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Design and development of single row maize planter

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Abstract
Maize cultivation gets popularity now a day in our country because of multifarious use of maize in human food and especially in the poultry industries. Maize is cultivated manually which is time consuming, labor intensive and costly. A low cost manually operated push type maize planter was designed and the planter consists of two supportive wheels behind the planter, a seed hopper, a vertical plate type seed metering device, a seed tube, a pair of bed former and handle. Power was transmitted from the ground wheels to the metering device through gear. Maize Seeds were used to test the planter. The seed planter was calibrated in the workshop of the department of Farm Machinery and Power Engineers to maintain the desired seed rate and seed rate was calculated as 20 kg/ha. In the field test the effective field capacity, field efficiency, and draft were calculated in three forward speed levels at 1.0 km/h, 1.5 km/h and 2 km/h as 2 ha/h, 62.51%, 35 kgf; 3.05 ha/h, 67.91%, 25.60 kgf and 4.5 ha/h, 75.49%, 17.5 kgf for area 100 m^2. The best performance of the maize planter was found at a 2 km/ha as a highest effective capacity, field efficiency and lower draft among them.

Keywords: Maize planter, hopper, metering device, field efficiency, field capacity

1. Introduction

India is primarily an agriculture-based country and its economy largely depends upon agriculture. Presently, contribution of agriculture about one third of the national GDP and provides employment up to 65%. Maize popularly known as “corn” is one of the most versatile emerging cash crops having wider adaptability under varied climatic conditions. Maize is an important source of carbohydrate, protein, iron, vitamin B, and minerals. It is called queen of cereals globally. In India, maize or corn is the third most important food cash crops after wheat and rice. (http://www.agrifarming.in), in developed countries, maize is consumed mainly as second-cycle produce, in the form of meat, eggs and dairy products. In developing countries, maize is consumed directly and serves as staple diet for some 200 million people. Most people regard maize as a breakfast cereal. However, in a processed form it is also found as fuel (ethanol) and starch. Starch in turn involves enzymatic conversion into products such as orbital, dextrin, sorbet and lactic acid, and appears in household items such as beer, ice cream, syrup, shoe polish, glue, fireworks, ink, batteries, mustard, cosmetics, aspirin and paint.

Production of maize in India 147.10 lakh ton and in Uttar Pradesh 10.50 lakh ton as at 2005 - 2006 data source from official website of government of India and Uttar Pradesh, Jowar Bajra and maize occupies an area of 34830 hectare and in Allahabad district the productivity is 0.92 quintal per hectare. The maize is grown throughout the year in all states of the country for various purposes including fodder for animals, food grain, sweet corn, baby corn green cobs, and popcorn. Corn flour is consumed widely in Indian cooking. Maize or corn serves as a basic raw material to thousands of industrial products that may include oil, starch, alcoholic beverages, pharmaceutical, food sweeteners, food cereals, cosmetic, and film, gum, textile, package and paper industries. (http://www.agrifarming.in), maize has multifarious uses. Actually every part of the maize plant is useful. Green cobs of maize are cooked by roasting or boiling in water. The top green portion of the plant after harvest of the cob is fed to cattle as fodder, and the dry portion of the stem along with fibrous roots are used as fire fuel. The greatest advantage of maize over rice and wheat is its high bio-mass content. Maize grain, full or broken is used in *khichuri*, gruel often mixed with pulses. Popcorn is consumed as snacks. Grains are the principal ingredients for poultry and cattle feed. Industries make use of maize for corn oil, starch, adhesives, medicines and in the manufacturer of various food products like corn flakes, chips etc. The major factors responsible for low maize yield are the use of low yielding varieties and inadequate cultural management practices particularly in the area of fertilization, insect, diseases, weed control, and most importantly, planting operation. Uttar Pradesh is one of state which contributes 5.09% of the maize or corn production. Sowing is one of the basic operations needed to get better revenue from agriculture.

Manual sowing has the problem of not giving adequate spacing between row to row and plant to plant leading to less population of crops than recommended by the agronomists. Also there is the problem of placing the seeds at correct depth and correct soil coverage. Manual sowing is time consuming and costly. Hence, there is a need for appropriate seed drill for sowing. This paper deals the development and testing of an appropriate seed drill for sowing cereal crops like maize, beans and sorghum. A recent study showed that seeding operation in maize is at low level as farmers still in the rural areas use machete or sticks use bare hands or hand tools to seed the furrow beds and then cover the seed by hand to use sowing seeds, often times more than the required numbers of the seed are dropped in a hole and covered. Planting seeds through this means is labour- intensive, more time consumption, the traditional planting method is tedious, causing fatigue and backache due to the longer hours required. Sowing maize by hand increases production cost as extra man-hours is required for thinning operation as excessive seeds is inevitably sown per hole in addition to drudgeries and boring nature of the work. The maize planters available in the market are imported, designed to operate in large farms, expensive and not suited to local conditions Therefore more profitable to developed a simple system that is manually operated single row maize planter it is easy to use less labour cost compare to traditional method. It can be operated by one person, which completes its planting working within one pass on the prepaid field like seed-to-seed distance, preparing bed row to row. It had affordable and easy to maintain which had alleviate these difficulties and thus, increase maize production in the rural areas. This most improve their yields work focused on the design and fabrication of affordable manually operated single row maize. Plate planters are those that principally use a moving plate with indents, i.e., holes, cells or cups, around its periphery and metering performance is generally highly dependent on matching the size (length, breadth and thickness) of the indents to the size of the seed. Keeping the above view, specific objective had been selected. Design and fabrication of single row maize planter, evaluate the performance of maize planter.

2. Material and Methods

To design of single row maize planter and tools were used to fabricate the manually operated maize planter which is mentioned below as shown in (Table no. 1). The information collected from the review was used to design and develop a single row maize planter.

Table 1: Tools and materials used in the Fabrication

S. No.	Machine/Tool name	Purpose
1.	Still ramb hard core drills machine	Hole/cell making
2.	Lathe Machine	Threading/Cutting/Finishing/Cutting/Shaping/Machining
3.	Grinding Machine	Grinding/Cutting Tool
4.	Cutting Blade	Cut Flat Bar
5.	Manual Facing Lathe Machine	Making Circular Wheel
6.	Round File	Smooth Rough Edges
7.	Electric Welding Machine	Welding
8.	Steel Scale	Measurement of Linear Distance
9.	Steel Tape	Measurement of Linear Distance
10.	Venire Calipers	Measurement of Outer Diameter And Inner Diameter
11.	Centre Punch	Hole Marking
12.	Choke	Marking
13.	Hammer	Used To Strike and Object
14.	Chisel	Cutting
15.	Scissors	Cutting Sheet Metal
16.	Vice	Clamping or holding
17.	Spanner	Tightening Nut and Bolt
18.	Screw Driver	Tightening Screw
19.	Hand Grinder	Grinding Metal Sheet
20.	Flat File	Smooth Rough Edges

Fig 3: Stationary view of single row maize planter

Table 2: Parameters of single row maize planter

S. No.	Names of parameters	Symbol	Units
1	Holes in seed metering mechanism	Holes	16 No(s)
2	Ground wheel diameter	D	42 cm
3	Seed hopper volume	SV	m^3
4	Spacing between two supporting wheels	W	30 cm
5	Row to row distance	Rd	60 cm
6	Plants to plants distance	Pd	20 cm
7	Length of strip	L	1333.33 m
8	For calibration number of revolution of ground wheel	G.rev	1000 rev
9	Area for one strip.	A	400 m^2
10	As the calibration seed is needed per hectare.	C (seed)	20 kg/ha
11	Physical properties of maize seed which had measured 100 numbers of seeds.	Lpp, Bpp, Tpp,	9.81mm, 8.85mm, 4.35mm.
12	Angle of elevation.	°	22°
13	**At speed 1.0 km/h**		
	Effective field capacities	Ce	2 ha/hr
	Field efficiency	n_e	62.51%
	Draft	Draft	35 kgf
14	**At speed 1.5 km/h**		
	Effective field capacities	Ce	3.05 ha/hr
	Field efficiency	n_e	67.98%
	Draft	Draft	25.60 kg f
15	**At speed 2 km/h**		
	Effective field capacities	Ce	4.5 ha/hr
	Field efficiency	n_e	75.49%
	Draft	Draft	17 kgf
16	Human power	HP	0.14 kW

Table 3: Specification of manually operated maize planter

Name of the component	No. of items	Dimension (cm)	Material
Frame	1	Length- 76, Width- 13	M.S. Flat bar
Handle	1	Length- 95, Pipe dia.- 2.5	Circular pipe
Seed hopper	1	Height-22, Width- 18.5	M.S. Sheet, metal
Seed metering wheel shaft	1	Length- 30, Dia.- 1.5	Medium carbon steel
Seed metering house	1	Dia.- 15	Cast iron
Adjustable furrow opener	1	40×4	M.S. Flat bar
Side wheel	1	-	Iron
Front wheel	1	Dia.- 42	Sheet metal
Lugs	34	Length- 6, Height- 1	Metal rod
Large sprocket	1	No of teeth- 42	Medium carbon steel
Small sprocket	3	No of teeth- 18	Medium carbon steel
Pintel chain	2	No of links- 97	Malleable links
Seed tube	1	Length- 22, Dia.- 2.85	Plastic
Ball bearing	4	Dia.- 5	Bronze
Idler sprocket	1	No of teeth- 18	Medium carbon steel
Nut bolts	13	-	Low carbon steel
Spacing between two supporting wheels	2	Dia. 30 cm	Plastic
Total weight	Approximate 17kg		

Independent parameter

The selected speed at three levels (1.0 km/h, 1.5 km/h, 2 km/h,) in the field test the effective field capacity, field efficiency, and draft are calculated in three speed level form area 100 m^2

Effective field capacity (ha/h)

Effective field capacity was measured by the actual area covered by the implement, based on its total time consumed and its width. Effective field capacity was determined by the following relationship.

Field efficiency (%)

Field efficiency is defined as the percentage of time the machine operates at its full rated speed and width while in the field. Using the field efficiency compute the actual, or effective, field capacity as follows.

Draft (KGF)

The maximum draft on the planter is the horizontal component of push parallel to the line of motion in order to overcome the soil resistance on the planter, and is a function of the soil resistance on the machine and the area of contact of the furrow opener with the soil.

$$\text{Draft (kgf)} = \frac{\text{HP} \times 75}{\text{forward speed of machine}}$$

HP = 0.35-0.092 Log t

t = operating time (min) According to (Combell., 1990) [19] useful work done by an average human on the drive machine develops the horse power as

HP = 0.35 – 0.092 Log t

Where, t is the operation time in minutes. Now, on average a human can work on the field 2-4 hours continuous. So power developed by the operator is 0.13-0.16 hp. Now if we take working time three hours then the power developed by a human is 0.14 hp.

Results and Discussion

This chapter deals with all the results and discussion which work was focused on the manually operated single-row maize planter that is cheap, easily affordable, easy to maintain and less laborious to use.

2.1 Physical properties of maize seed.

Physical properties of maize grain importance during fabrication and design, improvement and optimization for maize seed planter. In this study, some physical properties of corn seeds were determined as a function for sowing with fabricated maize planter. The average length, breadth, and thickens, it had considered table appendix.

2.2 Elevation angles measurement

Angle of repose for maize grain. 20°, 18°, 22°, 26°

2.3 Calibration of maize planter

The calibration of manually operated single row maize planter for the suitable seed rate (kg/ha).

Table 4: Calibration of maize seed planter for suitable seed rate.

S. No	RPM	Time in (min)	Weight of seed in (gms)
1	500	36.16	427
2	500	37.01	401
3	500	36.50	381
4	500	31.09	399
5	500	29.57	380
6	500	35.09	420
Total	3000	205.42	2408

Seed rate: (Kg/ha)

$$\text{Seed rate (kg/ha)} = \frac{\text{Average weight of seed in kg}}{\text{Area of a strip in ha}}$$

So the average will be $\frac{2408}{3}$ = 802.66 gm and on converting in kg, $\frac{802.66}{1000}$ = 0.80266 kg, Seed rate (kg/ha) = $\frac{0.80266}{0.04}$ = 20.06 kg/ha

2.5 Speed levels on 1.0 (km/h)

$\frac{1 \times 1000}{60}$ = 16.6 m = 17m/min

Table 5: Speed levels on 1.0 km/h time interval data take during the field test

S. No.	R1	R2	R3	Mean
Effective time in (sec.)	48.26	47.08	48.50	111.50
Total time during operative in (sec.)	30	60	25	98.33
Mean	63.26	77.08	61.0	160.66

$$\text{Average of the following data} = \frac{\text{Sum of total number}}{\text{Number of observation}}$$

Average time = 143.84÷3
= 47.94 sec
= 47.94 ÷ 60
= 0.8 min
Total time during operative in (sec) = 120
= 120 ÷ 4 (where 4 no rotation time loss)
= 30 sec

Speed levels on 1.5 (km/h)

= $\frac{1.5 \times 1000}{60}$ = 25m/min

Table 6: Speed levels on 1.5 km/h Time interval data in field test

S. No.	R1	R2	R3	Mean
Effective time in (sec)	65.01	63.05	64	149.39
Total time during operative in (sec)	53	76	74	153.67
Mean	91.51	101.05	101	151.53

$$\text{Average of the following data} = \frac{\text{Sum of total number}}{\text{Number of observation}}$$

Average time (Te) = 192.06÷3
= 64.02 sec
= 64.02 ÷ 60
= 1.07 min

Total time during operative in (sec) (Ts) = 203
= 203 ÷ 7 (where 7 no rotation time loss)
= 30 sec

2.8 Speed levels on 2 (km/h)

$\frac{2 \times 1000}{60}$ = 34 m/min

Table 7: Speed levels on 2km/h Time interval data in field test

S. No.	R1	R2	R3	Mean
Effective time in (sec)	96	95.5	95	95.5
Total Effective time during operative in (sec)	95	92	130	105.6
Mean	95.5	93.75	112.5	201.10

$$\text{Average of the following data} = \frac{\text{Sum of total number}}{\text{Number of observation}}$$

Average effective time = 286.5÷3
= 95.53 sec
= 95.53 ÷ 60
= 1.59 min

Total time during operative in (sec) (Ts) = 287
= 287 ÷ 10 (where 10 no rotation time loss)
= 31 sec

2.9 Moisture level 50% to 60%)

$$MC = \frac{W_1 - W_2}{W_2} \times 100$$

Where,
MC = Moisture content, per cent on dry basis
W_1 = Weight of the wet sample in gram
W_2 = Weight of the oven dried sample in gram
W_1 = 95
W_2 = 80

$$MC = \frac{95\_80}{80} \times 100$$

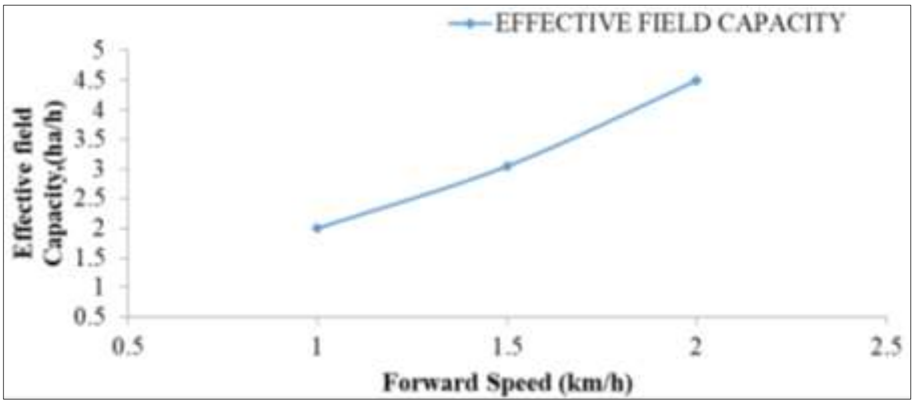

Fig 4: Graphical relations between forward speed and effective field capacity

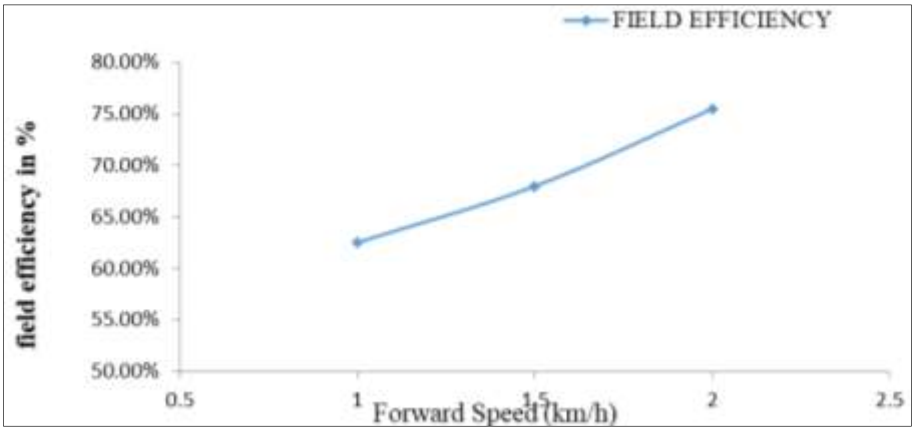

Fig 5: Graphical relations between forward speed and field efficiency

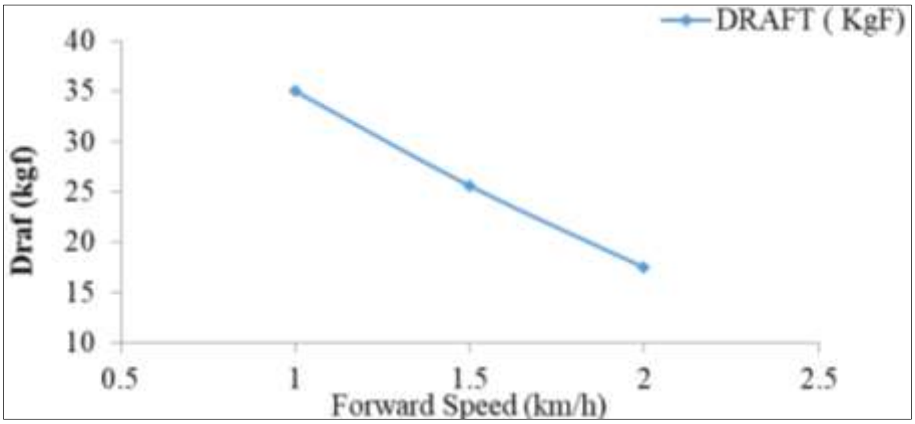

Fig 6: Graphical relations between forward speed and draft

Conclusion

This work focused on the design and fabrication of a manually operated single-row maize planter that is cheap, easily affordable, easy to maintain and less laborious to use. The planter will go a long way in making farming more attractive and increasing agricultural output. All parts of the planter were fabricated from mild steel material, except for the metering mechanism which was made from nylon 15 cm diameter and cells on its periphery and the planter consists of two supportive wheels behind the planter, a seed hopper height 22 cm and width 18.5 cm, seed funnel and tube length 22 cm and diameter 2.85 cm, which were made from rubber material. And a pair handles circular pipe length 95cm and pipe diameter 2.5 cm. Power was transmitted from the ground wheels to the metering device through gear. Maize Seeds were used to test the planter. The seed planter was calibrated in the workshop of the department of Farm Machinery and Power Engineers to maintain the desired seed rate and seed rate was 20 kg/ha as calibration. In the field test the effective field capacity, field efficiency, and draft were calculated in three level of forward speed at 1.0 km/h, 1.5 km/h and 2.0 km/h as 2 ha/h, 62.51%, 35 kgf; 3.05 ha/h, 67.91%, 25.60 kgf and 4.5 ha/h, 75.49%, 17.5 kgf respectively for area 100 m^2. The best performance of the maize planter was found at a 2 km/ha as a highest effective field capacity, field efficiency and lower draft of combinations in among them.

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