Development and Performance Evaluation of ManuallyOperated Drumstick Harvester

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Abstract- *The drumstick (moringaoleifera) i.e. 'Shevga' is called the 'tree of life' because of huge variety of uses. India is the largest producer of drumstick. The country produces 1.2 million tons from a 380km², as per the official release of 2010. In day-to-day life drumstick damage is the vital problem facing by farmers. It occurs in various ways while picking, by using sharp edge materials like scissors,blade, knife etc., by picking manually the drumstick get damaged whenever falls down which is a permanent damage or the labour can fell down because of its height from ground. Current forms of harvesting include climbing the trees and using ad-hoc harvester made out of scrap materials to ensure the drumstick is not damaged during harvesting, that's why drumstick harvester is designed in such manner. It mainly consist of mild steel pipe, harvesting scissor, lever, galvanized spring cable, conveyor bag. The improved harvesting system found better than traditional methods and reduce musculoskeletal stress on the operator. The harvesting capacity of developed manual drumstickharvester was found to be 21.99 kg/h (364.33 Nos. /h) and the average damage percent of the developed manual drumstick harvester was found to be 1.59 percent and damage drumstick percent was very low as compared to traditional drumstick harvesting devices.*

Keywords: **-**Scissor, Cable, Lever, Mild steel pipe, Conveyer bag

Introduction

India is the largest producer of drumstick tree (*Moringaoleifera***)** in the world, with an annual production of 1.1 to 1.3 million tons of tender fruits[1].Andhra Pradesh leads in both area of 156.65 km^2plantation and production of drumstick, followed by Karnataka102.8 km^2 and Tamil Nadu74.08 km^2 in other state occupies an area of 46.13 km^2[1]. In Maharashtra, drumstick is cultivated over around an area 800 ha. In India basically it is called *shevga* (Marathi); *sanjna, suhujna* (Hindi); *murunga, murangai* (Tamil) are mentioned for drumstick tree. The drumstick harvester is mostly found in large amount in Satara, Sangli, Solapur, Yavatmal, Nashik and Pune districts. Solapur is the largest producer of drumstick harvester, 91.5% of total cultivated area is under dry land farming. The varieties of drumstick is *Rohit-1*,*Coimbatore1*. The hybrid varieties are *PeriyakulamPKM-1, PKM-2* and height of the plant is 2 to 4 m. In day-to-day life drumstick damage is the vital problem facing by farmers. It occurs in various ways while picking, by using sharp edge materials like scissors, blade, knife etc., by picking manually the drumstick get damaged whenever it falls down which is a permanent damage or the labour can fell down because of the trees height from the ground.

The development of Indian agricultural sector depends on the development of farm mechanization, so that there should be introducing such a machinery and equipment to fulfill the need of the labour which is major problem now a days, and also reduces the human drudgery and product damages. Currently drumstick harvesting is done manually with knife sickles and stabs withhook attached to it. Skilled labour is to be needed for such traditionally harvesting method of drumstick.

Traditional harvesting is just that the current form of harvesting include shaking the trees by hand, climbing the trees, using hook and bamboo made out of scrap material. Drumstick tree is very delicate for climbing hence, there should be accidental chances for labour. Improved harvesting method is done by using the manually operated drumstick harvester. In operation, the operator would hold the cable in one hand and another hand hold free end of extension pipe. As soon as drumstick comes in cutting zone of the cutting mechanism, cutting mechanism operated by pulling cable in downward. The drumstick cut by cutting mechanism fallen into conveyor bag. Target the mature drumstick from the ground. To overcome such a problem, there is a need for design and development of manually operated drumstick harvester, which makes easy cutting of the stalk and easily conveys the drumstick pod.

Materials and Methods

This chapter deals with materials those were used for development of manually operated drumstick harvester and the methodology that was adopted during testing and evaluation of manually operated drumstick harvester. The project entitled "Development and performance evaluation of manually operated drumstick harvester" was fabricated by considering the following point in mind.

1. The developed harvesting device is affordable for using by small and marginal farmers.
2. The harvesting device developed is portable with minimum operator discomfort.
3. The harvester to be developed should have low initial cost, low maintenance and operating cost.

Harvesting Scissor

Scissor are used in gardening, arboriculture, plant nursery works, farming, flower arranging for cutting. Harvesting scissor is made of carbon steel. Carbon steel makings are more malleable butare brittle. It becomes brittle because of too much carbon which also makes it harder.

Brake Lever

Brake lever was used for pressing the movable blade towards fixed blade for cutting operation. The brake lever material used is aluminum alloy. The brake lever is provided to operate the cutting mechanism. It consists of steel cable with one end is connected to the cutting mechanism and another end connected to the free end of expansion pipe. When the pods are in the cutting zone,the cutting mechanism operates by pulling the cable downwards. The Cable takes its original position due to the action of a spring fitted on the cutting mechanism.

Galvanize Spring Cable

The galvanization is the process of applying a protective zinc coating to steel or iron. This type of metal is strong and very durable. The galvanize spring cable was used for cutting mechanismof drumstick harvester. The length of galvanize spring cable is 3.4 m.

Mild Steel Pipe

The body frame of unit consists of two M.S.Pipe of different diameter, different length for the purpose to reach up to the height of drumstick tree. The upper pipe was inserted in lower pipe for the adjustment according to the height of tree. The material of the pipe is selected from stainless steel with high strength, high hardness Corrosion resistance and high wear resistance. This long hollow stainless steel pipe is easily reachable to the drumstick. A locking mechanism is provided for extending or shortening.

Conveyor Bag

Drumstick conveyor bag is used for collecting the drumstick after cutting from trees. The Conveyor bag fitted at the end of the extension pipe in such way that the drumstick cutted by cutting mechanism will fall in the bag. The conveyor bag length is 3 m.

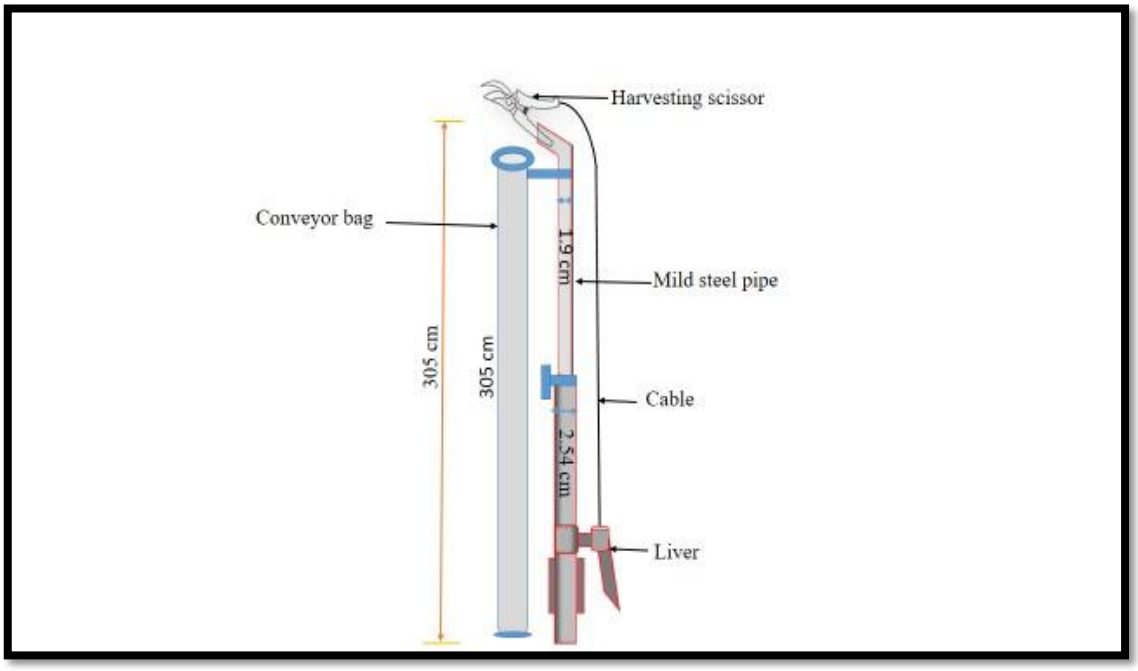

Fig.1:- Schematic Diagram of Developed Drumstick Harvester

The testing of manually operated drumstick harvester was conducted at the site of Nirgudi, Phaltan, and Dist. Satara. Testing was carried out as per RNAM test code for drumstick harvester. The experiment was replicated thrice. This harvester was compared for number of field test, comparative performance of the harvester and cost of operation etc. The results obtained after trials are discussed in this chapter.

Test Conditions

Performance of drumstick harvester varies according to the kind of crop, condition of crop.Therefore, condition of the test were clearly stated. The range of test condition is defined as follows:

Test Plot

Mr. Rajendra Ghorpade has drumstick farm of area 40R at Nirgudi (Phaltan) was selected for conducting trial of manually operated drumstick harvester. Details of test plot are presented in Table A. The table included plot, location, shape, area of the field, kind of field and type of soil.

TableNo.A:- Field Condition for Test for Manually Operated Drumstick Harvester

Sr. No	Particulates	Test
1.	Dates	29/10/2022
2.	Location	Nirgudi (Phaltan)
3.	Shape	Rectangle
4.	Area of the field (m^2)	4047 m^2
5.	Type of soil	Sandy loam
6.	Kind of field	Upland

Crop Condition

The crop conditions were considered during testing are physical properties of drumstick plant, maturity indices, harvesting index etc. The details of crop condition are given in Table B. The table included the details about name of crop, planting pattern, row spacing, and stage of growth day after sowing and height of crop.

Table No.B:- Crop Condition for Manually Operated Drumstick Harvester

Sr. No	Particulates	Test
1.	Variety of plant	Coimbatore
2.	Height of plant	4-4.5 m
3.	Distance between two plant	2.4 m
4.	Length of pod	350 mm

Condition of Implement and Operator:

The condition of implement and operator was important for Harvesting capacity and net operation. Harvesting capacity was directly depending upon skill of operator. If skill of operator results very good then Harvesting capacity will result best. The details of condition of implement and operator are in Table C. The table included the details about source of power, skill of operator, weight of implement, maximum height of implement, adjustment of working part, clearance between scissor and lever.

Table No.C:- Condition of Implement and Operator forManually Operated Drumstick Harvester

Sr. No.	Particulars	Performance Test
1.	Source of power	Human
2.	Weight of implement	2.6 kg
3.	Max height of implement	3048 mm
4.	Adjustment of working part	
	-Scissor	Rotate in 180º
5.	Clearance	
	-Scissor	49 mm
	-Lever	40 mm
6.	Skill of operator	Not necessary

Result and Discussion

The testing of manually operated drumstick harvester was conducted at the site of Nirgudi, Phaltan, and Dist. Satara. Testing was carried out as per RNAM test code for drumstick harvester. The experiment was replicated thrice. This harvester was compared for number of field test, comparative performance of the harvester and cost of operation etc. The results obtained after trialsare discussed in this chapter

Harvesting Capacity

The Harvesting capacity calculated in three test on field, then divided the area wise test. The total area is one acre and divided into three test plot. The average harvesting capacity of developed manual drumstick harvesting system was found to

be 21.99kg/h (364.33Nos./h). In developed manual drumstick harvesting system, the drumsticks could be harvested from a plant upto the height of 4.5 m from ground with comfort and safely without any injury. The harvesting capacity is higher as increased reach of human labour by device and hence more drumsticks are harvested within less time. The productivity increased due to saving of time and more time utilizedfor harvesting of drumstick due to higher reach.

The average harvesting capacities found to be for hook methods were 16.37kg/h (266.33 Nos. /h),respectively (Table D). The capacities are lower as more time is lost in locating drumstick and drumstick collection.

Harvesting capacity was estimated by number or weight of harvested drumstick per unit time by using following formula.

$$\text{Harvesting capacity (kg/hr)} = \frac{\text{weight of harvested drumstick}}{\text{Total harvesting time}} \quad \ldots (1)$$

$$\text{Or} \quad \text{Harvesting capacity (Nos./hr)} = \frac{\text{Total no. of drumstick harvested}}{\text{Total harvesting time}} \quad \ldots (2)$$

Table D:-Harvesting Capacity of Developed Harvesting System and Traditional Methods

Sr. No.	Harvesting Capacity			
	Developed harvesting system		Hook method	
	Kg/hr.	Nos./hr.	Kg/hr.	Nos./hr.
Test 1	20.91	334	18.11	273
Test 2	22.64	378	16.27	265
Test 3	22.42	381	14.75	262
Average	21.99	364.33	16.37	266.66

Damage Drumstick Percentage:

The result of the damage drumstick percent during developed harvesting system are presented in Table E. The average damage drumstick percent while harvesting pods by the developed manual pod harvesting system was found to be 1.59 %. This damage percent included the mechanical damage and pod falls during harvesting with and without platform from ground surface. The damage to drumstick was least as drumstick are conveying in down and device reach higher elevation and the chances of damage by harvesting and fall was minimum. The average damage drumstick percent of the hook method were calculated as 4.06 %. Damage to drumstick maybe due to harvesting by stick and falling of drumstick from height.

The number of drumstick pods that got damaged due to scratching or falling down from tree during harvesting. The following formula calculate the damage percent of pods.

$$\text{Damage Drumstick percent} = \frac{\text{No.of drumstick damaged during harvesting}}{\text{Total no.of drumstick harvested}} \times 100 \quad \ldots (3)$$

Table E:-Damage Pod Percent of Developed Harvesting System and Traditional Drumstick Harvesting System

Sr. No.	Damage drumstick %	
	Developed harvesting system	Hook method
Test 1	1.97	3.79
Test 2	1.39	4.28
Test 3	1.43	4.12
Average	1.59	4.06

Conclusions

The following conclusions were drown from the observations recorded during thelaboratory and field testing of the developed manually operated drumstick harvester.

1) The harvesting capacity of developed manual drumstick harvesting system was found to be21.99 kg/h (364.33 Nos./h).

2) The average damage percent of the developed manual drumstick harvesting system was foundto be 1.59 %.

3) It is light weight and therefore, can easily be carried from one place to another.

4) The harvester was most efficient and comfortable according to ergonomic observations.

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