



# “Design And Development Of An Ergonomic Crop Tray And Small Plant Handling Device”

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**Abstract:** In farming and nursery practices, crop trays are commonly used for growing and transferring seedlings. A standard tray generally contains around 105 to 125 plants. However, handling these trays in wet soil is often difficult, as it can cause damage to the seedlings and increase the chances of tearing the plastic tray. Manual shifting of trays in polyhouses or farms also requires significant labour effort and reduces overall efficiency. To overcome these challenges, an ergonomic tray handling device has been developed. This device is specifically designed to handle plants with care, including sensitive or weak-stemmed seedlings, ensuring their safety during transportation. The device consists of two strong metal sheets operated by a simple lever and gear mechanism. When the lever is pressed, the sheets move apart, allowing the tray to be placed easily without strain. On releasing the lever, the sheets move back together, holding the tray securely in position. After use, pressing the lever again automatically releases the empty tray, thereby eliminating the need for manual effort. This innovative design is simple, durable, and cost-effective. It makes tray handling easier, minimizes plant damage, reduces the risk of tray breakage, and saves valuable time during plantation activities. As a result, it improves both efficiency and safety in nursery and farming operations.

**Index Terms** - Ergonomic design, Crop tray handling, Seedling transplantation, Agricultural tool, Tray holder device, Lever mechanism, Plant protection, Greenhouse farming, Nursery management, Farm ergonomics.

## I.INTRODUCTION

Agriculture is one of the oldest and most essential practices for human survival, and continuous technological innovations have played a significant role in improving its efficiency and productivity. In modern farming and nursery operations, crop trays are widely used for germination and transplantation of seedlings, particularly in nurseries, greenhouses, and polyhouses. A typical tray can hold more than 100 seedlings, facilitating organized and large-scale seedling management. However, handling these trays manually, especially in wet or uneven soil conditions, is often difficult. This not only increases the risk of damaging delicate seedlings and tearing plastic trays but also requires considerable physical effort, reducing overall labour efficiency. Moreover, frequent handling in such conditions can be time-consuming and may compromise the quality of plantation activities. To address these challenges, there is a need for an ergonomic, low-cost, and user-friendly tray handling device that can securely hold trays, minimize seedling damage, reduce physical strain, and improve operational efficiency in modern agricultural practices.

## II.RESEARCH GAP

Existing tray handling methods primarily rely on manual lifting and transportation, which are prone to errors, plant damage, and tray breakage. While some mechanical solutions and automated systems exist for large-

scale operations, they are often expensive, complex, and not easily accessible to small or medium-scale farmers. Moreover, most available devices focus on increasing speed or automation rather than protecting delicate seedlings, which makes them unsuitable for fragile plants or wet and slippery conditions commonly encountered in nurseries and polyhouses. There is also a lack of ergonomic designs that reduce physical strain on workers, as many current tools still require significant manual effort for lifting, positioning, or releasing trays. Therefore, there is a clear need for a low-cost, user-friendly, and durable tray handling device that ensures seedling safety, minimizes labor effort, and can be effectively used across different farming scales and soil conditions.

### III. PROBLEM STATEMENT

Handling crop trays during plantation, especially in wet or muddy soil conditions, presents several challenges for farmers and nursery workers. Lifting and shifting trays manually can be difficult due to their weight and size, often leading to physical strain and fatigue. During transportation, seedlings are frequently damaged because the trays are not held securely, and uneven handling can cause plants to tilt, fall, or break. In addition, plastic trays themselves may get cracked or deformed when improperly handled. These issues not only reduce crop survival rates but also increase labor requirements and lower overall operational efficiency. Therefore, there is a need for a simple, ergonomic, and cost-effective device that can securely hold crop trays, minimize seedling and tray damage, reduce manual effort, and improve the speed and ease of plantation activities in both small-scale and large-scale farming.

### IV. OBJECTIVES

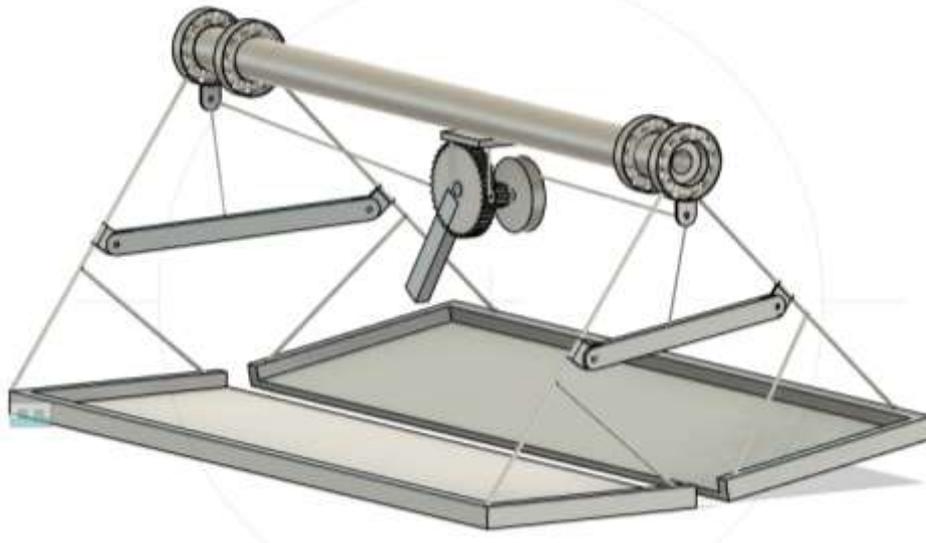
The main objectives of this project are as follows:

- To design and develop an ergonomic tray handling device that can lift and transport crop trays safely.
- To reduce the risk of damage to seedlings during shifting and plantation.
- To minimize labor effort and operator fatigue by providing an easy-to-use mechanical solution.
- To create a device that is lightweight, low-cost, and suitable for small-scale and large-scale agricultural operations.
- To incorporate a simple lever mechanism that allows automatic gripping and release of trays for faster operation.

### V. DESIGN AND METHODOLOGY

The design of the ergonomic tray handling device consists of two metal sheets and a lever-operated mechanism. Each metal sheet is sized to cover half of the crop tray, allowing trays to be securely held without slipping.

The tray handling device is designed to provide a simple, ergonomic, and farmer-friendly solution for lifting and transporting seedling trays in nurseries and polyhouses. It consists of two metal support plates suspended by cables from a cross-tube, operated through a lever and spur gear mechanism. When the lever is pressed, the plates move apart to allow easy placement of the tray, and when released, they return to hold the tray securely by its rim without damaging the seedlings. Pressing the lever again automatically tilts the plates, releasing the empty tray without manual effort. The design emphasizes low cost, durability, and ease of use, with stainless steel or aluminum construction, cable supports, and padded plate edges to prevent tray damage. The methodology for development includes CAD modeling of the mechanism. The device aims to reduce labor strain, improve safety, minimize seedling and tray damage, and save time during plantation activities, making it a practical tool for both small- and large-scale farming operations.



## VI. WORKING

The device lifts and secures a seedling tray using two rim-support plates that are suspended by cables from a cross-tube and driven by a central lever-gear mechanism. In the open state, pressing the hand lever rotates the output gear and link arms, which spread the two plates apart and slightly tilt them so a tray can be guided in without touching the seedlings. Releasing the lever lets the plates return to the clamp position: the cables keep both plates parallel while neoprene-lined rims gently grip the tray edges, preventing slip or tray deformation. The operator can now carry or slide the assembly along benches or rails; the bearing-mounted cross-tube and balanced cable angles keep the load steady and reduce effort, even on wet or uneven surfaces. After transplanting, a second press of the lever drives the plates to the release position, tipping the tray just enough for a controlled, hands-free drop or slide-out, avoiding sudden impact. Mechanical stops limit motion, a guarded gear set prevents pinch hazards, and turnbuckles on the cables allow quick leveling so the tray stays horizontal during transport. The all-metal, corrosion-resistant build rinses clean easily; routine checks include inspecting cable terminations, plate padding, and fastener tightness to ensure smooth, low-effort operation with minimal seedling or tray damage.

## VII. RESULTS AND DISCUSSION

The developed ergonomic tray handling device was tested in nursery and polyhouse conditions to evaluate its performance against conventional manual handling. The trials demonstrated that the device significantly reduced seedling damage and tray breakage compared to hand lifting, especially under wet soil conditions where trays are more prone to slipping. The automatic clamping and release mechanism ensured that trays were held firmly by their rims, preventing direct contact with delicate seedlings and thereby minimizing transplant losses.

In terms of labor efficiency, the device reduced physical effort and handling time per cycle. Operators reported less wrist strain and better posture while using the lever-operated mechanism, highlighting the ergonomic advantage of the design. The lightweight yet sturdy construction made it easy to carry across different farm conditions, while the padded contact surfaces provided additional protection to trays. Field observations confirmed that the design was simple to operate, required minimal training, and functioned effectively for both small- and large-scale farming practices.

Overall, the results indicate that the tray handling device provides a low-cost, practical solution that improves worker comfort, reduces seedling loss, and enhances efficiency in nursery operations. The discussion suggests that while current methods rely heavily on manual handling or expensive automation, this device bridges the gap by offering a farmer-friendly, durable, and efficient alternative.

## VIII.ADVANTAGES

- Reduces the risk of seedling and tray damage.
- Minimizes labour effort and operator fatigue.
- Simple and easy-to-use lever mechanism.
- Automatic tray release for faster operation.
- Lightweight and portable design suitable for small and large farms.
- Cost-effective solution for nurseries and polyhouses.

## IX.APPLICATIONS

- Useful in greenhouses and polyhouses for safe and efficient seedling transplantation.
- Suitable for small-scale nurseries and commercial farms to reduce labour effort and prevent plant damage.
- Ideal for wet or muddy soil conditions where manual handling is difficult.
- Applicable in large-scale farming operations requiring fast and secure tray handling.
- Can be used in any agricultural activity where seedlings grown in trays need to be shifted or planted carefully.
- Helps improve overall productivity and operational efficiency in nursery management.

## X.FUTURE SCOPE

- Use of lightweight composite materials or alloys to further reduce the device's weight.
- Development of multi-tray handling versions for faster operation in large-scale farms.
- Addition of ergonomic handles or adjustable height features for better user comfort.
- Integration with semi-automatic or automated systems for industrial nurseries.
- Mass production and cost optimization to make the device accessible to more farmers.
- Potential adaptation for different tray sizes and plant types to increase versatility.

## XI.CONCLUSION

The developed ergonomic crop tray and small plant handling device provides an effective solution to the difficulties encountered during seedling transplantation. By securely gripping trays and reducing the need for manual lifting, the device helps prevent damage to both seedlings and trays, ensuring higher survival rates. Its lever-operated mechanism and automatic tray release simplify the handling process, reducing labor effort, minimizing operator fatigue, and increasing overall efficiency. The design is lightweight, portable, and adaptable, making it suitable for small nurseries, polyhouses, and larger farms alike. Additionally, the device is cost-efficient and user-friendly, making it accessible for a wide range of agricultural operations. With future improvements such as multi-tray handling, ergonomic adjustments, or partial automation, the device has the potential to enhance tray management practices, making plantation work faster, safer, and more reliable. Overall, this innovative tool strikes a balance between practicality, simplicity, and efficiency, providing significant benefits to farmers and the agricultural sector.

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**REFERENCES**

- [1] CDC. (1999). Simple Solutions: Ergonomics for Farm Workers.
- [2] Li, T. et al. (2019). Seedling Tray Stacking Manipulator Design.
- [3] Suwathiga, M. et al. (2020). Ergonomic Evaluation of Manual Transplanter.
- [4] Zhang, Y. et al. (2023). Seedling Pick-Up Device Design and Testing.
- [5] ILO. (2014). Ergonomic Checkpoints in Agriculture.
- [6] Li, H. et al. (2023). Experimental Study of Seedling Tray Handling Device

