

DESIGN & DEVELOPMENT OF MULTIVEGETABLE TRANSPLANTER

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ABSTRACT

The manually operated vegetable transplanter is designed to streamline and improve the efficiency of planting small vegetable seedlings such as brinjal, tomato, and chili. Its sturdy frame, built using square tubes and angle sections, ensures both durability and structural stability. The machine is supported by four wheels, three of which rotate freely, while the fourth is driven by manual pushing force. The driven wheel is fitted with an 18-tooth freewheel chain sprocket, which transfers rotational motion through a chain mechanism to two cranks. These cranks are linked to the hopper mechanism, generating a synchronized back-and-forth movement. The hopper is designed with an automatic opening system controlled by a wire-based cam mechanism, enabling precise and efficient seedling placement at regular intervals. Engineered for accuracy, the transplanter maintains consistent planting depth and spacing, optimizing growing conditions for the seedlings. Its straightforward mechanical design reduces maintenance needs while ensuring ease of use. By lowering physical labour and improving planting precision, this transplanter presents a cost-effective and practical solution for small to medium-scale farmers.

Keywords: Analysis, investigation, research

I. INTRODUCTION

Agriculture plays a vital role in many economies, supplying food and essential raw materials for various industries. One of the crucial tasks in crop cultivation, particularly for vegetables like brinjal, tomato, and chili, is the transplanting of seedlings. Traditionally, this process has been done manually, requiring significant labor, time, and effort. Additionally, inconsistencies in planting depth and spacing can affect crop growth. To overcome these challenges, mechanized solutions such as vegetable transplanters have been developed to enhance efficiency, accuracy, and productivity in farming.

The Vegetable Transplanter is an innovative, manually operated machine designed to simplify and optimize the seedling transplanting process. Its design focuses on durability, simplicity, and cost-effectiveness, making it a practical solution for small and medium-scale farmers. Unlike motorized alternatives, this machine functions without external power sources, making it both sustainable and environmentally friendly.

The transplanter's main structure consists of a sturdy chassis made from square tubes and angles, ensuring long-term durability and resilience in various field conditions. It is supported by four wheels, with three functioning as idle wheels and one being manually driven by pushing. This powered wheel is connected to an 18-tooth freewheel chain sprocket, which transfers motion through a chain mechanism. This movement drives two cranks that, in turn, operate the hopper system.

At the core of the transplanter's functionality is the hopper, which is specifically designed to hold and release seedlings with precision. Its synchronized back-and-forth motion, powered by the crank system, ensures consistent spacing between transplanted seedlings. A built-in self-opening mechanism, controlled by a wire-based cam system, facilitates automatic seedling release. This design ensures accurate planting depth and spacing, creating ideal conditions for healthy crop growth.

A key benefit of the Vegetable Transplanter is its manual operation, making it highly accessible to farmers in remote or rural areas where advanced machinery or electricity may not be available. Additionally, its lightweight construction allows for easy handling, transportation, and operation in different field environments. By significantly reducing the physical strain associated with traditional transplanting methods, the machine helps lower labor costs and minimizes fatigue among farmers.

Another advantage of this machine is its low maintenance requirements. Built with simple mechanical components, it is easy to repair and maintain, ensuring long-term usability at a minimal cost. As a result, it offers an economical solution that aligns with the principles of sustainable agriculture by promoting efficiency and reducing dependency on extensive human labor.

II. METHODOLOGY

Our "DESIGN & DEVELOPMENT OF MULT-IVEGETABLE TRANSPLANTER" project wasn't just about building a machine; it was about solving a problem with a human-centered approach. We embarked on a systematic journey, carefully considering

every detail from initial design to the final evaluation, all with the goal of creating a manual, multi-row transplanter that was efficient, easy on the body, and versatile for various vegetable seedlings.

A. Design Considerations: The Farmer's Blueprint

Every decision we made was guided by practical needs:

- **Simplicity at its Core:** We envisioned a machine that could be built with readily available, local materials. This wasn't just about cost; it was about ensuring farmers could easily maintain and repair it themselves.
- **Stand Tall, Plant Strong:** No more bending or squatting! Our design prioritized a standing posture for the operator, aiming to eliminate the back pain and discomfort that often accompany manual transplanting.
- **A Versatile Partner:** We wanted a transplanter that could adapt. Whether it was brinjal, chili, or tomato, the machine needed to handle different crops and seedling sizes effortlessly.
- **Gentle on the Hands:** The force required to operate the transplanter was a critical concern. We designed it to be light enough for both men and women to use comfortably, ensuring it empowers everyone in the farming community.
- **Safety First:** Beyond efficiency, ensuring the operator's safety was woven into every design decision.

B. Building the Machine: Components and How It Works

Our multi-vegetable transplanter is a harmonious assembly of well-chosen parts:

- **The Backbone (Frame):** Crafted from sturdy L-shaped bars, this is the skeleton that holds everything together, ensuring stability as it moves through the field.
- **Wheels That Grip (Wheels):** Made from steel bars with clever lugs, these wheels aren't just for movement; they provide unwavering traction and even clean themselves as they turn, ready for any terrain.
- **The Seedling Sanctuary (Tray):** A conveniently placed tray keeps seedlings within easy reach, ready for their journey.
- **The Entry Point (Hopper):** This funnel-shaped component is where the seedlings begin their descent.
- **The Earth's Embrace (Planting Device/Jaw Mouth):** This ingenious mechanism, activated by a simple pedal or lever, plunges into the soil, creates the perfect opening, and gently releases the seedling.
- **The Farmer's Grip (Handle):** Made from MS pipe, the handle is designed for comfort, allowing the farmer to stand tall and work without strain.
- **Tucking Them In (Furrow Covering Device):** This final touch ensures each newly planted seedling is nestled securely in the soil, ready to flourish.

In action, the transplanter is a dance of simple mechanics. As the operator pushes or pulls, the planting mechanism prepares the ground. Seedlings are dropped into the hopper, slide down the tube, and with a simple foot or hand action, the jaw opens, releasing them precisely. The final touch? A smooth sweep from the furrow covering device, tucking each seedling into its new home.

C. Crafting the Machine: Materials and Fabrication

Our material choices were driven by practicality: readily available, affordable, and robust. Mild Steel (MS) forms the sturdy frame, while PVC pipes create the essential seedling delivery system. The fabrication process is straightforward: cutting, welding, and assembling these components into a seamless unit. This approach not only keeps costs down but also empowers local technicians to maintain and repair the machine, truly making it a tool for the community.

D. Measuring Success: The Evaluation Journey

To truly understand our transplanter's impact, we put it to the test in the field, meticulously measuring its performance:

- **How Much Ground Can It Cover? (Effective Field Capacity - EFC):** This tells us the actual area it can plant per hour. Our expectations, backed by similar studies, were for a significant increase over hand planting.
- **Working Smart, Not Hard (Field Efficiency):** How well does the machine utilize its potential? This metric reveals its true operational effectiveness.
- **Less Hands, More Harvest (Labor Requirement):** We quantified the reduction in man-hours needed per hectare, a direct measure of its economic impact.
- **The Little Ones Thrive (Seedling Survival Rate):** This crucial metric confirms that the transplanter handles seedlings gently, ensuring they establish well after planting.

- **Precision Planting (Planting Depth and Spacing):** We verified that the machine maintained consistent depth and spacing, vital for healthy crop growth.
- **Smooth Operations (Clogging Percentage):** We looked for any instances where seedlings might get stuck, ensuring a reliable flow.

III. MODELING

Model and Material which are used is presented in this section. Table and model should be in prescribed format.



Figure 1: 3D view of Model

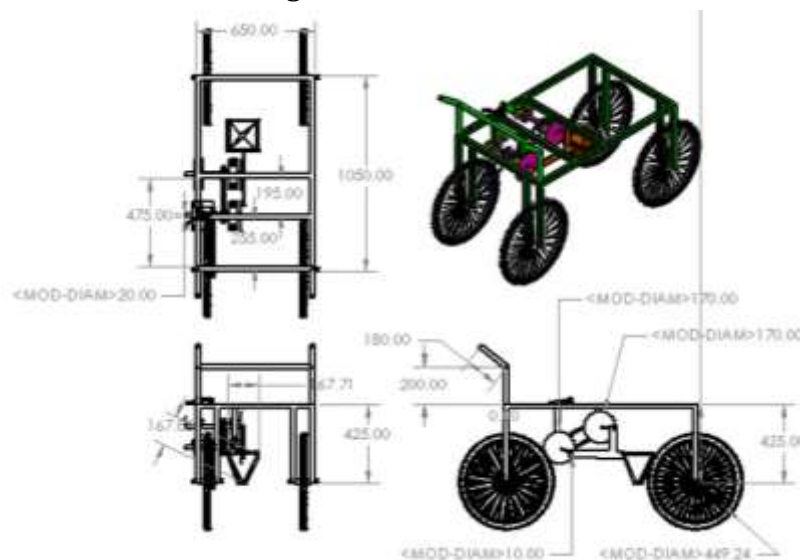


Figure 2: Drafting



Figure 3: 3D view of Model

IV. RESULTS AND DISCUSSION

Our project, Design & development of multi-vegetable transplanter, presents a comparison between traditional manual planting and a newly developed semi-automatic transplanter. The study was conducted on tomato crops over an area of 3 Guntha. The manual method took about 60 minutes (45 minutes of work and 15 minutes of additional handling), while the semi-automatic machine completed the same task in just 15 to 17 minutes. Furthermore, it reduced the manpower needed from 4 workers to only 2. Both methods used 400 seeds, but our machine caused much less plant damage, only 3% compared to 10% in manual planting. Spacing between plants was more accurate with the machine, having only 0.1 to 0.5 cm variation.

The cost of operation was also cut in half, from 1600 rupees for manual to 800 rupees with our device. Most importantly, the machine greatly reduced physical strain and tiredness for the operator, changing from very high fatigue in manual work to low fatigue with the transplanter. Overall, this project offers a practical, economical, and labor-friendly solution for farming, especially useful for vegetable growers. The machine increases work speed, reduces errors, and makes farming more comfortable for workers

Table 1. Observation table

SN.	Parameter	Manual	Semi Automatic
1	Crop	Tomato	Tomato
2	Area Covered	3 Guntha	3 Guntha
3	Time Required	60 min	15-17 min
4	Labor	4	2
5	Total Speed	400	400
6	Plant Damage	10%	3%
7	Average Spacing	Vary	0.1 to 0.5 cm deflection
8	Operational Cost	1600	800
9	Fatigue to operator	Very High	Low

V. CONCLUSION

The Vegetable Transplanter is a groundbreaking innovation designed to overcome the limitations of traditional transplanting methods in modern agriculture. Designed as a cost- effective, efficient, and user-friendly solution, this manually operated machine streamlines the process of transplanting seedlings such as brinjal, tomato, and chili. Its sturdy construction, incorporating a durable chassis, crank mechanisms, and a self-operating hopper, ensures precise and consistent planting while minimizing labor dependency and associated costs.

One of the key benefits of this transplanter is its accessibility for small and medium-scale farmers. Constructed using locally sourced materials such as square tubes, angles, and chains, it is both affordable and highly durable. Since it operates manually, there is no reliance on external power sources, making it a sustainable choice for farmers in remote areas with limited access to electricity or fuel. Additionally, its lightweight and ergonomic design facilitates easy transport and operation across different terrains and field conditions.

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