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Mango harvester with a battery: a solution for the farmer

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Abstract
India is the world's second-largest producer of fruit. Mango fruits are harvested with a traditional harvester (Vedo) by jerking and pushing the harvester such that the fruits fall out or a liquid is poured out when detaching. A manually controlled harvesting mechanism was created to alleviate the problems and limits of the traditional harvesting method (Vedo). Moreover, the manual harvesting method is time consuming and sometimes fruits may get damaged while harvesting. In addition to manual harvester required more effort while operation. In order to overcome the problem and limitations of the manual harvesting method, a battery operated harvesting device was designed. The main object of battery operated harvester is that timeliness operation with full of comfort. This research article includes the development, performance evaluation and techno-economics of the mango harvester to provide feasibility of the farmer for a complete solution of harvesting.

Keywords: mango fruit, developed device, capacity, loss, cost

1. Introduction
Mango (Mangifera Indica L.) is a popular fruit in India and is now grown all over the world (Tharanathan *et al*., 2006) [1]. Mangoes are regarded as one of the world's most popular fruits due to their appealing colour, delectable taste, and superior nutritional value. India is regarded as the world's second-largest fruit producer (Ravindran *et al*., 2007) [2]. Mango is a crop that is heavily cross-pollinated. It's high in B-carotene and vitamin A, as well as B-complex and vitamin C, nutritive minerals, digestible carbohydrates, and trace elements. Everyone is enthralled by its taste, flavor, and aroma. There are around 283 different types of mangoes in India, with only 30 of them being well-known.

Although, essentially a tropical fruit, the mango can grow from sea level to an altitude of about 1400 m, but there should not be high humid, rain or frost during the flowering period. The temperature may affect the production of mango. Cold temperature limits crop production. Low temperature promotes floral induction of mango. Higher temperatures during fruit developing hasten maturity and improve fruit size and quality (Indian Horticulture Database-2012).

India is the leader sharing 65 per cent of the world’s mango production. Its share in world’s fresh mango market is just 5.25 per cent in terms of quantity and 3.5 per cent in terms of value, which is very less considering the total production. In India, among the different states growing mango, Uttar Pradesh leads in productivity with 12.8 t/ha followed by Bihar registering 9.2 t/ha and Karnataka with 9.1 t/ha. However, the productivity in Tamilnadu is only 5.5 t/ha which is exactly the national average for the crop. The mango producing states in India are mainly Andhra Pradesh (25%), Uttar Pradesh (21%), Karnataka (9.8%), Bihar (9.7%), Gujarat (6.1%) and Maharashtra (5.09%). India exports mango to over 50 countries worldwide. India’s exports to UAE, Saudi Arabia, Qatar, Bahrain, UK, Kuwait, Singapore, Malaysia and Bangladesh together account for 97% of total exports of fresh mangoes from India (Balamohan *et al*., 2008) [4].

For over 4000 years, Mangifera indica (MI), often known as mango or aam, has been an essential herb in Ayurveda and indigenous medical systems. Mangoes are members of the genus Mangifera, which includes roughly 30 tropical fruiting trees in the Anacardiaceae flowering plant family. Ayurveda attributes various therapeutic virtues to various portions of the mango tree. (Shah *et al*., 2010) [5].

Harvesting

Harvesting is one of the most importing operations in fruit production, handling and preservation cycle. People harvested fruits by hand until relatively recent time and high percentage of the world's production is still being harvested as done down through the ages, one at a time by hand grasp. At first, people picked up fruits that could be reached from the ground. Later, they learned knock fruits down with sticks or rocks shaking small trees and climbing in to trees with the aid of crude ladders to position themselves better for picking. Other existing methods of fruits harvesting are manual harvesting of fruits with use of mechanical aids, mechanical detachment of fruits by direct contact devices, vibratory mechanism for the harvesting of fruits etc. These methods have some limitations such as high cost of harvesting and mango fruits do not mature at the same time which is major obstacle for introducing mechanical harvester. This is the reason why Indian farmers preferred manual harvesting or hand picking instead of mechanical methods. Small land holdings and easy availability of labors are other causes that aid manual harvesting.

In India harvesting of fruits is mostly done manually by means of a curved knife, blades attached to a hanging basket to the distant end of bamboo sticks (Devnani, 1980) [6]. Harvesting of mangoes by hand picking (manually operated low capacity gadgets) or tree shaking methods results high Labor, high energy requirements, drudgery, and damage to fruits and branches etc. The damage and bruising are also serious problems. The fruits should not be allowed to fall on the ground as the damaged fruits cause spoilage to other healthy fruits during packaging and storage. Fruits harvested with 8-10 mm long stalks look better on ripening as undesired spots on the skin caused by sap burn are prevented. Such fruits are less prone to stem-end and rot and other storage diseases (Sapowadia *et al*., 2001) [7].

Human comfort is the most important consideration in the field during harvesting operations. It took more work and was more difficult to run a manual harvester. A battery-operated mango harvester was invented and built to solve this problem. In comparison to a manual harvester, this harvester required less force. In a battery-operated mango harvester, an operator pushes a button, and power is sent to the motor, which rotates the blade. Power is also sent through the battery, which is kept in a battery bag and held by the operator's body, minimizing the battery's weight by distributing the force of the battery across both shoulders. So overall human comfort can be increasing and capacity of the harvester per mango tree also be increase.

Material and Method

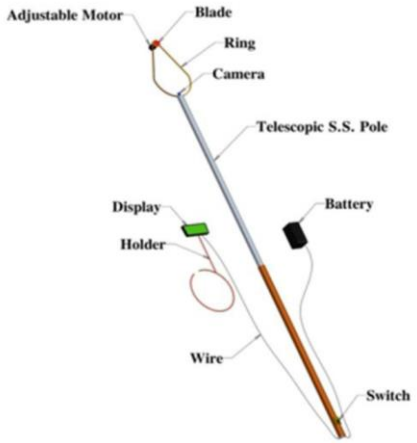


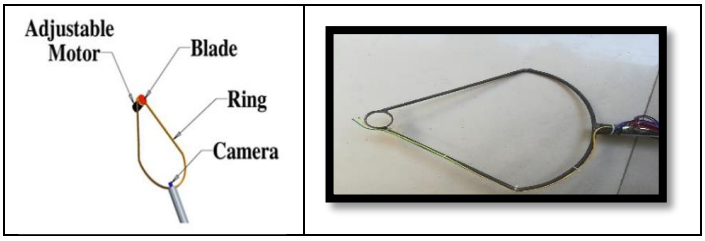
Fig 1: Schematic representation of mango harvester

The following considerations were made while designing a manually operated harvester for mango fruit. The device should be easy to operate. It should be handy and light in weight so as to be operated easily by single person. The losses in harvesting should be at minimum level. The device should be more comfortable for operator. The device should be give timeliness operation. The device should harvest more number of fruit per hour. The device should be durable, reliable for long time. It includes several components which are mentioned below.

Components

- **Over ring**

Over ring is fitted on the upper portion of the Harvester. It hangs the conveyor and gives support to the motor. Over ring is made from the 6mm iron reinforcement. Upper end of the frame consists motor holder and fixed together by means of welding. It helps in the harvesting e.g. Resist the movement of the mango in other direction while cutting the mango fruit.



- **SS Pole**

Pole is the main structural component of the harvester. Pole allows more height to the harvester for the harvesting of the big mango tree. Pole gives foundation to the different components of the harvester. Over ring is attached to one end of the pole. Pole is made from stainless steel. Main purpose of using stainless steel pole is that it has more strength, durability and more life. With compare to bamboo it is more reliable and resist the deformation against the humidity and easy to the handling the harvester.

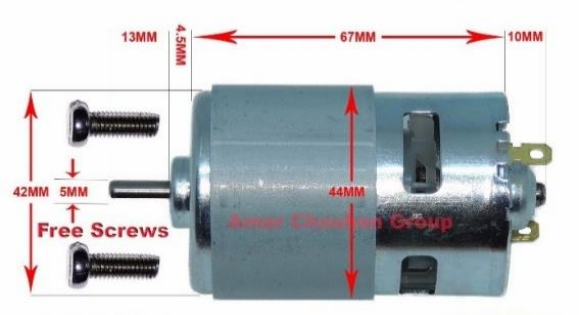
- **Battery**

D.C 12 v battery with 7.5A made from LI is used for power

supply. Wight of battery is 1.5 kilo-gram. Battery mounted on waist of operator. Life of battery on field is 3 hours in one-time charge. After 3-hour operator need recharge the battery with help of 2A charger.

- **Motor**

High speed 12v D.C motor with around 3000 rpm. Motor is mounted on front end of over ring. Diameter of motor is 42mm. length of motor is 189 mm. Blade is mounted on the shaft of the motor. It takes power from the battery and gives rotary motion to the blade at certain rpm. Motor is control by one micro-switch. Whenever we want to operate "switch on". All connection are connected with power conduct line.



- **Blade**

Blade made from GI. With 40 teeth. Blade is a main part of a cutting mechanism. Load applied on the motor is low due to light weight of the blade. Blade and motor shaft connected with each other either by steel welding or by brass welding. There is a sharpen teeth at outer edge of the blade.

- **Camera**

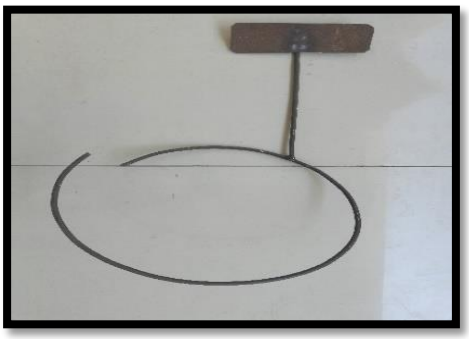
5MP camera is used. Camera is mounted on end of pole and starting of over ring. Size of camera is very small, so there are no chance to stuff with tree stalk/branch. Weight of camera is so light or negligible so it's doesn't give more load on the instrument. The function of camera is to check the quality of cutting. It gives additional vision to the operator. Moreover we can ensure the proper cutting of fruit without any damaging to the product during operation.

- **Display**

7-inch Bluetooth display with 720-pixel visual clarity. Display is mounted on operator waist. Due to the display operator need not to saw continually up side. Wearing of display is so comfortable. After the long-time operator does not feel tired. Display get power from the battery. Camera and display are connected with each other.

- **Display holder**

The main purpose of display holder is to hold display at waist of operator. Display holder made from 4mm iron rode. Very light in weight. Very comfortable for operator to hold display. Display is mounted on display holder in such a way that we can see the cutting operation effortlessly. It can provide the flexibility according to the operator.



- **Conveyor**

The main purpose of conveyor is to convey fruit from over ring to fruit bucket without any damage to the fruit. Conveyor is made from plastic net. It is very economical also. Length of conveyor is 5m. Conveyor should be light in weight. It can be dismantle from the main structure whenever needed in transport.

- **Wire**

10 code 1 mm thick wire made from aluminum use to supply power to camera, display and dc motor. Wire should be not destroy easily or it should be very durable. Wire is very light in weight.

- **Switch**

Micro push button switch is used to operate dc motor. Thickness of switch id 1.5mm and very light in weight.

Working Principle

11 feet stainless steel poll was taken to develop the mango harvester because it has high strength and durability as compared to bamboo and aluminum. Over ring was made with the help of iron to hold the motor at an angle of 45° by welding. The size of motor holder was kept quite bigger than the outer diameter of motor for well fixing. Over ring was thus attached with the SS pole with the help of nuts and bolts. GI sheet was taken to make blade and the tooth were made along the circumference of the blade by scissors. Blade and motor was fixed by the brass welding. 5 MP camera is installed at the point where SS pole and over ring was connect. Display was mounted on the display holder which is made from the 8 mm iron rod. The angle of display was set in such a way that operator can comfortably observe the harvesting process. 12 volt battery was used to supply efficient power. Camera, display and motor were connected with the help of wire and run through the battery. For operating the motor switch is provided on the SS pole. Conveyor is provided on the over ring to convey the fruit.

Techno-economic analysis of developed unit

The economics of the developed unit were evaluated using the benefit-cost ratio and the payback period.

Benefit-Cost Ratio

The benefit-cost ratio of the developed system was calculated by the given formula (ER Nakum Divyangkumar and Dr. Sudhir Jain., 2021) [8],

$$\text{Benefit} - \text{cost ratio} = \frac{\text{Total benefit}}{\text{Total cost}}$$

Payback Period (PP)

The payback period is the time it takes from the start of the project until the net value of the incremental production stream equals the total capital investment. The payback period (PP) of the developed system was calculated by the given formula (Yadav et. al, 2020) [9].

$$\text{Payback Period} = \frac{\text{Total Investment}}{\text{Total Profit}}$$

Result and Discussion

This chapter includes result obtained while performance of developed mango harvester. The experiment was conducted with display and without display and comparison was carried out to show the efficacy of display and camera. The total harvested fruits in 5 mins duration were calculated up to 60 mins for with display and without display as shown in table 1. Obtained results was plotted in the tabulated form to analyses the total harvested fruits per hour for both the replications. Same procedure was followed 5 times to check the regularity in the evaluations. Conclusion were drawn by taking average no of harvested fruit in 1 hour. It is found that the total number of mango can be harvest per hour was 339 and 414 for without display and with display respectively as shown in figure 1. As indicated in the table 1 it is found that maximum fruit can be harvest at 20-25 min for without display and with display. Benefit cost ratio and payback period was calculated according to cash inflow and outflow by assuming and discount rate factor and it is found 1.31 and 1 year 4 months respectively with taking total cost of unit Rs. 12000. The cost of developed mango harvester increased as compared to traditional and manual harvester because of camera, display and battery. The rising cost of unit is justified by the timeliness operation and human comfort with more number of fruit harvest.

Obtained results indicated that the more numbers of fruits can be harvested per unit time with the help of display and camera with extra human comfort by minimizing the human health. Timeliness operation can be performed by using developed battery operated mango harvester.

Table 1: Harvested Mango Fruits per unit time

Time (Min)	Harvested Mango Fruits (No)	
	Without Display	With Display
5	28	32
10	29	35
15	27	36
20	25	37
25	32	38
30	27	32
35	30	36
40	24	36
45	26	35
50	32	34
55	30	31
60	29	32
Total	**339**	**414**

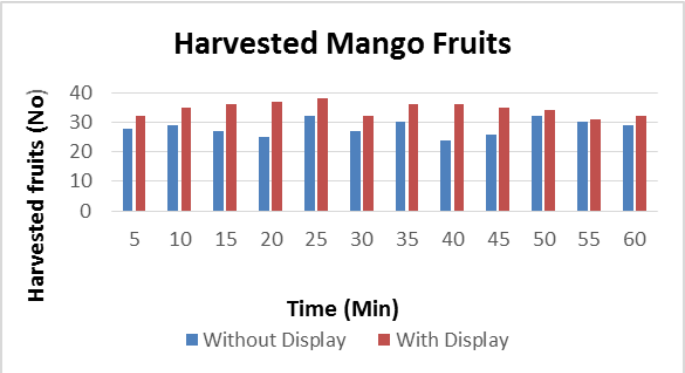


Fig 1: Graphical Representation of harvested fruits according to time

Conclusion

The mango is the popular fruits by its color, odour, taste and sweetness. Many varieties of mango fruits is available in India and its texture vary according to the different region of country. The harvesting methods was followed in the earlier century by traditional way but it has many disadvantages such as more time required, high damage percentage, low human comfort etc. The modern methods is required to overcome the problem mentioned above. The battery operated mango harvester is developed and tested in the field. Conclusion were drawn on the basis of data obtained from the performance evaluation and it is found that the best result

obtained when working with display and it can harvest 414 fruits per hour. Benefit cost ratio and payback period was about 1.31 and 1 year 4 months respectively. Extra cost of device is justified by more output. So, at the end authors conclude that the developed unit is feasible for the farmers and agro industries as well.

References

1. Tharanathan RN, Yashoda HM, Prabha TN. Mango (Mangifera indica L.), "The king of fruits"—An overview. Food Reviews International. 2006;22(2):95-123.
2. Ravindran C, Kohli A, Murthy BS, Srinivasa A. Fruit production in India. Chron Horticult. 2007;47(2):21-26.
3. Anonymous. Indian Horticulture Database-2012. National Horticulture Board, Ministry of Agriculture. 2012.
4. Balamohan TN, Mekala P, Rajadurai S, Priyadharshini G, Prakash K, Soorianathasundaram K and Kumar N. Canopy management in mango. An unpublished M. Tech. thesis, Tamil Nadu Agricultural University, Coimbatore. 2008.
5. Shah KA, Patel MB, Patel RJ, Parmar PK. Mangifera indica (mango). Pharmacognosy reviews. 2010;4(7):42
6. Devnani, R. S. 1980. Harvesting equipment developed in India. Technical bulletin No. CIAE/ 78 / 8, CIAE, Bhopal.
7. Sapowadia BD, Patel HN, Gupta RA and Pund SR. Design and development of mango harvesting device. AMA. 2001;30(1):31-34.
8. ER Nakum Divyangkumar, Dr. Sudhir Jain, 2021. Techno-economic feasibility of the latent heat storage material to use in a solar tunnel dryer. International Journal of Chemical Studies. 2021;9(1):323-326.
9. Narendra Kumar Yadav, GS Tiwari and SS Meena. Estimation of the cost economics of developed ground wheel operated sprayer. The Pharma Innovation Journal. 2020;9(10):198-199.