Design And Development of Power Tiller Attachment for Earthing –Up and Leveling

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***Abstract*—Small and marginal farmers widely use power tillers for various field operations; however, earthing-up and land leveling are still largely performed either manually or using separate attachments, leading to increased labour requirement, time consumption, and operational cost. Non-uniform earthing-up and repeated field passes further reduce field efficiency. To address these issues, the present work focuses on the design and development of a combined earthing-up and leveler attachment for a power tiller. The attachment is designed to be simple, low-cost, and compatible with commonly used power tillers. It consists of adjustable earthing-up blades and a leveling plate mounted on a common frame, allowing efficient soil heaping around crop rows while simultaneously leveling the field surface. The design aims to reduce labour dependency, fuel consumption, and overall operation time. Field performance evaluation indicates improved uniformity in earthing-up, better land leveling, and higher field efficiency compared to conventional methods. The developed attachment offers a practical and economical solution for small and marginal farmers, enhancing power tiller utilization and agricultural productivity.**

***Index Terms*—Power tiller attachment, earthing up, Land leveling, Farm mechanization, Implement design, Soil manipulation, Performance evaluation, Field efficiency.**

I. INTRODUCTION

Agriculture remains one of the most important sectors contributing to food security and economic development, particularly in developing countries like India. However, the sector faces challenges such as labor shortages, increasing production costs, and the need for timely field operations. To overcome these issues, farm mechanization has become essential for improving efficiency, reducing human effort, and increasing productivity. Power tillers play a significant role in small and medium-scale farming systems due to their compact size, affordability, and ability to operate in narrow and uneven fields. They are widely used for various agricultural operations such as ploughing, puddling, and intercoalition. However, certain field operations like earthing up and levelling are still often performed manually or using separate implements, which increases labor requirement, time consumption, and overall cost. Earthing up is an important agricultural practice that involves loosening and heaping soil around the base of crops. This operation enhances root development, improves plant stability, and promotes better nutrient and moisture retention. Similarly, levelling ensures a uniform field surface, which is crucial for proper irrigation, prevention of waterlogging, and efficient crop growth. Performing these operations efficiently and at the right time is critical for achieving higher yields. In this context, the design and development of a multipurpose attachment for power tillers becomes highly relevant. The proposed attachment is intended to perform both earthing up and levelling operations in a single pass. It typically consists of soil cutting components, guiding plates, and levelling units that work together to cut, lift, and redistribute soil evenly across the field. The main objective of this study is to develop a cost-effective, easy-to-operate, and efficient attachment that can be integrated with existing power tillers. By combining two essential operations into one implement, the system aims to reduce labor dependency, save time, and improve field performance. Additionally, it contributes to sustainable agricultural practices by optimizing resource utilization and minimizing operational costs.

II. FABRICATION AND MANUFACTURING PROCESS OF THE ATTACHMENT

The fabrication of the attachment was carried out using standard workshop processes to ensure proper strength, durability, and functionality. The entire manufacturing process includes material preparation, cutting, shaping, welding, assembly, and finishing. The attachment is designed to be mounted on a Power Tiller to perform earthing up and leveling operations effectively. Initially, the required materials such as mild steel sheet plates and a steel pipe were selected based on the design dimensions. Mild steel was chosen because it provides good strength, is easy to fabricate, and is suitable for agricultural implements that operate under soil resistance. After selecting the materials, the dimensions of each component were marked on the metal sheets according to the design drawing. The first stage of fabrication involved the cutting process. The sheet metal plates required for the central blade and side wing plates were cut to the required dimensions using cutting tools such as a gas cutter, mechanical shear, or angle grinder. The central mounting pipe was also cut to the required length. Care was taken to ensure accurate cutting so that the components would fit properly during assembly. After cutting, the shaping and bending process was carried out. The side plates were slightly bent and arranged at an inclined angle so that they could guide soil toward both sides during operation. Proper shaping of the plates is important to ensure smooth soil flow and uniform ridging. The edges of the plates were also ground using a grinding machine to remove sharp edges and irregularities. The next stage was the welding process, which was used to join the different parts of the attachment. Electric arc welding was used to weld the side wing plates to the central blade plate. The central mounting pipe was then welded at the middle of the blade assembly so that the attachment could be connected to the power tiller frame. Additional supporting plates or brackets were also welded to increase the structural strength of the attachment. During welding, proper alignment of the parts was ensured so that the attachment remained symmetrical and balanced. Once the welding was completed, the assembly process was carried out. All welded joints were checked for strength and alignment. If required, minor adjustments were made to ensure that the side wings were properly inclined and the attachment structure was rigid. The mounting pipe was also checked to ensure that it fits properly with the hitching mechanism of the Power Tiller. The final stage of fabrication involved finishing operations. The welded joints were cleaned using a grinder to remove slag and excess welding material. The entire surface of the attachment was then cleaned to remove rust, dust, and oil.

Figure 1: Attaching to power tiller

Figure 2: Front view of attachment

After cleaning, a coat of primer paint was applied to protect the metal surface from corrosion. Finally, a finishing coat of paint was applied to improve the appearance and durability of the attachment. After

completing all the fabrication steps, the attachment was inspected to ensure that it meets the required design specifications. The final product is a strong and durable implement that can be easily mounted on a Power Tiller to perform earthing up and leveling operations efficiently in agricultural fields.

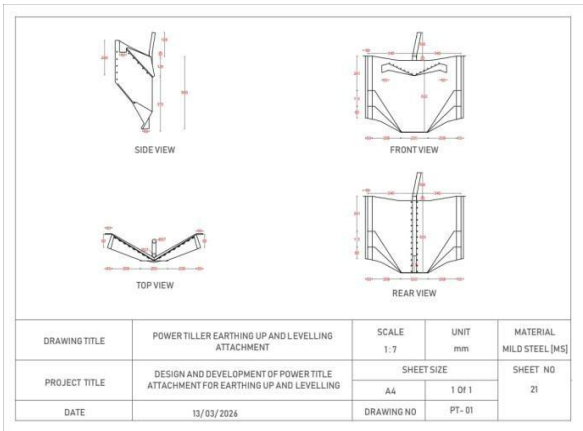

Figure 3: CAD drawing of attachment

III. WORKING PRINCIPLE

The attachment works on the principle of soil cutting, guiding, and displacement during the forward movement of a Power Tiller. The design uses inclined plates and a central guiding surface to direct soil toward both sides of the crop row while maintaining a leveled path for the tiller. When the power tiller moves forward in the field, the lower central edge of the attachment first comes in contact with the soil. This edge penetrates the soil and begins to cut and loosen it. As the soil moves along the surface of the attachment, it is guided by the inclined V-shaped plates present on both sides. The side plates are arranged symmetrically and inclined outward, which causes the loosened soil to move away from the center toward both sides of the crop row. This movement of soil results in the formation of uniform ridges on both sides, thereby performing the earthing- up operation. At the same time, the central lower portion of the attachment smooths the soil surface along the path followed by the machine. This action helps in leveling the soil behind the tiller and ensures that the machine path remains relatively even after the operation. The attachment is connected to the power tiller through a central mounting pipe, which transfers the pulling force from the machine to the implement. As the tiller continues to move forward, the soil is continuously cut, guided, and displaced, resulting in simultaneous earthing up and leveling in a single pass. Thus, the working principle of the attachment is based on the forward motion of the Power Tiller combined with the guiding action of the V-shaped blades, which direct soil to both sides and improve the efficiency of intercultural farming operations.

IV. ADVANTAGES

The power tiller attachment for earthing up and leveling offers several significant advantages that make it highly suitable for small and medium-scale farmers. One of the major benefits is the reduction in labor and time requirements. Manual earthing up and leveling typically require three to four laborers per acre per day, whereas the attachment can complete the same task within one to two hours, thereby reducing labor costs by approximately 70–80%. Additionally, the system is cost-effective, especially for small farmers, as power tillers and their attachments are considerably cheaper than tractors. This one-time investment helps eliminate recurring expenses on manual labor.

The use of this attachment also contributes to improved crop yield and quality, as uniform earthing up enhances root development, prevents lodging in crops such as sugarcane and maize, and supports better tuber formation in potato. Proper leveling ensures uniform water distribution in paddy fields, resulting in water savings of about 20– 25% and consistent crop growth. Another key advantage is its multi-purpose functionality, as the same power tiller can be used for multiple operations like tilling, earthing up, and leveling by simply changing attachments, thereby increasing machine utilization. Furthermore, it promotes better soil and water management. Earthing up improves soil aeration and drainage during heavy rainfall, while leveling helps prevent waterlogging in low-lying areas and dryness in elevated portions of the field. The attachment is also easy to operate and maintain due to its simple mechanical design, which does not involve complex hydraulics or electronics. Local mechanics can easily repair it, and farmers can quickly learn its operation. Overall, the combined benefits of reduced cultivation cost, improved yield, and efficient water use lead to increased net income for farmers.

V. RESULTS

The fabricated power tiller attachment for earthing up and leveling was tested under field conditions and gave satisfactory performance for both operations. The attachment with a working width of 450–500 mm could be operated at a depth of 80–120 mm for earthing up and 30–50 mm for leveling, with depth adjusted through the hitch holes provided on the shank. It achieved a field capacity of 0.08–0.10 ha/hr. during earthing up and 0.10–0.12 ha/hr. during leveling, which was significantly higher than the manual method that covers only 0.01–0.015 ha/hr. The quality of work was found to be uniform, forming trapezoidal ridges of 150–200 mm height for earthing up and reducing surface undulations from ±80 mm to ±25 mm in a single pass during leveling. In terms of labor and time, the manual method required 3–4 laborers and 8–10 hours to earth up one acre, whereas the power tiller with the attachment completed the same work in 1.5–2.0 hours with one operator, thereby reducing labor requirement by 75–80%.

The cost of operation also reduced substantially. Manual earthing up cost Rs 1800–2200 per acre, while with the attachment it was only Rs 450–600 per acre including fuel, operator charges, and depreciation, resulting in a saving of about 70–75%. The attachment was successfully operated with a 6.5 HP power tiller in 1st low gear with a fuel consumption of 0.8–1.0 L/hr., and no overloading or wheel slip was observed in medium soil at 15–18% moisture content. The total fabrication cost of the attachment was Rs 1800–2200, and the payback period was less than 5 acres of use when compared to manual labor cost. Operator feedback indicated that the attachment was easy to hitch and detach within 5 minutes, caused less fatigue due to steady pull, and depth control was effective using the provided holes. Overall, the developed attachment proved to be effective, economical, and suitable for small farms, showing clear advantages over traditional manual methods in terms of time, cost, and quality of work.

VI. CONCLUSION

The designed power tiller attachment for earthing up and leveling successfully addresses the need for affordable mechanization in small and marginal farms. It reduces manual labor, saves time, and improves the quality of field operations compared to traditional methods. The attachment is simple in construction, easy to operate, and compatible with existing power tillers, making it practical for adoption by farmers. Field-level implementation of this attachment can increase operational efficiency and reduce cultivation costs for crops like sugarcane, potato, maize, and vegetables. With further refinement in weight reduction, adjustable features, and durability, the attachment has strong potential for commercial production and widespread use through custom hiring centers. Overall, this project contributes toward promoting farm mechanization and improving productivity in Indian agriculture.

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