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Design and Development of Inter Cultivation Disc Plough Spacing Adjustment Mechanism

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ABSTRACT: Inter cultivation practices require machinery that is adjustable, efficient, and reliable. Traditional disc ploughs often lack the flexibility to adapt to different row crop spacings, reducing efficiency and increasing crop damage. This project aims to design and develop a spacing adjustment mechanism for an inter cultivation disc plough to enhance its adaptability and operational effectiveness. The mechanism enables farmers to adjust disc spacing based on crop row distances, ensuring optimal soil aeration and weed control. The design incorporates mechanical linkages and adjustable settings that are simple to operate. The model is developed considering ease of use, cost-efficiency, and durability for rural agricultural conditions.

KEYWORDS: Disc plough, Inter cultivation, Spacing mechanism, Farm machinery, Mechanical adjustment.

I. INTRODUCTION

Agricultural productivity heavily depends on timely and efficient intercultural operations like weeding, soil loosening, and aeration. These operations require tools such as disc ploughs that can operate between crop rows without damaging plants. However, the fixed-spacing nature of traditional disc ploughs limits their adaptability across different crop row spacing, making the process inefficient and increasing the risk of crop damage.

To address this issue, the current project focuses on the design and development of an Inter Cultivation Disc Plough with an Adjustable Spacing Mechanism. This mechanism will allow users to manually or mechanically adjust the spacing between plough discs to suit varying row crops such as sugarcane, cotton, soybean, and vegetables. The improved design enhances the versatility of existing plough systems while maintaining simplicity and cost-effectiveness for use in rural farms.
This project integrates knowledge from mechanical design, fabrication, agricultural engineering, and ergonomics to deliver a working prototype that demonstrates both reliability and practicality in the field.

II. LITERATURE REVIEW

Several researchers and innovators have worked on improving farming equipment to enhance productivity and reduce manual labor. A review of existing designs and studies highlights the gap in adjustable spacing mechanisms in disc ploughs for intercultural operations.

1. Prasad P.S. (2014) designed a basic handbrake system integrated with safety controls for vehicles, highlighting the importance of user-friendly mechanical systems for rural applications.
2. Sanjay B.S. et al. (2017) worked on pneumatic braking systems with automated controls, showcasing the utility of simple mechanical-electrical systems in improving functionality and safety.
3. In agricultural engineering, most innovations in ploughs have been targeted towards increasing tilling efficiency or reducing soil compaction, but fewer have tackled adjustability and modularity of disc spacing.

This study aims to fill this gap by designing a simple, robust mechanism for spacing adjustment that can be operated manually or semi-automatically depending on future enhancements.

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III. PROBLEM STATEMENT

In many farming practices, especially those involving row crops, the fixed spacing of traditional disc ploughs leads to operational challenges. Farmers are often forced to use equipment that is not suited to their crop layout, which can result in inefficient soil cultivation and accidental damage to crops.

There is a clear need for a disc plough that allows easy adjustment of spacing between discs to match various crop row distances. Most small and marginal farmers cannot afford multiple tools for different crop patterns, hence a single adjustable tool can serve multiple purposes and reduce overall equipment costs.

IV. OBJECTIVES

- To design a disc plough mechanism with adjustable disc spacing for inter cultivation.
- To ensure the design is cost-effective and easy to operate, especially for small-scale farmers.
- To fabricate a prototype demonstrating the spacing adjustment mechanism.
- To test the prototype under controlled conditions for performance, ease of use, and durability.
- To analyze the efficiency of the developed mechanism in comparison to traditional disc ploughs.

V. METHODOLOGY

The development process of the project was divided into sequential stages as follows:

Step 1: Problem Identification

Understanding the inefficiency of fixed-spacing disc ploughs and the need for a flexible mechanism.

Step 2: Data Collection and Concept Design

Studying existing tools and agricultural practices, followed by the conceptualization of the adjustable mechanism.

Step 3: Component Selection

Selecting appropriate materials and components for durability, affordability, and ease of fabrication.

Step 4: Design and Analysis

Creating detailed 2D/3D CAD designs and conducting basic structural and functional analysis.

Step 5: Fabrication and Assembly

Manufacturing the frame, adjustable arms, disc holders, and locking system; followed by full assembly.

Step 6: Testing and Evaluation

Testing the model for disc movement, stability, and operational effectiveness.

Step 7: Documentation and Reporting

Recording findings, preparing reports, and comparing results with traditional systems.

VI. CONSTRUCTION

The prototype consists of the following main components:

1. Frame: Made of mild steel angles, it supports the entire assembly and provides structural strength.
2. Guide Shaft: A rotating shaft used for power transmission, supported by bearings, and made from various materials based on application.

Fig.3.1. Guide Shaft.

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3. Washer: A disk-shaped component used to distribute load, reduce vibration, and prevent galvanic corrosion. Made of metal or plastic.
4. Nut and Bolt: Threaded fasteners that secure parts together. Load is primarily borne by the first few threads.

Fig.3.3. Nut and Bolt

5. DC Motor: A 12V, 60 RPM motor with a 6mm shaft, used for driving the mechanism. Speed is controlled by adjusting voltage or resistance.

Fig.3.4. DC Motors.

6. Spur Gear: A toothed rotating part used for torque transmission and speed control via gear ratios.

3.5. Spur Gear.

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7. Lead Screw: A screw mechanism used for lifting loads, requiring lubrication to prevent overheating and maintain efficiency.

Fig.3.6. Lead Screw.

8. Direction Control Switch (DPDT): Allows the motor to run in forward or reverse direction manually.

Fig.3.7. DPDT switch.

9. Circular Disc: A concave steel disc used for soil cutting and turning, made of heat-treated hardened steel.

Fig.3.8. Circular Disc.

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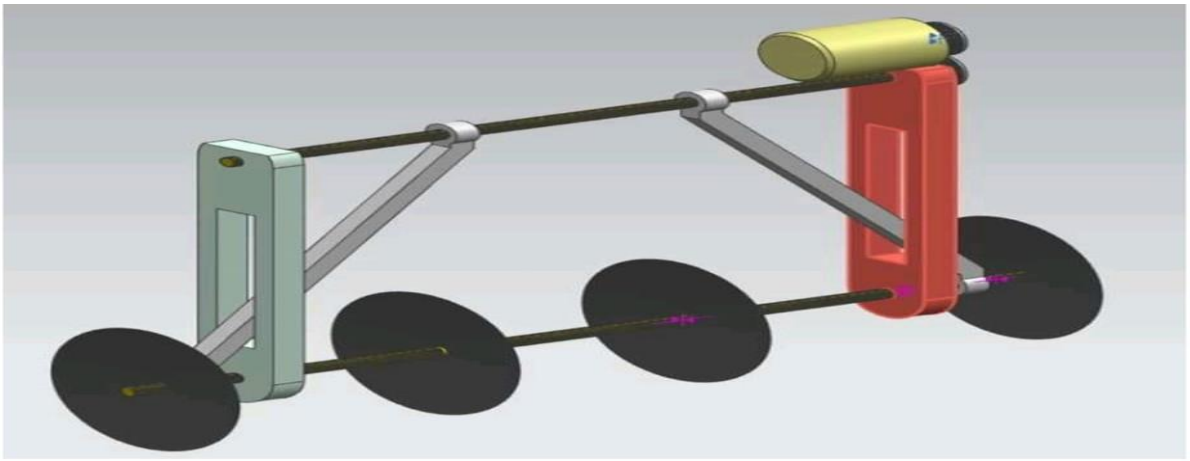
10. Ball Bearings: Comprise a housing, split bush, and cap, providing smooth rotation and support to moving parts

Fig.3.9. Ball bearing.

VII. WORKING

The mechanism allows the user to adjust the distance between the discs according to the required crop spacing. Once the desired position is set using the slotted guide rails and locking pins, the implement is fixed and ready for use. During field operation, the discs penetrate the soil and perform inter-row cultivation. The support wheels assist in maintaining uniform depth and direction.

This system reduces the time and labor needed to manually reconfigure equipment and prevents damage to growing plants by enabling precise alignment with crop rows.



VIII. ADVANTAGES, LIMITATIONS AND APPLICATIONS

8.1 Advantages:

- Adjustable for multiple crops with different row spacing.
- Reduces damage to crops during inter cultivation.
- Cost-effective and easy to fabricate.
- Increases efficiency and reduces labor.

8.2 Limitations:

- Adjustment mechanism may require occasional maintenance.
- Manual operation might be time-consuming if not automated.
- Not suitable for extremely uneven terrains.

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8.3 Applications:

- Inter cultivation in crops like sugarcane, cotton, and vegetables.
- Suitable for use in both small and medium-sized farms.
- Can be used with mini-tractors and bullock-drawn setups with minor modifications.

IX. CONCLUSION

The development of the Inter Cultivation Disc Plough with Spacing Adjustment Mechanism presents a practical and efficient solution for farmers dealing with various crop row distances. The design offers flexibility, durability, and cost-efficiency, addressing a significant limitation in traditional plough systems. Future improvements may include motorized adjustment and integration with smart farming technologies to enhance precision and usability.

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