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Design and Fabrication of Multipurpose Machine for Mini Farm Agriculture Using DC Motor

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ABSTRACT

Agriculture is the backbone of Indian economy and it will continue to remain so for a long time. The Multipurpose Agricultural Machine is used to ploughing the agricultural field and sowing the seeds into the land for making lots of plant production in field. The model is proposed with the objective of establishing a ploughing, seeding and spraying processing. It is a mechanical device, in which the spraying machine is used to spray the water. We can plough and plant different varieties using this machine. It also increases planting Efficiency and accuracy made from raw materials so it is much cheaper. and more suitable for small-scale farmers. The advantage of this method, it reduces seeding and spraying time in land and reduces human effort. The cost of this machine is very low and easy to operate simple construction.

Keywords: *Levelling, Sowing, Ploughing, Spraying, Weeding.*

1. INTRODUCTION

Agriculture has been and will continue to be the backbone of the Indian economy for a long time. Agriculture is an application of science. Agriculture s the science and art of farming, which includes soil cultivation, agricultural production, and livestock husbandry. Because tractors demand resources that many Indian farmers do not have easy access to, hand tools are still widely used for land cultivation in India. The necessity for agricultural mechanisation in India must therefore be addressed in the context of a better understanding of the operations of small-scale farmers. With small and marginal farmers, there is a large gap in technological adoption and implementation. We are making a multipurpose agriculture machine for this project. The machine is used to sow seeds into the ground in order to produce a large number of plants in an agricultural field. This project uses less electricity and has a lower cost. As a result, this is extremely important in the agricultural industry, as it allows for the development of a less expensive and simpler seed planting process. The versatile agriculture machine is a multipurpose piece of equipment that may be used for a variety of agricultural tasks such as levelling, ploughing, planting, spraying, and weeding.

1.1 DC MOTOR

An electric motor converts electrical energy into mechanical energy. It works on the basis of Fleming's left-hand rule, which states that when a current carrying conductor is placed in a magnetic field, mechanical force is experienced.

Fig 1. DC Motor

1.2 BATTERY

An anode, cathode, separator, electrolyte, and two current collectors make up a battery (positive and negative). The lithium is stored in the anode and cathode. Through the separator, the electrolyte transports positively charged lithium ions from the anode to the cathode and vice versa. The movement of lithium ions causes free electrons to form in the anode, causing a charge to form at the positive current collector. The electrical current then passes from the current collector to the negative current collector, passing through a powered device (cell phone, computer, etc.). The separator prevents electrons from flowing freely inside the battery. The anode delivers lithium ions to the cathode as the battery is discharging and delivering an electric current, resulting in a flow of electrons from one side to the other. Lithium ions are released by the cathode and received by the anode when the gadget is plugged in. Energy density and power density are two of the most popular concepts related with batteries. The amount of energy that a battery can store in relation to its mass is measured in watt-hours per kilogramme (Wh/kg).

The amount of power that can be generated by the battery in relation to its mass is measured in watts per kilogramme (W/kg). Imagine draining a pool to get a better picture. Power density is comparable to draining the pool as rapidly as possible, whereas energy density is comparable to the pool's size.

Fig 2. Battery

1.3 BEARING

A bearing is a mechanism that allows restricted relative motion between two pieces, most commonly rotation or linear movement. Bearings are classed in general terms based on the motions they allow and the mechanism of functioning. Low friction bearings are frequently used to improve efficiency, minimise wear, and enable high speeds. A bearing can minimise friction by virtue of its shape, material, or the introduction and containment of a fluid between two surfaces. Gains an edge by the use of spheres or rollers. By material, it takes advantage of the bearing material's properties.

Fig 3. Bearings

1.4 WHEELS

A wheel is a circular device that can rotate on its axis and is used to facilitate movement, transportation, or work in machines. A wheel and an axle eliminate friction by allowing motion to be achieved by rolling, either by gravity or by the application of another external force. Transportation applications are a good example. The phrase is also applied to various circular rotating or turning things, such as a ship's wheel and a flywheel. The wheel was most likely invented in antiquity. The wheel is a mechanism that allows an object to travel efficiently across a surface when there is a force forcing the object against it. A horse-drawn cart and the rollers on an aeroplane flap mechanism are two common examples.

Fig 4. Wheels

1.5 SEED HOPPER

The seed stopper is used to ensure that the seed is stopped at the appropriate time during seed planting. The seed stopper is attached to the flat face follower and directed along a guide path. In this piece of equipment, the cam is utilised to control the seed stopper's up and down movement.

Fig 5. Seed Hopper

1.6 CAM

A cam is a rotating or sliding piece of a mechanical linkage that is used to convert rotary motion to linear motion or the other way around. It's usually a portion of a spinning wheel (like an eccentric wheel) or shaft (like an irregularly shaped cylinder) that hits a lever at one or more places along its circular journey. The cam can be a simple tooth, as in a steam hammer, or an eccentric disc or other shape that creates a smooth reciprocating (back and forth) motion in the follower, which is a lever that makes contact with the cam.

Fig 6. Cam

1.7 STORAGE TANK

The seed is stored in the storage tank. A seed stopper is installed on the inside of the storage tank. The top side of the storage tank has a large open, and the bottom side has an open that is the same size as the seed stopper dimension.

Fig 7. Storage Tank

ADVANTAGE OF MULTIPURPOSE AGRICULTURAL MACHINE:

- Low cost
- Easy construction
- Easy to operate

2. PROBLEM IDENTIFICATION

- **Manuring**: The nutrients are provided to the seeds at regular intervals. manure is the decomposition product of plant and animal wastes. ϖ Weeding: Weeds or unwanted plants are removed using weedicides or removing them manually.
- **Harvesting:** After the crop is fully grown, it is cut and gathered. this process is called as harvesting.
- **Sowing:** seeds of good quality are sowed or dispersed in the soil.

3. REVIEW ON LITERATURE

Achutha et al. contributed to the creation and development of farm tools. The counterpoise was built by carpenters to elevate water from wells to irrigate farms. Cobblers utilised full skins of animals to carry water to irrigate horticulture crops alongside entering dust pathways, and potters employed large sizes of pottery to store grains for months to keep them secure from insects and pests. India's economy is based on agriculture. There is a lot of field work in the agriculture sector, such as weeding, reaping, seeding, and so on. Spraying is another crucial operation that the farmer must conduct to protect the produced crops from insects, pests, funguses, and diseases, for which a variety of insecticides, pesticides, fungicides, and fertilizers are used. For crop protection, pesticides are sprayed on the plants. Because agriculture was the mainstay of the population, farmers needed hand tools to conduct work, enhance labour productivity, and quality of work, which resulted in low production and yield. MAE (Multipurpose Agriculture Equipment) was designed to address these issues [1]. Balaji et al. this project ploughing, sowing, and harvesting huge agricultural activities. The modification entails the construction of a small, compact vehicle. The project is about creating a machine that makes farming considerably easier. Currently, small landholder farmers primarily use work bulls for land preparation. Using them for other farm tasks like as ploughing, harrowing, fertilizer application, sowing, and weeding can boost their utilization and make them more cost effective. Improved hand tools will make farm work easier as well. Throughout the year, oxen can be utilised to draw a cart, which maintains them in shape. Farmers must employ a variety of agricultural equipment and labour to do these tasks; our goal is to reduce the amount of time it takes by utilizing Oxen. The use of a ploughing machine reduces the amount of work required by humans [2]. Dhatchanamoorthy et al. worked on a project to design a multipurpose agricultural vehicle that could be used for ploughing, sowing, and harvesting. The modification entails the construction of a small, compact vehicle. The project is about creating a machine that makes farming considerably easier. The vehicle's chassis has been designed in such a way that it is acceptable for operations. The design for seed sowing equipment that is automatic has been completed. The plough is created and adapted to withstand the load from the currently available plough tool. Scotch yoke mechanism is used to design and operate the harvester (cutter) [3]. The major objectives of these procedures, according to Gorane et al. are to lay the seed, fertilizer, and seeds at the proper distance from each other with proper soil compaction. Increased population need necessitates the implementation of innovative cropping techniques in the farming industry to meet the demand. The most basic needs for a seed sowing machine are that it be simple in design and construction, and that it be inexpensive to farmers on a tight budget. Farmers will find it simple to handle and repair. The major goal of this project is to lower machine costs while increasing yield [4]. Hanumesha Pujar et al. worked on designing and fabricating a versatile agricultural vehicle that can do tasks such as products transport, pesticide spraying, inter-cultivating, and ploughing. These activities take place on deep sandy loam soil. Some modifications were made, including the fabrication of a tiny vehicle that can be readily moved in the fields. In India, farmers still choose to cultivate using hand tools because tractors require resources that many farmers cannot afford. In agriculture, the requirement for improvisation is critical, and it is critical to bridge the gap between farmers and technological deployment. The implementation of enhanced resource conserving farming systems is crucial to the improvement and sustainability of crops [5]. According to Kamaraj et al. most of the implemented solutions for cultivation have been determined to be out of reach or pricey for impoverished farmers or small-scale farming. However, the Indian government is now focusing more on new techniques and technologies to boost agricultural activities in a more cost-effective manner. Previously, farmers had to rely on tractors or other fuel-consuming devices or vehicles to speed up the process, which, in turn, increased air pollution. We discovered a low-cost, simple method for poor farmers to cultivate small plots of land. The design of a multi-purpose

farming tool fitted mobility cycle was done after taking into account a few key criteria, such as lowering cultivation costs and increasing mobility [6]. Ploughing, sowing, and fertilizing were among the key duties carried out by Mebrhit et al. The oxen-drawn plough has been used in farming for thousands of years. However, this approach is labor-intensive, time-consuming, and has a shallow ploughing depth. These flaws in the current agriculture system result in low productivity. Modern agricultural machinery is being imported into the country these days. However, just a few organisations, tiny agriculture investors, and a few wealthy farmers use them. In the issue of its cost-effectiveness for poor Ethiopian farmers, the researchers conducted a cost analysis and concluded that it is low-cost. The simultaneous ploughing, seeding, and fertilizing of many lines, as well as the seeding mechanism, are all unique elements of this innovative design. Its control system's link with wheel rotation, its ease of operation and maintenance, its low seed damage during the process, its high level of operational reliability, and its suitability for customization according on the user's capacity. As a result of adopting this machine, the majority of Ethiopian farmers will see significant increases in productivity at a cheaper cost [7]. The project's major goal, according to Panneerselvam et al. is to design and manufacture an automated onion planting machine. The onion (Allium cepa L) is one of the most widely farmed crops in India and internationally, both for domestic consumption and export. Farmers who cultivate onions face difficulties planting onion seedlings due to a labour shortage during the planting of onion harvests. As a result, the need for an automated onion planting machine grew. To create the automated onion planting machine, several physical variables such as soil, weather, plant, seedlings, and soil fertility were determined. The automated onion planting machine uses automation to plant onion plants in a straight row with a predetermined interval between each plant. The automated onion planting machine was developed with automation in mind to save farmers time and labour costs when planting onion plants in a row [8]. The major goal of this study, according to Rohan Patel et al. is to develop and build a smart solar-powered seed sowing machine that can mechanically plant seeds in the field based on variable pitch input from farmers via the equipment's keypad. This intelligent gadget is both cost-effective and simple to use for Indian farmers. The goal is to offer the ability to add the number of seeds to be sown using a keypad. Furthermore, because this vehicle is solar-powered, the farmer does not have to worry about charging. Land and crop analyses are used to determine which design considerations to take into account. Ploughing, grass cutting, fertilizer spraying, and cushioning mechanisms are also included in this machine [9]. This review paper by Sagar et al. provides a brief overview of semi-automatic seed feeding vehicles. The main purpose of this semi-automated seed feeding vehicle is to inseminate the seed to the desired depth and space, and then cover the seed with dirt using a closing jaw or furrow closer. This equipment is also employed in the furrow to feed the seed according to the depth. This semi-automated seed feeding vehicle will not harm the soil, but it will boost crop output overall. This equipment minimizes the amount of time and money it takes to feed the seed [10]. Weeds drain water and nutrients from the soil, preventing desired plants from getting enough nutrients, according to Tajuddin et al. As a result, weeds in the field must be eliminated. Mechanical and chemical approaches are primarily used to control weeds. Each of these strategies has advantages, and a prudent farmer will employ one or a combination of them to effectively and economically control weeds [11]. This project manual method of seed planting, according to Vaibhav et al., results in low seed placement, spacing efficiency, and considerable back pain for the farmer, limiting the extent of field that can be sown. Most of our farmers' purchasing power has been surpassed by the cost of imported planters. If drudgery can be reduced or eliminated from their planting procedures, happy farmers can do a lot to boost food output, especially grain production. The foregoing constraints must be optimised by careful design and selection of the components necessary on the machine to suit the needs of crops in order to produce the optimum performance from a seed planter [12].

4. DESIGN

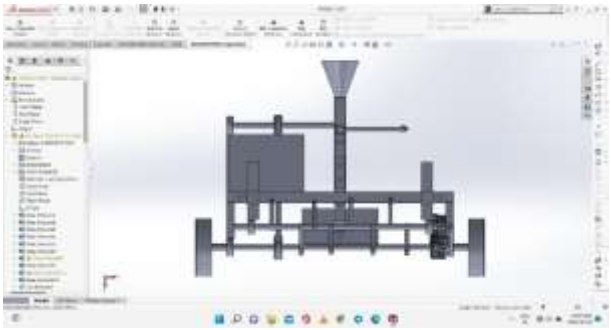

Fig 8. Front View

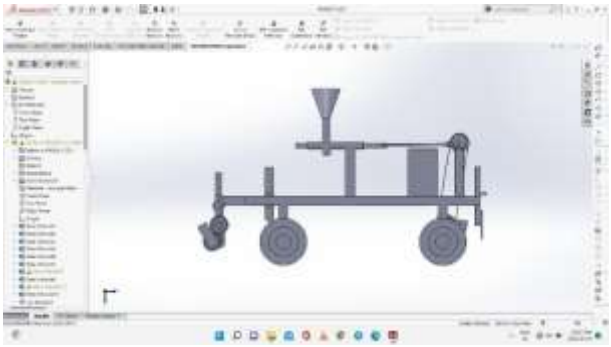

Fig 9. Side View

5. CALCULATION

Dimension:

Length - 914 mm

Width - 609 mm

Height - 586 mm

Battery:

12 volt, 7 amps

Battery watts = volt x amps

= 12 x 7

Battery watts = 84 watts

Motor:

Speed = 30 rpm

Voltage = 12 Volt

Power = 18 Watt

Torque of the Motor:

Torque = (P x 60) / (2 x 3.14 x N)

Torque = (18 x 60) / (2 x 3.14 x 30)

Torque = 5.72 N-m

Torque = 5.72 x 10^3 N-mm

Water pump:

12 volt, 70 psi, 4 liter per minute

Spur Gear:

Power = 18 W

Speed = 30 rpm

Torque (P x 60) / (2 x 3.14 x N)

Torque = (18 x 60) / (2 x 3.14 x 30)

Torque = 5.72 N-m

Torque = 5.72 x 10^3 N-mm

The shaft is made of MS and its allowable shear stress = 42 MPa

Torque = 3.14 x f_s x d^3 / 16

5.72 x 10^3 = 3:14 x 42 x d^3 /16

D = 8.85 mm

The nearest standard size is d = 9 mm.

Dimension of pinion:

$D_p = m\ T_p = 2 \times 24 = 48$ mm

D_p = 48 mm

$D_g = m\ T_g$

= 2 x 96

D_g = 192 mm.

Tangential load on the tooth (Ft):

$F_t = 477.45 / m$

$F_t = 1592.35 / 2$

$F_t = 239$ N

Calculation:

No of teeth on pinion = 24

No of teeth on gear = 96

Solutions:

Pitch line velocity = v

$= (3.14 \times D_p \times N_p) / (60 \times 1000)$

$= (3.14 \times m \times T_p \times N_p) (60 \times 1000)$

$= (3.14 \times m \times 24x\ 30) / (60 \times 1000)$

Pitch line velocity, v =0.0377 m m/s

Assuming steady state load conditions and 8-10 hour of service per day then the service factor $C_s = 1$ (from data book).

Then the tangential tooth load:

$F_t = (P \times C_s) / V$

$F_1 = (18x\ 1) / 0.0377$ m

$F_t = 477.45 / m$ N

Also, the tangential load using Lewis's equation

$F_t = f_0 \times C_v \times b \times 3.14 \times m \times y$

Were,

Velocity factor $C_v = 4.5 / (4.5 + V)$

Velocity factor $C_v = 4.5 / (4.5 + 0.0377m)$

Tooth form factor $Y_p = 0.154 - (0.912 / T_p)$

Tooth form factor $Y_p = 0.154 - (0.912 / 24)$

$Y_p = 0.116$

Similarly

Tooth form $Y_g = 0.154 - (0.912 / T_g)$

Tooth form $Y_g = 0.154 - (0.912 / 96)$

$Y_g = 0.1445$

$fo_p \times y_p = 42 \times 0.116 = 4.872$

$fo_g \times y_g = 42 \times 0.1445 = 6.069$

From the above value the pinion is weaker.

Tangential tooth load = $f_o \times Cv \times b \times 3.14 \times m \times y$

$477.45 / m = 42 \times (4.5 \times 10m \times 3.14m \times 0.116)$

$2148.525 + 17.99m = 688.76\ m^3$

Solving the equation

m = 1.467mm

m = - 0.733 mm (negelecting)

Take m-2 mm

Face width b = 10m = 10 x 2 = 20mm

6. RESULT AND DISCUSSION

Our multipurpose agricultural equipment can be used for weeding, ploughing, sowing, leveling and water spraying. All the parts are connected in such a way that in every stage of agriculture the equipment can be rearranged or easily assembled with fasteners to required length and specifications of field operation.

Our team has successfully combined many Ideas from various fields of mechanical engineering and agricultural knowledge to improve the yield and by reducing the labor effort and expenses. The whole idea of multipurpose equipment is a new concept, patentable and can be successfully Implement in real life situations.

Fig.10 Fabricated model

7. CONCLUSION

This multipurpose agriculture machine has considerable potential to greatly increase productivity. Other countries of the world where the two-wheel tractor is the main traction unit in farming. The main task now is to promote this technology and have available to farmers at an affordable price. It can be readily made from local components in workshops. The only specialized items required are the seed meters plunger which can be sourced at an inexpensive price from local promoter and plunger is easily manufactured. By using of this machine, achievement of flexibility of distance and depth variation for different seed plantation is possible. The traditional method of seed sowing has many disadvantages such as need more manpower, high cost etc., With the adaptation of this multipurpose agriculture 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.

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