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Design and Development of Tractor Mounted Inter-Cultivator.

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ABSTRACT:

In today's world everything is getting modernized. Agriculture fields are slowly destroying and these lands are used for some other purpose. This is because the income from agriculture is less although the work involved is high. Most of the field work is done manually and so the farmers depend on the field workers for doing it. Because of the higher pay offered in other sectors like construction, workers prefer those jobs and so agricultural sector takes shortfall of manpower. This being the scenario, workers are not available for the works such as plucking out the unwanted grass and weeds growing in between the plants. It is very important to pluck out the grass and weeds in order to obtain fruitful results from the cultivation, as the grasses and weeds absorb a part of nutrition given to the plants. Given the present situation, removing weeds becomes a costlier affair. In order to address this problem, this project proposes a simple, economical and efficient machine to remove the weed, which would be operated by a single person – savings of labor as well as time. Right now, we have planned a weeding vehicle to remove and clean the undesirable grass and weeds. To solve this problem, we have developed and fabricated a weed removing machine using hydraulic motor and direction control valve. When the plant comes across with the rod, the mechanism is getting actuated and the cylinder pushes the mechanism out of track of plant. The hydraulic motor is placed on a disc having blades on its bottom. There are four blades are attached on disc which removes the weed present in between rows of plants. The machine has been designed, fabricated and tested.

I. INTRODUCTION

The tractor-mounted inter-cultivator (TMIC) is a vital agricultural implement designed to assist farmers in performing essential field operations such as soil cultivation, weed control, and improving soil aeration. By attaching to a tractor, this device enhances the efficiency of farming operations, reducing the reliance on manual labor and increasing productivity. The development of the tractor-mounted inter-cultivator is part of a broader effort to modernize agriculture, making it more mechanized and sustainable.

Inter-cultivators have been used for decades, but with the rise of advanced agricultural technology, the design of these machines has evolved. Traditional hand tools or animal-drawn implements were labor-intensive, slow, and limited in scope. However, the tractor-mounted version combines the power of modern tractors with the functionality of a precision farming tool, providing faster, more accurate, and cost-effective solutions for crop management.

The design process of a tractor-mounted inter-cultivator involves several considerations, including the types of crops being cultivated, soil types, row spacing, and ease of operation. The aim is to create a versatile, durable, and efficient implement that enhances crop growth and reduces operational costs. The machine typically consists of adjustable blades, tines, or discs that are capable of performing multiple tasks such as loosening soil, removing weeds, and aerating the root zone.

As the demand for more sustainable and efficient farming practices grows, the development of advanced tractor-mounted inter-cultivators plays a crucial role in improving the overall productivity of the agricultural sector. These machines help farmers save time, reduce labor costs, and achieve better crop yields, ultimately contributing to the modernization of farming and food production.

II. LITERATURE SURVEY

1) C. Cordilla, T.E. Grift b, *, Design and testing of an intra-row mechanical weeding machine

As an alternative to chemical weed control, mechanical weed control between crop rows can be achieved using standard tools such as field cultivators. This paper ad- dresses the related problem of achieving mechanical intra-row weed control in maize. The object was to non-specifically remove weed plants within the row by enabling dual tine carriers to engage the soil whilst circumventing the maize stalks.

2) Graham Brodie, Melbourne University, Dookie, VIC, Australia, The Use of Physics in Weed Control

Modern no-till cropping depends on herbicides for weed management; therefore, herb- icide applications are an important system input. Unfortunately, herbicide resistance in many weed species is becoming wide spread (Heap, 1997, 2008), and multiple herb- cide resistances in several economically important weed species have also been

widely reported (Owen et al., 2007). In time, herbicide-resistant weeds may ultimately result in significant yield reductions and grain contamination. The International Agency for Research on Cancer (IARC), which is part of the World Health Organiza- tion (WHO), has also concluded that glyphosate is probably carcinogenic to humans (Guyton et al., 2015)

3) Walter Franco, Filippo Barbera, Developing intermediate machines for high-land agriculture

Micro-innovations contribute significantly to the production of positive externalities, increasing the added value not only of the single farm but of the entire value-chain. These innovations are strongly place-based and relocate the value generated in the same place that produced it. As we will argue in the following, microinnovations require a user-centered approach able to highlight the key role of co-design for devel- opment. These principles, in turn, require to set inclusive place-based mechanisms able to empower the “capability for voice” of marginal actors and left-behind areas (Rodríguez-Pose, 2017). To this end, after outlining the geographical setting and the analytical frame-work of the research, we shall illustrate the methodology adopted and the needs emerging from our analysis. We shall then describe several machinery con- cepts, design and prototypes, developed by us, in order to validate the design method- ology and provide some examples of appropriate technologies for mountain agricul- ture..

4) Sokunroth Chhun, Virender Kumar, Weed management practices of smallholder rice farmers in North- west Cambodia

One-hundred farmers from lowland rice systems of Battambang province in Cambodia were surveyed in 2017 using a structured questionnaire with the objectives to

(1) determine farmers’ current knowledge and weed management practices and document the effect of adopted agronomic practices on management of weeds in rice

(2) quantify the extent of weed seed contamination in farmers’ own saved paddy seed lots. To estimate the level of contamination by weed seeds, a one kg paddy seed sample was collected from each surveyed farmers. All farmers practiced broadcast direct- seeded rice (DSR), with an average seeding rate of 181 kg ha 1 . For sowing the rice crop, 82% of farmers used their own saved seeds or bought seed from their neighbour. All the paddy seed samples were contaminated with seeds of 34 weed species with an average of 1,070 weed seeds kg 1 of paddy seed. The most common weed contaminants in the seed samples were Oryza sativa f. spontanea (weedy rice), Fimbristylis miliacea, Echinochloa colona, Echinochloa crusgalli, and Ischaemum rugosum.

III. RELATED WORKS

3.1 Hydraulic Circuit Design

The hydraulic system must be designed to ensure rapid response times. The cylinder must retract quickly to prevent accidental contact with the tree, especially at higher forward speeds.

3.2 Sensing Rod Sensitivity

The sensing rod must be calibrated for the size and type of trees. For mature trees with thick trunks, the rod may require more force to trigger. For young saplings, a more sensitive probe with a lighter spring is needed to prevent damaging the tree.

3.3 Fail-Safe Modes

In the event of hydraulic failure or sensor malfunction, the arm should default to a safe position (either fully retracted or raised) to avoid damaging trees or the equipment.

3.4. Environmental Protection

Given that the system operates in outdoor agricultural environments, all components, especially the sensing rod and rotating arm, should be made from corrosion-resistant materials and equipped with protective covers to prevent soil and debris ingress.

3.5.Manual Override

Operators may require a manual override switch to fully retract or extend the arm during setup, transport, or troubleshooting.

3.6 Normal Weeding Mode

When operating between trees, the rotating arm extends fully into the row. The rotating disc, equipped with blades continuously works the soil to remove unwanted vegetation. The sensing rod remains extended in front of the rotating arm, scanning the path ahead.

3.7.Tree or Root Detection

As the system approaches a tree, the sensing rod makes contact with the tree trunk or a prominent surface root. This contact causes the sensing rod to pivot or compress, activating a hydraulic direction control valve pilot signal.

3.8.DCV Activation

The signal from the sensing rod is transmitted to the directional control valve (DCV), which immediately shifts to redirect hydraulic fluid flow. This causes the hydraulic cylinder to retract, pulling the rotating arm away from the tree.

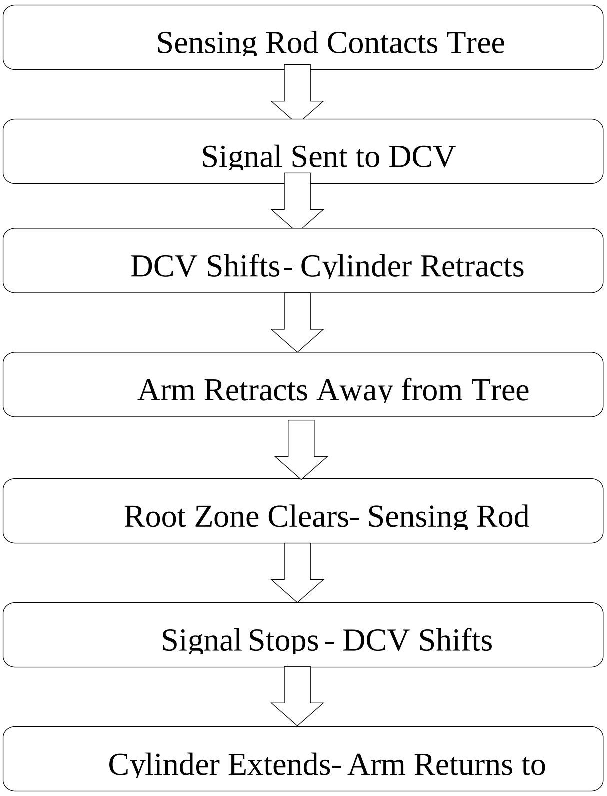
3.9.Tree Skipping Action

As the tractor continues moving forward, the rotating arm stays retracted to avoid contact with the tree trunk and root zone. The rotating disc may pause or rotate at reduced speed while in the retracted position to minimize unnecessary wear.

IV. MATERIALS AND METHODOLOGY

1,1 Block Diagram: The development of the intra row rotary tiller for farms was carried out in a systematic manner, incorporating design conceptualization, fabrication, field trials, and performance evaluation. The following steps were followed to ensure the equipment meets the operational needs of farmers. The system described consists of an automatic rotating arm designed for continuous weeding between trees in an orchard, plantation, or similar environment. The arm is equipped with a sensing rod which functions as a mechanical probe to detect the presence of tree roots. The rotating arm is mounted on a frame, typically connected to a tractor that moves along a row of trees. The objective is to allow the arm to weed continuously between trees, but to retract or bypass the tree trunks and roots themselves to prevent damage.

Summary Process Flow Diagram



V. COMPONENTS:

1 Rotating Arm Assembly

The rotating arm is the primary weeding tool. It is typically driven by a hydraulic motor, allowing it to rotate and cut, till, or remove weeds from the soil surface.

Motor Capacity: 70 LPM (clockwise and anticlockwise)

Figure: Hydraulic Motor

2. Hydraulic Cylinder (Arm Actuator)

The rotating arm is connected to a hydraulic cylinder, which provides the actuation force to retract and extend the arm. This allows the system to physically move the rotating arm away from the tree when needed.

Figure: Hydraulic Cylinder

3. Directional Control Valve (DCV)

The DCV is a critical hydraulic component. It controls the flow of hydraulic fluid to the cylinder. Depending on the signal from the sensing rod, the DCV either allows the arm to extend for normal weeding or retract to skip around tree trunks and roots.

Figure: Direction Control Valve

4. Hydraulic Pressure Pipe

Hydraulic Pressure Pipe

The hydraulic pipe is called a hydraulic pipe because it is a pipe for transmitting hydraulic pressure. It has a hard pipe and a hose. The hard pipe is mainly a seamless steel pipe, and the hose is used. The steel mesh of the layer and the rubber are bent together to form a pipe. The hose is often used in the working environment where the bending is required, and the hard pipe has strict standards. We can choose the diameter of different pipes and hoses according to the flow rate of the transport medium, and we can also select the pressure level of the pipe according to the different pressure of the hydraulic pipe.

VI. ADVANTAGES:

a. **Increased Efficiency –** Faster Operation: Being tractor-mounted, it allows for faster and more consistent inter-cultivating operations compared to manual or animal-powered systems.

b. **Cost- Effective** – Low Operational Costs: Compared to manual labor or larger machinery, the tractormounted system is often more economical in terms of fuel consumption and maintenance.

c. **Improved soil health -** Better Aeration: The inter-cultivator loosens the soil, which promotes better air circulation to the roots, improves water retention, and enhances overall soil health.

d. **Environmental Benefits** – Eco-Friendly: The ability to apply fertilizers or herbicides in precise amounts reduces the need for over-application, minimizing environmental harm.

e. **Time Saving** –Reduces Time Spent on Cultivation: Farmers can perform inter-cultivating tasks much faster, allowing them to focus on other aspects of farm management and further increasing overall productivity.

VII. LIMITATIONS:

f. Initial investment cost.

g. Suitable mainly for flat or slightly sloped farms.

h. May require regular blade sharpening

VIII. APPLICATIONS:

i. Orchards (fruit and nut trees)

j. Vineyards

k. Pomegranate

l. Row Crops with Perennial Plants

VIII. Conclusion:

The intra row rotary tiller for farms developed through this project successfully addresses the critical need for efficient weed management. Its compact design, precision weeding capability, and ease of use make it a viable solution for small and medium-sized farms. Field trials confirm high weeding efficiency with minimal impact on tree roots, contributing to sustainable and profitable cultivation. The future scope for the design and development of tractor-mounted inter-cultivators lies in a combination of advanced technologies such as automation, IoT integration, AI, and environmentally sustainable practices. Innovations in materials, customization, and efficiency will allow these machines to become even more indispensable in modern farming, driving both productivity and sustainability. These developments will not only improve farm yields and reduce costs but will also ensure that farming practices are more eco-friendly, technologically advanced, and suited to the challenges of the future.

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