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# Design and Fabrication of Solar Powered Mulch Laying Machine

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## ABSTRACT
The use of mulching, especially plastic mulching is a popular method for conserving soil moisture, controlling weeds, and regulating soil temperature. However, the process of laying mulch paper can be time-consuming and expensive for farmers. To address this issue, a Semi-Automatic Mulch paper laying machine with a hole punching attachment has been developed. This machine is designed to lay plastic mulch paper on prepared plantation beds while simultaneously punching holes at the required measurements. The machine has a mainframe with hoeing blades, hole punching wheels, and punching mechanism, as well as a solar panel and battery assembly. The product is suitable for cultivating crops such as tomatoes, watermelons, muskmelons, and some other hybrid varieties. By using this machine, farmers can reduce labor costs and time spent laying mulching paper while also maintaining moisture in the soil and avoiding demoisturization. This innovative approach will provide a more convenient and efficient way of laying mulching paper while improving crop productivity and reducing water requirements.

Key Words:
**Solar powered machine, semi-automatic mulching machine.**

## I. INTRODUCTION
Mulch, being a natural resource, has become one of the most effective technologies for optimum yield and quality enhancement of crops besides reducing the cost of production. The use of plastic mulch in agriculture has been increased dramatically in the last 10 years throughout the world. This increase is due to the benefits such as increase in soil temperatures, easy of weed management, moisture conservation, reduction of certain insect pests, high crop yields, less crop contamination, less soil compaction and improved germination rates and more efficient use of soil nutrients (Gowd and Prasad, 2017). These benefits lead to higher yields (by up to 100% for certain crops) in early duration crops (by upto one month) and in some case the ability to grow certain crop, which would not be possible without the mulch film (Clarkson, 1957). According to Reynolds (2009), Globally every year over 80,000 square km of agricultural lands are covered with plastic mulch films. Plasti-culture is the art of using plastic materials to modify the production environment in vegetable crop production. They are used commercially for both vegetables and small fruit crops. To be more competitive in today's markets, vegetable growers are looking for new ways to achieve higher-quality produce, superior yields, and early spring markets. The plasticulture system–which combines raised beds, plastic mulch, drip irrigation, and fumigation has helped an increasing number of producers reach these goals. Growers using the plasticulture system have doubled and tripled yields and harvested their crops two to three weeks earlier than is possible with traditional growing practices. Agricultural work in Use of mulching machine in India is increasing day by day.
Nowadays in India, it is necessary to do farming in smart way to save the natural resources. Most of the farmers use different agricultural methods to cultivate their cereal. But during the period of seeding and harvesting they spend lots of money on labours and on old water feeding technique to the plants, and lastly they will not gain that much as they wished or they deserved. So for all those farmers mulching machine is the best way to recover and redeveloped farming in foreign style. Traditional; manual mulching process characterized as labour intensive, poor quality of work, disturbances due to wind during laying of mulch sheet, tearing of sheet during handling and difficulty in the covering of mulch sheet. Presently, for laying plastic mulch sheet manually and laying operation are 3 to 4 labours are required. India is carried out by using manual, animal and mechanical power sources. Power operated machine is economical but needed specific characteristics for effective working such as high land holding, uniformity in the topography, needed road facility to reach the machinery in the field as well as high hp power sources (high hp tractor) to operate the machine. Journal of Pharmacognosy and

Phytochemistry such conditions are not possible to maintain in the Chattisgarh. There is need to develop a mulching machine which can be suitable to operate in Chattisgarh condition, operated by animal, easily possible to transport in the field, effective in operation, minimizing the labour forces involved in operation and economical to use for small farmer

## 2. LITERATURE SURVEY:

1. **Swapnil Sutar, Rajesh Yangar, Pawan Patil, Sangram Bhosale & Prof. U. Y. Sidhha:**
   Plasticulture is crucial to Indian agriculture in view of the changing technological scenario for boosting crop yields and productivity. Introduction of linear low-density polyethylene (LLDPE) as a mulch film has brought a revolution in agricultural water management. It is actually a boon to dry-land farmers. This is one of the fastest growing plasticultural applications in the world. The cost of LLDPE film is also lesser than one third of LDPE mulch film. Moreover, for mulch activity lower thickness (15 to 20 microns) is highly suitable. However due to ever increasing cost of raw materials the films are costlier now. Hence Government should take all possible measures to produce the film in a mass scale and make it available to the farmers at a reasonable price. Subsidy may also be given through banks to encourage the farmer to adoption soil mulching. Low cost machines may be developed for spreading and rolling down the film in the field. PFDC's may be geared up for large scale demonstration in farmer's field to give a wide publicity.

2. **Chitra Madhu Sudhan Gowd & Prof. B. Durga Prasad**:
   Developed a machine which lays plastic mulch at the exact position on the prepared plantation bed and secures it with soil. The laying of plastic mulch, drip pipe and hole punching will be done in one pass. The machine was developed for the mulch width of one meter length. A 100cc IC Engine was used for motion of the machine. The chain drive mechanism was used for motion transmission from the engine to the rear wheel setup.

3. **Harshwardhan D. Jadhav, Jitendra J. Kadam, Anil D. Karche, Hanumant P. Kharat, WasnikMonish:**
   Mulching has become an important practice in modern field production. Mulch paper reduces the application of chemical fertilizer and herbicide, weed control and maintain the land temperature. This article reviews the published research on paper mulches and discusses the opportunities that they solving the problem in agriculture.

## 3. PROBLEM STATEMENT:

Most of the available techniques are efficient for performing a particular task like laying mulch or punching a hole in the mulch paper. There are integrated machines but they are either expensive or too big to be operated in small scale farms. The aim of the project is to build a small size portable machine which integrates all the above mentioned tasks like laying paper as well as drilling holes and will perform efficiently. Such a machine reduces the efforts and saves time taken for laying the mulch paper and making the hole for sowing the seeds separately.

- To design a mechanism for mulch paper laying and drilling the hole, and it can be operated by 1 or 2 persons easily.
- To Design a Semi-automated mulching machine that can lay the mulching paper and drill a hole as in a single pass

## 4. METHODOLOGY

The machine is powered by a solar-powered battery, which provides the necessary energy for its operation. This makes it environmentally friendly and reduces dependence on external power sources. The operator controls the machine by using a handle and pulling it towards the bed. As the machine is pulled forward, the wheels start to rotate, and a mulching paper roll is placed under the front wheels. This causes the mulching paper roll to unwind as the machine moves forward. The unwound mulching paper is laid on the soil bed as the machine moves forward. The paper is fed through a roller-operated mechanism, ensuring a smooth and even distribution of the mulching material across the bed. The machine features a paper punching wheel mounted on the front wheel. As the machine's speed varies, the cutting wheels' speed also varies, resulting in holes being punched at a fixed length regardless of the machine's speed. The cutting wheels are operated using a self-weight mechanism, utilizing gravitational force to punch holes in the paper. After the mulch paper laying process is finished, the machine utilizes a ploughing blade to plow the soil on the sides of the bed. This helps secure the mulch paper tightly, preventing it from getting loose. The ploughing depth can be set to keep the paper at a desired height, typically between 7 to 10 cm.

## 3. MATERIAL USED

### MULCHING PAPER

Mulch is a layer of material applied to the surface of an area of soil. It is designed to conserve moisture, improve the fertility and health of the soil and control weed growth. Soil mulching also reduces the need for pesticides, fertilizers and irrigation. The technique of mulching is the easiest practice that you can undertake for your garden that will produce unimaginable results. Mulch comes in two basic forms organic and non-organic. The most frequent items used in organic mulching are grass, straw and bark. While the most frequently used items in non- organic mulching are stones, small chips of brick and even plastic. Taking the mulching task into your own hands can save you huge costs compared to having it done professionally.

Mulching paper

**Metal Frame (Mild steel, 1 inch sq tube):**

The metal frame is generally made of mild steel bars for machining, suitable for lightly stressed components including studs, bolts etc. It can be case hardened to improve wear resistance. They are available in bright rounds, squares and flats, and hot rolled rounds.

Suitable machining allowances should therefore be added when ordering. It does not contain any additions for enhancing mechanical or machining properties. Bright drawn mild steel is an improved quality material, free of scale, and has been cold worked (drawn or rolled) to size. It is produced to close dimensional tolerances. Straightness and flatness are better than black steel. It is more suitable for repetition precision machining. Bright drawn steel has more consistent hardness, and increased hardness. Bright steel can also be obtained in precision turned or ground from if desired.

Mild steel

**Solar Panel (12V, 10Watts):**

A solar panel is a device that collects photons of sunlight, which are very small packets of electromagnetic radiation energy, and converts them into electric current that can be used to power electric loads. Using solar panels is a very practical way to produce electricity from many applications. The obvious would have to be off-grid means living in a location that is not serviced by the main electric utility grid. Remote homes and cabins benefit nicely from solar power systems. No longer is it necessary to pay huge fees for the installations of electric utility poles and cabling from the nearest main grid access point. A solar electric system is potentially less expensive and can provide power for upwards of three decades if properly maintained.

Solar Panel

**Battery (2nos x 12v, 5-7ah):**

In isolated systems away from the grid, batteries are used for storage of excess solar energy converted into electrical energy. The only exceptions are isolated sunshine load such as hydraulic pumps or drinking water supplies for storage. In fact for small units with output less than one kilowatt.

Batteries seem to be the only technically and economically available storage means. Since both the photo-voltaic system and batteries are high in capital costs. It is necessary that the overall system be optimized with respect to available energy and local demand pattern.

Battery

**Wheels (4nos x 13 inch):**

A Wheel is a circular component that is intended to rotate on an axial bearing. The wheel is one of the main components of the wheel and axles, allow heavy objects to be moved easily facilitating movement or transportation a load, or performing labor in machines. Wheels are also used for other purpose, such as a ship's wheel, steering wheel, potter 's wheel, and fly wheel.

Common examples are found in transport applications. A wheel greatly reduces friction by facilitating motion by rolling together with the use of axles. In order for wheels to rotate, a moment needs to be applied to the wheel about its axis, either by way of gravity, or by the application of another external force or torque.

Wheels

**Drive motor (4nos x 12V, 60rpm, 60kgcm):**

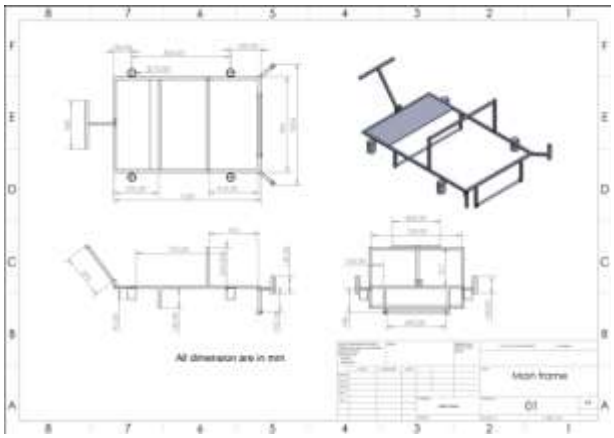
A torque motor is a specialized form of electric motor which can operate indefinitely while stalled, that is, with the rotor blocked from turning, without incurring damage. In this mode of operation, the motor will apply a steady torque to the load (hence the name). A torque motor that cannot perform a complete rotation is known as a limited angle torque motor.

A common application of a torque motor would be to supply and take-up reel motors in a tape drive. In this application, driven from a low voltage the characteristics of these motors allow a relatively constant light tension to be applied to the tape whether or not the capstan is feeding tape past the tape heads. Driven from a higher voltage, (and so delivering a higher torque), the torque motors can also achieve fast-forward and rewind operation without requiring any additional mechanics such as gears or clutches. In the computer gaming world, torque motors are used in force feedback steering wheels.

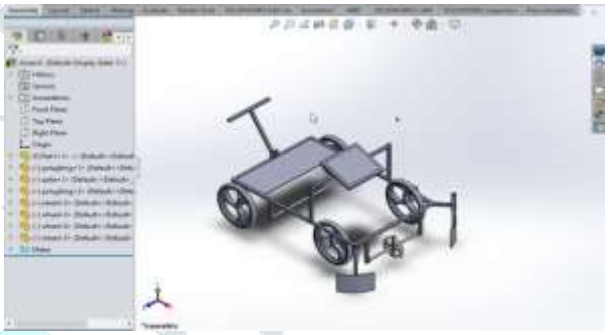
This motor will be bit noisy while running. For long life, this motor is not recommended for application requiring dynamic torque of more than 60 kg-cm.

Drive motor

## 4. DESIGN OF THE MODEL



Frame structure of the machine



3D model of the machine

Machine model

## 5. THEORETICAL DESIGN CALCULATIONS

In the numerical simulation, a model was implanted with unlimited variations to produce complex scenarios. These capabilities allow the analysis and understanding the interaction of each element in the system. Firstly, the design of the model must be developed. The model represents the system itself, whereas the simulation represents the operation of the

system overtime. To conduct a simulation and fabrication, a design calculation is introduced and applied.

$$W = mg;$$

DC Motor:

The motor is being used of 12volts and 12Watts.

Since the motor is of 12Watts and from the battery it is required the power of 12Watts hence the battery can deliver the power to the motor.

Motor speed=N= 60rpm

Power=12watts

$$P = \frac{2\pi NT}{60}$$

$$\therefore T = \frac{P \times 60}{2 \times \pi \times N}$$

$$= \frac{12 \times 60}{2 \times \pi \times 60}$$

T = 1.9096 N-m

Machine speed:

Diameter of the wheel = 13inch = 330mm

Motor speed = 60rpm = 1rps

Machine speed = (2πr) x (motor speed in rps)

$$= (2 \times \pi \times \frac{330}{2}) \times (1)$$

= 1032.7 mm/sec

= 1.0327 m/sec

## 6. ADVANTAGES

1. Increase in Crop Yield.
2. Reduction in Weed growth.
3. A good alternative to Costly Machines.
4. Multifunction like laying mulch and Hole Making attachment.
5. Good crop yield in low water availability areas.
6. Simple working and easy to use
7. Even unskilled worker can use it.
8. Prevents soil erosion

## 7. APPLICATIONS

1. In the application of mulches to cultivated fields it has been customary to lay the mulches, which comprise long strips of paper of appropriate width done up in rolls, by hand to cover either the planting area of the plant rows, or to cover the area between the planting rows and, in order to prevent the mulches from being blown away by the wind or disturbed by other conditions.
2. This system is widely used in the field of horticulture.
3. Normally used in the fields of fruits.

## 8. CONCLUSION

The laying of plastic mulch film entails considerable time, labour expenditure and is extremely tiring. Laying of plastic mulch film by means of machines increases efficiency and results in less expenditure on labor. The increasing demand for horticultural produce and health consciousness among people it has become imperative for us to produce more as well as good quality produce to sustain in the international market. Plasticulture is crucial to Indian agriculture in view of the changing technological scenario for boosting crop yields and productivity. To minimize the time consumption and capital requirement during laying operation and to increase the efficiency, with low cost, it demands appropriate technology. Since the majority of farmers are small and marginal using the manual as a source of power, an effort he has been made to developed semi-automated solar powered mulch laying machine. The developed semi-automated solar powered mulch laying machine was fabricated for laying mulch film and punch hole on the pre-prepared bed for different vegetable crops in a single pass.

## 9. COMPARISION

| Sl.no | Parameters | Tractor drawn mulching machine | Semi-automatic machine |
|---|---|---|---|
| 1 | Time required to lay the mulch film and punch hole | very high as the punching of hole should be done separately | Comparatively less as the hole punching is done simultaneously when the mulch is laid |
| 2 | Number of labors required | 4 - 5 | Exactly 2 people are enough |
| 3 | Accuracy of operation | As the punching of hole is manual the distance between each hole is uneven | The punching of hole is determined and is even |
| 4 | Initial cost | High | Comparatively low |
| 5 | The machine works on | Tractor and fuel | On solar powered battery |

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