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Design and Fabrication of Automatic Seed Sowing Machine

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Abstract

Today's era is marching towards the rapid growth of all sectors including the agricultural sector.In future food demands,the farmers have to implement the new techniques which will not affect the soil texture but increases the overall crop production. The normally used seeding operation takes more time and more labor during farming methods. The seed feed rate as well as the time required for the total operation is more and the total cost is increased due to labor, hiring of equipment.The sowing machine is less efficient and time consuming.The machine reduces efforts and total cost of sowing the seeds and fertilizer placement.Sowing machine should be suitable for all farms, all types of crops, also it should be reliable, and this is the basic requirement of sowing machine.Thus, the sowing machine designed for reducing the efforts of farmers by using a remote control device and also operate the machine in automatically.This machine carries various types and sizes of seeds which also can vary the space between two seeds while planting.Also which may be increase the planting efficiency and accuracy.Our machine is made up of scrap materials thus it is so cheap and very usable for small scale farmers.The machine structure is easily understandable,so it should be functioned by any farmer or untrained labour.The adjustment and maintenance methods are also simplified.

Keywords: Seed Sowing, Machine, Farmers, Planting, Agriculture

1. Introduction

The major occupation of the rural people in India is agriculture and cultivation. Both men and women are equally involved in the process. Agriculture has been the backbone of the Indian economy and it will continue to remain so for a long time. It has to support almost 18% of world population from 2.2% of world geographical area and 4.3% of world's water resources. The main aim of sowing operation is to place the seed and fertilizers in rows at desired depth and spacing, cover the seeds with soil and provide proper compaction over the seed. The desired row to row spacing, seed rate, seed to seed spacing and depth of seed placement vary in accordance with crop and for different agricultural and climatic conditions to achieve optimum yields and an efficient sowing machine should attempt to fulfill all of these objectives. Also, saving in cost of operation time, labor and energy are other advantages to be expected from use of developed machinery for such operations. The agriculture has always been the backbone of India's sustained growth. As the population of India continues to increase, the demand to produce growth in cultivation also increases. Hence, there is greater need for multiple cropping in the farms and this also requires efficient and time saving machines. In the past, various types of design have been developed with different design approaches, which have their own advantages and disadvantages and also operational limitations.

Now a days, most of the countries don't have sufficient skilled man power especially in agricultural sector and it affects the growth of developing countries.Conventional way of farming based on consideration of seed to seed distance level of seed plantation which is highly ineffective, time consuming and besides of this it's require lots of efforts Farmers are facing one more serious problem because of different harmful pests and insects. Farmers use conventional way of pesticide spraying by carrying the heavy pump on their back throughout the field which requires lots of efforts and time.The main requirement of Automation is to reduce man power in our country; the industrial firms generally involves electrical, electronic component as well as mechanical part. Automation saves a lot of manual work and speeds up the production processes. So it is a time to automate the sector to overcome this problem. Almost 72% of the people depended on agriculture in India. In the present scenario most of the countries do not have sufficient skilled man power in agricultural sector and that affects the growth of developing countries. Therefore farmers have to use upgraded technology for cultivation activity (digging, seed sowing, fertilizing, spraying etc.) for reducing operation time and increasing production. So it's a time to automate the sector to overcome this problem which in turn will also eliminate the requirement of labors and also avoid the wastage of seeds.

Seed has been an important agricultural commodity since the first crop plant was domesticated by pre-historic man. This model for seed sowing process is designed and automated to reduce the human effort and increase the yield. The plantation of seeds is automatically done by using DC motor.
Cropping is the important activity for any farmer, and for large scale this activity is so lengthy also it needs more workers. Therefore we use agriculture machines for simplifying the human efforts. In manual method of seed planting, it can cause low seed placement, less spacing efficiencies and serious back ache for the farmer. This also limits in the size of field that can be planted. Hence for achieving best performance from a seed planter, the above limits should be optimized.

2. Experimental Methods

2.1 Shaft

- Shaft material is cast iron having tensile strength = 350 N/mm^2 and shear strength of 200 N/mm^2
- Factor safety, assume 2.
- Identifying all forces and moments maximum bending moment is found out to be 25000 N-mm.
- Permissible shear stress found out to be =147.4MPa.
- Taking power as 101.25W and speed as 23rpm.
- As standard shaft diameter is chosen as 12mm.

2.2 Bearings

- Bearing with bore diameter 12mm are SKF 6201,6301,6401 and 6501.
- Considering light load usage , SKF 6201 is taken first and consider a 1000 hours of safe working. Then we get the dynamic load on the bearing as 75N. The load capacity of the bearing is 6890N, hence the bearing is safe.
- In SKF 6201, 6 represent single row ball bearing 2 represent bearing 02 width series and 01 represent 12mm bore diameter.

Figure 2.2 Bearings

2.3 Spur Gear

The most common gears are spur gears and are used in series for large gear reductions. The teeth on spur gears are straight and are mounted in parallel on different shafts. Spur Gears of module 20mm is used in this model. The gear mounted is as shown in the figure

Figure 2.3 Spur Gear

- The diameter of the pinion 25 mm, no of teeth 10, speed of the pinion 50rpm
- The diameter of the gear 40 mm, no of teeth 16
- Using both the speeds the gear ratio is obtained as 1.6.
- The material is cast iron having allowable static stress 80000 kN/m2
- The strength of gear material id found as 352.85N
- Both the dynamic loads are less than beam strength of gear teeth.
- The gear chosen is safe for this device.

Figure 2.4 Bevel Gear

2.4 Motor

Trail run was made with many motors but only the wiper motor worked out, it is the only motor which is easily controlled by the motor drive which has been used. It also works at low voltage (12v and 5amps). The wiper motor is permanent- magnet direct current (DC) one. Wiper motor, is the core of the whole wiper system. Therefore, the quality of the wiper motor must be guaranteed to ensure performance. The technical Specifications of the wiper motor are,
Rated torque =71.85 Nm,
Maximum wattage = 50W / 12 VDC ,
Unload high speed = 50rpm, 10A
Motor noise = < 45dB,
Unload low speed =35rpm, 1.0A,
Spindle/post thread size = M-6

Figure 2.5 Wiper Motor

2.5 Hopper

- The seed hopper is developed for a size 10000cm3 in order to accomadate 3 kg of asparagus seeds.
- The seed hopper is designed based on the bulk density of the seeds.
- It is used to store a certain quantity of seed and delivers the seed to the discharge spout through the metering plate.

Figure 2.6 Hopper

Volume of seed box is given by, Vb = 1.1 Vs

Also Where,

Vb = Volume of seed box, cm^3
Vs = Volume of seed, cm^3
Ws = Weight of seed in box, g
s = Bulk density of seed, cm^3

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 asparagus seed, the hopper must be fabricated with a volume of 10000 cm^3.

2.6 Metering Disc

- 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 carrot, onion, corn and cotton.

The number of cells on the seed metering plate may be obtained from the following expression

N=(x D)/ i x 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)

Figure 2.7 Metering Disc

2.7 Battery

The Smart Battery 12V 100AH Lithium Ion Battery is the Ultimate High Performance solution for virtually any application. This battery features an automatic built in battery protection system (BPS) that keeps the battery running at peak performance and protects the cells for thousands of cycles.

Figure 2.8 Battery

2.8 Sprockets and Chains

A sprocket or sprocket-wheel is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain, track or other perforated or indented material. The sprocket helps the chain driver motor to drive it easily. It is a 4 wheel drive mechanism. It gives the power to turn in muddy region or farms. The material chosen for the sprocket is cast iron with a pitch of 10.82 mm, Number of teeth is 10, and width of 50mm is used in this machine as shown in figure. It is a way of transmitting mechanical power from one place to another. Chain is often used to convey power to the wheels of a vehicle, particularly bicycles and motor cycles. It is also used in a wide variety of machines besides vehicles.

Figure 2.9 Sprockets and Chains

2.9 Disc Type Bed Former

- Disc type Bed former is used to form a ridge by gathering soil.
- The sweep type bed former of the seed planter makes a ridge by gathering soil from the two sides of the falling seed in the land and cover the seeds with soil.
- The bed were made of rigid mild steel sheet. The diameter of the bed formers was 20 cm. The bed formers were attached to an adjustable frame maintaining a disc angle of 45 and tilt angle of around 10 to 15.
- There were holes on both sides of the frame by which the position of the be which can be adjusted. This affects in the height and width of the ridge.

Figure 2.10 Disc Type Bed Former

2.10 RELAY CIRCUIT

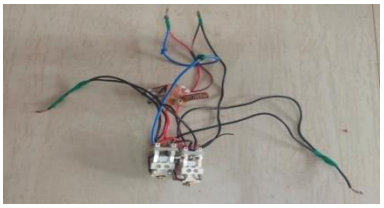

Figure 2.11 Remote Receiver with Relay Circui

Sl NO	PART	DIMENSIONS	VALUE
1	WHEELS	LENGTH WIDTH	46 cm 7 cm
2	DISC	DIAMETER	14 cm
3	GEAR	NO OF TEETH PITCH DIAMETER	16 40 mm
4	BEARING	DESIGNATION	SKF 6201
5	SHAFT DIAMETER	DIAMETER LENGTH	46 cm 12 mm
6	PINION	NO OF TEETH PITCH DIAMETER	10 25 mm
7	SEED HOPPER	VOLUME	10000 cm^3
8	BED FORMER	DIAMETER	20 cm

Table 2.1 Dimension of parts

VEGETABLES	DISTANCE BETWEEN PLANTS (cm)	NUMBER OF HOLES IN THE METER DISC	ANGLE (ə)
CORN	25	4	90°
COTTON	60	2	180
BEET	4	22	16
CAULIFLOWER	55	2	180
CABBAGE	45	2	180
ONION	7	12	30
POTATO	25	4	90

Table 2.2 Dimension of Seeds

To achieve the best performance from a seed drill or planter, the above factors are to be optimized by proper design and selection of the components required on the machine to suit the needs of the crops. The seed drill or planter can play an important role in manipulating the physical environment. The metering system selected for the seed should not damage the seed while in operation.

Percent cell fill is defined as the total number of seeds discharged divided by the
total number of cells passing the discharge point. According to this definition 100% cell fill does not mean that every cell contains a single seed but implies that any empty cells are offset by extra seeds in multiple fills. The most uniform seed distribution is obtained with combinations of seed size, cell size, and cell speed that give about 100% cell fill. Cell fill is influenced by:

- Maximum seed size in relation to cell size
- Range of seed sizes
- Shape of seeds
- Shape of cells
- Exposure time of a cell to seed in the hopper
- Linear speed of cell

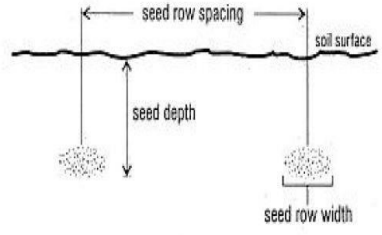

Figure 2.12 Various parameters in seeding

3.Working

The machine includes a seed hopper ,plate type seed metering device ,seed tube ,disc type bed former, runner wheel, handle and power transmission system. Seed hopper contains the seed and the seed metering device. The amount of seed contained depends upon the size of the seed hopper. The seed rate and seed spacing are adjusted by metering device. Maize seeds are relatively large and at plate type seed metering device is well suited for planting maize seeds. The entire metering device is attached to vertical shaft. A differential mechanism was used between the vertical shaft and a horizontal shaft, attached to the runner wheels. Seed tube is a plastic tube through which seeds are passed from the metering device to the soil. Bed former is used to form a ridge by gathering soil. The sweep type bed former makes a ridge by gathering soil from the 2 sides of the falling seed in the land and cover seeds with soil. Runner wheels are used to take the planter in forward or backward by pushing the handle. Power is transmitted from the runner wheel to the seed metering device through bevel gears using a differential mechanism.

Runner wheel: There were two runner wheels in the maize planter. Runner wheels
were used to take the planter in forward or backward. The diameter of the runner wheel was 40.64 cm. Distance between the runner wheels was fixed to 60 cm to maintain the spacing between the rows.

Plate type seed metering device: Metering device is the most important part of a maize seeder. The seed rate and seed spacing are adjusted by metering device. Maize seeds are relatively large and at plate type seed metering device is well suited for planting maize seeds. The stationary ring surrounding the plate should fit well for best performance.

Plates with round or oval holes were used for drilling and hill dropping seed. The
diameter of the metering device is 16.8 cm with 8 cells open for passing the seed. The entire metering device is attached to a vertical shaft. A differential mechanism was used between the vertical shaft and a horizontal shaft, attached to the runner wheels. Disc type bed former: Bed former is used to form a ridge by gathering soil. The sweep type bed former of the maize planter makes a ridge by gathering soil from the two sides of the falling seed in the land and cover the seeds with soil. The bed formers were made of rigid mild steel sheet. The diameter of the bed formers was 25.4 cm. The bed formers were attached to an adjustable frame maintaining a disc angle of 450 and tilt angle of around 100 to 150. There were holes on both sides of the frame by which the position of the bed formers were adjusted. This affects in the height and width of the ridge.

Power Transmission System: The maize seeder was operated manually to make it cost effective. Power was transmitted from the runner wheel to the seed metering device through bevel gears using a differential mechanism. Here the entire system is controlled by a remote since it is automated.

3.1 Block Diagram

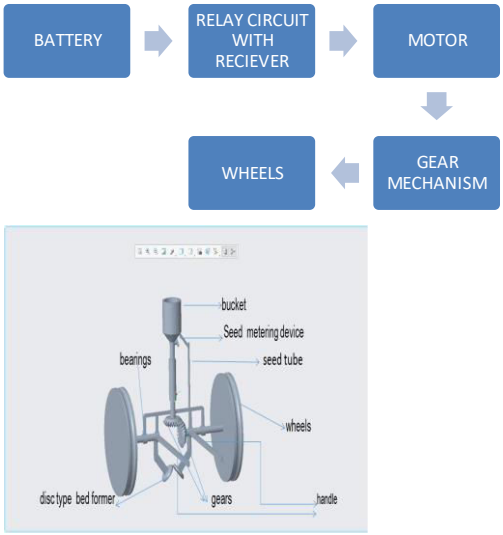

Figure 3.1 CREO Model

Figure 3.2 Side View

Figure 3.3 Top View

4. Future Work

- By increasing the equipment strength and quality to its peak, we can have multipurpose agricultural equipment for life time usage. By providing hydraulics, gear arrangements and some minor

adjustments the equipment can also be made as tractor powered equipment.

- After installation and establishing successful working of the machine, it is proposed to concentrate on value engineering to increase the future value of the machine in all aspects. Presently, full focus is given only to design modification in seed metering mechanism for the benefit of the small farmers. At present, seed metering mechanism is used for sowing different types of seeds with single metering mechanism. We can use separate metering mechanism for every seeds. Thus, we can increase the value of the machine in future.
- A disc type best former can be motorized or can be coupled with additional tools to make ridges and plough soul eve in hard surfaces.
- Additional system for watering of fertilization can be incorporated into the machine.
- This robotic system can be improved by setting left-right movement with the addition of motor.

5. Conclusion

This seed sowing machine has great potential for increasing the productivity, even small scale farmers can purchase with affordable price. This machine can be even made by raw materials also which saves the cost of purchasing higher priced equipment and is easily manufactured in available workshops. Using this seed sowing machine the flexibility of distance and control depth variation for different seeds are attained and hence usable to all seeds.

Development of seed planter was simple and very easy to fabricate with locally

available materials as evidenced by this study. Its operation was easy and required very less power to push. Therefore, one female person also can operate it. The fabrication cost of the seed planter was low. The cost of the developed maize seeder was approximately Tk.1800 which is within the buying capacity of the farmers of Bangladesh. The average missing rates of seed planter was 13.43 percentage. The field capacity of developed seed planter was 0.128 ha/hr and field efficiency of maize seeder was 76.65 percentage. So, the overall performance of low cost seed planter was satisfactory. Therefore, the low cost maize seeder may be accepted for demonstration and use.

Calibration of the seed metering device should be done accurately to get right seed rate and seed spacing. The machine should operate at normal working speed (2- 3 km/hr), because too fast causing splitting the seed and slow walking decrease field capacity of the machine. The maize planter is needed to test in the farmers field to judge its performances.This seed plantation machine has great potential for increasing the productivity of the planting. Till now tractor was the main traction unit for nourishment in farming. With the adaptation of this seed planting machine its purpose will be done. Hence there is need to promote this technology and made available to even small scale farmers with affordable prices. This machine can be made by raw materials also which saves the cost of whole project and is easily manufactured in available workshops. The only cost is of metering device and sensors. Hence by using this machine we can achieve flexibility of distance and control depth variation for different seeds. Hence it is usable to all seeds.

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