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# Design and Development of Multi Vegetable Transplanter

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**A B S T R A C T :**

The hand-operated vegetable transplanter is crafted to enhance the planting process of young vegetable seedlings like tomato, chili, and brinjal. Constructed from robust square tubing and angular metal sections, its frame offers both long-lasting strength and dependable stability. The equipment is mounted on four wheels—three of which move freely, while the fourth wheel is driven manually by the operator's forward motion.

This driven wheel is connected to an 18-tooth chain sprocket with a freewheel mechanism. As the operator pushes the unit, the wheel's motion is transferred through a chain to activate a pair of cranks. These cranks drive the hopper assembly, creating a rhythmic to-and-fro movement that coordinates with the planting action. The hopper includes a mechanism that opens automatically, triggered by a cam system connected via a tensioned wire. This setup allows for the controlled and accurate release of seedlings into the soil at consistent intervals. Designed with precision in mind, the device ensures uniform planting depth and spacing, which supports healthy crop development. It's simple yet effective mechanical layout minimizes the need for complex upkeep and makes it user-friendly. By reducing manual workload and improving planting consistency, this tool offers an efficient and budget-friendly option for farmers operating on small to medium scales.

**Keywords**: Analysis, Investigation, Research

## 1. INTRODUCTION

Agriculture serves as the backbone of numerous economies, providing both nourishment and raw materials essential for various industrial sectors. One key operation in vegetable farming—especially for crops like chili, brinjal, and tomato—is transplanting young seedlings. This task, when done manually, demands considerable labour, time, and precision. Manual efforts often lead to uneven planting depths and irregular spacing, which can negatively influence crop yield and quality. To address these limitations, manual vegetable transplanters have emerged as an efficient, accurate, and farmer-friendly solution. 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.

This manually operated vegetable transplanter is a thoughtfully engineered device that simplifies the otherwise labour-intensive seedling transplantation process. Its core design prioritizes cost-effectiveness, durability, and ease of use, making it highly suitable for small to mid-sized farms. Unlike motor-driven machines, it operates entirely without fuel or electricity, offering an eco-friendly alternative that aligns with sustainable farming practices. 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.

The main frame is constructed from solid square tubes and angular sections, providing structural strength capable of withstanding demanding field conditions. The unit rolls on four wheels—three of which rotate freely, while one is driven by the pushing action of the user. This primary wheel is equipped with a freewheel chain sprocket featuring 18 teeth. As it rotates, the chain drive transfers motion to a pair of cranks that activate the planting system.

Central to the operation is the hopper unit, designed to hold and release seedlings with high precision. The cranks generate a synchronized oscillating motion, enabling the hopper to maintain uniform spacing during planting. A cam system, controlled by a taut wire mechanism, governs the automatic opening of the hopper. This setup ensures that seedlings are deposited into the soil at consistent intervals and correct depths—crucial factors for healthy crop development.

With its simplified mechanics and low maintenance requirements, the transplanter significantly reduces the physical strain of farming while improving planting uniformity. It represents a practical and sustainable investment for farmers seeking greater efficiency without relying on expensive or complex machinery.

## 2. METHODOLOGY

Our project titled **"Design and Development of a Multi-Vegetable Transplanter"** was more than just constructing a piece of agricultural equipment—it was about tackling a real-world farming challenge using a people-centred mindset. From initial sketches to hands-on field testing, our goal was to develop a manual, multi-row transplanter that could improve planting efficiency while being easy to use and adaptable to various vegetable crops.

### A. Design Principles: Shaped by Farmer Needs

- Built for Simplicity: The transplanter was intentionally designed using commonly available materials, ensuring it remains affordable, easy to maintain, and repairable with local resources.
- Upright Operation: One of our main goals was to eliminate the physical strain of transplanting. Our solution allows the user to operate the machine while standing upright, removing the need for continuous bending or squatting.
- Adaptability: Whether planting chili, tomato, or brinjal, the machine was engineered to adjust easily to different seedling types and sizes without modification.
- Effortless Handling: Ease of use was a core concern. The mechanism requires minimal force, making it suitable for both male and female farmers, ensuring inclusivity in operation.
- User Safety: While enhancing productivity, we ensured that safety remained an integral part of every feature and component.

### B. Assembling the Transplanter: Parts and Mechanism

- Main Structure (Frame): Constructed using durable L-angle bars, the frame serves as the sturdy foundation that holds the entire assembly together.
- Traction Support (Wheels): Made from solid steel rods with lugs for grip, these wheels offer reliable traction and self-cleaning action, allowing smooth movement across various soil types.
- Seedling Tray: Positioned for convenience, the tray keeps seedlings easily accessible for continuous planting without interruptions.
- Feeding Unit (Hopper): Seedlings enter the system through this funnel-shaped section, designed for efficient flow.
- Planting Mechanism (Jaw Mouth): Activated by a foot pedal or lever, this mechanism carefully creates an opening in the soil and positions the seedling with precision.
- Control Handle: Built from mild steel piping, the ergonomically designed handle offers comfort and stability, allowing the operator to work efficiently in a standing posture.
- Soil Covering Unit: This part ensures that the seedling is firmly tucked into the soil after placement, providing ideal conditions for growth.

### C. Building It Right: Materials and Manufacturing Process

In terms of materials, we prioritized availability, affordability, and strength. Mild Steel (MS) was chosen for the frame due to its reliability and resilience. For the seedling delivery system, lightweight and durable PVC pipes were utilized. Fabrication was kept simple—cutting, welding, and assembling—all of which can be easily handled by local workshops. This approach empowers local mechanics to handle maintenance and repair, promoting long-term usability within the farming community.

### D. Field Testing: Proving Performance

- Effective Field Capacity (EFC): This measures how much area the machine can cover within an hour. Based on prior data and our trials, we observed a notable boost in efficiency compared to manual methods.
- Field Efficiency: We evaluated how efficiently the machine performs in real-world conditions versus its theoretical potential.
- Labor Input: By calculating the reduced manpower needed per hectare, we were able to demonstrate the time and cost-saving potential of the machine.
- Seedling Establishment Rate: We carefully monitored the survival rate of transplanted seedlings to ensure the mechanism was gentle enough for successful growth.
- Depth and Spacing Accuracy: Consistent planting depth and proper spacing were verified, both of which are essential for healthy plant development.
- Clog Prevention (Clogging Rate): We checked for any disruptions in seedling flow to ensure seamless and continuous planting operations.

## 3. MODELING

**Model and Material which are used is presented in this section**

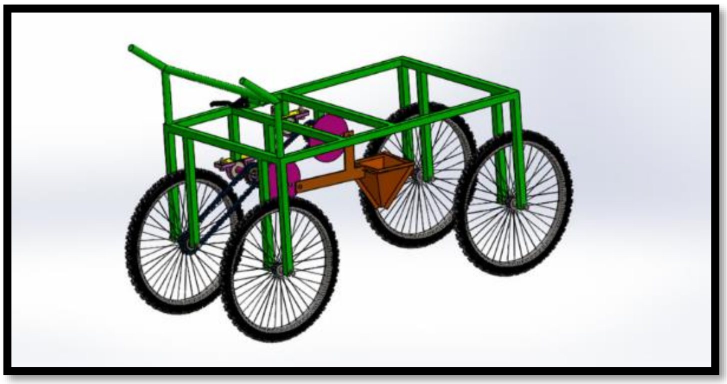

**Figure 1: 3D view of Model**

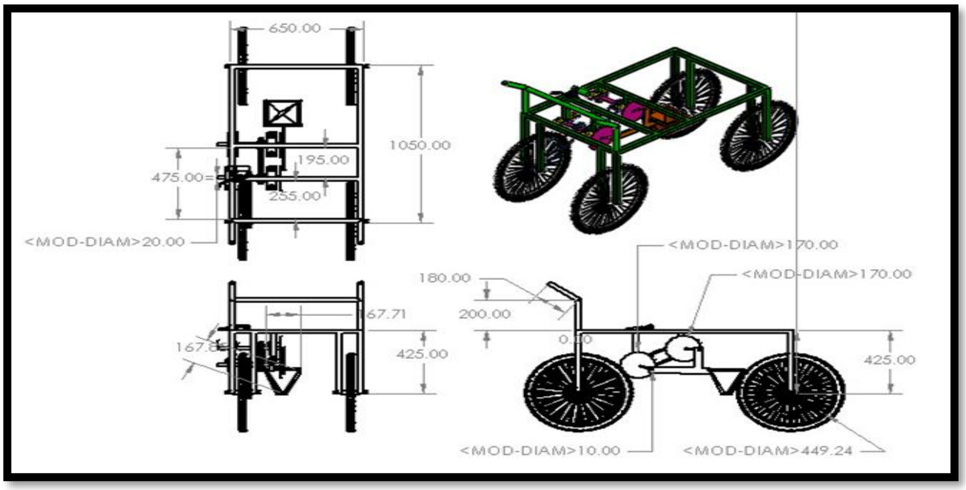


**Figure 2: Drafting**

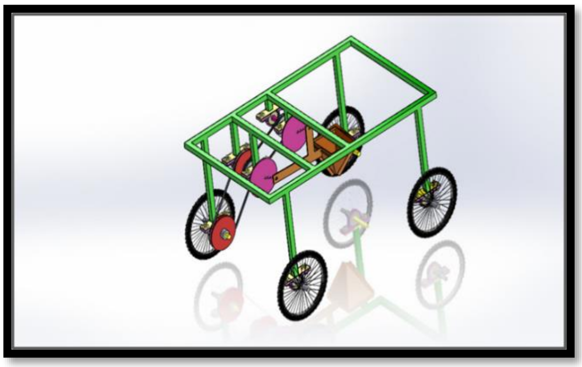

**Figure 3: 3D view of Model**

## 4. RESULTS and DISCUSSIONS

As part of our initiative titled **"Design & Development of a Multi-Vegetable Transplanter,"** we conducted a comparative field study to assess the efficiency and benefits of our newly developed semi-automatic transplanter against traditional manual transplanting methods. The trials focused on tomato seedlings over a standardized area of **3 Guntha**.

In terms of **time efficiency**, the manual method required approximately **60 minutes**, including both planting and necessary adjustments. In contrast, our semi-automatic machine completed the same task within **15 to 17 minutes**, showcasing a significant improvement in operational speed.
When it came to **labor requirements**, manual transplanting demanded **four individuals**, whereas the mechanized version reduced the need to only **two**, effectively cutting manpower in half.

Both approaches involved the planting of **400 seedlings**, but the rate of **plant damage** was markedly different. Manual methods led to around **10% damage**, while our transplanter minimized this to just **3%**, emphasizing its gentler handling of seedlings.
**Spacing accuracy** was another notable advantage. The manual process resulted in inconsistent spacing, while the semi-automatic unit-maintained uniformity with a deviation of only **0.1 to 0.5 cm**, ensuring healthier and more uniform crop growth.

From a **cost perspective**, the difference was also significant. Manual operations incurred a cost of around **₹1600**, whereas the machine brought this down to **₹800**, reflecting a **50% reduction in operational expenses**.
The level of **physical fatigue** experienced by operators further emphasized the benefit of our solution. Manual transplanting was associated with **very high exertion**, while the semi-automatic device drastically reduced physical strain, resulting in **low fatigue levels** for the user.

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