Plant Archives Vol. 25, Supplement 2, 2025 pp. 3085-3090 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.396

ASSESSMENT OF AN ONION DETOPPER FOR REDUCING DRUDGERY OF FARM WOMEN

Mandava Hemalatha*, Shailaja Gogu, Kailash Madne and Vara Prasad Chittem
DDS-Krishi Vigyan Kendra (Medak 1), Zaheerabad, Sangareddy, Telangana, 502228, India
*Corresponding author E-mail: hemalathamandava13@gmail.com
(Date of Receiving : 19-05-2025; Date of Acceptance :31-07-2025)

ABSTRACT

Onions are used as spices, condiments and vegetables almost daily in every kitchen as a seasoning for wide varieties of dishes. Onion is one of the most important vegetable crops grown in India, having both the food and medicinal values. India is the second-largest onion-growing country in the world. It is widely cultivated for domestic consumption as well as for export purposes. Onions for use in green stage are harvested as soon as they reach edible size. The matured onions are harvested and left in the field for 3-5 days for field curing. Harvesting of onion at the stage of maturity is a very important factor in deciding storage life of the onion, as the bulbs may be stored for about six months. Both digging and top removal are done manually, which is very tedious, time consuming and costly. To overcome these difficulties, it has become necessary to mechanize the onion harvesting and detopping process. Different researchers have designed and developed various detopping mechanisms and developed the onion detopping machine. The onion detopper assessed in the present study is a battery-operated machine designed to remove leaves and roots from onion bulbs with minimal damage. The performance comparison between the traditional onion topping practice and the use of an onion detopper reveals notable differences in topping efficiency, work output and increased percent over traditional practice. The onion detopper demonstrated a significant improvement in productivity by processing 67 kg of onions per hour, compared to 48 kg/hr using traditional methods. This represents a 40 percent increase in the number of onions detopped per hour over the traditional approach. The increase in output suggests that mechanization can substantially enhance labor efficiency, making the process more suitable for large-scale operations. In terms of damage to onions**,** the traditional method caused slightly less damage (0–1%) compared to the detopper (2–2.5%). A significant advantage of the onion detopper is the reduction in physical strain**.** Traditional detopping is labor-intensive and results in high physical exertion, whereas the detopper minimizes manual effort, contributing to better ergonomics and potential long-term health benefits for operators. The adoption of mechanical solutions in onion harvesting and detopping, therefore, plays a critical role in improving the occupational health and productivity of women in agriculture.

Keywords: Onions, Onion De topper, work efficiency, drudgery reduction and physical strain

Introduction

Onion (*Allium cepa* L.) is one of the most important vegetable crops in India, valued for its culinary and medicinal properties. Onions are an indispensable part of the Indian diet, used daily as vegetables, spices and condiments across households. Onions are versatile plants that develop bulbs from enlarged leaf bases connected to the lower part of the stem beneath the soil. The ideal temperature for onion growth ranges from 13 to 24 °C.

Onion Cultivation in India and Telangana

Over the past decade, global onion cultivation has doubled, with China leading production in 2020 at 20 percent of the total. India ranks second globally and contributes 6 percent to its overall vegetable output. In 2021–22, India cultivated onions over 1.62 million hectares, yielding 26.64 million tonnes, with Maharashtra being the top producer at 28.32%. Major onion producing states are Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Bihar, Andhra Pradesh,

Rajasthan, Haryana and Telangana. As the second-largest onion producer globally, India contributes significantly to both domestic consumption and international exports, with 1,717,439.35 metric tonnes of fresh onions exported during 2023–24 (APEDA, 2024). However, India's onion yield remains below the global average, partly due to continued reliance on manual harvesting and detopping methods that lead to significant losses (Kumawat and Raheman, 2022)

In India, onions are cultivated either by transplanting seedlings or using bulbs, typically during the kharif, late kharif, and rabi seasons. Harvesting generally takes place about three months after planting, aligning with these seasonal cycles. Among them, the rabi season has emerged as the most productive, accounting for approximately 69.36% of the country's total onion yield in recent years (Ashwini *et al.,* 2014). According to Ministry of Agriculture and Farmers Welfare, 2025, Telangana has 7.49 thousand hectares of area under cultivation of onions and 139.87 thousand metric tonnes of production during the year 2024-25. Onion production and productivity in Telangana have experienced varying degrees of fluctuation over the years due to factors such as climate conditions, the quality of irrigation systems, price instability in the market, insufficient cold storage facilities and the preferences of the local farmers. In Telangana, several districts have emerged as significant contributors to onion cultivation. These include Sangareddy, Mahabubnagar, Nizamabad, Karimnagar, Medak, and Nalgonda. Estimates indicate that Sangareddy has an area of between 3,000 to 4,500 hectares dedicated to onion cultivation annually, subject to fluctuations each year. Production figures suggest annual yields ranging from approximately 75,000 to 100,000 tonnes.

Onion harvesting involves several stages including digging, lifting, field curing for 3–5 days, trimming the necks to separate bulbs from foliage, followed by cleaning, grading, shed curing, and storage. A key indicator of harvest maturity is the softness or bending of the bulb's neck. Timely harvesting and proper detopping are crucial for maintaining bulb quality and extending storage life, which can be up to six months under optimal conditions. In India, the detopping process is still largely manual, making it labor-intensive and time-consuming, whereas in western countries harvesting and detopping is done mechanically. Their high-cost limits adoption among Indian farmers (More *et al.,* 2018).

Furthermore, significant post-harvest losses occur due to limited awareness and access to appropriate handling and processing technologies. Manual harvesting and detopping of onions are particularly strenuous and time-consuming, increasing the physical burden which often referred to as "drudgery" on farm women who constitute a large proportion of the agricultural labor force. The manual cutting of roots and shoots adds to the labor burden and the overall low level of mechanization and limited access to advanced technology are key factors contributing to reduced productivity. Moreover, labor shortages further increase costs and result in financial losses for farmers (Chaudhary *et al.,* 2016). However, traditional methods not only slow down the harvesting process but also adversely affect efficiency and output. To address these challenges, the mechanization of onion harvesting and detopping offers a viable solution for reducing labor intensity, increasing productivity and minimizing post-harvest losses.

While manual onion detopping remains widely practiced, mechanized methods are increasingly being considered for their potential to improve efficiency and reduce costs. To evaluate the effectiveness and feasibility of these approaches, both manual and mechanical onion detopping techniques have been examined across different agricultural settings.

The present study focuses on evaluating the usage of an onion detopper as a technological intervention aimed at reducing the physical drudgery experienced by farm women engaged in traditional detopping practices. By comparing mechanized and manual methods, the research aims to highlight the benefits of adopting appropriate farm tools to improve labor efficiency, occupational health and the overall well-being of women in agriculture.

Mannual Onion Detopping:

Traditionally, onions are harvested manually, involving the labor-intensive processes of hand-pulling, root trimming and peeling, which are typically performed by women in rural farming communities. In manual onion harvesting, the bulbs are extracted from the soil by hand using a khurpi, along with the attached leaves. After allowing the harvested onions to cure in the sun for 2 to 3 days. The individual onions are picked and detopping is done by using sickle and the leaves are trimmed to a neck length of approximately 20 mm (Fig 1).

According to Nisha and Shridar (2018), harvesting one hectare of small onion requires about 15 woman-days, while manual detopping of 1 metric ton of onion bulbs takes approximately 12.5 man-hours. During peak harvest seasons, farmers face labor shortages due to high demand. In India, the traditional

detopping process involves workers sitting and using tools like sickles or khurpis to remove the leaves from the onion bulbs (Parab *et al.,* 2019). Rathinakumari and Kumaran, 2022 revealed that the manual detopping capacity is about 20 - 30 kg/h.

Farm women engaged in traditional onion detopping practices are found to experience a high degree of physical strain. This task, which is typically carried out manually, requires the continuous use of hands to remove the leaves of onions, often while sitting in a static position for extended periods. The repetitive motion of using hands and fingers to detop each onion individually places considerable stress on the muscles and joints of the shoulders, wrists, and fingers. Over time, this results in pain, stiffness and even long-term musculoskeletal issues leading to drudgery.

Mechanical Onion Detopping

Mechanical detopping of onions is carried out using specialized harvesters and detopping machines. According to Williams and Franklin (1971), the use of mechanical harvesters for onion harvesting and storage can lower production costs by approximately 20 percent per hundred weight of onion bulbs.

The key component of onion detopping machine is detopping mechanism. Different researchers have designed and developed various detopping mechanisms and developed the onion detopping machine.

Helical roller detopping tool had 98.44±1.07%, 2.05±0.45%, kg/h detopping efficiency, percentage damage, conveying efficiency and output capacity, respectively. Lead screw type detopping tool had 2.86±0.43%, 2.14±0.45% kg/h detopping efficiency, per cent damage respectively. Square shaft with two cutting edge resulted 95.42±2.15%, 21.60±3.38%, kg/h detopping efficiency, per cent damage respectively. Square shaft with four cutting edge had 96.00±1.67%, 23.20±1.83% kg/h, detopping efficiency, per cent damage respectively (Rathinakumari and Kumaran, 2024).

In a study conducted by Bhanage, *et al.,* 2016, found that the average detopping efficiency was 86.59% with 315.03 kg/hour output capacity. Carson and Williams developed a six-row onion topper featuring tined wheels to lift lodged tops and six 457 mm circular blades for top trimming. Despite this design, the machine produced uneven top lengths and lower topping quality than manual methods, largely due to differences in moisture content of the onion tops. The Topping efficiency was found to be 92% for the developed tool.

Kumawat and Raheman, 2022 studied the cutting torque and efficiency of a wire-type rotary unit for onion leaf topping under field-like conditions. They examined how factors like cutting unit speed, cutting width and machine forward speed influenced performance. The Topping efficiency was found to be 85.24- 97.73%. Their findings suggested limiting the rotary speed to 1800 rpm and the forward speed to 1.2 km/h to prevent leaf damage and achieve effective topping.

Prasanth *et al.,* 2020 carried out lab tests on a detopping unit for a mini-tractor onion harvester, using a vertical shaft with reinforced nylon cutting threads. They found that square nylon threads, especially in four- and eight-string configurations, provided the best results, achieving an average neck length of 23 mm ideal for reducing storage losses.

Laryushin and Laryushin, 2009 evaluated energy-efficient onion harvesters, including the OLL-1.4, designed to remove tops and weeds. It features adjustable cutting height and counter-rotating blades enclosed in a housing. The rotating blades create airflow to lift debris into the cutting zone. The Topping efficiency was found to be 98.7 %. Shredded material is expelled through an outlet into the space between rows.

Material and Methods

The detopping unit is the key component of the detopping machine which should detop the onion tops efficiently without damaging the onion bulbs. The onion detopper assessed in the present study is a small battery-operated machine designed to remove leaves and roots from onion bulbs with minimal damage. Once fully charged, the machine can operate continuously for up to three hours. It is equipped with rotating blades that efficiently cut away the foliage and roots. When an onion is placed near the blades, the rotating mechanism automatically detaches the leaves from the bulb and removes the roots effectively. The design of the detopper is more suitable for small and medium sized onions. The machine features two slots for inserting onions, allowing two individuals to use it simultaneously, thereby improves work efficiency and reduces labor time (Fig 2). The detopped onions were collected below the onion detopping machine.

The study was conducted in a village named Potapally, Jharsangam mandal, Sangareddy district of Telangana. The Geo coordinates are Lat: 17.744824, Long 77.639062. Farm women sitting on either sides of onion detopper have operated the machine.

Parameters like work output per hour, topping efficiency, percent of damaged onions, perceived physical strain were recorded. The same parameters have been recorded in traditional practice using sickles by the same women.

Results and Discussion

The performance comparison between the traditional onion topping practice and the use of an onion detopper reveals notable differences in topping efficiency, work output and increased percent over traditional practice.

Fig. 1. : Manually onion de-topping of cured onion bulbs by using sickle

Fig. 2 : Two persons handling the onion detopper simultaneously

Table 1 : Parameters observed in traditional practice and onion detopper.

Parameters	Traditional practice	Onion detopper
Total detopped onions per hour (Kg)	48	67
Effectiveness of detopping (%)	99	97
Percent of damaged onions (%)	0-1	2-2.5
Physical strain	High	Low
Increased percent over traditional practice (%)	-	40

Detopping Output and Productivity

The onion detopper demonstrated a significant improvement in productivity by processing 67 kg of onions per hour, compared to 48 kg/hr using manual method. This represents a 40 percent increase in the number of onions detopped per hour over the traditional approach (Fig 3). The increase in output suggests that mechanization can substantially enhance labor efficiency, making the process more suitable for large-scale operations.

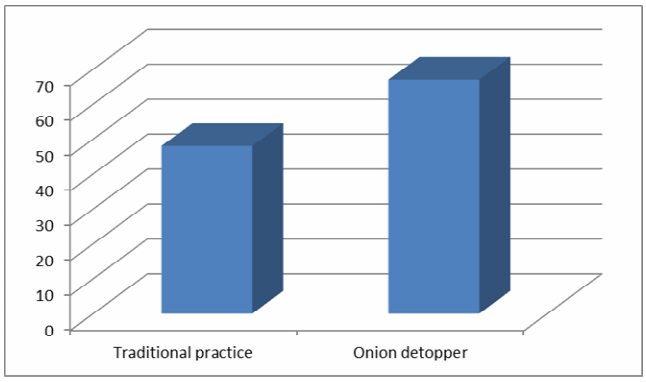

Fig. 3 : Total detopped onions per hour (Kg)

These findings are consistent with those reported by Rathinakumari and Kumaran (2022), who noted that manual detopping typically handles 20–30 kg/h, whereas the onion detopping machine evaluated in their study achieved a significantly higher capacity of 370 kg/h. The variation in machine capacities across studies could be attributed to differences in machine design, feed rate, cost of the machine and operational conditions. The detopper used in the present study is a small battery operated and low cost machine. Nevertheless, both studies collectively affirm the substantial productivity gains achievable through mechanized detopping, highlighting its potential for improving labor efficiency.

Effectiveness of detopping and percent of damage:
Detopping Efficiency: It is the ratio of the number of onion bulbs topped to the total number of onion bulbs performed for detopping, it is expressed as a percentage and determined using the following equation (Wingate Hill, 1977).

$$\text{De-topping efficiency (\%)} = (NTo/NT) \times 100$$

where, NTo is number of topped onion bulbs;

NT is total number of onions performed for detopping

The effectiveness of detopping, which considers the completeness and quality of the topping, was marginally higher in the traditional method (99%) than in the detopper (97%). In terms of damage to onions**,** the traditional method caused zero or slightly less damage (0–1%) compared to the detopper (2–2.5%) (Table 1). This could be attributed to the precision of manual handling over mechanical action. Despite this, the level of damage from the detopper remains within acceptable limits for commercial processing. This minimal loss can be attributed to the bulbs avoiding direct contact with the rotating blades during the process.

The onion detopper used in the present study was well suited for small and medium sized onions. When the onion bulbs are bigger in size, the detopping efficiency decreased. This is because bigger bulbs had thicker and stronger tops, which are harder to cut. Also, large bulbs did not fit well in the de- topper, making it harder to remove the tops properly. The results of this study align with the observations of Rani and Srivastava (2012), indicating that detopping efficiency decreases as the size of onion bulbs increases and the total loss caused by machine and operational factors remained below 5 percent.

Physical Strain

Physical strain perceived by farm women is found to be high in traditional practice compared to mechanical method. This physical strain include stress on the muscles and joints of the shoulders, wrists, fingers and frequent movements of hands which results in long term musculo-skeletal issues. Moreover, the posture maintained during manual detopping contributes significantly to the discomfort. Continuous forward bending while detopping causes fatigue and discomfort after prolonged work hours.

The present study revealed that, with the use of onion detopper, the physical burden is considerably reduced. As a result, farm women experienced less pain and fatigue, allowing for more comfortable and efficient work. The adoption of mechanical solutions in onion harvesting and detopping, therefore, plays a critical role in improving the occupational health and productivity of women in agriculture.

Conclusion

In manual harvesting of onion bulbs, the process of removing the leaves is typically carried out by workers using tools such as sickles, khurpis, or knives after the bulbs have been sun dried for 2 to 3 days. This task often requires women to remain in a sitting position for extended periods, which leads to physical strain and fatigue, ultimately lowering their productivity. Additionally, manual detopping is a labor-intensive and time-consuming activity that demands a large workforce. The present study evaluated a low cost detopping tool in reducing drudgery of farm women and found there is a 40 percent increase in the number of onions detopped per hour over the traditional practice. The usage of onion detopper also reduced physical strain. This shift of using mechanical methods not only improves their physical well-being but also enhances their productivity and overall quality of life.

Although various onion detopping machines are available in India, their use on farms remains limited due to unawareness and their complex operation. As a result, most farmers continue to rely on traditional manual methods for detopping in the field. Awareness programmes and demonstrations should be conducted for higher adoption rate.

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