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Analysis And Experimentation On Solar Operated Multifunction Agriculture Machine

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Abstract- Approximately 70% of people in India make their living from agriculture. A variety of tasks, including planting seeds and plough work, are essential in the agricultural sector. The methods now in use for these jobs are difficult and need costly and heavy machinery. In order to improve India's agricultural system, a method that minimises time and manual labour must be developed. The goal of this project is to create a solar-powered soil-plow and seed-spreading robot. The system as a whole runs on solar power, offering a sustainable alternative. This solar-powered seed-spreading and soil-ploughing device is intended to help farmers in isolated locations without easy access to fuel. This concept, if put into practice on a commercial basis, may help approximately 70 percent of Indian farmers as well as meet the demands of little gardens that are starting to appear in urban areas. This demonstrates the machine's excellent efficiency and flexibility in handling different agriculture circumstances with in this research we have done FEM analysis actual experimentation on multipurpose agriculture machine.

Keywords—Solar panel, Battery, Adapter, seed spreader, Soil Ploughing etc.

I. Introduction

India's economy has always been based on agriculture, which is both the art and science of farming that involves raising cattle, cultivating crops, and preparing land. Small-scale farming has historically predominated, with farmers preparing the ground, planting, weeding, and harvesting it using hand labour and traditional implements including wooden ploughs, yokes, levellers, harrows, mallets, spades, and huge sickles.

However, due to their high cost and difficulties of acquisition, small landholders continue to embrace modern agricultural methods and tools at a restricted rate. Many farmers still use antiquated farming practices despite the possibility for scientific farming approaches to increase output and crop quality. This is frequently because they lack expertise or cannot afford to buy current equipment.

Our suggested concept is to develop a multipurpose agricultural equipment that is managed by motorised elements via a connected control panel in order to overcome these obstacles. The main goal is to create an model analysis and experimentatation on machine by using ANSYS Software for various forum.

The suggested design effectively combines mechanical and electrical systems in an effort to cover a range of agricultural characteristics. The ultimate objective is to improve farming methods by offering farmers a practical, cost-effective solution that integrates contemporary technology.

II. Problem Identification

Many nations, like India, are currently experiencing a labour shortage in the agricultural sector, which is having an adverse effect on the development of emerging countries that primarily depend on agriculture. India's population growth is creating a greater demand for food, which means more crops must be produced per acre. In order to tackle these issues, farmers have to adopt the most recent technology developments for different agricultural tasks, such planting, tilling, and watering, in order to maximise productivity and minimise waiting times.

Planting seeds in the proper depth and with a precise distance among each pair of sown seeds is a crucial part of the sowing process. Using a seed sowing equipment that excavates trenches and plants seeds, this goal may be accomplished. The machine spreads the seeds and then packs dirt over them once they are placed in the furrow. Incorporating soil ploughing and seed spreading capabilities into a single device not only minimises labour costs but also saves time, assuring optimal seed broadcasting.

III. Fabricated machine

Fig. 1. Block Diagram of system

Working Principle

1) This machine incorporates a solar panel to harness solar energy, converting it into electrical energy. The electrical energy generated is stored in a 12V battery with a capacity of 14 Amp Hours. Subsequently, this stored energy is utilized to power a high-torque DC motor. The power from the motor is then transmitted through a gear and chain mechanism, propelling the entire machine.
2) The farm field is going to be ploughed to produce a furrow to hold unsown seeds because of the shear deformation caused by the cutter's teeth.
3) The dc motor attached to the seed spreader rotates, dispersing the seeds throughout the ground. Rotation torque is produced by ground contact. Because of their own weight, seeds will fall from the perforations onto the ground.
4) The fundamental goal of soil ploughing is to arrange seeds in rows at the desired depth, ensuring seed-to-seed spacing, covering the seeds with soil, and facilitating proper compaction over the seeds. Recommended parameters such as row-to-row spacing, seed rate, seed-to-seed spacing, and depth of seed placement may vary for different crops and under various agro-climatic conditions to achieve optimal yields.
7) The forward movement of the vehicle and the rotation of the seed roller are achieved by pulling the machine with the assistance of a high-torque DC motor, which in turn rotates the wheels.
8) The fabrication process encompasses multiple steps, including the cutting and welding of mild steel, cutting of the solid shaft, cutting and welding for the cutter, ball bearing clamping, DC motor bolting, slot creation for lateral DC motor movement, clamping of batteries and solar panel, and wiring and clamping for the seed spreader and adjuster.

IV. Selection of Materials

- **Selection of Electric Motor**

To facilitate effective soil ploughing and machine movement, it is recommended to have a motor power with at least 100 kg torque, a rotational speed of 3,000 rpm, and the capability to produce a shear force of approximately 10.5 N.

-Mounting the motor
To achieve proper mounting of the motor onto the mower deck, it was crucial to focus on centering and secure attachment. This involved measuring an equal distance from the sides of the motor to the outside diameter of the mower, ensuring a centered position.

- **Bicycle Rim**

The bicycle rim is of 20 inch in diameter. Sprocket is mounted on the rim and with the help of the chain the desired motion is achieved.

-Mounting the front wheels
Affixing the front wheels onto the motor shaft with gear and chain mechanisms presented a substantial challenge during the mounting process. After experimenting with various methods, we ultimately settled on a specific approach, choosing welding as the preferred method.

- **Mounting the battery**

After successfully mounting the motor, the next task was to determine an appropriate location for the battery. Building upon the details of the motor mounting section, where the base of the motor faced the rear of the mower, providing a stable surface for the battery mount. To achieve optimal weight distribution, the goal was to position the battery as close as possible to the back wheels. This placement strategy would leverage the handlebars as a lever, facilitating easy pivoting when the mower is on its back wheels.

- **Mechanical arrangement**

During the first stage, we were just interested in the mechanical configurations that drove the dynamo. The group split the work into two sections, one of which was in charge of the mechanical setup,

- External framework
- Solar frame
- **External Framework**

The outside structure is made up of four pairs of rectangular hollow pipes that are welded together to form pillars, and it has an inch diameter. The platform's surface is supported by these pillars.

- **Solar framework**

Iron cylinder hollow pipes are welded into a rectangle to form the solar frame, which holds the solar panel. The battery and the five-watt solar panel are connected.

- **Speed Regulator**

  Speed control is an electric circuit used to control the speed of the motor. This control is done by the knobs which are linked to the potentiometer provided in the circuit. Through this, the operator can change the motor speed according to the requirements. This gives the required operational speed. The speed can be controlled by altering the voltage with the help of knobs.

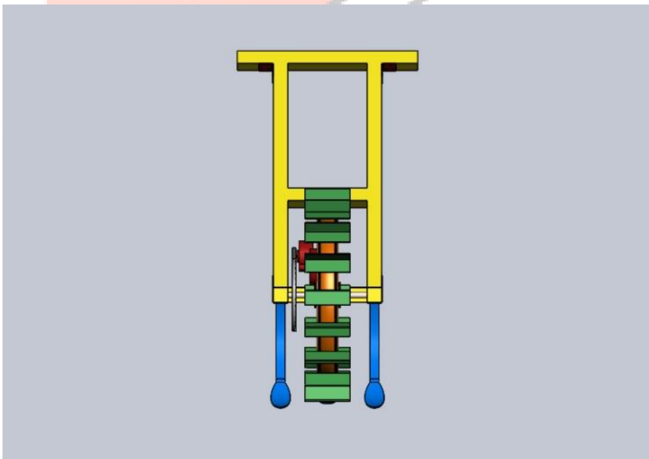
- **Chain**

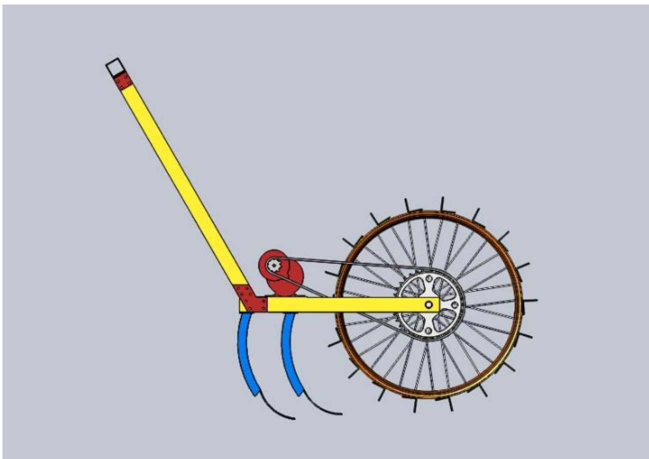
For transferring the power from drive sprocket to driven sprocket, a pintle chain was used for heavy-duty, slow-speed work in any exposed atmosphere. It is made of malleable links, held together by suitable pins. The pitch of the chain is 12.7cm.

V. Design and Calculation

Design:

Fig..2 Cad design with dimensions





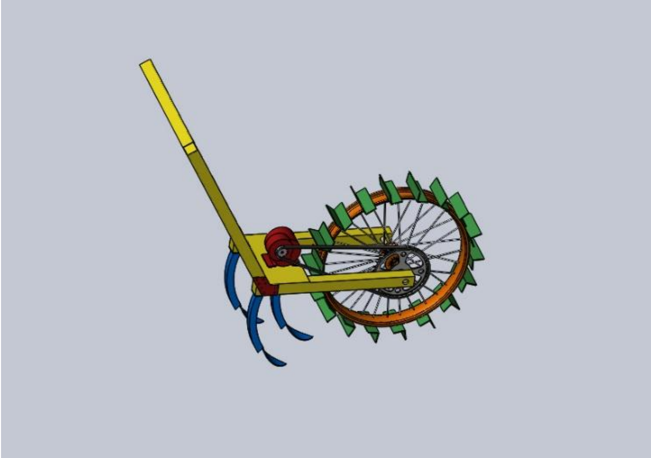


Fig.3. CAD model of frame structure

Calculation:

Power requirement

Assumption for power requirement is as follow ,

Soil resistance has a considerable effect upon the power requirement of tiller. Also width of cut and speed of operation influences power requirement of tiller. For calculating power requirement of the tiller, maximum soil resistance was taken as 0.8 kgf/cm2. The speed of operation of the tiller was consider as 0.7m/s to 1m/s. Total width of coverage of tilling blades was in the range 20 to 30 cm. The depth of operation was consider as 5 to 8 cm. transmission efficiency is 79% Power developed = hp.

Where,
SR= soil resistance, N/m2
d = depth of cut, m
W = effective width of cut, m
V = speed of operation, m/s
Soil Resistance (S.R) = 0.8 Kgf/cm2 =78480 N/m2
Hence power requirement is estimated as
Pd=2.5248 hp
Total power required
Pt =
Pt= 3.1959 hp =2.3831 kW
The total power required for power tiller 3.1959 hp i.e.3.5 hp.

c= traction efficiency for the forward rotation of rotor shaft as 0.9,
z= coefficient of reservation of engine power (0.7-0.8), u= minimum tangential speed of blades, u=
u =1.47445 m/s
Where,
N = Revolution of rotor, rpm, and R = Radius of rotor, cm. Ft=73.24 kg
After substituting values for revolution of rotor shaft (176 rpm) and its radius as 8 cm in above equation, tangential peripheral speed was obtained as 1.47445 m/s. Using the tangential peripheral speed and other parameters in equation and the maximum tangential force was determined to be 73.24 kg.
The maximum moment on the rotor shaft (Ms) is calculated through the following:
Ms= Ks * R
Ms =73.24 * 8
Ms =585.92 kg-cm
In the above equation, R is the rotor radius (cm).

The yield stress for rotor is made by rolled steel (AISI 302) was 520 MPa. The allowable stress on the rotor (τall) was calculated by the following equation τall=
Where,
τall = Allowable stress on rotor shaft, kg/cm^2, k = Coefficient of stress concentration (0.75),

f = Coefficient of safety (1.5), and σy = Yield stress, 520 MP
τall=150.02 MP= 1530.6 kg/cm2,
By substituting above values in the following equation, rotor shaft diameter was calculated as:
D=12.492=14 mm
In order take into account fluctuating load during the operation, diameter of the rotor shaft was selected higher than the calculated value as 14 to 16 mm.

VI. RESULTS AND DISCUSSION

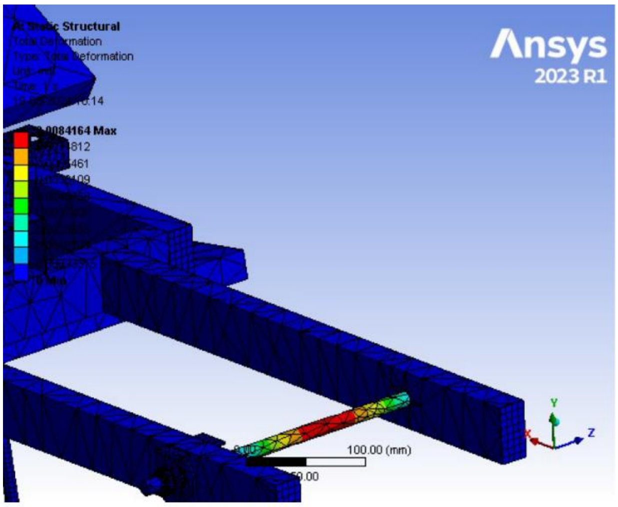
To reduce or eliminate more time consumption, hard
work and high cost from traditional power tiller. New
power tiller is designed which -

- Provides more comfort and generates less fatigue to the operator.
- Increases productivity in farming.
- Provides ease of use and operation of the tiller machine.
- Provides an economical alternative for small scale farming.

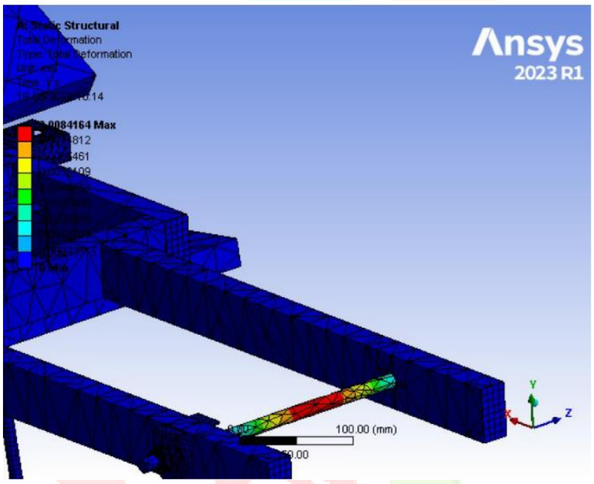
The power tiller is most suited for usage in hilly locations, moist conditions, and on small farms because it can do both primary and secondary tillage operations. The power tiller, with the correct set of tools and attachments, can handle most of the field operations in intensive cultivation. The lightweight power tiller makes it ideal for working in both wet and dry situations. Depending on the type of work, external attachments can be added to the tiller. As a result, the tiller can be utilized for a variety of tasks.

Discussion:

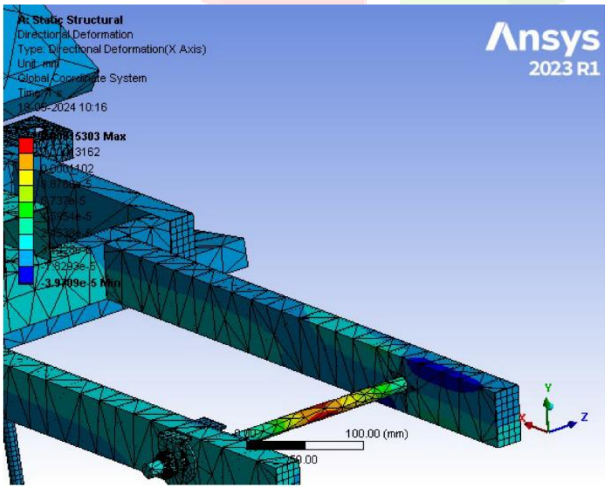
FEM Result



Total Deformation



Deformation in x direction



Equivalent stress

Project Model Image:

Fig.4. project model

Our project is solar operated electric power tiller; it is implemented for emphasis on minimization of harmful efforts of using the manual power tiller. We made it in college workshop. The power tiller with a new design and operated by electric motor and battery. We were referring most of the referral matters to successfully done our project on our best level.

Electric power tiller is actually solar operated means its renewable type as such that which will be advantageous for future agricultural site.

Parameter	Solar operated electric power tiller
Time required to remove weeds in 450 square feet area	At low speed (60 rpm) – 40 mins
	At high speed (96 rpm) – 30 mins
Depth of blade	70 mm
Charging time	1. *40 mins with AC supply of 240 volts* 2. 8 hrs with average sun light intensity of $1 Kw/m^2$

VII. Conclusion

The outcomes obtained will significantly benefit individuals undertaking the project for further modifications. This project is particularly well-suited for farmers, offering numerous advantages such as no fuel cost, no pollution, and minimal fuel residue for their agricultural functions. Its efficiency is enhanced by the presence of fewer moving components, resulting in less wear and tear. Additionally, the operation is powered by solar energy, providing a sustainable and environmentally friendly solution.

Furthermore, this system encourages physical exercise for individuals and is designed for easy handling. A notable feature of the system is its capability to charge the batteries while the solar-powered seed spreader is in motion, making it highly suitable for crop cutting activities. Moreover, the system can be operated at night, utilizing the stored energy from the batteries charged during daylight hours.

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