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Design and Modeling of a Dual-Purpose Paddy Weeder with Dual-Row Puddlers

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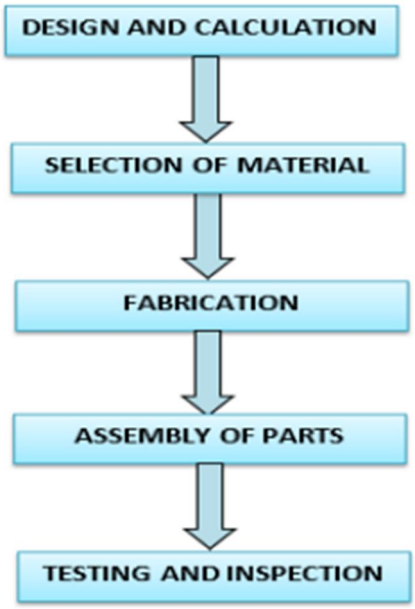
Abstract: ***Using SolidWorks as a modelling tool, this study focusses on the design and development of a dual-purpose weeder that is constructed for both wetland and dryland situations. It is combined with dual-row puddlers and power tiller controls. The device seeks to increase operational effectiveness under various field circumstances, lowering labour costs and increasing output. Among the main elements of the design are an easy-to-use control system for a seamless transition between wetland and dryland operation, adjustable weeding blades that optimise performance in a variety of terrains, and a lightweight yet robust chassis for effortless movement. The dual-row puddlers effectively puddle the soil in rainy fields, enhancing water retention and promoting a robust crop establishment. The SolidWorks-based design's ability to accurately model 3D, analyse stress, and optimise performance ensures durability, structural integrity, and ease of maintenance. The application makes it easier to identify design flaws early on, enabling improvements to boost machine durability and effectiveness. Ultimately, the multifunctional weeder integrates state-of-the-art design elements that increase agricultural productivity and labour efficiency. By decreasing manual labour and enhancing soil preparation, the machine offers a sustainable answer to modern farming, resulting in increased crop yields, reduced operational expenses and better resource management.***

Keywords: Dual-purpose weeder, Operational effectiveness, Adjustable weeding blades, Lightweight yet robust chassis, Tiller controls, Field versatility, Reduced operational expenses

I. INTRODUCTION

In order to increase productivity, lessen reliance on labour and support sustainable farming, agricultural methods must be mechanised. Traditional weeding methods are labour-intensive, time-consuming, and often physically demanding, which decreases their efficacy in both dryland and wetland environments and drives up farmers' expenses. This project focusses on building and developing a dual-purpose weeder that is specifically built to interact with dual-row puddlers and work seamlessly with power tiller controls in order to improve soil aeration and enable more effective weed eradication. Offering a versatile solution that can be tailored to a range of field conditions, the innovative design aims to significantly improve agricultural efficiency. This machine ensures ease of operation, offering a user-friendly experience while maintaining high operational efficacy across various agricultural conditions by improving power tiller compatibility. This weeder is easily adaptable to enable optimal performance in a variety of situations, including dry fields in dryland scenarios and flow. The design of this multipurpose weeder was intended for small and medium-sized farmers, particularly those engaged in dryland and wetland agriculture. The weeder increases productivity, lowers labour costs and boosts efficiency, all of which support the growth and sustainability of farming practices. The machine's ability to aerate soil, effectively eradicate weeds and promote better crop establishment makes it an essential tool for boosting yields and ensuring more efficient resource management on farms of all sizes.

Fig 1: Picture of Manual Weeding Method



LAYOUT

II. COMPARATIVE ANALYSIS OF EXISTING SYSTEMS

TABLE I

Aspect	Traditional System	Dual-Purpose System
Weeding Mechanism	Conventional weeders uproot or chop weeds using revolving or oscillating blades or tines. To propel the weeding process, some designs use motorized or passive wheels.	The weeding and puddling mechanisms are combined in a dual-purpose system. To effectively manage both duties, this system needs a more robust design, which could lead to increased maintenance requirements.
Puddling Mechanism	The majority of modern puddling machines use single-row or less effective paddles and are just concerned with preparing the soil.	The majority of modern puddling machines use single-row or less effective paddles and are just concerned with preparing the soil.
Frame and Build Quality	Traditional weeders and puddling machines often have simpler designs, are lightweight, and are constructed of steel or aluminum.	To accommodate the extra parts and systems, a dual-purpose machine needs a stronger frame, which could result in more weight but also improved longevity.
Power Transmission	Conventional weeders usually have limited flexibility and rely on mechanical linkages or direct engine connections.	Gearboxes and pulley systems are used in dual systems to distribute power efficiently, allowing both weeders and puddlers to operate at the same time.
Adjustability of Components	The operating flexibility of standard machines is sometimes limited by their fixed paddles or simple height adjustments.	More control over weeding depth, puddling intensity, and width is possible with a dual-purpose design, but this adaptability frequently comes at the expense of increased complexity and expense.

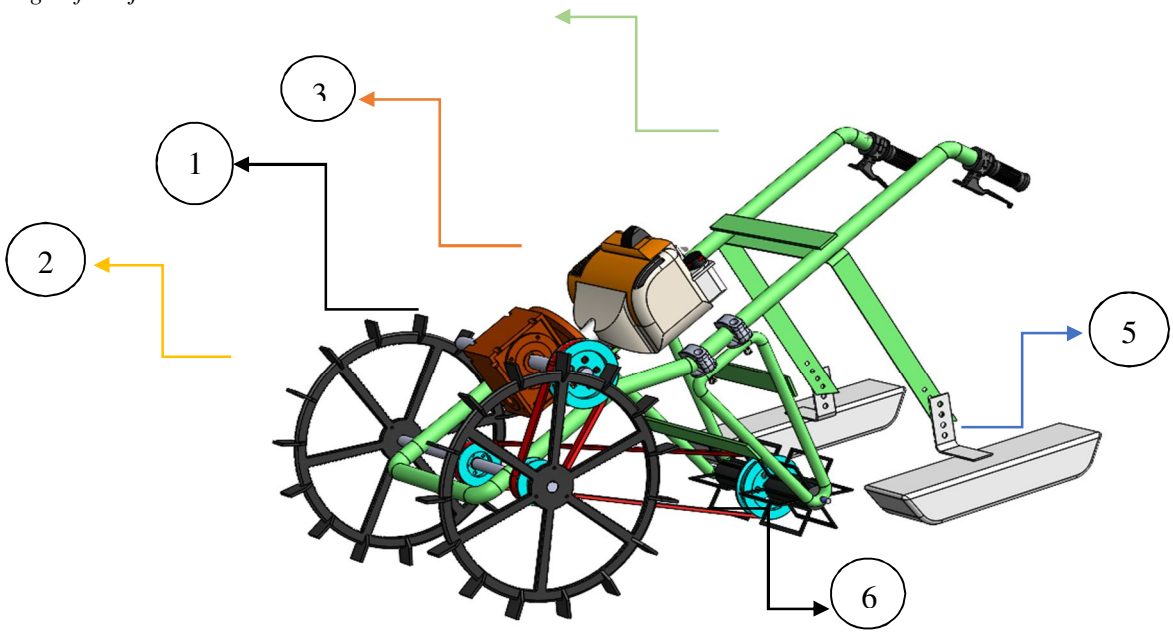
Fuel Consumption	Because they are tailored for a single task, single-task machines usually utilize less fuel.	The efficiency increase from fewer runs across the field can make the overall fuel consumption more economical in large fields, even though more fuel is used because of the additional complexity and work being done simultaneously.
Field Coverage	Conventional machines cover smaller areas and need several passes to finish chores like puddling and weeding.	Conventional machines cover smaller areas and need several passes to finish chores like puddling and weeding.
Maintenance	Because of the machine's simplicity, maintenance is usually easier and less frequent.	Dual systems' complexity makes maintenance more difficult and necessitates more regular inspections, fixes, and part replacements—all of which can be more expensive.
Labor Requirement	For weeding and puddling, traditional machines need several passes, which raises labor and operating expenses.	For weeding and puddling, traditional machines need several passes, which raises labor and operating expenses.
Economic Viability	Due to their lower initial expenses, conventional techniques are frequently more suitable for small-scale farmers.	Dual-purpose systems are more costly, but they save time and labor over time, which may make them more practical for bigger farms or cooperative farming models.
Adaptability	Because different soil types require different machinery, traditional systems may not be able to handle a variety of soil conditions.	Because they have depth mechanisms that can be adjusted for both weeding and puddling, dual-purpose machines can be more versatile, but they need to be calibrated carefully.
Design Complexity	They are simpler to construct and maintain since they have fewer moving parts.	The integration of numerous components functioning together makes dual-purpose systems more complicated, necessitating better engineering knowledge and more exact design.
Assembly and Disassembly	Because they have fewer parts and simpler designs, they are easier to build and disassemble.	Due to the more intricate and integrated components, assembling dual-purpose machines takes more time and experience.

III. MATERIALS AND METHODOLOGY

By completing both weeding and puddling duties concurrently, the dual-purpose paddy weeder with dual-row puddlers is designed and modeled to increase efficiency. To get rid of weeds without harming the rice crop, the weeder mechanism uses revolving or oscillating blades composed of sturdy, rust-resistant materials. For the best rice development, the dual-row puddlers, which can be adjusted for various soil conditions, guarantee consistent soil agitation and puddling. For longevity, the machine's structure is made of high-strength materials like steel or aluminum. Several crucial steps are involved in the design and modeling process for a dual-purpose paddy weeder with dual-row puddlers that is driven by an engine coupled to a gearbox and belt pulley system. The engine, which is usually an internal combustion engine, first supplies the power required to run the complete system. It is attached to a gearbox, which controls torque and speed to meet the requirements of the puddler and ground wheel mechanisms. By modifying the force given to the puddler blades and the ground wheels' speed, the gearbox makes sure that power is distributed properly.

Following that, the power is transferred via a belt pulley system, in which various pulleys—often with varied diameters—assist in regulating the speed and torque distribution to the ground wheels and puddlers.The machine is propelled forward by the ground wheels, which provide traction in muddy and wet situations. Meanwhile, the same pulley system powers the puddling mechanism, which stirs the soil to produce the perfect growing conditions for rice. For different types of soil, the puddling depth can be fine-tuned using mechanical or hydraulic devices that are adjustable. To make sure the parts are effectively integrated, CAD software is utilized for modeling and simulations. To guarantee optimum performance in weeding and puddling, the design is prototyped, tested in the field, and improved in response to feedback, offering farmers a practical option.

A. Design of Project



1.Gear box 2. Ground wheel 3. Engine 4. Frame 5. Float 6. Puddler

Fig:2 DESIGN OF PROJECT

IV. RESULT AND DISCUSSION

To effectively handle the difficulties of weeding and puddling in rice fields, a dual-purpose paddy weeder with dual-row puddlers has been designed and modeled. The method greatly increases operating efficiency by combining a weeder mechanism that efficiently removes weeds with a puddling mechanism that prepares the soil for rice cultivation in a single pass. Compared to conventional single-row systems, the dual-row puddlers provide more coverage, requiring fewer passes, thus saving fuel and time. The sturdy frame of the machine is made to support both mechanisms without sacrificing structural soundness. The weeder and puddler may work together because the power transmission system, which is made up of gearboxes and belt-pulley drives, makes sure that both parts are in sync.

A. Enhanced Operational Efficiency

The operational efficiency of the dual-purpose paddy weeder with dual-row puddlers is greatly increased. Time, fuel, and labor are saved when weeding and puddling are combined into a single machine, which minimizes the number of passes needed in the field.

B. Performance in Different Field Conditions

The adjustable weeder mechanisms and dual-row puddlers offer increased adaptability to different types of soil. The device effectively removes weeds and prepares soil in both upland and marsh environments.

C. Cost-Efficiency

Even while the dual-purpose machine costs more up front, there are significant long-term benefits. Quicker returns on investment (ROI) result from labor and operating time decrease. The machine's dual function guarantees that fewer equipment are needed, which lowers total expenses for extensive farming operations.

D. Maintenance and Durability

Because the linked systems are complicated, regular maintenance is necessary. However, compared to conventional machines, the machine requires fewer maintenance because of its sturdy design and premium materials, which guarantee that it operates effectively in demanding field circumstances.

Parameter	Manual method	Through this method	Percentage time saved
Time taken for weed removal per person	20 hours	3 hours	69.78%
Time taken for dual purpose puddlers	3 hours	1 hour	97%

E. Time taken for weed removal per person

Manual method: It takes 20 hours for a person to remove weeds using traditional manual labor.

Through this method (dual-purpose weeder): The dual-purpose paddy weeder reduces this task to just 3 hours.

Percentage time saved: The percentage time saved in this case is calculated as:

$$\text{Time Saved} = \frac{\text{Time (manual)} - \text{Time (dual-purpose)}}{\text{Time (manual)}} \times 100$$

$$\text{Time Saved} = (20-3)/20 \times 100 = 69.78\%$$

This shows that using the dual-purpose paddy weeder saves **69.78%** of the time for weed removal, significantly improving efficiency.

F. Time taken for dual-purpose puddlers

Manual method: Traditionally, 3 hours are needed to puddle the field manually.

Through this method (dual-purpose puddlers): The dual-row puddlers reduce this task to just 1 hour.

Percentage time saved: The time saved for puddling is calculated as:

$$\text{Time Saved} = (3-1)/3 \times 100 = 97\%$$

The dual-purpose system achieves an impressive **97% time saving** for puddling compared to the manual method, significantly boosting operational efficiency.

V. CONCLUSION

In conclusion, the Dual-Purpose Wetland and Dryland Weeder, designed using SolidWorks, represents a remarkable step forward in agricultural machinery. By integrating advanced features such as power tiller controls and dual-row puddlers, it offers a versatile solution for weeding across both dryland and wetland terrains. The efficient design optimisation process facilitated by SolidWorks has resulted in a machine that not only enhances operational convenience but also reduces labor costs, making it an invaluable tool for small to medium-sized farming operations. Its lightweight, customizable and durable design ensures it can perform reliably under various field conditions, improving both soil quality and crop establishment. Ultimately, this high-performance weeding solution enhances agricultural productivity while contributing to a more efficient and sustainable farming approach.

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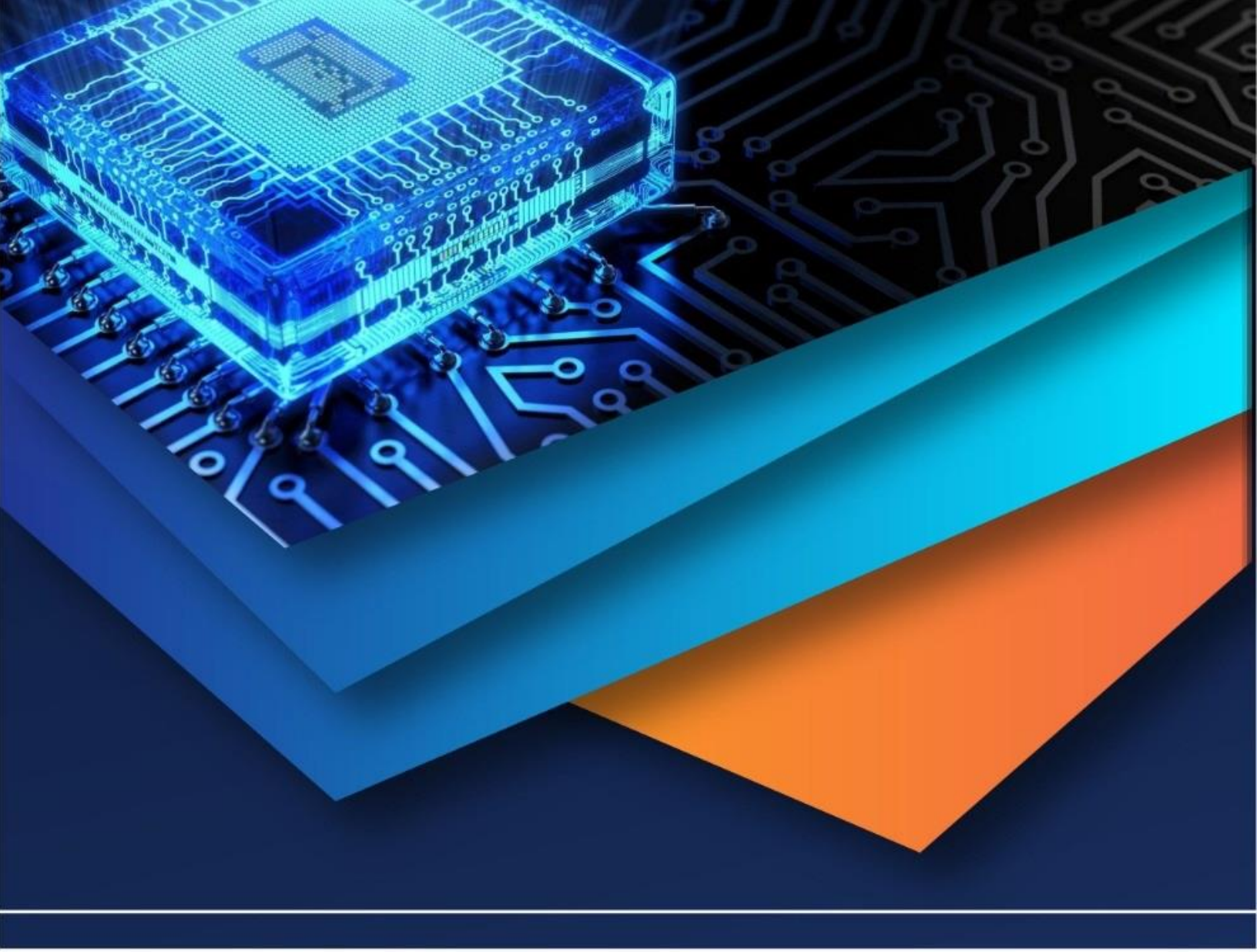

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