Design and Development of Manually Operated Cotton Seed Planter

V.A. Mhasaye and C.V. Patil
PG Student, Professor
Mechanical Engineering
Shri Sant Gajanan Maharaj College of Engineering Shegaon, India

Abstract: In India, nearly 70% of the people are dependent on agriculture. So the agricultural system in India should be advanced to reduce the manual efforts of farmers. Various operations are performed in the agriculture field like seed sowing, weeding, cutting etc. by the farmers. The very basic and significant operation is seed sowing. But the present methods of seed sowing are very costly. The present equipment used for seed sowing is very difficult and inconvenient to handle. So there is a need to develop a machine which will reduce the efforts of farmers and the cost of plantation also. To overcome the difficulties in the previous papers, efforts are taken to develop manually operated cotton seed planting machine which introduces a control mechanism to drop the seeds at a particular position with specified distance between two seeds and lines while sowing. As day by day the labour availability becomes the great concern for the farmers and labour cost is more, this machine reduces the efforts and total cost of planting the seeds. This technology in the farming system reduces the manual efforts of farmers, saves time, energy and labour cost.

Keywords: Cost, Cotton, Planter, Seed, Sowing.

I. INTRODUCTION

The agricultural industry has always been the backbone of India's sustained growth. As the population of India continues to grow, the demand for produce grows as well. Hence, there is a greater need of mechanization of the Agricultural industry in India is still in a stage of infancy due to the lack of knowledge and the unavailability of advanced tools and machinery. India is set to be an agricultural based country approximately 75% of the population of India is dependent on farming directly or indirectly. Special emphasis was laid on the later as more than 70% of the farmers fall in small and, marginal category. Our farmers are using the same methods and equipment for the ages. E.g. seed sowing, spraying. There is a need for the development of effective machine for increasing the productivity. A developing country like India is expected to continue to rely more on hand tools for the foreseeable future for cultivation. The use of hand tools for land cultivation is still predominant in India because draft animals and tractors require resources that many Indian farmers do not have easy access to. As our population continues to increase, it is necessary that we must produce more food, but this can only be achieved through some level of mechanization. These small holder farmers still continue to plant manually, the result of which is low productivity of the crops. It is therefore necessary to develop a low cost planter that will reduce the effort of poor farmer.

LITERATURE REVIEW

Traditional methods include broadcasting manually, opening furrows by country plough and dropping seeds by hand and dropping seeds in the furrow through a bamboo/metal funnel attached to a country plough. For sowing in small areas dibbling that making holes or slits by a stick or tool and dropping seeds by hand.
Thorat S.V. and G. Patil: This article represents the advanced system for improving the agricultural processes such as cultivation on ploughed land, based on robotic assistance. We developed a vehicle having 4wheels and operated by DC motor. The machine will cultivate the farm by considering particular column at fixed distance depending on crop.
Kalay Khan and Ashok Kumar: Author presented a brief information for single row multi crop planter which planting the various crops like wheat, maize, okra etc. But it is not suitable for the large seed spacing crops like cotton.
Kyada A.R. and Patel D.B.: This article provides information about the manual seed planter machine has considerable potential to greatly increase productivity. By using of this machine, achievement of flexibility of distance and depth variation for different seed plantation is possible.

The paper discuss about the cotton seed planter machine which will be helpful for the agriculture industry to move towards mechanization we are designing of an advanced manually operated cotton seed planter, their utilization methods advantages, disadvantages and the process involving to design and fabrication of these planter for the purpose of utilization of poor farmers.

II. Research Methodology

For the robust, strong design of planter, we select the M.S. material for every part of planter. All the design and fabrication made in workshop of SSGMC of Engineering Shegaon, Maharashtra.

1. Concept of design:

The sowing operation is to put the seed in rows at desired depth and seed to seed spacing, cover the seeds with soil and provide proper compaction over the seed.

2. Calculations:

Velocity of machine: Generally, the human walking speed in the range of 2km/h to 2.5km/h. We choose the minimum speed which is 2km/h or 0.56m/s.

Diameter of rear wheel: the diameter of wheel is given by

$$V = \frac{\pi dN}{60}$$

Where, V = velocity of Machine.
N = speed of wheel.
d = diameter of wheel.

Diameter of shaft: the power of useful work done by an average human on the machine is given by

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

Where, t is operation time in minutes.

Then power developed by machine in watt is $P = \frac{2\pi NT}{60}$,

By this formula we calculate the torque and after that we put it into the torsion equation for the calculation of diameter as below. (We take Ƭ = 42 MPA for the shaft.)

$$\frac{T}{J} = \frac{\tau}{r}$$

Where, $J = \frac{\pi}{32} * d\wedge 4$ and $r = d/2$.

Bevel gear: From the recommend series of bevel gear in Indian standard, and the availability in market we choose the bevel gear which is use in the differential of low heavy vehicle.

We use the bevel gear with gear ratio of 1.8:1 and the teeth of the bevel gear are
T1 = 18 teeth, T2 = 10 teeth.
Where, T1 = Number of teeth on the bevel gear.
T2 = Number of teeth on the pinion.

From this we calculate the gear ratio as

Gear ratio = i = T1/T2.
Then i = 1.8
With this requirement we get the desired 50 rpm of rear wheel.

Disc: Two discs are use in this machine, one is fixed by the frame and another one is rotating with the upper shaft of bevel gear. The diameter of this disc is calculated by using the seed to seed spacing we use in the machine as below.

We required the seed to seed distance is 45 cm. Then the diameter of the disc is calculated by,

$L = \pi \times D$.
Where, L = peripheral length, cm.
D = diameter of disc, cm.
Now, the peripheral length means our seed to seed distance of this machine (L = 45cm).

Hopper: Hopper is designed for the storage of seed with capacity of 3kg of seed. Which is sufficient storage for the 1acre of land with the seed to seed spacing 45 cm and the row spacing is 45 cm.

Handle: The handle is designed on the basis of human comfort,

The length of the handle is calculated based on the average standing elbow height of the operator.
So, generally the average standing elbow height of the operator is 100cm.
Then the angle of inclination (ɵh) with the horizontal is given by

$$\text{Tan } (\theta h) = \frac{a1}{a2}$$

Where, $a1$ = the height of centre of wheel to the elbow.
$a2$ = the horizontal distance between normal to the centre of wheel and normal to the elbow line.
Generally, the distance of the wheel centre from the operator is changes with the different operator height and different operating condition also.
So, we take the distance of the wheel centre from the operator is 45 cm (for the operator elbow height of 95 – 105 cm).
After the calculation of angle of inclination, we calculate the length of the handle by this formula.

$$\text{Sin } (\theta h) = \frac{a1}{lh}$$

Where, (θh) = Angle of inclination.
$a1$ = Height of centre of wheel to the elbow.
lh = length of the handle.

Furrow Stand: The Furrow stand is mounted on the middle shaft of frame, and it is fixed with nut bolt assembly. We use the sword type furrow opener for this planter and design it in this way that it is adjustable depth and angle also with the requirement of soil.
The adjustment angle is given to the furrow opener is 30°,60°,90° with the frame (or horizontal). And the Depth of the furrow is adjust by the four drills provided on it with the distance of 1.5 cm to each from another and through this drills the nut bolt is placed with the frame. Hence it gives the variation in depth of seed placing as 1.5cm, 3cm, and 4.5cm as the farmer required.

After all this calculation, we design all the parts of the Planter in CATIA V5 as shown in Fig.1.

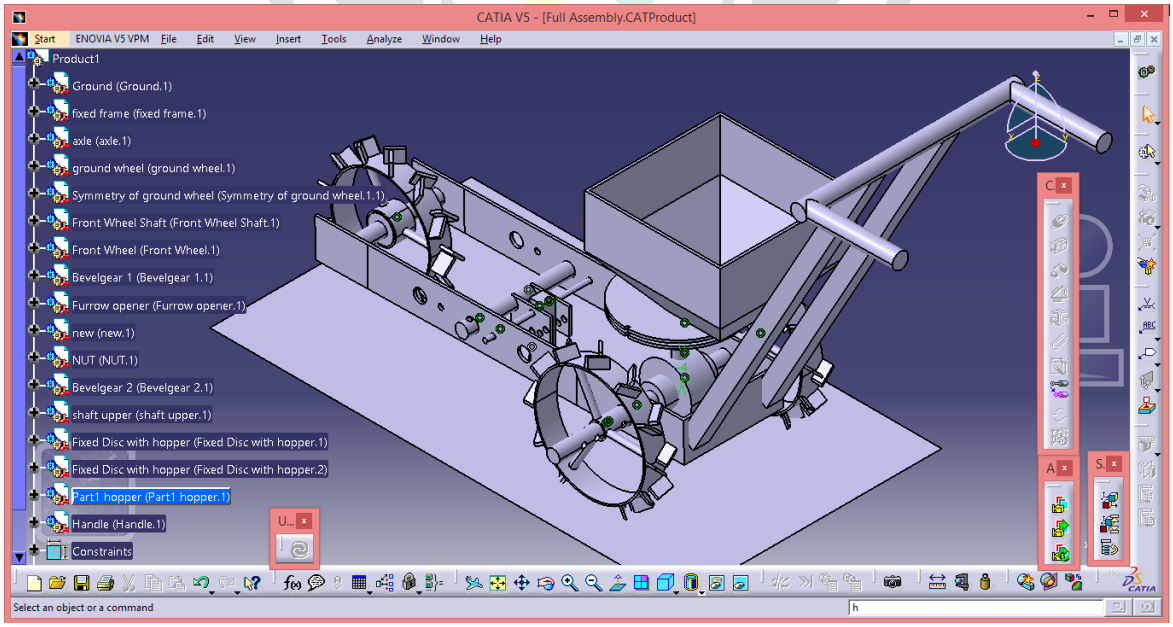

Figure 1. Design of Planters

3. Parts of Planter

We fabricate the model in workshop with the help of various machines like drilling, grinding, milling, welding and lathe machine as we see in the Fig.1 it contains the following part of machine.

Frame: We design the frame which gives the support to all parts of the machine with the support bar, nut bolt assembly and with fixed welding. The frame has the dimension of ($720mm \times 72mm \times 5mm$) as shown in fig.1.

Shafts: Four shafts (diameter 25mm) are used for front wheel, rear wheel, upper shaft for disc and for furrow opener. Which are operating with the roller bearing on the both side of the rear axle, middle in the front axle and one needle bearing is used for the upper shaft with the disc.

All the four shafts having diameter of 25mm but the one rear shaft having two diameters one is 25mm and another 50mm for the mounting of bevel gear in the middle of shaft as shown in Fig.1.

Furrow Stand: It is adjustable in the variable depth as 1.5cm, 3cm, 4.5cm and angle 30, 60, 90 degrees with the frame for variable soil nature. This stand is mounted on the frame in between the front and rear shaft and the shovel furrow are fixed on this with nut bolt assembly.

Sword type furrow: We use the sword type Shovel furrow for the row marking in the field and for that we take the shank of the furrow is 9cm, depend on the height of the frame and the depth we required.

Again the radius of curvature is 6cm, generally radius of curvature for this furrow is not greater than 12cm (R<=120mm).

Wheels: Three wheels are used in which two wheels are operating with bevel gear having diameter of 21.3cm and one for support having diameter of 19.2cm. All three wheels having a 12 Langes on it for the slip reduction with height of 3cm and angle between the Langes is 45°. And also we change the spacing between the rear wheels for various row spacing with the help of nut bolt arrangement on both sides with the help of that we get variable row spacing such as 30cm, 35cm, 40cm, and 45cm.

Front wheel having same dimension of rear wheel except the diameter is less than the rear wheel (d = 19.1cm), because the planter stand perfectly in the field. And the front wheel shaft is fixed on the frame by welding and the one roller bearing is used in the middle of shaft with the front wheel.

Bevel gear: The bevel gear ratio of this gear is 1.8:1 and having the teeth on the gear, pinion is 18, 10 respectively and this gear is use for the transmission of the power from rear wheel axle to the disc. The bevel gear transmits the power directly 90° from the axle.

Disc: Two discs of diameter 20cm are use in this planter, one is fixed and another one is moving with the upper shaft of pinion. The clearance between two discs is 2mm. The needle bearing is placed on the upper shaft with the rotating disc. Both discs having groove on the surface for the delivery of seed having dimension of 10mm×10mm.

Hopper: It is used for the storage of cotton seed and the capacity of hopper is 3kg. This is made up of thin sheet material and the opening of the hopper for the seed delivery is having the dimensions of 15mm × 9mm as show in below Fig.

Handle: After all this calculations are done of the handle then the length of the handle and the angle of inclination is 90cm, 60.65° respectively. We design the handle for this machine with the human comfort.

Nut: This part is used for the fixing of furrow with the furrow stand and also changing the depth of the furrow as 1.5cm, 3cm, 4.5cm and the angle of the furrow as 30°, 60°, 90° with the frame or horizontal on the basis of soil condition.

Upper Shaft: This shaft having diameter of 25mm with the length of 100mm is the connecting shaft between the disc and the pinion gear. It is fixed with the pinion gear and the both disc one rotating, another fixed.

The rotating disc is fixed with the upper shaft by the needle bearing in it for the continuous and smooth rotation.

4. Mechanism and Working of planter

This planter works on the principle of bevel gear mechanism. We use the bevel gear mechanism for the uniform seed to seed spacing and mechanism for the depth of seed placing with the help of Furrow stand arrangement, changing of row spacing as 30cm, 35cm, 40cm and 45cm by the Rear axle arrangement with nut bolt assembly. This all mechanisms are use in this planter for the various objective completions.

This planter works on the principle of bevel gear mechanism. We manually operates this planter by pushing it on the field by the handle and the wheel rotates, causing the bevel gear rotates with the rear axle and it transmit the rotating power by 90° from rear axle to the upper shaft which is fixed with the disc by needle bearing in it for continuous and smooth rotation.

After that the disc is rotates and the groove provided on both discs, the rotating disc is filled with the cotton seed from the opening of hopper and it rotates until the groove match over the fixed disc. Then matching the groove of both discs is delivered the seed to the ground through the tube and tube is placed at the back of furrow stand which is used for row marking and providing the proper depth with the nut bolt assembly. After placing the seed with proper depth then one chain is provided on the back of the frame for covering the seed with soil properly as we see in the fig.2.

Figure 2. Manually operated Cotton Seed Planter

III. RESULT AND DISCUSSION

We have tested this planter in farm field of 1 acre in my village of coordinate (latitude N 21° 5´22.4´´ and longitude 76° 37´50.7´´) successfully.

1. **Testing of the Planter**

After the testing of machine in Actual field with 45cm seed to seed spacing and variable row spacing (30cm,35cm,45cm) on the basis of Farmer requirements the following result comes and we see the percentage of one seed and two seed at a time in table 1.

Table.1. Three trials of checking seed delivery

Type of sowing	Seeds Delivery at a Time		
	Zero Seed (%)	One Seed (%)	Two Seed (%)
First Trial (45x30)	0	76	24
Second Trial (45x35)	0	69	31
Third Trial (45x45)	0	71	29

2 Comparing the results

On the basis of this information we take the calculation and find the result in the form of chart 1 as shown in below.

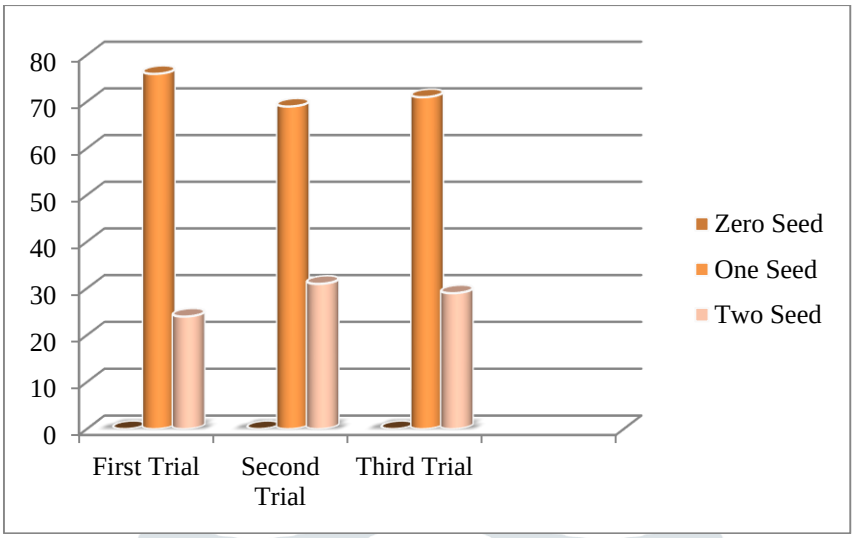

Chart.1. Trials of Seed delivery

By this chart shown the result of the three trials, we can say there is no place in the field where the seed is not placed and the place where the one seed placed at one position is higher than the two seed placed at one position.

3 Parameters of the Seed

After we discuss the seed delivery with this planter, some parameter are given below in Table 2 on the basis of three trials that we taking in the field successfully.

Table.2. Parameters of the Seed

Parameter	First	Second	Third
Seed to Seed Spacing (cm)	45	45	45
Row Spacing (cm)	30	35	45
Depth of Seed Placing (cm)	1.5	3	4.5
Speed (km/h)	2	2	2
Singulation (%)	76	69	71
Doubling (%)	24	31	29
Seed Damage (%)	0	0	0

These singulation and doubling percentage are calculated from the one seed and two seed percentage in field and which is calculated by the number of one seed placed to the total number of seed placed in the field. And the seed damage in this planter is zero percentage.

Hence the efficiency of this planter is calculated by the singulation and doubling percentage and the efficiency of this planter is 72%.

4 Comparing of different Planters

After we discuss all the parameter, the difference between the various types of planter like Tractor drawn, one or two bull operated and the manually operated planters as shown in the table 3.

Table.3. Difference between various type Planters

Parameter	Tractor drawn Planter	Bull operated planter	Manually operated planter
Requirements	Tractor is required	One or two bull is required	Only one operator is required
Cost of the Planters (Rs)	40000	14000	4000
Speed (km/h)	6	2.5	2
Seed Damage	The seed damage is higher.	Seed is wasted during planting.	There is no seed damage.
Time required to plant the 1 acre of land (Hr)	0.45	2	2.5

5 Costs of the Planters

On the basis of the above table, we plot the chart of the cost of the planters because the cost of planter is also a major concern for the small land farmer as the chart 2 is shown below.

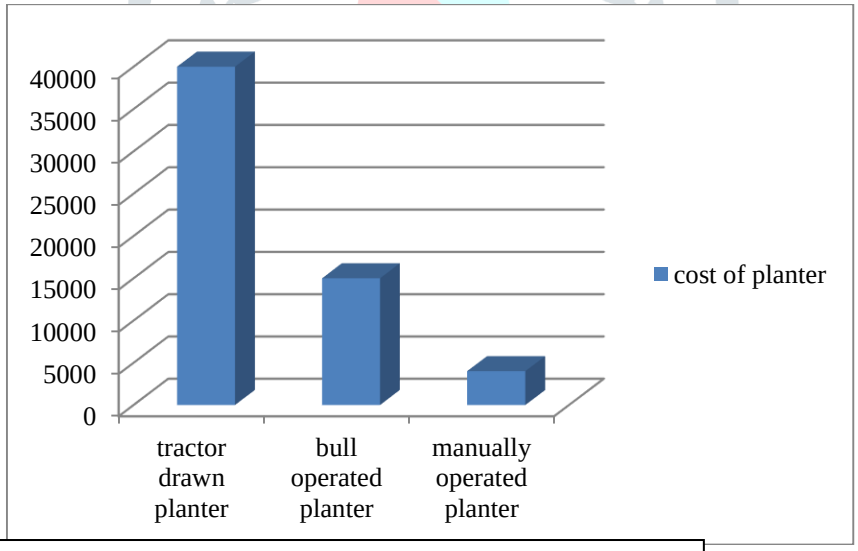

Chart.2. Cost of the Planters

IV. CONCLUSION

The need of a poor and small land farmer has fulfilled by the manually operated cotton seed planter with very low cost and they can easily and effectively plants their seed in the field uniformly in a row with optimum distance between plants (45cm). This project work demonstrates the application of engineering techniques to reduce human labor specifically in the small Field, which is cheap, easily affordable. This will be safe, easy to operate by unskilled person also and reduce the labor cost as compared to the traditional system.

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