

The Development of Banana Bunch Wrapper

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Abstract: Banana is one of the most known fruits in Malaysia for its richness in nutrients. However, bananas need to be well cared for by wrapping some of the bananas to prevent them from being attacked by diseases and pests. In this study, a two-meter wrapping tool was developed to facilitate the banana wrapping process. This tool consists of a stick, lever, and two hooks as the main components. Once the plastic bag and a rubber strap are in place, the tool is ready to be used. The lever should be pulled as soon as the plastic bag covers the banana bunch. By pulling the lever, the iron string that is attached to the hook will pull the hook upwards and close it. The rubber strap will move and tie the plastic when the hook is closed. The design of the tool and each part are drawn by using SolidWorks 2020 for precise sizing. The performance test has been performed on the working model and the average wrapping time is approximately 40% less than the conventional method. This tool is practical and convenient to use. With its simplicity, it will benefit the farmers and agriculture industries.

Keywords: Banana Wrapping, Bunch Wrapping Tool.

1. Introduction

Banana is a typical fruit that almost every people love to eat. Beside its sweet taste, banana also contain lots of fibre and nutrient such as vitamin A, vitamin C, phosphorus, and magnesium which are good for human health [1]. Bananas have been identified as one of the fruits with the highest per capita consumption (PCC) in Malaysia in 2019 [2]. It always has high demand because people usually used banana to make dessert, cake, banana fritters and snacks in mass production. In addition, it was listed as one of the six fruits that have the potential to be marketed into new markets such as China and the Middle East besides the existing export market in Singapore, Hong Kong, Indonesia and the Netherland

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[3], [4]. Due to high demand, banana trees have seen widely planted in Malaysia to ensure the stock of banana fruits always available to fulfil the demand from consumers.

Table 1: Planting area and production of banana [4]

Year	Planting Area (hectare)	Production (metric tonnes)
2016	28 036	309 508
2017	34 894	350 493
2018	30 486	331 255
2019	26 079	325 447

Table 1 shows the planting area and production of banana in Malaysia from year 2016 to 2019. The table shows highest planting area (hectare) is in 2017 which is as much as 34 894 areas have been planted with banana trees and it makes the biggest value of production (metric tonnes) as much as 350 493 meanwhile the lowest is in 2016 with 28 036 area planted and the production value is 309 508 (metric tonnes). The places that contribute the highest amount of planting area are Johor (7612 hectare), Pahang (2541 hectare) and Sabah (3720 hectare) [4].

To produce healthy banana fruit, it must be well cared by farmers. Many factors can affect the quality of banana yields including the quality of seeds, pH and soil type, temperature, water supply and fertilization. The suitable type of soil and enough fertilization is required to ensure the trees can live and absorb the nutrients from soil. Banana trees can live in all kinds of well-drained soils with suitable pH concentration around 5.5 – 8.0 [2], [5]. In addition, the temperature should be around 12 °C - 32 °C, has high humidity and has frequent rainfall distribution [5].

Besides that, wrapping banana at early fruit aged (see **Figure 1**) also can increase or maintain the quality of the fruits [5], [6] because they are vulnerable to the environment. Wrapping banana could protect them from diseases and pests such as paddy leaf folders (*Erionata Thrax*), fruit flies (*Bactrocera Papaya*), and Thrips spp, as well as animals such as monkeys, squirrels, and birds [5], [6]. Typically, the bananas bunch need to be wrapped after the last comb on the bunch is formed [5].



Figure 1: Wrapped bunch of bananas on tree [7]

Usually, farmers use the climbing method to wrap the banana bunches at the tree. They use the ladder which is transported from one banana tree to another with the height of banana trees that is generally around 7 until 8 feet from the ground for moderate height [5], [7]. In general, the process includes ladder transportation, climbing, wrapping the banana using a plastic bag or sack and then

securing the package with the rope. The farmer or worker must then descend the ladder and repeat the same process for the other trees.

This conventional approach is considered unsafe and risky to the farmers especially in uneven farming area when the ladders cannot be placed in balanced and stable conditions. They have a probability of falling from the ladders and exposing themselves to the risk of falling ladders and hitting farmers during work. In addition, this method also takes more time and requires more energy as farmers need to carry and transport the ladder from one tree to another and need to go through the ascending, wrapping and descending processes continuously during wrapping process.

Hence, in this study, an adjustable wrapping tool is designed and developed with a length of around 2 m long with a maximum diameter bunch of bananas that can be wrapped is about 45 cm. The aim is to help farmers facilitate the work and overcome the risks that have been discussed earlier. It could reduce the risk and fatigue of farmers and help farmers carry out the wrapping process in less time and effort.

In Malaysia, the types of bananas that are typically wrapped are from thin-skinned type bananas that are widely in demand such as Pisang Nangka, Pisang Nipah, and Pisang Cavendish. By wrapping these bananas at certain ages may prevent the attack of pests and avoid bruises in turn can maintain the quality of the fruit before it reaches the mature ages.

Table 2: Weight and Size of Banana [9]

Types of Banana	Weight (kilogram)	Size
Pisang Berangan	12-22	Medium-large
Pisang Nipah	15-28	Short
Pisang Tanduk	7-10	Large and long
Pisang Cavendish	20	Large
Pisang Rastali	10-15	Medium
Pisang Nangka	12-14	Large

Table 2 shows the weight and size of banana that commonly found in Malaysia. In this study, the size of bunch diameter and the height of the Pisang Nangka tree are used as references in determining the size of the wrapping tool that will be produced. From the random measurements that has been made, generally, the diameter for Pisang Nangka's bunch is more than one feet or about 30-40 cm, and the height of its tree is approximately around 2.2-2.6 m from the ground.

2. Materials and Methods

Methodology is a method by doing research with systematics description about the activities. This method is important when doing project. The detailed design of the banana bunch wrapper will be discussed together with the material for each product component and other specifications. Hence, the detail related to the preparation of methods also will be discussed in this section.

2.1 Materials

Material selection is a process of selecting a suitable material or a set of similar materials for the designed product to perform its intended operation [10]. The materials selected for this project are based on engineering properties, cost and availability factors.

Table 3: The material selection for parts in banana wrapper

Item No.	Part Name	Material	Quantity
1	Supported Hook Holder	Aluminum Alloy	1
2	Lock	Aluminum Alloy	1
3	Hook	Aluminum Alloy	2
4	Rivet	Button Head Rivet M3 40 mm	4
5	Iron string	Stainless Steel Cable Line Core	1
6	Connector	Aluminum Alloy	2
7	Lock Connector	Cast Iron	1
8	Stick	Round Bar Aluminum Alloy 200 x 4 cm	1

Table 3 shows the material selection for parts in banana wrapper tool. Most of the material proposed in this project is aluminum alloy due to its lightweight and toughness.

2.2 Methods

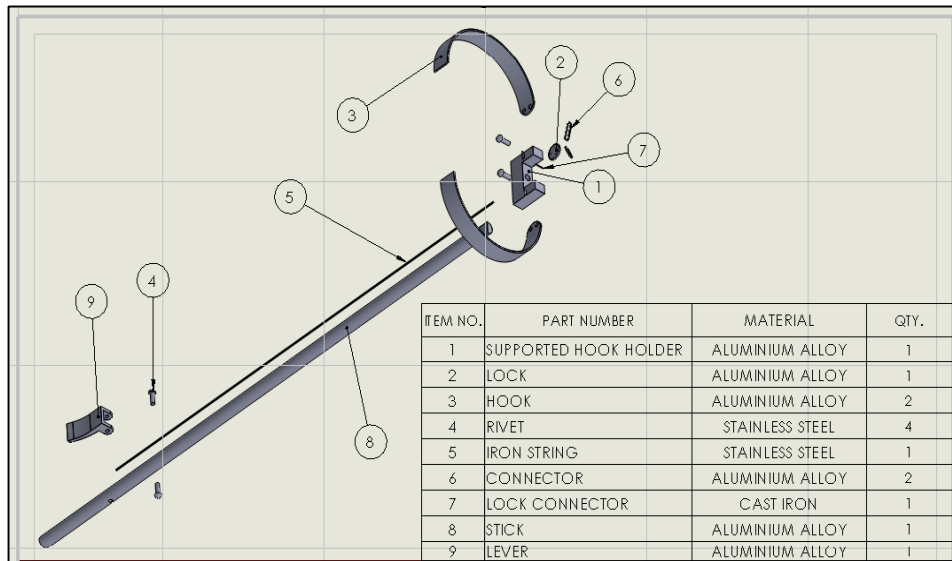
Based on the knowledge and research that has been done, banana wrappers are rarely seen in the market. The only similar tools that may exist are wrapping tools used to wrap other type of fruits such as mangoes and Jack fruit. The conceptual design of these tools may be applied in this design of banana wrapper. However, some improvements or modifications would need to be made in order to achieve the project objective. The product design specifications are then subsequently generated from the relevant information collected.

Table 4: Product design specification

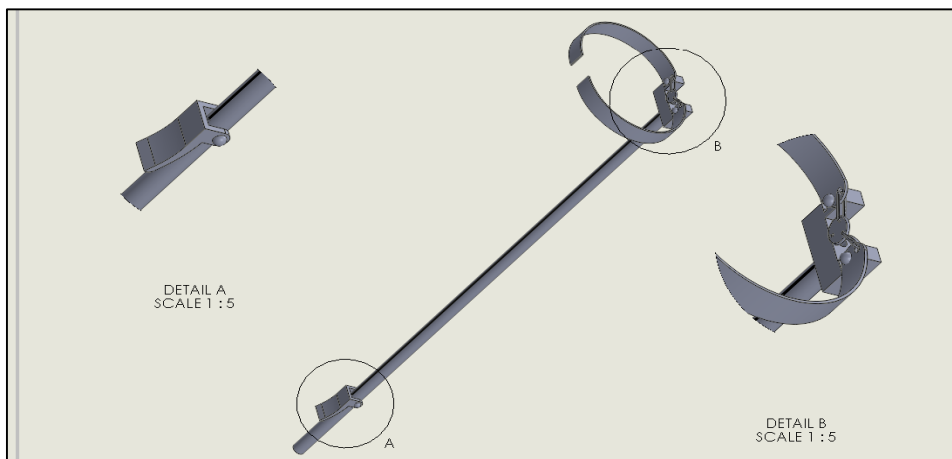
No.	Specification	Description
1	Weight	The weight of the tool must not more than 2 kg.
2	Size	The diameter for the hook is around 45 cm or more, and the stick has at least 2 m long.
3	Material	Must be tough, stiff, strong and light weight.
4	Ergonomics	Adjustable and must be convenience to carry and handle.
5	Maintenance	Minimum
6	Operating environment	Must be able to close the hook wisely to move the rubber strap and tie the plastic bag.

The product design criteria or specifications for the banana bunch wrapper tool are shown in **Table 4**. Based on the specification of these desired design criteria, several conceptual ideas related to this banana wrapping tool have been generated. The selection of suitable materials was also considered at this stage, generally according to the required engineering properties. The concepts of the ideas that have been presented are then evaluated according to a particular weightage and scale to determine the best idea design options that meet the requirements that have been listed.

After choosing the best idea design, the idea was then converted to a detailed drawing using SolidWorks 2020 software. At this stage, engineering drawings of each component were produced according to the dimensions specified for manufacturing and assembly purposes. All the component is then assembled to turn into a complete system design of banana bunch wrapper tool. **Figure 2(a)** shows the Bill of Materials of the wrapping tool while **Figure 2(b)** shows the assembly drawing and the detailed of connection between hook and lock connector.



(a)



(b)

Figure 2: Proposal design of banana bunch wrapper tool

This banana wrapping tool consists of a hook holder, lock, iron string, connector, lock connector, stick, and lever. The hook is a spot to put plastic bags and rubber straps. This hook is connected to the lever by an iron string to control the opening and closing of the hook during the operation. Once the plastic bag and rubber strap are put in place, the tool is ready for use. The hook that has been fitted with the plastic bag and rubber strap earlier has to be inserted into the banana bunch from the bottom side. When the hook reaches the end position of the bunch, the lever needs to be pulled to release the rubber strap and plastic bag around it. As the lever is pulled, the iron string reacts and pulls the hook upwards. At this point, the hook will close almost as it is pulled upwards. The rubber travels and binds the plastic bag around the bunch stem. When the plastic bag is secured, release the lever and the hook will also be released from the bag slightly closed upwards to the original state.

3. Results and Discussions

A series of performance tests were conducted on the banana bunch wrapper to determine the time taken to complete the wrapping process of banana bunches using the working model of this wrapping tool. The average result was then compared to the time of the conventional method.

Table 5: Performance result

Wrapping Method	Average time (second)
Ladder	59.29
Banana wrapper	23.26

Table 5 shows the performance result for both wrapping methods. The results show that the time taken for the whole wrapping process by using a ladder is almost 1 minute while the average time taken by using a banana wrapper is almost 24 seconds only. It shows a decrease in time of about 36 seconds which is approximately 40%. These results show that the use of this tool can really help reduce in wrapping time and in turn can increase the productivity of related agricultural industries.

4. Conclusion

Through this project, an adjustable banana bunch wrapper was designed and successfully developed. With a maximum length of 2 m, this tool can reach a target height of more than two meters from the ground. According to the tests that were conducted, this banana bunch wrapping tool managed to wrap the bananas in less time compared to conventional methods. It can be assumed that time is reduced by approximately 40% over the average time using ladders. It shows that consumers or farmers are able to wrap bananas more quickly and efficiently with this wrapping tool. However, the design of this tool can be improved in order to reduce the weight of the first prototype. With the applications of simple leverage system, it is suitable for almost everyone and with all the advantages offered by this tool, hopefully it can replace the ladder as a safer and faster alternative.

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