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Development of harvesting tool for drumstick (*Moringa oleifera*)

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Abstract
Harvesting of fruits and vegetables is an inevitable need. Drumstick harvesting process faces a wide range of problems like that of time consuming and become inefficient due to heavy in weight of tool. It is very helpful and important allied in agriculture sector. Mechanization of harvesting operation will play a vital role in removing the negative attributes of the traditional harvesting technique and promote to use of developed harvesting techniques for drumstick with desired capacity. This paper shows the chronological development of harvesting tool and highlights on new concept of drumstick harvesting tool. The purpose of our paper is to design and develop and fabricate the prototype of harvesting tool. It is aimed at providing a base for the commercially production of harvesting tool, using locally available raw material at a relatively low cost. The drumstick harvesting tool was designed in telescopic nature to reach the variable height of the moringa tree with "V" shape serrated cutter at the top end. The minimum and maximum expansion length of the drumstick harvesting tool is 2.4-7.31 m respectively. The total weight of the harvesting tool was 2.8 kg that enables the easy carry by the farmer without any difficulties. The harvesting capacity of the drumstick harvest. The tool constitutes of a fiber plastic pipe, 'V' shape serrated cutter.

Keywords: C

Introduction
Moringa oleifera, popularly known as the drumstick tree is a fast-growing perennial widely grown in tropical and subtropical regions for its nutritional, medicinal and economic benefits. The pods which are consumed as vegetables are highly valued for their protein, vitamin, and mineral content making them an essential component of diets in several countries (Leone *et al*., 2015) [4]. In addition to its food applications different parts of the tree are also utilized in pharmaceuticals, cosmetics and even in water purification practices which further enhance its socio-economic importance (Saini *et al*., 2016) [7].

At present, harvesting of drumstick pods is largely carried out using traditional manual techniques such as climbing trees or beating branches with sticks. These practices are not only physically demanding but also time-consuming, and they often lead to pod damage as well as injuries to the tree branches (Kumar *et al*., 2019) [3]. Such challenges restrict productivity, increase labor requirements, and reduce the quality of harvested produce

Drumsticks are harvested traditionally by using bamboo sticks and sickle attached with wooden stick. The traditional harvesting method of drumstick damages the tree branches and stems as well as drumstick. Farmers usually relied on traditional methods and techniques such as knife, bamboo sticks for harvesting operations which is a laborious time-consuming task, risk of fatigue and mainly leads to broken and ruptured drumstick pods. Though these methods and techniques are not efficient enough for the above-said operations, a harvesting tool is a primary option to withstand such task.

Along with the difficulty in the collection of drumstick, the conventional bamboo or wooden stick that is used for harvesting in difficult to carrying and handling due to its heavy weight. Apart from this bamboo/wooden sticks are not foldable. Various problems occurred during the harvesting, is analyzed. There is a need for a tool to be designed for assisting the ease in harvesting, operations of mature drumstick to overcome the several obstructions and efficient operation.

Therefore, by considering all the above constraints related with harvesting, of drumstick a study is chosen for research work. This study has taken under research to develop efficient and alternative methods over traditional methods.

Material and methods

Methodology

- Study of harvesting tool mechanisms
- Developed a new design for harvesting
- Material selection for frame, cutter
- Fabrication of tool

Components and description

Main Frame

The main frame was made of fiber plastic pipe attached with serrated cutter at the top of the pipe. The maximum expansion length of the fiber pipe was decided on the basis of average height of the moringa tree. The main frame was composed of three fiber plastic having equal length i.e. 2438 mm and different diameter to be facilities the easy jointing in telescopic manner. The length of main frame is up to 7315 mm after the tool is in fully extended position while the length of each pipe is 2438 mm each. This frame is telescopic in nature and its height is adjustable according to height of drumstick tree (Fig.1). Three fiber plastic pipes were selected to construct the main frame to provide the enough strength with light weight according to suitability of operator.

The base, middle and top diameter of this assembly are 36 mm, 33mm and 28 mm respectively. Also, this pole assembly is very light in weight i.e. 2.8 kg and does not feel inconvenient while operating the tools.

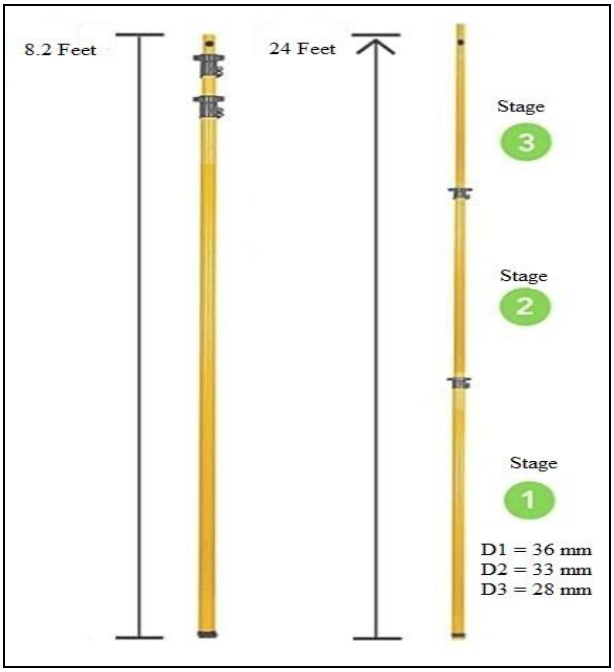

Fig 1: Main frame

V-shape serrated cutter

A cutter is part of a tool that has a serrated edge. The serrated blade was fastened horizontally at the top of fiber plastic pipe (main frame) look like alphabet letter 'V' reset in horizontal position, the strength of serrated cutter depends upon the amount of forceapplied to the blade on very small area that results in higher pressure on the object to be cut (Fig.2). The blade is constructed using mild steel. The dimension of cutting blade is mentioned in Table 1.

Fig 2: V-shape serrated cutter

Table 1: Specifications of materials

S. No.	Materials	Specification
1.	Fiber plastic pipe	3 nos. each 2438 mm D_1= 36 mm D_2= 33 mm D_3= 28 mm
2.	Thickness of pipe	2 mm
3.	Extension of pipe	2438 - 7315 mm
4.	'V' serrated cutter	Depth = 70 mm Width = 30 mm
5.	Serrated blade	Length = 70 mm Thickness = 2mm
6.	Weight of tool	2.8 kg

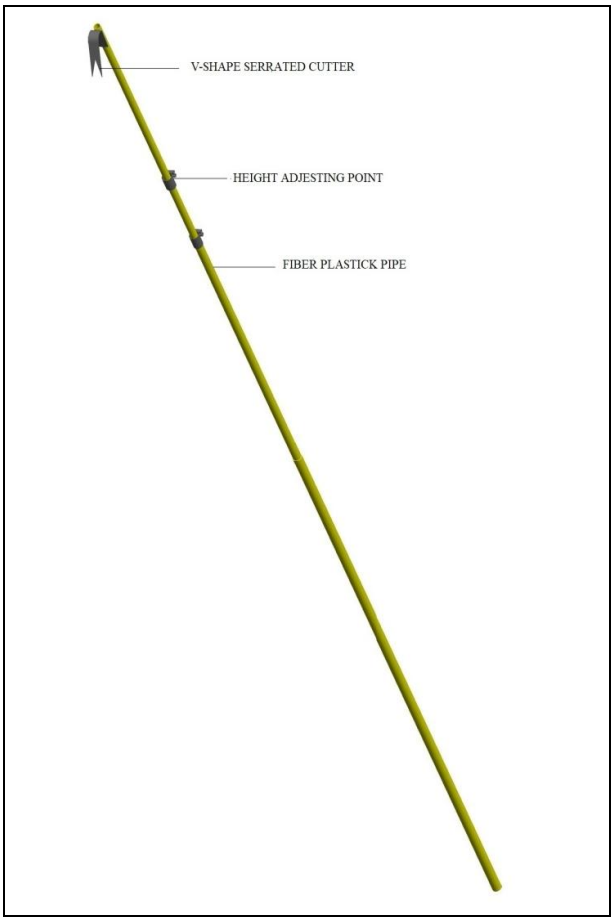

Fig 3: Design of harvesting tool

Fig 4: Developed drumstick harvesting tool

Working

The mechanism of this harvesting tool is simpler. During the harvesting firstly height of the tool was adjusting according to moringa tree height and locate the place of drumstick between the "V" shape serrated cutter, detach the drumstick pod from stem by pulling force and collect harvested drumstick.

Results and discussion

Actual capacity of drumstick harvesting tool

The harvesting of drumstick was done on different moringa tree at different location by using the developed harvesting tool. During the harvesting number of drumstick plucked down in 1 hour. The human comforts, effective working time and rest period were recorded during the working hour. From the field experiment it was found that at least 380 and maximum 600 drumsticks were harvested within 1 hour while the productive time was 40 and 49 minute respectively (Table 2).

Table 2: Actual capacity of developed manually operated drumstick harvesting tool

S. No.	Required time (min.)	No. of Pods	Productive time (min.)	Non-productive time (min.)
1.	60	500	45	15
2.	60	380	40	20
3.	60	450	43	17
4.	60	600	49	11
Mean	60	482	44	15

Table 3: Comparison between traditional method and developed harvesting tool

S. No.	Particulars	Traditional method	Developed harvesting tool
1.	No. of drumstick harvest in 1 hr	280	482
2.	Ease of operation	Difficult	Easy
3.	Productive time for operation	32 min	44 min
4.	Non productive time	28 min	16 min
5.	Drumstick damage	20%	10%
6.	Labor required	1	1

4. Conclusion

At the end of construction, a satisfactory harvesting tool was fabricated using the available raw materials. The overall performance of the tool is more efficient compared to traditional methods (Bamboo, sickle). The maximum expansion length of the tool is 7.31 m and the minimum length of the harvesting tool was 2.4 m. The weight of the tool was 2.8 kg that enables the easy carry by the farmer without any difficulties, safe and easy to repair. Harvesting capacity of the tool was found 380-600 drumsticks harvested per hour including the non productive time. The cost of production and maintenance is relatively cheap. Harvesting tool was used for different fruits like mango, apple and guava etc. Hence the tool will be welcomed by ruler areas given its performance, simplicity and affordability. It has low operating cost; hence the tool was a successful one.

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