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Design and Fabrication of Multipurpose Agricultural Machine

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A B S T R A C T

The majority of Indians are employed in agriculture, which is the foundation of the country's economy. However, a lot of human labor is frequently needed for traditional agricultural methods, which can be ineffective and time-consuming. Mechanization in agriculture has become crucial due to technological improvements in order to increase output, decrease human labor, and guarantee sustainable farming. The development of a multifunctional agricultural machine offers a workable way to deal with these issues. The versatile agricultural machine can be used for a variety of farming tasks, including seeding, cultivating, and spraying pesticides. This invention aims to reduce the time and cost dependence of marginal farmers by combining multiple agricultural tasks into a single machine.

Keywords: 'Agriculture', 'Efficiency', 'Seed Sowing Machine', **'**Design'**, '**Fabrication'.

1. INTRODUCTION

This device is designed to serve small and marginal farmers who might lack the funds to purchase pricey, specialist equipment. This machine increases the total productivity of the farming process by offering an economical and effective substitute. Because of labor constraints and the desire for farming operations to be more efficient, there has been a surge in demand for agricultural automation in recent years. Farmers frequently have labor shortages, particularly at busy times of the year, which causes important farming tasks to be delayed. These problems are addressed by the multipurpose agricultural machine, which provides an easy-to-maintain and operate mechanized alternative. It improves accuracy and efficiency while lowering the total amount of work needed to farm, which eventually results in higher agricultural yields. A number of variables, including as power efficiency, durability, and convenience of use, were carefully considered during the machine's design and construction. Because of its lightweight design, the machine is easy to maneuver in a variety of soil conditions. Innovative technical methods are needed to integrate several functions into a single device while maintaining smooth operation and low energy usage. Additionally, the machine's accessibility for farmers in rural areas is increased by using locally accessible materials for production, which lowers manufacturing costs. Three functions, including seed sowing, cultivating, and spraying pesticides, will be included in the machine.

One of the main benefits of the versatile agricultural machine is that it may be tailored to meet the unique requirements of farmers. Depending on the needs, the machine can be equipped with extra attachments to carry out operations like irrigation and fertilizer application. It is a useful tool for contemporary farming methods because of its adaptability, which enables farmers to engage in a variety of agricultural pursuits without having to purchase additional equipment. Farmers may upgrade or adapt the machine to suit their evolving demands thanks to the modular approach, which increases the unit's usefulness.

2. LITERATURE SURVEY

Singh et al. (2018) claim that mechanization has significantly decreased human labor and improved operational efficiency, especially in emerging nations with erratic labor availability. More sophisticated multipurpose agricultural machines that can handle several jobs with a single unit were made possible by the introduction of early mechanized instruments like seed drills and plows.

Patel and Sharma (2020) investigated a small, multifunctional farming device that may be used for weeding, sowing, and plowing. According to the study, integrating several tasks into a single machine optimizes energy and land use while also lowering equipment prices.

In another study, Kumar et al. (2019) designed and tested a prototype for an integrated farming machine that included mechanisms for soil tillage, seed planting, and fertilizer application. Their findings indicated that multipurpose machines significantly reduce the time required for different farming operations, leading to better yield outcomes and improved economic feasibility for farmers.

Das and Kumar's (2023) review looked at a number of production processes, such as CNC machining, welding, and casting, to guarantee accuracy in the construction of agricultural machinery. Because agricultural machinery is frequently subjected to severe weather conditions, the study also emphasized the importance of corrosion-resistant materials.

2.1 Problem Statement

To Design, Fabrication and development of Multipurpose Agriculture which overcome extensive manual labour, time-consuming with advancements in technology as the need for mechanization in agriculture has become essential to improve productivity, reduce human effort, and ensure sustainable farming.

2.2 Objective of Project

1.To study various existing agriculture machines used and its drawbacks.

2.To Design and Fabrication of multipurpose agriculture machine.

3.To do Experimental Analysis of Multipurpose agriculture machine.

3.VARIOUS COMPONENTS AND ITS WORKING PRINCIPLE

3.1 Cultivator

A cultivator is an essential agricultural instrument that improves aeration, loosens the soil, and gets rid of weeds in order to get it ready for planting. By loosening up compacted soil, it facilitates seed germination and robust plant development. The most popular rotavators for large-scale farming are tractor-mounted, self-propelled models, though cultivators can be hand-held, animal-drawn, or machine-operated. A stable frame, tines or blades for penetrating soil, a hitch system for attachment, and a depth control mechanism are the essential parts of a cultivator. According to its basic operation, weeds are uprooted and clumps are broken up by the tines digging into the ground as the tool advances.

Figure 1 – Cultivator

3.2 Sowing

Figure 2 – Sowing

An indispensable agricultural instrument, a seed sowing machine is made to effectively plant seeds while guaranteeing consistent soil coverage, depth, and spacing. It improves crop yields by increasing sowing precision, lowering labor costs, and minimizing seed waste. These devices come in a variety of forms, including precision planters and drill seeders, each of which is appropriate for a particular farming requirement. In order to improve accuracy and efficiency, modern seed sowing machines integrate cutting-edge features including GPS-enabled automation, plant metering systems, and adjustable row spacing.

3.3 Spray Pump

Figure 3 – Spray Pump

An agricultural mechanical project utilizing a 20-liter metal water tank must include a spray pump, which is crucial for producing the pressure required for efficiently spraying water, fertilizer, or insecticides. It guarantees a constant and regulated liquid flow through the nozzle, enabling even dispersion throughout the soil or crops. Depending on how much automation is needed, the pump may be motor-driven, battery-operated, or manual. Usually connected to the water tank by a pipe system or hose, the spray pump in this project draws liquid from the tank and forces it out through the nozzle at a regulated pressure. Depending on the agricultural demand, this device can spray fine mist, jet, or programmable patterns.

3.4 Water Container

Figure 4 – Water Container

Metal water tanks are used extensively in automated irrigation systems in agriculture, where they store and distribute water via pipeline networks, sprinkler systems, or drip irrigation. In order to apply fertilizer and pesticides, they are also placed on tractors, drones, and other agricultural equipment and utilized in automated spraying systems. These tanks are also included into watering and seed-sowing equipment, guaranteeing the right moisture content for germination. Metal tanks are particularly advantageous to livestock farms since they give animals a steady supply of water and are frequently linked to automatic dispensers.

3.5 Nozzle

Figure 5- Nozzle

In an agricultural mechanical project that uses a 20-liter metal water tank, a nozzle is an essential part that ensures controlled water distribution for purposes such as seeding, spraying, or irrigation. It is connected to the tank's output and controls the pressure, flow rate, and spray pattern to enable effective water use. The nozzle used in this project can be operated manually or by a motorized pump, depending on the coverage area and pressure specifications. Usually composed of sturdy materials like brass or stainless steel

3.6 Diaphragm Pump

Figure 6- Diaphragm Pump

A flexible diaphragm is used in diaphragm pumps, a form of positive displacement pump, to generate reciprocating motion for fluid transfer. In order to create a pressure differential that permits fluid to pass through inlet and outlet check valves, the pump alternately expands and contracts the diaphragm. Diaphragm pumps are perfect for use in businesses like water treatment, chemical processing, pharmaceuticals, and agriculture because of their great efficiency and ability to handle a variety of fluids, including corrosive, viscous, and abrasive liquids.

3.7 Battery

Figure 7- Battery

Motorcycle batteries are usually lead-acid, smaller than vehicle batteries, and used to power lights, other electrical components, and start the engine. Ampere-hours are used to assess capacity, and the majority are 12 volts. There are two varieties: maintenance-free and flooded lead-acid. Each motorcycle model has a different size. Regular maintenance is necessary for flooded batteries, but not for maintenance-free batteries.

4.0 DESIGN CALCULATION & SELECTION CRITERIA

1-Soil Resistance

For Moist Soil, A bike pulling a plow

Factors:

• Motorcycle weight = 112 kg

• Plow weight = 10 kg

• Soil density = 1.5 g/cm³ (typical for moist soil)

• Plow depth = 18 cm (7 inches)

• Plow width = 76 cm (30 inches)

Calculations:

1) Calculate total weight:

Motorcycle + Plow

= 112 kg + 10 kg = 122 kg

2) Calculate soil volume displaced:

18 cm (depth) × 76 cm (width) = 1368 cm²

3) Calculate soil mass displaced:

1368 cm² × 1.5 g/cm³ = 2052 g

4) Calculate soil resistance force:

2052 g × 9.8 m/s² (gravity) = 20.10 N

2- Gear Ratios:

• For first gear: 3.5 : 1

• For second gear: 2.2 : 1

• For third gear: 1.6 : 1

• For fourth gear: 1.2 : 1

Notation:

It is given in the form of X : 1, where:

X = Number of teeth on engine output shaft gear

1 = Number of teeth on transmission gear

Most Common Values of Gear Teeth:

The most common values of teeth on gears are [17, 21, 22, 26].

• For gear 1 = 17

• For gear 2 = 21

• For gear 3 = 26

• For gear 4 = 22

3-Spraying Details and Specifications

• Distance: 10 ft

• Total Turns: 15 turns

• Total Distance Covered: 2.2 km

• Fuel Consumption: 0.57 liters

Pump Details

• Type: Diaphragm pump used for spray pump

• Spray Pump Specifications

• Flow Rate: 20 liters/min

• Water Refilling: Needs to be changed after 4 times

A- Nozzle Coverage: 1.66 ft

B-Pump Battery:

• Voltage: 12V

• Current: 7.5A

• Power: 84W

4-Agricultural Calculations

A-Vehicle Details

• Vehicle: Hero Honda Splendor

• Power Output: 7.5 HP

B-Spray Tank Specifications

• Tank Capacity: 25 liters per tank

• Pump Weight: 5 kg

• Soil Type: Moist soil

C-Sowing Calculation

• Blade Distance: 3 ft

• Land Area: 1 acre = 40,000 sq. ft

• Length (L): 266.18 ft (81m)

• Width (W): 150 ft

• Total Turns : 50 turns

• Final Output: 4 km distance covered

• Fuel Consumption: 1 liter for 4 km distance

D-Weeding Calculation

Distance Covered per Pass: 2 ft

Total Turns Required: 75 turns

Final Output: 6.5 km distance covered

5.0 MANUFACTURING PROCESS

Following steps are followed for manufacturing the final attachment to Multipurpose Agricultural Machine.

- Marking
- Cutting
- Drilling
- Welding
- Assembly

- Coloring

Finely the multipurpose attachment is fitted on motor cycle which was tested. figure below shows the CAD model for the same.

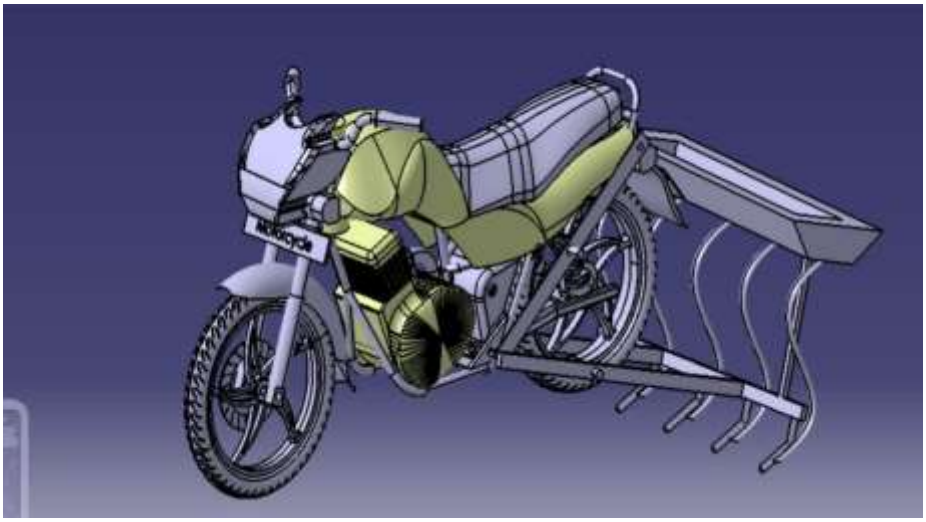

Figure 8- CAD model of Multipurpose Agricultural Machine

6.0 Conclusion:

Thus this study can be summarized as,

- The design and fabrication of a multipurpose agriculture machine represent a significant advancement in modern farming practices. This project aims to address the critical challenges faced by farmers including Efficiency, cost reduction and versatility in agricultural operations.
- The conclusion of this project highlight several benefits including Increased Productivity, Time savings and Potential environmental advantages through reduction fuel consumption and soil compaction
- This Machine is useful for small scale farmers as it includes all the farming tools which are essential for Agriculture

Based on all this it can be concluded that this project is a new concept which is patentable and can be applied for real time situations.

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