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Effect of an Improved Ring Cutter on Drudgery Reduction in Brinjal Harvesting: Testing of Women-friendly Technology

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Agricultural activities in India heavily rely on women, yet their tools often lack ergonomic considerations, resulting in physical strain and health hazards. Brinjal harvesting, predominantly carried out by women, involves repetitive motions, awkward postures, and traditional tools that exacerbate discomfort and reduce productivity. This study evaluated the effectiveness of an

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ergonomic intervention—an improved ring cutter—in reducing drudgery and enhancing the work efficiency of thirty farm women in Shamshabad Mandal, Telangana. Data was collected on assessing grip and pinch strength, work output, health hazards and satisfaction levels, comparing traditional methods with the improved tool. Results demonstrated that the ring cutter significantly improved grip and pinch strength, reduced harvesting time and increased productivity from 56–75 kg/day to 60–80 kg/day. The tool minimized musculoskeletal discomfort and eliminated injuries like cuts and hand muscle pain, common in traditional methods. Additionally, 76.7 per cent of respondents were fully satisfied with the ergonomic tool, with 100 per cent willing to adopt it. The findings emphasized the importance of women-friendly technologies in agriculture, contributing to reduced drudgery, enhanced productivity and sustainable development in rural communities. This study advocates for integrating ergonomic interventions into agricultural practices to improve the health and well-being of farm women.

Keywords: Drudgery reduction; ergonomic tool; ring cutter; brinjal harvesting; farm women; agriculture.

1. INTRODUCTION

Agriculture is a pivotal sector for economic development and employment in rural India, with women playing an integral role in this domain. Despite their significant contributions, farm women frequently face labour-intensive tasks that compromise their health and productivity. The drudgery of these tasks, coupled with ergonomically unsuitable tools, results in physical strain and health hazards, highlighting an urgent need for interventions tailored to the specific needs of women workers (Singh & Reddy, 2023). Brinjal (eggplant) harvesting is one such activity where women are disproportionately involved, often encountering challenging postures, repetitive actions and inadequate equipment that exacerbate the physical toll. Developing women-friendly technologies like ergonomic tools is essential to address these challenges, enhance efficiency and improve the overall well-being of farm women (Patel & Mehta, 2019; Lakshmi & Deepika, 2019). Women are expected to perform heavy work in crop production, which includes bending over for extended periods of time, jerking movements while threshing, cuts and bruises while harvesting, and carrying loads on the head, back, and shoulders (Joshi et al., 2024). These unfavourable working conditions are taxing on women's health. In a study, it was reported that tasks involving lumber flexion or extended postures for long (manual weeding, harvesting, and threshing) are relatively common.

Women constitute nearly half of India's agricultural workforce, yet their needs and limitations are seldom addressed in tool design (Rao & Rani, 2019). Traditional harvesting methods for brinjal involve the use of fingers or makeshift tools that often lead to cuts, numbness and muscular pain, emphasizing the need for an ergonomically designed alternative. Ergonomically optimized tools can not only minimize physical discomfort but also increase harvesting efficiency and productivity (Nandi et al*.,* 2020). Vegetable harvesting often requires repetitive hand movements, awkward body postures and long hours in harsh environmental conditions. These factors cumulatively lead to musculoskeletal discomfort, chronic pain and reduced productivity over time. Women engaged in such tasks are particularly vulnerable due to their smaller physical stature and lower muscle strength compared to men, making ergonomic considerations a necessity for alleviating drudgery (Mukherjee et al*.,* 2018). Traditional tools and methods used for harvesting are neither designed for prolonged use nor attuned to the physical capacities of women, exacerbating the risks associated with these labor-intensive tasks.

Drudgery in harvesting has both physical and psychological dimensions. Prolonged exposure to repetitive strain injuries, fatigue, and awkward postures not only affects the physical well-being of farm women but also diminishes their morale and efficiency. Acknowledging these challenges, ergonomic interventions aim to create tools that fit the anthropometric and biomechanical needs of women workers, thereby minimizing health risks and enhancing productivity.

The study contributes to the growing discourse on gender equity and sustainability in agriculture. By focusing on women-specific challenges and addressing them through scientific interventions, it aligns with the larger goals of rural development and poverty alleviation. The objectives of this study include:

1. Assessing the drudgery experienced by farm women during traditional brinjal harvesting.
2. Evaluating the effectiveness of an improved ergonomic tool (the ring cutter) in reducing physical strain.

2. MATERIALS AND METHODS

The present study employed an exploratory research design to assess the drudgery faced by farm women in brinjal harvesting and to assess the impact of an improved ergonomic tool. This design was chosen to examine existing practices causing drudgery. The study was conducted in Kaveliguda village, located in Shamshabad Mandal of Rangareddy District. This area was selected due to its extensive cultivation of brinjal over large acres, making it an ideal site for studying harvesting practices and challenges. A total of 30 farm women were selected as respondents for the study, representing those actively engaged in brinjal harvesting activities. Data collection focused on multiple parameters, including grip strength, pinch strength (expressed in kilogram force (kgf), the criterion score for both grip and pinch strength was determined as the average of three repetitions), work output, time required for harvesting, postures adopted and occupational health hazards encountered during the activity. Both traditional harvesting methods and the use of an improved ergonomic tool—the ring cutter—were evaluated.

Picture 1. Ring cutter

The study utilized quantitative and qualitative techniques to compare the two methods. Grip and pinch strength were measured before and after the harvesting activity to assess the physical effort involved. Work output was analyzed in terms of the quantity of brinjal harvested and the time spent on the activity. The postures adopted by women were observed to identify discomfort and ergonomic risks, while health hazards, such as cuts, numbness, and muscle pain, were recorded through structured questionnaires and interviews. The drudgery experienced by the respondents was assessed based on work demand, feelings of exhaustion, difficulty perception, and workload perception. Satisfaction levels and willingness to adopt the improved tool were also evaluated through participant feedback.

The intervention involved providing the participants with an improved ring cutter designed to reduce discomfort and enhance productivity. The findings from both methods were analyzed to determine the effectiveness of the ergonomic intervention in reducing drudgery, improving work efficiency, and minimizing health hazards associated with brinjal harvesting.

Picture 2. Brinjal harvesting

3. RESULTS AND DISCUSSION

3.1 General Information of the Respondents

The findings indicated that a significant proportion of the farm women engaged in brinjal harvesting belonged to the age group of 31-40 years (50%), followed by the younger age group of below 30 years (30%) and a smaller group aged above 40 years (20%). This reflected that brinjal harvesting is predominantly undertaken by women in their most productive years.

In terms of work experience, the majority of respondents (63%) had less than 10 years of work experience, indicating a relatively young workforce with emerging expertise. About 26 per cent of women reported 11-20 years of experience, demonstrating a mix of skilled and semi-experienced individuals in this activity. A small fraction (10%) had more than 20 years of experience, likely representing seasoned laborers involved in brinjal cultivation.

These findings align with the study by Rao & Rani, (2019), which suggests that middle-aged women, owing to their roles in the household and farming communities, tend to undertake more

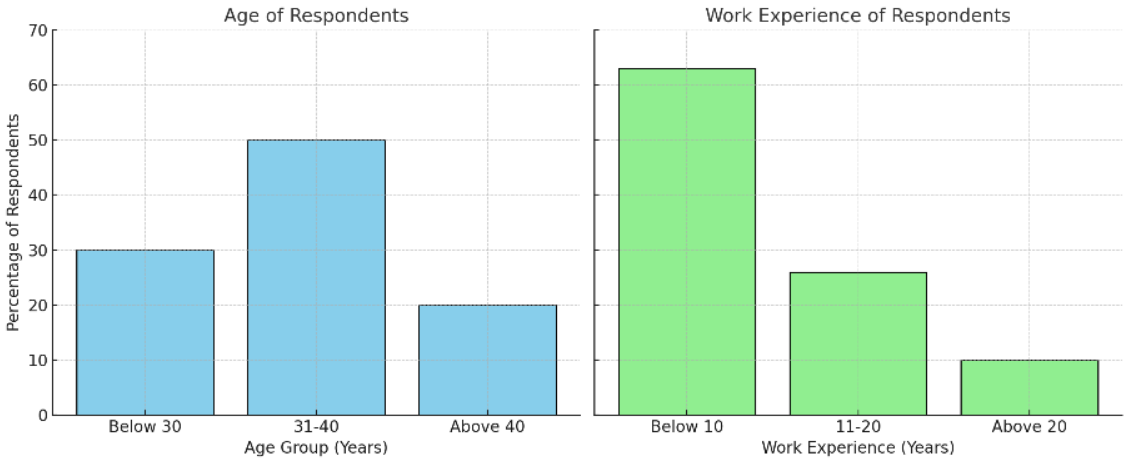

Fig. 1. General information of the respondents

physically demanding agricultural tasks. The younger cohort, though less experienced, participates actively, likely due to their physical energy, whereas older women have limited engagement, possibly due to declining physical capacity. This interplay of age and experience highlights the need for ergonomic tools and technologies to support women across different age groups, ensuring sustainable participation in agriculture.

3.2 Comparison of Grip Strength of Respondents During Brinjal Harvesting using Traditional and Improved Method

The grip strength of respondents was compared in both traditional and improved method. The data was collected before and after harvesting the vegetable using both methods. The data indicated that, there was difference in strength of the hand grip before and after performing the harvesting task by using both the hands. The grip strength has increased when the respondents used improved ring cutter while harvesting brinjal compared to traditional method. The rate of harvesting increased from 4-5 kg/day on an average using improved method along with the time saved of 30 minutes compared to traditional method.

3.3 Comparison of Pinch Strength of Respondents During Brinjal Harvesting Operation in Traditional and Improved Method

The pinch strength of respondents was studied to know the discomfort caused in fingers while harvesting the vegetable. The Two-point pinch (tip to tip pinch) test was done by placing pinch meter between the tip of the thumb and tip of the index finger and instructed the respondent to pinch as hard as possible. The findings indicated that in both traditional and improved method there was a change in pinch strength of fingers of the respondents. The change in pinch strength in traditional and improved method indicated that, the improved ring cutter has proved to be reducing the discomfort caused while harvesting brinjal. Jadhav and Khurana (2021) observed that innovative agricultural practices positively affect women farmers' output and contribute to rural development. Tools designed with women-specific anthropometric and ergonomic considerations, as highlighted by Sharma and Kapoor (2019), significantly mitigate physical strain during repetitive tasks like brinjal harvesting. Their findings resonate with the improvements in grip and pinch strength reported in this study when using the improved ring cutter.

3.4 Work output and time required during brinjal harvesting in traditional and improved method

The work output in terms of yield, measured as the quantity of brinjal harvested and the number of hours contributed daily to harvesting, is presented in Table 3. The findings revealed that women using the traditional method harvested 56 to 75 kilograms of brinjal in 4 to 5 hours per day. In contrast, those using the improved ring cutter harvested 60 to 80 kilograms in 3.5 to 5 hours daily.

Table 1. Comparison of grip strength of respondents during brinjal harvesting using traditional and improved method (N=30)

Parameters	Traditional Method Mean± SD		Improved Method Mean± SD	
	Rt. Hand	Lt. hand	Rt. Hand	Lt. hand
Before work	22.6± 6.3	20.6± 4.40	24±4.6	20.2±3.8
After Work	17.6+ 6.1	17.2±4.3	20.6±4.2	18.8±3.2
(%) Change in pinch strength	22.12	14.56	14.16	15.84

Table 2. Comparison of pinch strength of respondents during brinjal harvesting using traditional and improved method (N=30)

Parameters	Traditional Method Mean±SD		Improved Method Mean±SD	
	Right Hand	Left Hand	Right Hand	Left Hand
Before work	32.53±4.55	30.20±5.74	35.43±5.05	34.03±5.25
After Work	28.17±4.58	28.30±5.90	34.40±5.47	33.33±5.81
(%) change in pinch strength	13.4	6.29	2.9	2.05

Table 3. Work output and time required for harvesting brinjal in traditional and improved method (N=30)

	Traditional Method		Improved Method	
	per hour	per day	per hour	per day
Work output (brinjal harvested)	14 to15 kgs	56 to75 kgs	16 to 17 kgs	60 to 80 kgs
Time spent (hours)	1-2	4-5	1-2	3.5-5
Number of working days /month	30 days		30 days	
Area harvested/day	1 acre		1 acre	

3.5 Drudgery Experienced During Brinjal Harvesting in Traditional and Improved Method

The drudgery experience while performing the brinjal harvesting task using traditional and improved method was studied in terms of six parameters i.e. work demand, feeling of exhaustion, perception on level of difficulty about posture assumed in work, perception on manual loads, difficulty perception and work load perception. The scores were given from 5 to 1 based upon the difficulty and the demanding work situation while harvesting brinjal in both the methods. From Table 4, the findings revealed that (77%) of sample opined that the task was very demanding when compared to the improved method where it was found that (80%) of sample stated as less demanding when the task was performed using the ring cutter. Nearly forty percent of the sample found the task while to be exhausting psychophysically while performing using traditional method and seventy percent felt mildly exhausted while harvested using ring cutter. This mild exhausted situation was due to other work environmental conditions.

The perception of the farm women about the working postures revealed that over half of the participants (63%) reported difficulty with the body postures required during the traditional method. In contrast, only 13 per cent found the postures moderately difficult when using the improved method, while 30 per cent experienced less difficulty, and 57 per cent reported very minimal difficulty. Regarding difficulty perception, 50 per cent of the participants described the traditional method as moderately painful. However, when using the improved method, all participants (100%) reported no pain.

3.6 Health Hazards Encountered During Brinjal Harvesting in Traditional and Improved Method

During the analysis of symptoms experienced during brinjal harvesting, it was found that in the traditional method, all the respondents (100%)

Table 4. Perception of respondents about drudgery experienced during brinjal harvesting with traditional and improved methods (N=30)

		Work demand		Feeling of exhaustion		Posture assumed in work		Perception on manual loads operatives		Difficulty perception		Workload perception	
		F	%	F	%	F	%	F	%	F	%	F	%
Traditional method	**5**	23	77	12	40	19	63	-	-	10	33	30	100
	4	5	16	16	53	11	37	-	-	15	50	-	-
	3	2	7	2	7	-	-	27	90	5	17	-	-
	2	-	-	-	-	-	-	3	10	-	-	-	-
	1	-	-	-	-	-	-	-	-	-	-	-	-
Improved method	**5**	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	3	10	-	-	-	-
	3	-	-	4	13	4	13	23	77	-	-	-	-
	2	24	80	7	23	9	30	7	23	-	-	27	90
	1	6	20	19	63	17	57	-	-	30	10	3	10

** Work demand (score 1-5) Very demanding (5), demanding (4), moderate (3), less demanding (2), very less demanding (1).*
***feeling of exhaustion (score 1-5)– Very exhausted (5) exhausted (4), moderately exhausted (3), mildly exhausted (2), No exhaustion (1).*
**** posture assumed in work – Very difficult (5), difficult (4), moderately difficult (3), less difficult (2), very less difficult (1),*
*****perception on manual loads –Score (1-5): score 5>20kg, score 4 for 15-20kg, score 3 for 10-15kg. score 2 for 5-10 kg, score 1 for 0-5 kg*
******difficulty perception Score (1-5): – Very painful (5), painful (4), moderately painful (3), mild pain (2), no pain (1).*
*******work load perception Score (1-5): – Very heavy loads (5), heavy loads (4), moderately heavy loads (3), light loads (2), no loads (1).*

Table 5. Occupational health hazards observed during brinjal harvesting in traditional and improved methods (N=30)

Health hazards	Traditional Method				Improved Method			
	Yes		No		Yes		No	
	F	%	F	%	F	%	F	%
Cuts	30	100	0	0	0	0	0	0
Swelling	1	3			0	0	0	0
Stiffness	2	7	28	93	0	0	0	0
Numbness	6	20	24	80	0	0	0	0
Hand muscle pain and discomfort	30	100	0	0	0	0	0	0

Table 6. Postures adopted by respondents during brinjal harvesting (N=30)

Parameters	Posture/ activity	Traditional method	Improved method
Nature of posture	Standing	yes	yes
	Bending	yes	yes
	Twisted trunk	yes	yes
	Sitting	-	-
	Squatting	-	-
	Kneeling	-	-
Repetitive strain nature	Continuous	yes	yes
	Cyclic	-	-
Repetitive strain rating	Very exhausted	yes	-
	Exhausted	yes	-
	Moderately exhausted	-	-
	Mildly exhausted	-	-
	Comfortable	-	yes

Table 7. Respondents' satisfaction levels with the use of the improved ring cutter (N=30)

Intervention	Satisfaction level						Would like to adopt			
	Fully satisfied		Partially satisfied		Not satisfied		Yes		No	
	F	%	F	%	F	%	F	%	F	%
Improved Ring cutter	23	76.7	7	23.3	-	-	30	100	-	

**Fully Satisfied: high level of comfort and positive experience regarding utility with the ring cutter. Partially Satisfied: some issues or scope for improvement despite recognizing the tool's utility. Not Satisfied: complete dissatisfaction with the tool*

reported cuts and discomfort or pain in the hand muscles. Additionally, 20 per cent experienced numbness, and an equal proportion reported stiffness while harvesting. These findings highlighted that the ergonomic intervention significantly reduced injuries and contributed to minimizing drudgery. Consistent with Das and Singh's (2020) research on ergonomically designed hand tools, this study confirms that such tools effectively reduce the risk of musculoskeletal injuries.

3.7 Postures Adopted by Respondents During Brinjal Harvesting

The postures adopted during an occupation play a crucial role in identifying the causes of various injuries. The nature of the posture, along with its repetition, can lead to specific postural risks and alterations, ultimately resulting in pain and injuries.

The data presented in the table indicates that respondents adopted standing, bending, and twisted postures while harvesting brinjal. The work style was observed to be continuous and repetitive, with exhaustion levels ranging from moderate to severe. In contrast, the improved method was found to be more comfortable, with a lower repetitive strain rating when using the technology. Chawla and Mahajan (2021) observed that the adoption of improved agricultural tools not only lightens women's workload but also boosts productivity.

3.8 Satisfaction Levels of the Respondents Regarding Usage of Improved Ring Cutter During Brinjal Harvesting

The findings from Table 7 revealed that 76.7 per cent of the respondents were fully satisfied with the improved technology, while 23.3 per cent expressed partial satisfaction. All the respondents indicated their willingness to adopt the technology (Table 7). The study highlighted that the improvised ring cutter was comfortable to use but required more practice to enhance the harvesting rate further. Kumar and Gupta (2022) emphasized that women-centered technology design significantly improves well-being, addressing gender-specific gaps in agricultural mechanization. Majority of the respondents expressing full satisfaction rate and unanimous willingness to adopt the tool in this study underscore the readiness of farm women to embrace innovations designed to meet their specific needs.

4. CONCLUSION

The findings of the study revealed that, most of the women belonged to adult middle-aged group (31-40 years) and had experience of 10 years. Farm women were found spending 4-5 hours per day for harvesting 56-75 kilograms of brinjal crop in traditional method at the same time 60 to 80 kilograms of brinjal was harvested using improved ring cutter. The intensity of body discomfort was found severe to moderate. The posture women adopted while performing the activity, indicated that they were working in discomfort posture that has led to occurrence of musculoskeletal symptoms which were ranging from frequently to sometimes and rarely. All the respondents had agreed to adopt the technology. The study findings demonstrated that the improved ring cutter not only enhanced the work performance of farmers but also reduced labor costs associated with harvesting. It helped reduce discomfort and minimize injuries commonly experienced during brinjal harvesting.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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