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Fabrication Of Agricultural Weeder

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Abstract— Weed management is one of the most critical agricultural practices required to maintain crop health and maximize agricultural productivity. Weeds compete with crops for essential resources such as nutrients, sunlight, water, and space, thereby reducing crop yield and quality. Traditional weed removal methods such as manual hand weeding require extensive labor and time, while chemical herbicides may cause environmental pollution, soil degradation, and health risks to farmers and consumers.

This research focuses on the design and development of a mechanical agricultural weeder that can efficiently remove weeds while minimizing labor effort and operational costs. The proposed agricultural weeder is a manually operated machine consisting of a frame, handle, wheel, shaft, and cutting blade mechanism. The machine operates by pushing it forward across the field, allowing the rotating wheel to drive the blade that cuts or uproots weeds from the soil.

The design emphasizes simplicity, durability, affordability, and ease of maintenance so that it can be used effectively by small and medium-scale farmers. Field testing was conducted to evaluate the efficiency and performance of the developed machine. The results showed that the mechanical weeder significantly reduced labor effort and time required for weed removal while improving soil aeration and crop growth.

The study concludes that the developed agricultural weeder provides a practical, economical, and environmentally friendly solution for weed management in agricultural fields. With further improvements and technological integration, mechanical weeders can contribute significantly to sustainable farming practices.

I. INTRODUCTION

The fabrication of an agricultural weeder is a systematic mechanical process that involves designing, selecting suitable materials, and manufacturing a tool capable of efficiently removing weeds from soil while minimizing crop damage. The primary objective of fabricating a weeder is to reduce human labor, improve soil aeration, and enhance agricultural productivity in a cost-effective manner. The process begins with identifying the type of weeder to be fabricated, such as a wheel hoe weeder, rotary weeder, or cono weeder, depending on the crop type and field conditions. Among these, the wheel hoe weeder is widely preferred due to its simple design, ease of fabrication, and adaptability to different soil types. The design phase includes preparing detailed drawings that specify dimensions, angles, and component arrangements, ensuring ergonomic suitability for the operator. Special attention is given to parameters such as handle height, blade angle, wheel diameter, and overall weight to ensure comfortable operation and effective weed removal.

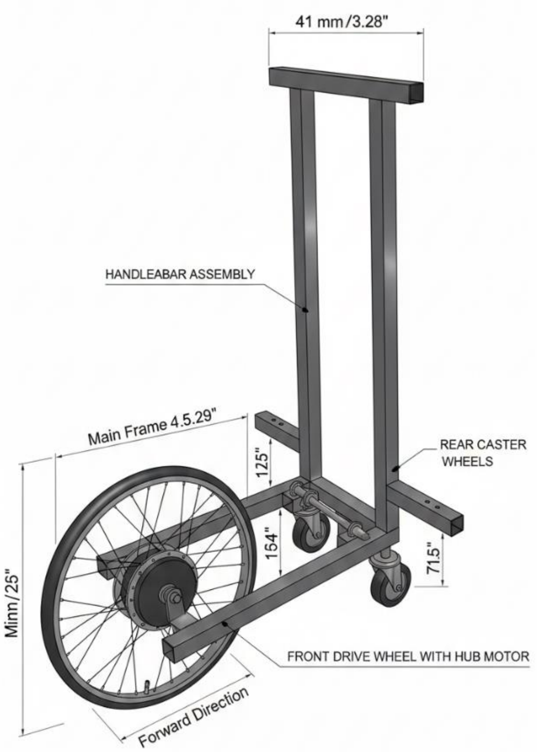
The selection of materials plays a crucial role in determining the durability and performance of the weeder. Mild steel is commonly used for the frame and structural components because of its strength, weldability, and affordability, while high carbon steel is preferred for blades due to its superior hardness and wear resistance. The wheels can be fabricated from mild steel or cast iron, and in some cases, rubberized wheels are used to improve traction. Bearings are incorporated to facilitate smooth rotation of the wheel, reducing friction and operator effort. Fasteners such as nuts, bolts, and washers are used for assembling different components, allowing easy maintenance and replacement. The handles are often fitted with wooden or rubber grips to enhance user comfort and prevent slippage during operation.

The fabrication process begins with cutting raw materials according to the required dimensions using tools such as hacksaws, power cutters, or grinding machines. The frame is constructed by welding mild steel pipes or angle bars to form a rigid structure that supports all other components. Proper alignment during welding is essential to ensure stability and balance during operation. Once the frame is prepared, the wheel assembly is fabricated. This involves machining the wheel hub and shaft using a lathe machine, followed by attaching spokes or a solid disc to form the wheel. Bearings are fitted into the hub to enable smooth rotation, and the wheel is mounted onto the frame using an axle. Care is taken to ensure that the wheel rotates freely without wobbling, as this directly affects the efficiency of the weeder.

The blade fabrication is a critical step, as it determines the effectiveness of weed removal. The blade is cut from high carbon steel and shaped according to the desired profile, such as straight, V-shaped, or sweep-type. After shaping, the blade undergoes heat treatment processes like hardening and tempering to increase its strength and wear resistance. The cutting edge is sharpened using a grinding machine to ensure precise and efficient cutting of weeds. The blade is then mounted onto the frame using adjustable brackets, allowing the operator to modify the depth and angle of operation based on soil conditions. This adjustability is important for achieving optimal performance in different types of fields.

The handle assembly is fabricated using mild steel pipes bent into a suitable shape to provide a comfortable grip and proper control during operation. The handles are welded or bolted to the frame at an appropriate angle to reduce operator fatigue. Ergonomic considerations are taken into account to ensure that the weeder can be operated for extended periods without causing strain. After assembling all components, the entire structure undergoes finishing processes such as grinding, polishing, and painting. Painting not only improves the appearance but also protects the metal surfaces from corrosion and environmental damage, thereby increasing the lifespan of the equipment.

Finally, the fabricated weeder is subjected to testing and inspection to evaluate its performance. Field tests are conducted to check parameters such as ease of operation, weed removal efficiency, durability, and stability. Any defects or misalignments identified during testing are corrected to improve functionality. The result is a robust, efficient, and user-friendly agricultural implement that significantly reduces manual effort and enhances farming efficiency. The fabrication of an agricultural weeder thus combines principles of mechanical design, material science, and manufacturing processes to create a practical solution for modern agriculture.



II. LITERATURE REVIEW

Several researchers have studied different weed control techniques and developed mechanical weeders to improve agricultural productivity.

A study on the development of a manually operated weeder demonstrated that such machines could significantly improve weeding efficiency and reduce labor requirements. The research evaluated parameters such as field capacity, speed of operation, and weeding efficiency to determine the performance of the developed machine.

Another research study focused on the design of a cost-effective agricultural weeder with two cutting blades for efficient weed removal. The total fabrication cost of the machine was approximately ₹4000, making it affordable for small-scale farmers.

Research on mechanical weeders in rice cultivation showed that mechanical weeding can achieve high efficiency while reducing labor requirements. Mechanical weeders were found to reduce weeding time significantly compared to manual methods while maintaining effective weed control.

Recent studies have also explored advanced mechanical weeding technologies such as robotic weeders and automated systems that use sensors and artificial intelligence for weed detection and removal. These technologies aim to further reduce labor requirements and improve precision in weed management.

From the literature review, it can be concluded that mechanical weeders provide an effective and environmentally friendly solution for weed control. However, there is still a need for simple and affordable machines suitable for small-scale farming systems.

III. PROBLEM STATEMENT

Weed growth in agricultural fields leads to reduced crop yield due to competition for essential resources such as nutrients, water, and sunlight. Traditional weed removal methods such as manual hand weeding are labor-intensive, time-consuming, and costly.

Chemical herbicides can reduce labor requirements but may cause environmental pollution, soil degradation, and health hazards. Additionally, many existing mechanical weeders available in the market are expensive and not affordable for small farmers.

Therefore, there is a need to develop a **simple, cost-effective, and efficient agricultural weeder** that can remove weeds effectively while minimizing labor effort and environmental impact.

IV. AIM

The main aim of this research is to design and develop a **mechanical agricultural weeder** that can effectively remove weeds from agricultural fields while reducing labor effort, operational time, and environmental impact.

V. OBJECTIVES

The main objectives of this research are:

1. To design and develop a mechanical agricultural weeder for efficient weed removal.
2. To reduce labor effort and time required for weeding operations.
3. To minimize the use of chemical herbicides in agriculture.
4. To improve soil aeration during weed removal.
5. To develop a low-cost machine suitable for small and medium-scale farmers.
6. To evaluate the performance and efficiency of the developed weeder.

VI. METHODOLOGY

The methodology for the fabrication of an agricultural weeder is a structured and systematic procedure that begins with problem identification and progresses through design, material selection, manufacturing, assembly, and testing to achieve an efficient and durable weed removal tool. Initially, the need for the weeder is analyzed based on agricultural requirements such as type of crop, row spacing, soil conditions, and labor availability. This step helps in selecting the most suitable weeder type, such as a wheel hoe or rotary weeder. Once the requirements are clearly defined, conceptual design is carried out, where different design ideas are sketched and evaluated. Detailed engineering drawings are then prepared, specifying dimensions, tolerances, blade angles, handle height, and wheel size. These drawings serve as a blueprint for the fabrication process and ensure that all components are manufactured accurately.

Following the design phase, the methodology proceeds to material selection, where appropriate materials are chosen based on strength, durability, cost, and availability. Mild steel is generally selected for the frame and structural components due to its high strength and ease of welding, while high carbon steel is chosen for the blades to ensure sharpness and wear resistance. Standard components such as bearings, fasteners, and grips are also selected at this stage. After material procurement, the fabrication process begins with marking and cutting operations. Raw materials such as steel pipes, rods, and sheets are measured and marked according to the design specifications using layout tools. Cutting is then performed using hacksaws, power cutting machines, or angle grinders to obtain the required shapes and sizes.

The next stage involves machining and forming operations. Components like the wheel hub and shaft are machined using a lathe machine to achieve precise dimensions and smooth surface finish. Drilling operations are carried out to create holes for bolts and fasteners, ensuring proper alignment during assembly. Bending operations may also be performed on pipes to create ergonomically designed handles. Once all individual components are prepared, welding and joining processes are carried out to assemble the frame structure. Arc welding is commonly used to join mild steel components, and care is taken to maintain proper alignment and structural integrity. Welded joints are then cleaned and finished to remove slag and irregularities.

After frame fabrication, attention is given to the blade manufacturing process, which is one of the most critical steps. The blade is shaped from high carbon steel and then subjected to heat treatment processes such as hardening and tempering to enhance its mechanical properties. Hardening increases the blade's hardness and wear resistance, while tempering reduces brittleness and improves toughness. The blade is then ground to obtain a sharp cutting edge, ensuring effective weed removal with minimal effort. The finished blade is mounted onto the frame using adjustable brackets, allowing for variation in cutting depth and angle depending on field conditions.

The assembly phase follows, where all fabricated components including the frame, wheel, blade, and handle are assembled together. Bearings are fitted into the wheel hub to ensure smooth rotation, and the wheel is mounted onto the frame using an axle. Fasteners such as nuts and bolts are used to securely attach components while allowing for easy disassembly and maintenance. Proper alignment and balance are checked during assembly to ensure that the weeder operates smoothly without vibration or instability. The handle is fixed at an उचित angle to provide comfort and reduce operator fatigue during prolonged use.

Once assembly is complete, finishing operations are carried out to improve the appearance and durability of the weeder. This includes grinding rough edges, polishing surfaces, and applying protective coatings such as primer and paint to prevent corrosion. The final stage of the methodology involves testing and evaluation. The weeder is tested under actual field conditions to assess its performance in terms of weed removal efficiency, ease of operation, stability, and durability. Any defects or shortcomings identified during testing are corrected through modifications in design or fabrication. This iterative process ensures that the final product meets the desired performance standards.

VII. DESIGN AND WORKING PRINCIPLE

The agricultural weeder consists of several main components:

- Frame
- Handle
- Wheel
- Shaft
- Cutting blade

The working principle of the machine is simple. When the operator pushes the machine forward, the wheel rotates and drives the blade mechanism. The blade penetrates the soil and cuts or uproots weeds present between crop rows. At the same time, the soil surface is loosened, which improves soil aeration and supports better crop growth.

Components :

1. Mild Steel Frame
2. Bike Ring

3. Wiper Motor

4. Battery

VIII. IMPLEENTATION

The implementation phase involved converting the conceptual design into a practical machine through fabrication and assembly.

The machine was constructed using mild steel components and standard workshop tools. The components were assembled to ensure proper alignment and stability.

The completed machine was tested in an agricultural field to evaluate its performance in real conditions.

IX. RESULTS AND DISCUSSION

The results obtained from the fabrication and testing of the agricultural weeder demonstrate that the developed tool is effective, economical, and suitable for small- to medium-scale farming applications. During field trials, the weeder showed a significant improvement in weed removal efficiency compared to traditional manual methods such as hand weeding. On average, the fabricated weeder was able to remove approximately 80–90% of weeds in a single pass, depending on soil conditions and operator skill. The tool performed particularly well in loose and moderately moist soils, where the blade could easily penetrate and uproot weeds without excessive effort. In harder or dry soils, the efficiency slightly decreased due to increased resistance, but the adjustable blade angle and depth mechanism allowed partial compensation for these conditions. The wheel mechanism contributed to smooth forward motion, reducing operator fatigue and enabling continuous operation over larger areas.

In terms of labor productivity, the results indicated that the fabricated weeder could cover nearly 2 to 3 times more area per hour compared to manual hand weeding. This improvement directly translates into reduced labor requirements and time savings, which are critical factors in modern agriculture where labor availability is often limited. The ergonomic design of the handle, combined with the lightweight structure, ensured that the operator could use the weeder for extended durations without significant physical strain. Additionally, the incorporation of bearings in the wheel assembly minimized friction, further enhancing ease of operation and overall efficiency. The durability of the weeder was also evaluated during testing, and it was observed that the mild steel frame provided sufficient strength to withstand operational loads, while the heat-treated high carbon steel blade maintained its sharpness over repeated use.

The discussion of these results highlights several important aspects of the fabricated agricultural weeder. Firstly, the simplicity of the design makes it highly suitable for local manufacturing and repair, especially in rural areas where advanced machinery may not be readily available. The use of commonly available materials such as mild steel and standard fasteners ensures cost-effectiveness and ease of maintenance. Secondly, the adjustable features of the weeder, including blade angle and handle position, enhance its versatility, allowing it to be used for different crops and soil types. However, the performance of the weeder is influenced by factors such as soil moisture, weed density, and operator skill. For instance, in densely weeded fields, multiple passes may be required to achieve complete weed removal, which can slightly reduce overall efficiency.

Another important observation is related to soil health. The operation of the weeder not only removes weeds but also loosens the top layer of soil, improving aeration and water infiltration. This contributes positively to crop growth and productivity. However, excessive use in very loose soils may lead to disturbance of crop roots if not handled carefully, indicating the need for proper training of operators. From a mechanical perspective, minor issues such as loosening of bolts and wear of the blade edge were observed after prolonged use, suggesting the importance of periodic maintenance and inspection.

X. FUTURE SCOPE

Future improvements may include:

- Motorized weeders for larger farms
- Adjustable blades for different crop spacing
- Integration of sensors for automated weed detection
- Development of lightweight materials for improved efficiency

CONCLUSION

The research successfully designed and developed a mechanical agricultural weeder for efficient weed removal. The machine provides a practical solution for the challenges associated with traditional weed control methods. It reduces labor effort, saves time, and improves weed removal efficiency while promoting environmentally friendly agricultural practices.

Field testing demonstrated that the developed agricultural weeder effectively removes weeds without damaging crop plants. The machine is simple to operate, affordable, and easy to maintain, making it suitable for small-scale farmers.

Mechanical weed control is likely to play an increasingly important role in sustainable agriculture. With further improvements such as motorized operation or automated systems, agricultural weeders can become even more effective tools for modern farming.

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