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Design and Development of Manual Mulching Machine with Punching Mechanism

T. Varun Kumar¹, M. Parthasarathy², J. Muhammed Mubeen³, D. Gowtham⁴,

T. Karthik Kumar⁵, K. Arul Prasath⁶

Department of Mechanical Engineering, P.A College of Engineering and Technology, Pollachi, Tamil Nadu, India^{1,2,3,4,5,6}

ABSTRACT: Many farming operations in India, including threshing, harvesting, and transplanting, are costly, timeconsuming, and labor-intensive. Another significant issue is inadequate irrigation. Mulching machines are a practical way to bring farmland back to life. Manual mulching is time-consuming, vulnerable to wind-related interruptions, and produces subpar work, such as sheet tearing. Crop health depends on maintaining soil moisture, especially in arid regions. Plastic mulch aids in weed control, soil preservation, and water conservation. With its punching mechanism, hole-punching wheels, and hoeing blades, our mulching paper laying machine makes the procedure easier by simultaneously laying mulch and punching planting holes. On prepared beds, it effectively spreads mulch and installs drip irrigation without causing any harm to the sheet. This device improves planting efficiency, saves time, and uses less labor for crops including tomatoes, watermelons, and muskmelons. It is especially helpful for small farmers and was made with affordability, portability, and ease of use in mind.

KEYWORDS : Manual Mulching, Plastic Mulch, Weed Control, Soil Moisture, Small Farmers

I. INTRODUCTION

The practice of mulching the soil to promote plant development is known as mulching. In order to preserve soil structure, prevent weed growth, preserve moisture, and shield crops from pollution, both organic and inorganic materials can be utilized. Similar to synthetic mulch, organic mulches can sustain beneficial soil organisms and preserve organic matter, much like plant and animal materials can. Natural mulches, on the other hand, can differ in quality, are frequently hard to find, and can hinder crop growth by spreading weed seeds or slowing soil warming in the spring Because plastic mulch may retain moisture, manage weeds, raise soil temperatures, lower pests, and boost crop yields, it is commonly employed in agriculture. Paper mulch has been tested, although it is typically more costly and less effective than plastic. Both low-value crops like maize and ginger as well as high-value crops like tomatoes, melons, and strawberries are frequently covered with plastic mulch. Water loss from soil can be effectively decreased by using surface cover strategies, such as mulches and tillage practices that leave plant residues. As towns restrict water consumption, more and more gardeners are using mulch to keep moisture in and suppress weeds.By protecting the root zone and changing the plant's developing environment, organic mulches such as wood chips, bark, straw, and grass clippings are particularly beneficial in less-than-ideal circumstances like cool weather or little rainfall.

1.1 TYPES OF MULCHES

Generally there are two kinds of mulches based on the material that is employed. They are as follows:

1.1.1 Organic Mulches

Organic mulches are made from organic resources including farmyard manure, crop residues and byproducts, and forest sector byproducts.

1.1.2 In-Organic Mulches (Plastic Mulches)

When used for mulching, inorganic materials like plastic papers are referred to as inorganic mulches. Plastic mulch can be made available in a variety of colors and thicknesses to achieve the desired effects, even when natural mulches might not always be available.





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II. LITERATURE REVIEW

Mohamed et al (2017) Designed a machine for mulching was created for raised beds of strawberries, which included GR irrigation lines and plastic film coverings. When tested on loamy sand soil, the ideal parameters were a cutting depth of 10 cm, a angle of skimmer turn-over of 120°, an angle of kick-out of 30–40°, and a angle skimmer of 40° at a speed of 1.5 km/h. With GR pipes, the field capacity is 0.43 feddan/h, without them, it is 0.54 feddan/h, mulching efficiency was 100% at 1.5 km/h. The machine cost 30,000 LE, and it costs 178.4 LE each hour to operate. Compared to hand mulching, which costs 900 LE/feddan, mulching without GR pipes cost 330.4 LE/feddan. It took 1.4 years to pay it back.

Omprabha et al (2019) Evaluating by the maximize growing conditions, this study sought to improve plastic culture in the production of vegetable crops utilizing plastic materials. A main frame, press wheel, mulch roller support, soil covering unit, and hitching system were all included in the model of an Plastic mulch laying machine pulled by an animal. Field tests revealed a 0.162 kW power demand, a draft of 447.86 N, and an operating speed of 1.35 km/h. With 69.67% efficiency, the machine's effective field capacity was 0.113 ha/h. With an energy usage of 177 MJ/ha and an operating cost of 1205 Rs/ha, this method outperformed more conventional ones.

Amin et al (2022) Integrated by the development of a tractor-drawn mulch laying equipment reduced labor costs by combining bed construction, combining hole punching, mulching, covering, and drip line installation into one run. It was tested with bed widths of 76.2 cm and 91.4 cm, hole spacings of 15.2 cm and 20.3 cm, 3.0, 5.0, and 7.0 km/h speeds. Field efficiency was increased and draft requirements were decreased by increasing velocity, breadth of the bed, and distance between holes. Missing holes, uncovered mulch, and mulch damage were reduced at 3.0 km/h. The machine cut expenses by 75% and man-hours by 97%; for best results, it was advised to run at 3.0 km/h.

Pawar et al (2023) Evaluating by the Mulching lowers weeds, increases soil fertility, preserves moisture, and improves appearance. Traditionally, mulching and seedbed preparation are carried out independently, which takes a lot of time and effort. A machine that can complete all mulching tasks in a single pass was created in order to solve this problem. Three different speeds were tested: 1.0-1.5, 1.5-2.0, and 2.0-2.5 km/h. The maximum field efficiency (83.07%) was at 1.0-1.5 km/h, while the maximum field capacity was 0.1595 ha/h at 2.0-2.5 km/h. At 1.0-1.5 km/h, the mulch sheet covering efficiency (94%) and fuel usage (3.0 l/h) were similarly the lowest.

III. PROBLEM STATEMENT

Creating a manual mulching machine that can drill holes, lay mulching paper, and do a single pass all at once is a very effective way to improve agricultural practices. The time and labor needed for agricultural cultivation would be greatly decreased by this machine, which would combine several tasks into a single, efficient operation. For ease of manual operation, the machine's design would prioritize a strong yet lightweight structure. While a precision drilling equipment punches holes at regular intervals, a mechanism would be put in place to roll out and fasten the mulching paper. An indispensable tool for small to medium-sized farming enterprises, such a machine would increase planting accuracy, preserve soil moisture, manage weeds, and increase overall agricultural productivity.

IV. COMPONENTS USED

The following table.4.1 components and materials used are listed in the table; mild steel is chosen for pipes, plates, and rods because of its strength and ease of machining. The cycle rim is made more durable by stainless steel, the wheel is made more flexible by rubber, and the steel cup and mulching paper are made of polythene and silver to ensure efficiency and economy.





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S.No	Name of the Component	Material	
1	Square Steel Rod	Mild steel	
2	Steel Plate	Mild steel	
3	Steel Pipe	Mild steel	
4	Cycle Rim	Stainless Steel	
5	Wheel	Rubber	
6	Steel Cup	Silver	
7	Mulching Paper	Polythene	

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Table.4.1 Components

V. MODELING

The mulching machine's design was finished with the help of CATIA V5, a mechanical design program that allows designers to sketch their creative concepts, experiment with various dimensions, and create models and detailed drawings. All of the components of our project, including the wheels, punching setup, and frame of the mulching machine, are designed using CATIA V5 software. Next, use CATIA V5 to put all the components together to create the final result as the shown in fig 5.1, 5.2, 5.3.



Fig.5.1 2D Sketch



Fig.5.2 Machine Frame



Fig.5.3 3D Model Of Machine





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VI. FABRICATION

The fabrication process, which includes drilling, welding, cutting and grinding, was the primary emphasis of this project. These techniques are crucial for forming and putting together materials especially metals for a range of structural and mechanical uses. While welding produces robust, long-lasting couplings between components, drilling guarantees accurate holes for bolts or connections. Cutting enables precise material separation or shaping, while grinding aids in surface finish refinement or dimension adjustment. These procedures work together as the foundation of fabrication, guaranteeing the end product's quality and structural integrity. This following fig.6.1 showcase this project.



Fig.6.1 Manual Mulching Machine with Punching

VII. WORKING PROCESS

The machine's primary function is to punch holes and spread mulching paper over soil beds. By employing the most practical techniques and completing the full process in a single machine pass, it can assist save the initial cost and time required to lay the mulching paper. The operator pulls the machine forward toward the bed while controlling it with the handle. Even when the wheels begin to rotate and paper is positioned beneath the front wheels, the mulching paper roll likewise begins to rotate and unwind as a result. The roller-operated device was used to move the mulching paper. The paper continues to unwind and lay on the beds as the machine advances. Since we know that the paper cutting wheel is mounted on the front wheel that spins with the axle, it also begins to make holes in the paper. Since the cutting wheel's speed fluctuates along with the machine's speed, the holes are formed at a set length and at any pace. The self-weight operated mechanism that powers the cutting wheels allows for the punching of holes, thanks to the force of gravity. There is a hook arrangement on the drum, which the drum will attach to when punching is completed and disengage there. Following the mulch paper laying procedure, the plowing blade aids in plow the dirt along the bed's edges, ensuring that the mulch paper adheres firmly and won't come loose for up to 7 to 10 cm. The manual mulching machine operates in this manner. The following fig.7.1 is the working process of manual mulching machine with punching mechanism.

The project uses three different kinds of working techniques.

- 1. The Process of Mulch Rolling
- 2. The Process of Mulch Laying
- 3. The Process of Mulch Punching



Fig.7.1 Working process of Manual Mulching Machine with Punching





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VIII. RESULT AND DISCUSSION

Mulching devices serve a crucial part in agricultural practices, boosting soil health and productivity by dispersing organic material. These devices exist in numerous configurations, including animal-drawn, tractor-drawn, and manual alternatives, each adapted to unique operational needs and resources. These machines' suitability for various farming scales and conditions can be better understood by comparing them based on factors including power source, labor needs, operating speed, starting cost, maintenance, and environmental impact. By highlighting each type's advantages and disadvantages, this analysis assists consumers in choosing the best option for their agricultural needs. the following table.8.1 is the comparing the other mulchine machines.

S. No	Parameters	Animal drawn mulching machine	Tractor drawn mulching machine	Manual mulching machine
1	Power sourse	Animal (Oxen, Cows)	Tractor and fuel	Human power
2	Number of labors required	4 - 5	2 - 3	1 - 2
3	Speed of operation	Low (animal speed)	High (faster)	Moderate (manual speed)
4	Initial cost	Low	High	Low
5	Maintenance	Moderate (animal needs)	High (regular maintenance)	Low (little maintenance)
6	Environmental impact	Low (no emissions)	High (fuel use)	Low (no emissions)

Table.8.1 Comparing the other mulching machine

ADVANTAGES

- 1. Reduced weed development and pest control.
- 2. Excellent crop output in places with limited water availability.
- 3. An excellent substitute for expensive machinery.
- 4. Easy to use and simple to operate, even a worker without much experience can utilize it.
- 5. Keeps soil nutrients stable and stops soil erosion.
- 6. Easily transportable to various locations.
- 7. Mulch improves soil health by giving earthworms a place to live and food.

APPLICATION

- 1. Typically, it is utilized in fruit farms.
- 2. This technology makes mulching in small-scale farming and gardening easier.
- 3. Commonly utilized in the horticultural industry.
- 4. Using a single instrument to do both punching and mulching lowers labor costs.
- 5. Makes it simple to plant by creating holes in the mulch layer.
- 6. Improves soil health by minimizing erosion and holding onto moisture.
- 7. Reduces soil evaporation, which encourages water conservation

IX. CONCLUSION

Plastic mulch film installation takes a lot of time, requires a lot of labor, and is very exhausting. When plastic mulch film is laid by machines, productivity is increased and labor costs are reduced. We must now produce more highquality produce in order to compete in the global market due to the growing demand for horticultural products and people's increased awareness of their health. Given the evolving technical landscape, plasticulture is essential to Indian agriculture in order to increase agricultural yields and productivity. It requires the right technology to boost efficiency at a reasonable cost while reducing the amount of time and capital needed during the laying operation. An attempt has been made to create a manual plastic mulch laying machine because most farms are small and marginal, and therefore rely on their hands for power. In order to spread mulch film on the pre-made bed for various vegetable crops, a hand plastic mulch laying machine was invented.

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