Crafting a semi-automatic leaf plate stitcher for tribal artisans

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ABSTRACT

Disposable plastic plates, common at celebrations and community events, create significant environmental pollution. The study explores an eco-friendly solution: leaf plates. While tribal communities have traditionally made these by hand, the process is tough, slow and can cause injuries. Existing machines are usually big, expensive (starting around Rs 5,000) and not practical for remote areas. To tackle these issues, a portable, user-friendly device for stitching leaf plates was created. This development followed an iterative, user-centered design approach, blending traditional know-how with modern manufacturing techniques like 3D printing and computer numerical control (CNC) machining. Tribal artisans were visited and interviewed, which helped to understand their main problems: injuries from repetitive movements, inconsistent stitch quality and low output. The final prototype, a compact tool that works like a stapler, showed impressive improvements. It boosted productivity by 40-50 per cent compared to hand stitching and its ergonomic design significantly cut down on injuries and fatigue. The stitches were much better, with uniform depth and tightness. Since the projected cost was under Rs 300, it's highly affordable. Feedback from the field, especially from tribal women artisans, confirmed strong acceptance. This invention offers a practical, sustainable and empowering way to make leaf plates.

Keywords: Leaf plates; sustainable livelihood; ergonomic design; tribal artisans; affordable technology

INTRODUCTION

The widespread use of disposable plastic plates, particularly during festivals and community gatherings, severely impacts our environment. Their non-biodegradable nature means they pile up in landfills and pollute ecosystems. In stark contrast, leaf plates, crafted from renewable sources like sal, teak, banana and jackfruit leaves, present a compelling, earth-friendly option. These natural plates naturally break down, don't harm the environment, can be stored for a long time and are easy to compost after use (Kora 2019).

Making leaf plates by hand has been a long-standing tradition among tribal communities in various Indian states, including Odisha, Jharkhand and Chhattisgarh. However, this traditional method, which often involves hand-stitching leaves with bamboo sticks or Juna grass, is extremely demanding, takes a lot of time and can lead to various health problems for the workers.

The current study aimed to address these challenges by developing a hand-held device for stitching leaf plates. This new tool was designed to make the production process simpler and faster, focusing on keeping it affordable, easy to use and portable to meet the specific needs of tribal populations.

Traditional leaf plate stitching, which relies on handling sharp bamboo sticks manually, frequently results in worker injuries, increased tiredness and low output. On the other hand, existing mechanical stitching machines come with their own difficulties; they're bulky, expensive (starting from Rs 5,000) and largely impractical for use in remote areas. This highlighted a clear need for an ergonomic, efficient and low-cost device that tribal artisans could easily adopt without needing extensive technical training.

Kalita et al (2008) designed an efficient, high performance and user-friendly hand-operated machine for bowl and plate manufacture from areca palm leaf

sheath. New machine was very effective in terms of cost, productivity, quality, versatility, space required and ease of operation for normal as well as physically handicapped people with leg deficiency. New machine minimized fatigue and could be operated in seating position.

Poudel (2022) gave techniques for design and development of areca nut leaf plate making machine which used manual power (foot operated) as the main power source. Martinus et al (2021) designed, developed and fabricated a teak leaf plate molding machine for producing an alternative product for plastic in Indonesia that performed quite well.

So, the efforts were focussed on creating a lightweight, user-friendly and affordable leaf plate stitching device. This invention sought to improve the speed and quality of leaf plate production, reduce the health risks and physical discomfort tied to manual stitching and, thereby, support forest-based livelihoods, fostering opportunities for stable income.

METHODOLOGY

The development process followed an iterative, user-centred design approach, starting with pinpointing the problem, moving to concept generation, prototyping and rigorous user testing. This design strategy uniquely blended traditional knowledge with modern manufacturing methods, including 3D printing and computer numerical control (CNC) machining. During the field visits and interviews with tribal artisans, several key difficulties were uncovered: repetitive strain injuries from inserting bamboo sticks, inconsistent stitch quality, the slow pace of work and resulting low productivity.

Conceptual design and prototyping

Several early conceptual models were developed and assessed:

Multi-hole plate: The initial design was a basic GI metal plate featuring alternating holes and slots (Plates 1, 2, 3). While it allowed for 2-3 stitches at once, it required manual pressure and pre-cut sticks. A significant drawback was its lack of proper alignment and stability.

Improved multi-hole plate: An enhanced multi-hole plate as a 3D-printed model was created. This version included an integrated stick-cutting blade and support plates, which improved handling and made stick insertion easier. Despite these advancements, it still had limitations: it could only stitch a single row and was still prone to misalignment (Plates 4, 5).

Leaf plate stapler

The efforts progressed through several steps to refine the stapler concept:

Step 1. Mechanical stick insertion rod: This was a notched rod designed to carry and insert sticks into folded leaves (Plates 6, 7). However, it tended to enlarge the hole size, leading to looser stitching and it was still susceptible to misalignment.

Step 2. Modified cutter-based device: Adapted from a utility cutter, this version used a rubber-mounted push button to advance the stick (Plate 8). The main issues here were inconsistent stick movement and frequent stick breakage.

Step 3. Stapler with metal tip holder: A CNC-machined tapered tip to provide better stick support was incorporated (Plate 9). This reduced plant damage but unfortunately increased the device's overall weight.

Step 4. Lead pencil inspired mechanism: This design featured a jaw-based mechanism, similar to mechanical pencils, for holding and releasing the stick (Plate 10). A common problem was that sticks often jammed, which made the device less usable.

Final prototype – leaf plate stapler

The final device was a compact, hand-held tool that operates much like a standard stapler (Plate 11). This stapler allowed for easy leaf alignment, precise stick insertion and manual cutting in a single, smooth motion. Its core components included:

Main body: The foundational structure holding all other parts

Stick push button: Used for advancing the stick

Blade-mounted trigger: A spring-loaded cutter for trimming the stick

End cap: The insertion point for the bamboo stick

Retracting spring and stopper: For controlling the blade's movement

Plate 1. Multi-hole plate

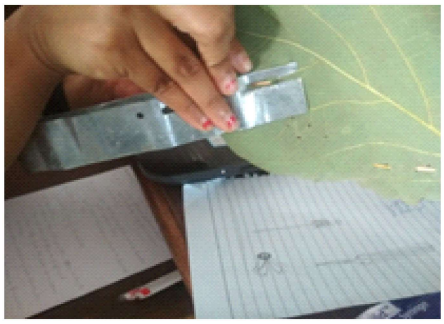

Plate 2. Back side of the multi-hole plate

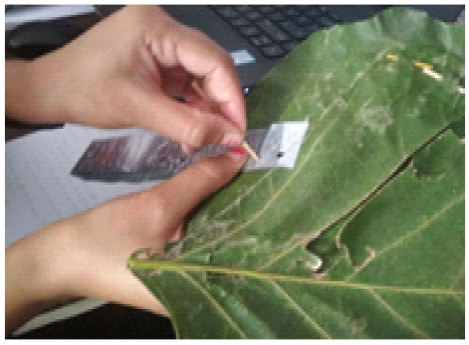

Plate 3. Leaves held in between flaps shown on top side of the plate

Plate 4. Improved version of multi-hole plate

Plate 5. Working of leaf stitching

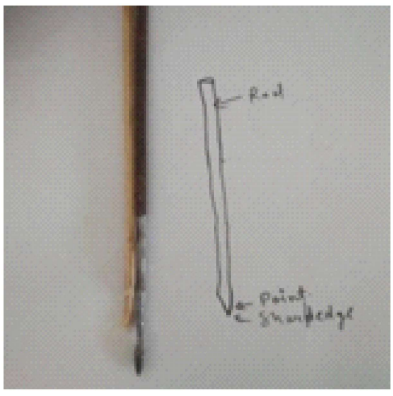

Plate 6. Developed rod shown in figure

Plate 7. Working with stick insertion rod

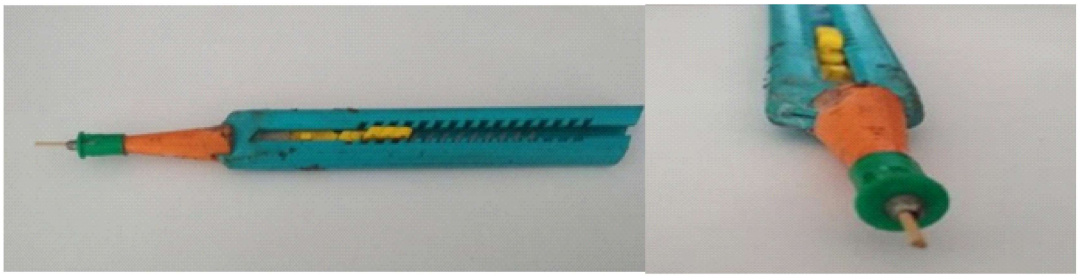

Plate 8. Modified cutter-based device

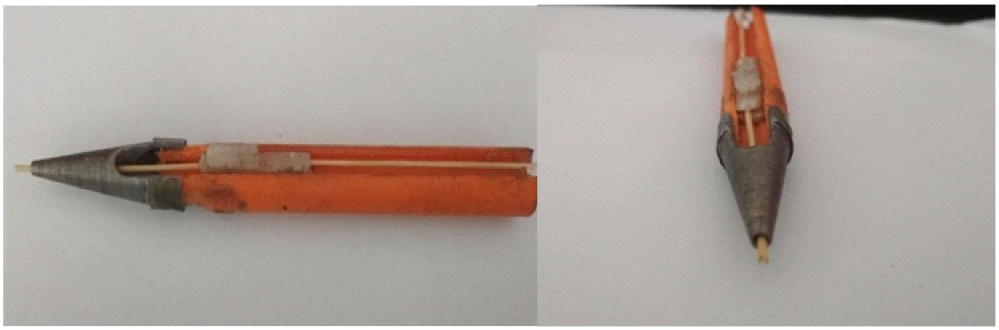

Plate 9. Stapler with tip holder mechanism

Plate 10. Lead pencil inspired mechanism

Plate 11. Final prototype: leaf plate stapler

Evaluation

The prototypes were rigorously tested for several criteria: stitch quality and consistency, the time it took to stitch each plate, ergonomic comfort, stick wastage and how easy it was to train new users and operate the device. The final model showed significant gains in both productivity and user comfort compared to traditional methods.

RESULTS and DISCUSSION

The final product notably boosted productivity by 40-50 per cent compared to traditional hand stitching. Its ergonomic design effectively minimized both injuries and user fatigue, which were prevalent issues before. Additionally, the stitch quality greatly improved, consistently showing uniform depth and tightness. With an estimated manufacturing cost under Rs 300, the device is very affordable. Field observations and feedback strongly indicated its acceptance among tribal women artisans, suggesting its practical viability.

CONCLUSION

Developing this hand-held leaf plate stapler marks a significant stride toward a more sustainable and equitable approach to leaf plate production. This inventive device provides a practical and appealing solution for replacing the demanding and often risky traditional manual stitching techniques. By directly addressing previously identified challenges like repetitive injuries, physical fatigue and low productivity from hand-stitching with bamboo sticks, the stapler notably enhances working conditions.

Its success stems from its user-centered design, making it a tool that is not only light and easy to use but also remarkably affordable, with a projected cost under Rs 300. This affordability stands in stark contrast to existing bulky and expensive mechanical machines that are largely out of reach for artisans in remote areas. The device's ergonomic build has been crucial in reducing physical discomfort and injury, while its precise stick insertion and single-motion operation contribute to significantly better stitch quality, ensuring consistent depth and tightness.

Crucially, implementing this device has been shown to boost productivity by 40-50 per cent compared to traditional methods. This direct increase in output translates into improved income opportunities for tribal artisans, supporting forest-based livelihoods and fostering greater economic stability. The positive feedback and strong acceptance from tribal women artisans further highlight its practical benefit and potential for widespread adoption.

In essence, the leaf plate stapler doesn't just promote a sustainable alternative to polluting disposable plastic plates; it also acts as a catalyst for socio-economic improvement. By simplifying production and enhancing working conditions, it empowers communities to earn more efficiently while championing environmentally responsible practices. This innovation beautifully combines traditional wisdom with modern engineering, creating a tool that benefits both people and the planet.

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