the draft is 18 kgf was observed at 30° angle.

b) Field efficiency was obtained as ratio of theoretical field capacity to actual field capacity.

The theoretical field capacity of the developed unit1, unit2 and unit3 is 0.147, 0.153 and 0.147 ha/h respectively. The developed seed drill unit 1, unit 2 and unit 3 operate for long run and measured actual field capacity is 0.137, 0.147 and 0.137 ha/h respectively. The average field efficiency of the developed unit 1, unit 2 and unit 3 was 93.83 %, 93.46 % and 93.83 % respectively. Average field efficiency is 93.91 % is there. The developed seed drill gave better field efficiency. Overall the developed seed drill gave better performance in sowing operation with less energy requirement.

## 4. CONCLUSIONS

The major conclusions drawn from this experiment were;

1. The Under laboratory test conditions, seed spacing between two consecutive seeds found by the developed seed drill unit-1, unit-2 and unit-3 were and 19.50, 14.83 and 10.95 cm respectively. The unit 2 was found nearly recommended spacing.
2. Mechanical damage in new developed seed drill was not found.
3. The coefficient of uniformity by the developed seed drill unit-1, unit-2 and unit-3 found were 76.92, 98.86 and 73 % respectively.

4. The maximum field efficiency of the developed seed drill unit-1, unit-2 and unit-3 were observed as 93.83 %, 93.46 % and 93.83 % respectively.

5. Developed pull type bajra seed drill unit-2 gave better performance as compared to unit-1 and unit-3, due to which Unit-2 has 4 mm size seed holes is recommended for good performance.

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