

## Mechanical Fruit Picker

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### Abstract

The traditional method of picking fruit by hand and ladder is indeed tiring and usually takes a long time, especially if it involves a large quantity of harvested fruit. By using a fruit picking tool, the process of picking fruit can be easier, faster, and more effective. In this project, a simple mechanical fruit harvester was modified and manufactured. With its maximum length span of 3 meters, the fruit picker can reach high tree branches that were cultivated without much difficulty. Additionally, with its elastic and flexible chute, it has no problem holding too much fruit in it as the fruits will fall into the container placed below. Furthermore, the trigger handle connected to the lever principle has made the picker substantially easier to handle. Because it operates without a motor or electrical power, this tool is considered environmentally friendly. Based on results from performance studies, fruit picking can be done 40 to 50% faster compared to other tools. This tool is suitable for fruits like mangoes, rambutan, mangosteen and kedondong.

## 1. Introduction

Malaysia is a tropical country that has a variety of fruit crops. According to crop statistics released by the Malaysian Department of Agriculture, approximately 1,796,804 metric tonnes of main fruit crops, including sweet lime, mango, mangosteen, pulasan, rambutan and others have been produced, which covers land use of 198,111 hectares in 2022 [1].

Therefore, garnering the fruits shall become much more important, making the process of picking fruits faster an ideal way to increase income. Modern fruit pickers, including automatic technologies, enhance picking efficiency and reduce operational impurities, making the harvesting process more effective. But farmers in Malaysia usually use traditional methods for harvesting fruit. They often only use their hands to gather fruit from low-lying trees or use poles or ladders for tall trees. Using a ladder while picking fruit is quite risky, especially if the ground is uneven, which can result in an unstable position of the ladder.

The use of poles is more popular because it is safer than ladders. Traditional pickers, which are made of long sticks with a split part at the top end, need a little skill and strength to harvest the fruit. This is true because traditional pickers will usually place a split end on the branch or fruit stalk and twist it until the fruit stalk is separated from the tree. The more advanced traditional pickers are usually equipped with a cutter or are sometimes provided with a bag collector at the top end, large enough to prevent the fruit from falling to the ground. The poles that serve to reach high parts of trees usually have a fixed length or height and some are adjustable.

There are various designs of simple fruit pickers available on the market. The pull-type fruit picker, as seen in Fig. 1(a) and (b) has a pulling metal arranged like a blade pointing upwards. When the fruit has entered the middle of the blade, the user will pull the picker to allow the fruit to separate from the stem and then enter the

collector. A collector is used to keep the fruit from falling to the ground. It's advantages since the fruit's quality can be preserved, but the amount of fruit picked is limited at one time depending on the size of fruit and the collector. The fruit needs to be dropped and removed from the collector before the picking process continues.

The picker shown in Fig. 1(c) has a claw at the end of top pole, typically connected to the trigger placed at the bottom of the pole by the cable. When the fruit enters the open claws, the claws are then closed, controlled by the trigger located at the bottom. The fruit caught in the claws will then be pulled from the stalk before being taken down. This type of claw is usually suitable for fruits such as limes and apples, and it can only pick one fruit at a time. There are also fruit pickers that include scissors or cutting blades in their design as shown in Fig. 1(d) and (e). This cutting blade is used to cut fruit stalks and is usually controlled by a hand lever placed at the bottom of the pole, which is connected by a cable. There are also designs that include the use of motors or actuators or gear systems to ease the process of cutting fruit stalks or the picking process itself [2][3][4].



(a)



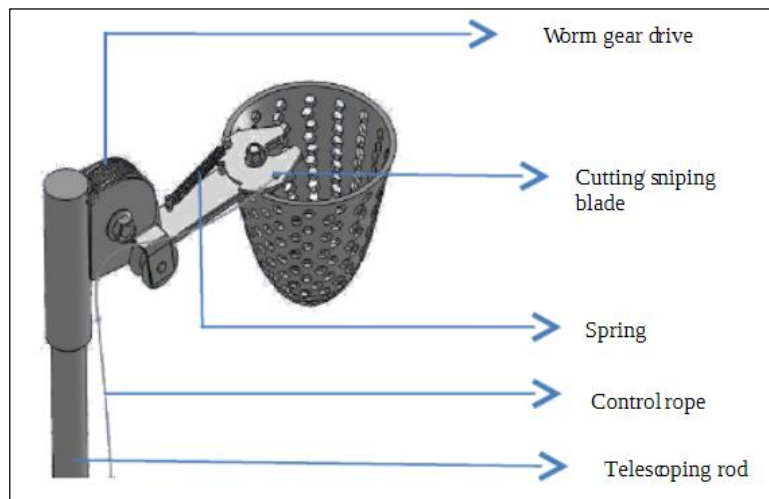
(b)



(c)



(d)



(e)

**Fig. 1** (a) Pull type picker; (b) Pull type picker; (b) Claw type picker; (d) Picker with blade; [5], (e) Picker with blade [6]

## 2. Materials and Methods

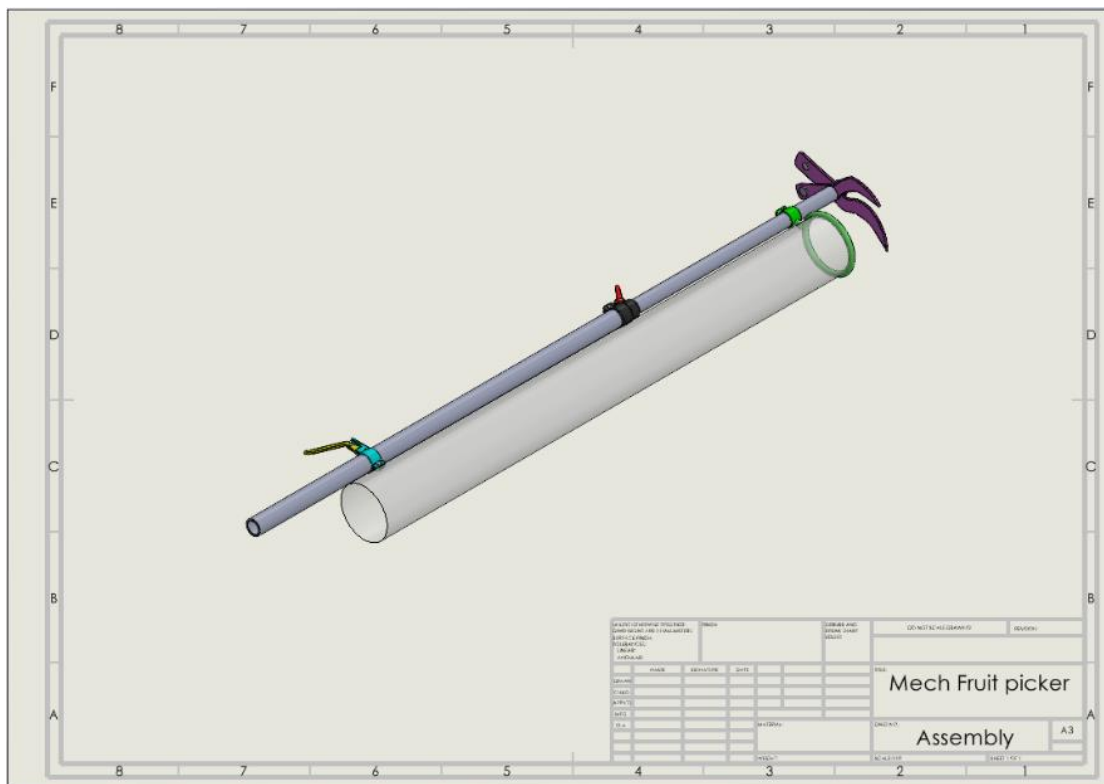
This project has gone through multiple stages of development, including periods for information gathering, design, fabrication, prototype generation, and product testing. The design effort also includes the steps of coming up with design concepts based on the desired criteria, creating a design proposal, choosing materials, and producing engineering drawings before the prototype is manufactured.

**Table 1** Product design specification

Specification	Description
Weight	The weight must be around 2 kg.
Length	The length has different lengths for different heights up to 3 m.
Ergonomic	Adjustable length and easy to handle.
Size	The diameter of the guard should be bigger to accommodate fruit sizes.
Operating environment	Any condition for the robust design.

In Table 1, there are some criteria that need to be considered in the design of fruit picker. For instance, its weight must be around 2 kg to not make the handling hard and sluggish. Besides that, the length of the pole is flexible for different heights up to 3 meters. Moreover, the picker must be ergonomic enough so that it can be used easily without causing too much discomfort. Additionally, the size of the guard should be big to accommodate the larger fruit sizes. Finally, the mechanical fruit picker must be able to withstand a standard operating environment.

Based on the criteria or specification product specifications for the mechanical fruit picker shown in Table 1, a conceptual idea has been generated. The conceptual ideas that have been created then are assessed to specifications to determine the best design for the requirements that have been set. After further brainstorming and research, a conceptual design has been made in SolidWorks software. All the engineering drawings of each component are drawn according to the specification of the dimension for assembly purposes as shown in Fig. 2. The main parts of this tool include a handle, a pole, a cutter or pruning shear and a chute to direct or channel the fruit down.



**Fig. 2** Conceptual design of mechanical fruit picker

**Table 2** The Materials Selection for Mechanical Fruit Picker

Component	Material	Quantity
Cutter/pruning shears	Carbon steel	1
Telescopic pole	Aluminium alloy	1
Guard	Stainless steel	1
Net	Nylon	4
Cable tie	Nylon	84

The material for each component has also been selected based on practicality and suitability for mechanical properties, budget and availability factors. Based on Table 2, the materials selected for mechanical fruit picker include for cutting part which is made from carbon steel. A telescopic pole made from aluminum alloy was chosen because of its light and easy to handle nature. Furthermore, a stainless steel guard is necessary to hold the chute while also ensuring the fruit does not go over the guard. Moreover, 4 nylon nets which individually have a length of 95 cm are sufficient as a chute. Lastly, the cable ties are used to tie up the chute together and to hold the guard and the chute together in place.

### 3. Results and Discussion

Fig. 3(a) shows a prototype of fruit picker, which may look a bit different from the conceptual design shown earlier. The main components are still the same as described before, where this fruit picking tool consists of a telescopic pole, handle lever, cutter, guard and chute. The adjustable telescopic pole can be extended from 1.8 meters to 3 meters. A cutter or pruning shear as shown in Fig. 3(b) is used to trim the fruit stalks that want to be harvested. A guard is used to prevent fruit from falling out of the chute. It also serves as the holder for the chute and cutter. A chute is used to guide and lessen the impacts of the fruit against the ground to preserve the quality of the fruits.



**Fig. 3** (a) The rototype of Fruit Picker; (b) Cutter or pruning Shear

The lever handle located at the bottom serves to make it easier for the user to press the duty of the pruning shear to cut through the branch. The lever handles the load on the user's energy and is even equipped with a safety lock as part of the precautions. The user will start using the fruit picker by holding it with both hands, with one hand holding the bottom lever and the other on the upper grip to support the weight distribution of the rod. The moving rod inside moves the cutter in a shear movement. This can be moved by pressing the lever. It is intended to cut the stalk of a fruit. By holding the fruit picker in the right way and putting the pressure on the lever to cut the branch in the correct amount, the shear cutter will cut off the stalk or branch of the fruit easily.

The targeted weight of fruits that can be plucked is up to multiple fruits at a time, since it rolls down the chute and is collected in a box or container that can be placed at the bottom. The pole itself weighs quite heavy so it will add on another weight if some fruit is plucked until it is completely rolled down the chute into the box. As a precaution, a box needs to be placed at the end of the net chute to ensure that fruits are not falling on the dirty and uncovered ground surface. Thus, the fruits are properly taken care of its quality.

Performance tests were conducted on the mango tree to determine the time picked fruit in one minute interval time using the prototype model of the mechanical fruit picker. The average result was then compared to the time fruit picked in one-minute intervals of the other fruit picker mechanism.

**Table 3** Performance Result

Mechanism	Quantity of fruit harvested
Pull type	10
Universal type	11
Mechanical Fruit Picker (trigger type)	19

Table 3 shows the performance result of all the mechanisms tested. The results show that the trigger type (mechanical fruit picker) with the modification, harvested most fruit in one minute interval. This is due to the delivery system that has been implemented into the design. It shows that the fruit picker picked almost 40% to 50% more fruit harvested than the other mechanism. The result has concluded that fruit pickers that have been produced can help harvest more fruit in a shorter period.

However, noticeable limitations that can be seen is the chute is not easy to remove from the picker. Besides that, the chute has a fixed length, meaning it cannot be contracted or extended to find a suitable height. Moreover, the fixed guard diameter resulting in larger fruits cannot be picked. Nonetheless, the weaknesses of the picker do not impede it from being a good tool. Other than that, the length of the pole could be a problem for certain people due to height and arm's length to hold on to the pole. This prototype also could not cut branches that are huge in size than it is supposed to. Fruits can be plucked from branches that were cut and easily collected through the chute falls.

#### 4. Conclusion

In a nutshell, a modified mechanical fruit picker that utilizes a simple mechanical mechanism that is lever action has been designed and constructed. The fruit picker's adjustable length of 1.8 to 3 meters allows it to easily reach the branches of nearly any fruit tree. A lot of fruit may easily be handled by the elastic and flexible chute since it will fall into the container placed below. It shows that the fruit picker picked almost 40% to 50% more fruit harvested than the other mechanism. The result has concluded that fruit pickers that have been produced can help harvest more fruit in a shorter period. But, due to numerous constraints as well as material shortages, there are a few recommendations that can be implemented to make the mechanical fruit picker much more effective. One such recommendation is to find a much larger guard so that it can store much more fruit. Moreover, instead of using nylon net, canvas can be used but must be sewn together for the impact of the fruits to lessen as well as having much more flexibility.

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#### Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

#### Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Haikal Daniel Ameruddin, Ainul Ridhuan Zafian, Muhammad Imran Haziq Nazruddin; **data collection:** Haikal Daniel Ameruddin, Ainul Ridhuan Zafian, Muhammad Imran Haziq Nazruddin; **analysis and interpretation of results:** Haikal Daniel Ameruddin, Ainul Ridhuan Zafian, Muhammad Imran Haziq Nazruddin; **draft manuscript preparation:** Siti Mariam Basharie.

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