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Development of Pull Type Inclined Plate Planter

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A B S T R A C T

India is an agricultural country where about 87% of farmers fall under small and marginal farmers. The basic requirements for small scale cropping machines are they should be suitable for small farms, simple in design and technology and versatile for use in different farm operations. A pull type planter was developed with inclined plate metering mechanisms for maize, red gram and castor crops to reduce seed damage. The size of seed hopper is 3 kg. Standard tine type furrow opener was used and bevel gears were used for power transmission from drive wheel. Cost of planter was Rs. 4150 with an operating cost of Rs. 36.1 per hour. The planter was a useful implement for small farmers for early sowing of seeds who cannot afford large machinery.

Introduction

India is an agricultural country, agriculture is demographically the broadest economic sector and plays a significant role in the overall economy of India. It contributes 14 % of country's GDP, 11% of its exports and 60% of its employment potential. Rain fed agriculture occupies 55% net sown area, contributing 40% of food grain production and supporting 40% of the population. The land holding pattern in India is dominated by the small and marginal farmers (>60%). The small and marginal farmers of India rely mostly on draught animals for their field operations, transport and agro-processing. The extent of area under the command of draught animals is estimated to be around 57 percent. Reduction of this area through farm mechanization with indigenous technologies would enhance the productivity of the small and marginal farmers and make them more sustainable (Mayande *et al.*, 2004).

Farm machinery has become one of the important inputs that improve the efficiency in field operations at lower cost and high precision, ensuring comfort with reduced drudgery. It has been widely proved that mechanization of various field operations increase the overall productivity by 12 to 34%, facilitates enhancement of cropping intensity by 5 to 22 % and more than all, increases gross income to the farmers by 29 to

40% (Srivastava *et al.*, 1993). Farm mechanization does not mean the use of only big machines and tractors for farm work. Mechanization is a need based process which provides sufficient time gap for self-adjustment of various inputs without causing sudden impact of changes.

Planting is the placement of seeds firmly in the soil for germination and growth. In this method of planting, in which row to row and plant to plant distance is uniform. An effective sowing method should maintain the proper row spacing, plant density, seed rate, plant population etc. When these parameters are controlled there is increase in the yield of different crops. In planting, seeds are planted precisely along straight parallel furrows.

Planter is normally used for those seeds which are larger in size. Seed metering mechanism is the heart of planter and its function is to distribute seeds uniformly at the desired application rate. There are a number of seed metering devices available for use in a planter. The most common device is a rotating circular plate with cells which is provided at the bottom of seed hoppers (horizontal plate). In some planters, vertical plate and inclined plate are also used. There is more spillage and less accuracy in horizontal and vertical plates. To avoid spillage and crushing of the seeds, inclined plate seed metering mechanism is preferred and also which results in more accurate seed placement of seeds in the furrow.

The timely seeding is essential in rain fed farming. Delayed sowing beyond normal window period prolongs growing, causing moisture stress on maturing crops. With the current seeding practices, farmers are unable to sow the crop at appropriate time because the conventional devices are slow in operation, and require high labour cost, thereby increasing cost of production. Mostly unskilled labours drop the seed leading to gaps and bunching of plants in a row which results in non-uniform cropping. The non-uniform cropping creates imbalance in utilization of nutrients and moisture which leads to reduction in crop productivity.

To overcome these limitations and to improve the productivity at reduced cost of production, improved design of seed planter with precise seed metering mechanism is need of the hour. Hence, this study "Manually Operated Pull Type Planter" was developed.

Materials and Methods

The seed planter was designed and developed at the Department of Farm Machinery and Power, College of Agricultural Engineering, Sangareddy, PJTSAU. The components of the seed planter include seed hopper with shutter adjustment, inclined metering plate, drive (ground) wheel, guide wheel, discharge spout, furrow opener (shovel), covering device, hitching system and the handle. The development of each component is described below.

Power developed by the operator

According to Campbell *et al.*, (1990) the power of useful work done by the human being is given by

$$HP = 0.35 - 0.092 \log (t)$$

Where, t = time in minutes

Seed hopper

It is used to store a certain quantity of seed and delivers the seed to the discharge spout through the metering plate.

Volume of seed box is given by, $V_b = 1.1\ V_s$

Also,

$$V_s = \frac{W_s}{\gamma_s}$$

Where,
V_b = Volume of seed box, cm^3
V_s = Volume of seed, cm^3
W_s = Weight of seed in box, g
Γ_s = Bulk density of seed, cm^3
Therefore,

$$V_b = 1.1 \frac{W_s}{\gamma_s}$$

For light weight and easy operation of the drill, let 3 kg seed was filled in the box at a time. To fill the seed hopper with 3-4 kg of castor seed, the hopper must be fabricated with a volume of 10000 cm^3.

Drive wheel

The purpose of drive wheel is to transmit power to the seed metering plate through bevel gears for discharge of seeds.

Guard wheel

The purpose of the guard wheel is to minimize the seed loss while turning and balance the planter while in operation.

Design of inclined metering plate

The metering mechanism is the heart of sowing machine and its function is to distribute seeds uniformly at the desired application rates. The size and number of cells on the seed metering plate depends on the size of seed and desired seed spacing. The metering plate was developed for the seeds like maize, red gram and castor. The number of cells on the seed metering plate may be obtained from the following expression

$$N = \frac{\pi \times D}{i \times X}$$

Where,
N = number of cells on roller
D = effective diameter of ground wheel, cm
x = required seed to seed spacing, cm
i = gear ratio (1:1)

The diameter of seed metering plate is determined by the following equation:

$$d_r = \frac{V_r}{\pi \times N}$$

Where,
d_r = diameter of seed roller, cm
V_r = peripheral velocity of roller (1650 cm/min is assumed for minimum seed breakage)
N_r = RPM of the roller (40-50 rpm)

Handle

The handle was developed to accommodate 5-95% of operators, a standard light weight M.S. 2.75 cm outside diameter conduit pipe of 140 cm long is used for handle. The height of handle can be adjusted to suit different operators.

Hitching system

The hitching system is provided to maintain the required furrow depth by adjusting the tyne adjustment rod. It is also designed for the adjustment of handle height as per the requirement of the operator.

Cost of operation

Cost of operation of the planter was determined by using straight line method.

Results and Discussion

The left side view of developed planter is given in figure 1.

Power developed by operator

For 3-4 hours continues work the power developed by the operator would be 0.13 – 0.14 HP, say 0.135 HP.

From the formula

$$HP = \frac{pull(kgf) \times speed(m/s)}{75}$$

The operating speed of machine is taken as 56 cm/s i.e. 2 kmph.

Therefore,

$$Pull(kgf) = \frac{HP \times 75}{speed\ (\frac{m}{s})}$$

$$= \frac{0.135 \times 75}{0.56}\ kg = 13.0 \text{ kgf}$$

Hence the size of the machine is taken as one row.

Seed hopper

The hopper is developed for a size 10000cm^{3}in order to accommodate 3 kg of castor seeds.

The seed hopper is designed based on the bulk density of the seeds. Rectangular shape of hopper is developed for the easy flow of seeds.

The dimensions of hopper are 25x20x24 cm respectively. The hopper also includes a shutter that is provided to adjust the flow of seeds to metering plate.

Drive wheel

A 98 cm MS flat of width 1.8 cm and thickness 0.5 cm was bent into circle shape to form a wheel. The drive wheel has a diameter of 36 cm (including pegs). Trapezoidal lugs of 5 cm height were provided on the circumference of drive wheel to minimize slippage. Therefore, the effective diameter of drive wheel is 31 cm. The lugs were welded to the circumference of the wheel.

Guard wheel

The diameter of the guard wheel is 31 cm. A 98 cm MS flat of width 1.8 cm and thickness 0.5 cm and bent into circle shape to form a wheel.

Metering plate

The metering plate was developed for crops namely maize, redgram and castor. The metering plates were fabricated from nylon because of long life and durability. The desired seed to seed spacing for maize, redgram and castor was set to be 20cm, 20cm and 30cm respectively.

For maize, nylon sheet of thickness 0.6 cm and diameter 11.5 cm was taken and 5 cells were made on the metering plate. For every 72º, a hole of 0.5 cm was drilled and cell of length 1.2 cm was made on the circumference of metering plate which was slightly rectangular in shape. For red gram, nylon sheet of thickness 0.6 cm and diameter 11.5 cm was taken and 5 cells were made on the metering plate.

For every 72º, a hole of 0.5 cm was drilled and cell of length 0.6 cm was made on the circumference of metering plate which was circular in shape. For castor, nylon sheet of thickness 1 cm and diameter 11.5 cm was taken and 3 cells were made on the metering plate. For every 120º, a hole of 0.8 cm was drilled and cell of length 1.8 cm was made on the circumference of metering plate which was circular in shape. The metering plates were shown in Fig.2.

Fig.1 Left side view of planter

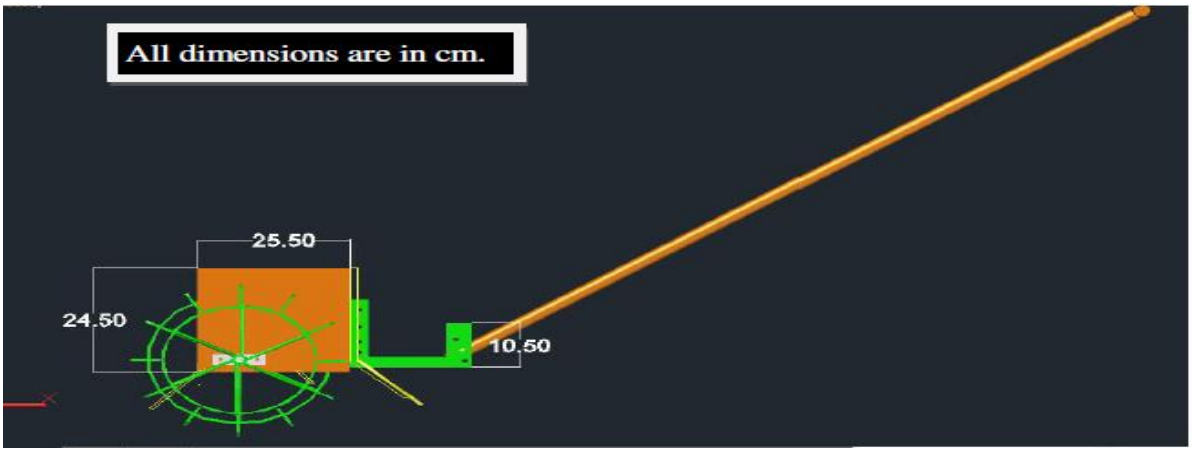

Fig.2 Seed metering plates for Maize Red gram and Castor

Table.1 Specifications of planter

S.No.	Parameter	Specifications
01	Seed Hopper	**25*20*24 cm**
02	Seed metering device	Thickness 0.6 cm and diameter 11.5 cm
03	Furrow opener	Standard tyne (15 cm)
04	Seed tube	2.5 cm diameter and length 11 cm
05	Ground wheel	Effective diameter 31 cm, With lugs diameter 36 cm
06	Guard wheel	31 cm diameter
07	Power transmission	Bevel gear
08	Transmission ratio	1:1
09	Covering device	24 cm length

Discharge tube

The discharged tube is a circular shaped cylindrical pipe of diameter 2.5 cm and length 11 cm from which the seeds drop into the furrow.

Furrow opening device

The furrow opener (standard tyne) was made of 5 cm mild steel with a length of 150 mm which is slightly beveled at the lower edge (5º) to facilitate an easy cut through the soil.

The depth of cut can be adjusted using the tyne adjustment rod to which the tyne is connected using nut and bolt system.

Furrow covering device

A MS flat of width 3 cm and thickness 0.5 cm was used for furrow covering device. Three pieces out of which two outer ones are of length 23 cm and inner one as 24 cm length were welded in the form of U-shape. This device is connected to the seed hopper using small links.

Handle

A standard light weight M.S. 2.75 cm outside diameter conduit pipe of 140 cm long was used as handle of the planter.

Hitching system

A MS angular bar of thickness 0.2 cm and width 3 cm was used for hitching system. Two pieces of length 16 cm was taken and 4 holes of diameter 1 cm at a distance of 3.5 cm were drilled on the two pieces for adjustment of tyne. These pieces were welded to the hopper with a 15 cm distance between them. The handle is connected to the hitching system by nut and bolt arrangement. The specifications of planter were given in table 1

Cost of operation

The total cost of planter was Rs.4150 with an operational cost of Rs.36.1 per hour. The cost of operation was calculated using straight line method. The planter was simple to operate. The cost of planter was Rs.4150 with an operational cost of Rs.36.1 per hour. The developed planter can meet the requirements of the small scale farmers in reducing the cost of cultivation and increasing the yields. The drudgery can be reduced which increases efficiency of sowing.

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