

Appendix III

Production Cost of Grafted Tomato Seedlings (1000 seedlings)

Seedling Production

I. Labor Cost (tomato & eggplant)

- Hauling of soil media (1/4 MD x P150.00)	37.50
- Potting in plastic potlets (3" x 4") (2000 pcs x .05/pc)	100.00
- Sowing of seeds (1/2 MD x P150.00)	75.00
- Care of seedlings (1 MD x P150.00) (pricking, watering, spraying & fertilization)	150.00
- Grafting (140 pcs/day at P380.00/day)	<u>2,700.00</u>
P2.70/pc for 1,000 grafted tomato	

Total Labor Cost

3,022.50

II. Material Cost (seeds)

- eggplant (1.50 x 10 gms)	15.00
- tomato (F ₁) 70,000/kg x 4 gms	280.00
- 5 bags garden soil (P5.00/bag)	25.00
- 2 bags hog manure (P11.00/bag)	22.00
- 2 bags burnt rice hull (P14.00/bag)	28.00
- 2 bags composted soil dust (P25.00/bag)	50.00
- 1 can Peter solution (starter) 100 gm at P175.00	17.50
- 1 kg Crop Giant (19-19-19 + M.E.) 100 gms at P115.00	<u>11.50</u>

Total Material Cost

449.00

Total Production Cost

P3,471.50

DESIGN AND DEVELOPMENT OF MANGO PICKER

By

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ABSTRACT

Mango is one of the leading export agricultural products of the Philippines. Bruised mango which is usually caused by the improper handling and harvesting may not qualify in the export market. Harvesting mango is one of the major difficult operations in the mango industry because of the height and profile of the mango tree.

Existing mango picker in the Philippines, which is locally known as "Sigpao" is usually seen in the provinces of Batangas, Rizal, and Pangasinan - the mango growing areas of the country. Based from the results of field tests of the three (3) "Sigpao" models, it showed that Batangas model has an average picking time of 3.58 minutes/kaing with an average of 13.7 kgs. of mangoes. Rizal and Pangasinan models showed slightly longer picking time with an average of 4.34 minutes/kaing of 13.24 kgs. and 5.38 minutes/kaing of 12.8 kgs., respectively.

Picking losses of the three (3) models were recorded. Rizal model showed the highest losses with an average of 3% considered as fallen mangoes during picking.

The two (2) BPI designs called BPI "Sigpao" Models I & II have the advantage over the existing "Sigpao" models. These are on the aspect of convenience in terms of height factor of the mango tree since these models have an extended aluminum handle especially when harvesting under the tree. The picking time recorded for Model I & II is 3.20 minutes/kaing & 2.32 minutes/kaing, respectively. Model I has 2.67 % losses while Model II has no losses while conducting the field trial testing.

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INTRODUCTION

Mango is the third largest fruit export of the country. The Philippines is the ninth leading mango producer in the world, accounting for 2% of the estimated 17.7 million metric tons of world production.

Mango production is seen to expand by 10% annually as the country now ranks high in the world mango production. In 1995, the country produced 433.32 thousand metric tons harvested from farms covering the area of 68.06 thousand hectares. Major export markets for Philippine mangoes are Hongkong, Japan, Singapore, Australia, United Kingdom, Belgium, USA, Switzerland, Germany, and France. Mango exports have continued to grow from 1991 to 1997 from 22,425,756 metric tons amounting to 24,377,165.00 US dollars in 1991, the export volume has doubled to 44,938,503 metric tons in 1997 valued at valued 40,476,893.00 US dollars. Manila Super Mango is the Philippines' best variety that can compete in the global market for fruit crops.

With the enactment of R.A. 7900, known as the High Value Commercial Crops Development Act of 1995, mango has been identified as the country's most important high-value crop second to banana in terms of domestic consumption. It is also one of the leading export earners, hence, this fruit crop should be given enough attention to meet the export quality requirements.

Harvesting (picking) is the most tedious stage of mango production. Damage to fruits through cut and losses (falling from the picker) must be avoided to maintain better quality. Because of the increasing peso contribution of mango to economic growth, the fruit needs more attention particularly in the harvesting operation and post harvest handling to ensure good price in the market.

In line with the Department of Agriculture's "Agrikulturang Makamasa" for High Value Commercial Crops Program, the Bureau of Plant Industry - Agricultural Engineering Division (BPI-AED)

responded to the need of mango producers for efficient harvesting equipment. An improved manual mango picker – a device to help ease the burden of manual picking was developed.

OBJECTIVES

1. To design and develop an improved manual mango picker.
2. To compare the existing mango pickers "Sigpao" with BPI "Sigpao" Models I & II.

REVIEW OF RELATED LITERATURE

Mango fruits are easily bruised. Quality problems associated with bruising and latex staining arise from inappropriate methods of harvesting. Therefore, mango should be handled carefully in the field and in the packing tables. If the fruits can be reached, these are carefully harvested by hand. However, when hand picking is not feasible due to tree shape and size, picking is done by climbing the tree and taking the fruits with the aid of picking pole with net, which is locally known as "Sigpao".

On the manner of the harvesting time, latex flow of the mango is a factor that should be given consideration. Studies showed that latex flow is minimal after 11:00 o'clock in the morning. However, it is recommended that harvesting be started at 9:00 o'clock in the morning to take advantage of the cooler temperature in the morning. Avoid picking too early in the morning, as this will cause rapid exudation of latex. The recommended harvesting period is from 9:00 o'clock in the morning to 3:00 o'clock in the afternoon when the latex flow is minimal. Having a short length of two (2) centimeters to five (5) centimeters of the pedicel on the fruits during harvesting helps the latex flow away from the fruits. Laying the fruits in an inverted position (pedicel end down) on a rack made of suitable material (burlap) helps minimize latex stains.

METHODOLOGY

A. Survey of Existing Equipment for Mango Picking

Survey were conducted in different mango plantations in Batangas, Pangasinan and Rizal to determine the traditional way of picking mangoes as well as the pickers being used.

Every mango plantations and nearby Barangays were surveyed to know what are the existing mango pickers.

In Malvar, Batangas and nearby areas, it was found out that they were using picking pole and a catching net called "Sigpao" (Figure 1).

In Pangasinan areas in Mapandan, Mangaldan, San Jacinto, and Sta. Barbara, the following methods were observed:

1. Traditionally, mangoes are harvested by hands. The manpicker has to climb the tree or use an adjustable ladder to reach the fruits by hand.
2. Mangoes are generally harvested manually, detached by snap picking with the use of a picking pole and a catching net.
3. Mango growers usually get mango pickers to up the trees to pick the fruit one by one since it is a careful process. They also use a pole-picker made of bamboo or rattan with a basket attached to the end.
4. The other way of harvesting mango is to use a long looped bamboo pole with a net called the "Sigpao" (Figure 2).

In Talim Island of Rizal and nearby areas, mangoes are harvested manually by the use of a long looped bamboo pole with a net called the "Sigpao" (Figure 3).

B. Field Testing of Existing Mango Picker

The BPI manual mango picker alongside with the existing mango pickers were field tested, taking into account the following parameters by using Regional Network on Agricultural Machinery (RNAM) Test Codes:

- over-all mango picker performance
- work capacity (weight per kilo/hour/minutes)
- operating accuracy (picking time)

1. Test Conditions:

- Variety : Piko
- Maturity period : As scheduled to harvest
- Mango tree height : 15 meters high
- Age of the tree : 30 years
- Qualitative assessment : excellent, good, fair, bad, rough, satisfactory, unsatisfactory
- Skill of operator : 10 years experienced in harvesting mango
- Name of operator : Jimmy Pitogo
- Address of operator : Barangay San Pedro, Malvar, Batangas
- Height of operator : 5' 6"
- Weight of operator : 150 kgs.
- Wage of operator : 350 Php/ day

2. Field Performance

- Date of test : May 2000, May 28, 2001 and June 5, 2001
- Time of start : __ hours __ min. 10 AM
- Time of finish : __ hours __ min. 3 PM
- Actual operation : __ hours __ min.
- Ease of operation : easy, manageable, and difficult

3. Interviews:

Other than the above mentioned qualitative data, quantitative test parameters and other relevant non-quantitative information were gathered through interviews with farmers as well as the filling up of questionnaire developed for the purpose.

C. Analysis and Interpretation of data
After a series of field-testing, data gathered were analyzed and based from this data some modification has to be incorporated to the new design concept.

D. Design concept

The mango picker design concepts were based on the information gathered through the ocular evaluation of the existing mango picker and interviews with farmers.

E. Prototype Fabrication

Fabrication of the new design was done at the Agricultural Engineering Division (AED) fabrication shop.

F. Field Test of Modified BPI Model

Upon looking at the test field results, this modified "Sigpao" should be used by the skilled operator whose job is mango picking so that he can give the best comments and analysis in using the mango picker.

The BPI-AED modified design of the mango picker was field tested utilizing experienced and skilled mango picker. It was presumed that he can give the best comments and analysis on the new picker.

Principle of Operation of the Mango Picker and Use for Gathering of Data

The operator chooses and climbs the branch to harvest and position himself where he can use the picker conveniently. He then extends the adjustable aluminum pole and reaches for the target fruit in sight. He guides the circular picker and net towards the fruits and then pulls the picker until the fruits are detached from its stems. He repeats the process until he gathers all the fruits within 5.5 meters from his location. then he transfers to another branch from vertical, horizontal, diagonal positions to reach the other fruits.

G. Analysis of Data
Data gathered from the three (3) existing "Sigpao" models were compared to the data of the BPI-AED "Sigpao" Models I and II.

RESULTS AND DISCUSSION

1. Survey of Existing Mango Picker in the Philippines

There were three (3) mango pickers "Sigpao" considered in the study. These were the Batangas, Pangasinan, and the Rizal Models.

Batangas "Sigpao" Model

The Batangas "Sigpao" has a round ring with a diameter of 27 centimeters. It weighs 1.1 kilograms including the handle. The handle is made of bamboo. The selling price of the "Sigpao" in the market is 120 Php. (Figure 1).

Pangasinan "Sigpao" Model

The Pangasinan "Sigpao" model is almost similar to the Batangas "Sigpao". It weighs 1.15 kilograms with round bar opening and a diameter of 26 centimeters. The cost of this unit in the market at Pangasinan is 120 Php. (Figure 2).

Rizal "Sigpao" Model

The Rizal "Sigpao" model, (primitive type) is made of bamboo ring with elongated shape and its handle is also made of bamboo. It has the smallest net capacity. It cost 80 Php in the market. (Figure 3).

2. Field Test of Existing Models and Analysis of Data Gathered

The three (3) models considered were bought from the places where they are usually found and used. All of these "Sigpao" were brought to Malvar, Batangas for the field trial testing. Only one skilled operator was utilized in this experiment so that there will be no variation on the performance of the operator.

Batangas "Sigpao" Model

Test results revealed that Batangas Sigpao model got the shortest picking time of 3.58 minutes/kaing and the lowest losses of 0.22 kilogram which is equivalent to 1.7% (Table 1 and Figure 1.a).

Pangasinan "Sigpao" Model

Test results revealed that Pangasinan "Sigpao" model recorded a picking time of 4.34 minutes/kaing with 0.26 kg. losses which is equivalent to 1.94% (Table 2 and Figure 2.a).

Rizal "Sigpao" Model

Test revealed that Rizal "Sigpao" has the longest picking time of 5.38 minutes/kaing with the highest amount of losses which 0.40 kg. which is equivalent to 3.02% (Table 3 and Figure 3.a).

3. Design, Prototype Fabrication, and Field Testing of the New Models

The BPI Model "Sigpao" Model I has round bar with the 26 diameter, with aluminum adjustable handle. It weighs 1.35 kilograms. Estimated cost is Php 133.00.

The BPI "sigpao" Model II has an adjustable handle made of aluminum with the normal length of 3.35 meter and a maximum length of 5.5m. The ring is 25 centimeters in diameter with three (3)-tooth comb. The net is made of nylon cord.

The picker is made of a stainless round bar attached with a blade and a net is attached to the end portion of the upper pole to support the fruit from falling, and it serves as cushion to protect the fruit from damage.

The handle is adjustable to various heights until it reaches the fruits to be harvested. The picker is positioned near the fruits, then the picker is pulled until the fruits are detached from its stem.

Fabrication of the BPI "Sigpao" Model I

The Agricultural Engineering Division has designed improved BPI "Sigpao" Models I & II. The BPI "Sigpao" Model was fabricated at the fabrication shop of the AED. The technical drawing with technical specification and the Bill of Materials (Table 7 and 8, Technical Drawing 1, and Technical Drawing 2). The material cost amounting to 111 Php and 382 Php, respectively and 20% for the labor cost of about 22.00 Php and 76.40 Php, respectively. The estimated selling cost of the BPI "Sigpao" Models I & II is about 133.00 Php and 458.40 Php, respectively.

Field Testing Results of the New Models

Field testing BPI "Sigpao" Model I revealed that the picking time is 3.65 minutes/kaing with 0.38 kilogram losses which is equivalent to 2.47 %. (Table 4 and Figure 4.a).

The BPI Model II field test revealed the shortest picking time of 2.32 minutes/kaing with a zero loss during picking (Table 5 and Figure 5.a).

Based on comments of the skilled operator, this unit has potential for commercialization however, with little modifications like the removal of the pointed stainless bar on the tip of the ring. The 3-tooth comb should be made into 4 and adjust it backward. The net is too deep, which cause difficulty in discharging the harvested mango inside the net. The diameter should be 27 cm. instead of 25 cm.

CONCLUSION AND RECOMMENDATIONS

The BPI "Sigpao" Model II has great potential for commercialization with some modifications to be made and can be adaptable to other kind of fruits.

- Modify the BPI "Sigpao" Model II with the following:
- for lighter weight remove the pointed tip on the ring
 - additional teeth on the comb
 - shallow net is recommended
 - larger ring diameter

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Table 1. Performance Test Results of "Sigpao" from Batangas

Trial	Picking Time	Weight (per kaing)	Weight of Losses	Percentage of Losses
1	3.00 min.	12.40 kg.	0.30 kg.	2.42%
2	3.20 min.	13.00 kg.	0.20 kg.	1.54%
3	4.50 min.	14.00 kg.	0 kg.	0%
4	3.30 min.	13.00 kg.	0 kg.	0%
5	3.40 min.	13.20 kg.	0.25 kg.	1.89%
6	4.00 min.	14.00 kg.	0.15 kg.	1.07%
7	3.75 min.	13.70 kg.	0.35 kg.	2.55%
8	3.00 min.	12.90 kg.	0 kg.	0%
9	3.20 min.	13.00 kg.	0.20 kg.	1.54%
10	4.50 min.	12.50 kg.	0.75 kg.	6.00%
Mean	3.58 min.	13.17 kg.	0.22 kg.	1.6%

Table 2. Performance Test Results of "Sigpao" from Pangasinan

Trial	Picking Time	Weight (per kaing)	Weight of Losses	Percentage of Losses
1	4.00 min.	13.20 kg.	0.50 kg.	3.79%
2	4.30 min.	12.50 kg.	0.30 kg.	2.40%
3	5.00 min.	14.00 kg.	0.20 kg.	1.42%
4	4.30 min.	13.40 kg.	0.35 kg.	2.61%
5	4.00 min.	14.30 kg.	0.15 kg.	1.05%
6	4.20 min.	13.00 kg.	0.30 kg.	2.31%
7	4.50 min.	14.00 kg.	0 kg.	0%

8	5.00 min.	14.20 kg.	0.25 kg.	1.76%
9	4.30 min.	12.75 kg.	0.40 kg.	3.14%
10	3.75 min.	11.00 kg.	0.20 kg.	1.82%
Mean	4.34 min.	13.24 kg.	0.26 kg.	1.94%

Table 3. Performance Test Results of "Sigpao" from Rizal

Trial	Picking Time	Weight (per kaing)	Weight of Losses	Percentage of Losses
1	6.00 min.	13.20 kg.	0.50 kg.	3.79%
2	5.80 min.	13.00 kg.	0.40 kg.	3.10%
3	5.40 min.	12.00 kg.	0.30 kg.	2.50%
4	5.30 min.	12.50 kg.	0.25 kg.	2.00%
5	5.00 min.	12.60 kg.	0.35 kg.	2.92%
6	5.70 min.	13.00 kg.	0.35 kg.	2.69%
7	5.25 min.	13.20 kg.	0.30 kg.	2.27%
8	5.00 min.	13.50 kg.	0.50 kg.	3.70%
9	4.90 min.	12.00 kg.	0.60 kg.	5.00%
10	5.5 min.	13.10 kg.	0.47 kg.	3.59%
Mean	5.38 min.	12.81 kg.	0.40 kg.	3.02%

Table 4. Performance Test Results of BPI "Sigpao" Model I

Trial	Picking Time	Weight (per kaing)	Weight of losses	Percentage of losses
1	3.30 min.	11.50 kg.	0.3 kg.	2.61%
2	4.10 min.	11.40 kg.	0.5 kg.	4.39%
3	3.40 min.	12.00 kg.	0.4 kg.	3.33%
4	3.37 min.	12.10 kg.	0.2 kg.	1.65%
5	3.45 min.	11.50 kg.	0.3 kg.	2.61%
6	3.50 min.	12.10 kg.	0.2 kg.	1.65%
7	4.10 min.	12.20 kg.	0.1 kg.	0.82%
8	3.50 min.	12.00 kg.	0.3 kg.	2.50%
9	3.55 min.	11.40 kg.	0.3 kg.	2.63%
10	4.20 min.	12.00 kg.	0.4 kg.	3.33%
Mean	3.65 min.	11.82 kg.	0.3 kg.	2.47%

Table 5. Performance Test Results of BPI "Sigpao" Model II

Trial	Picking Time	Weight (per kaing)	Weight of Losses	Percentage of Losses
1	2.20 min.	11.90 kg.	0	0
2	2.45 min.	11.75 kg.	0	0
3	2.30 min.	12.00 kg.	0	0
4	2.35 min.	12.20 kg.	0	0
5	2.30 min.	12.1 kg.	0	0
6	2.40 min.	11.80 kg.	0	0
7	2.25 min.	11.90 kg.	0	0
8	2.20 min.	12.00 kg.	0	0

9	2.35 min.	11.90 kg.	0	0
10	2.45 min.	12.00 kg.	0	0
Mean	2.32 min.	11.95 kg.	0	0

Table 6. Comparative analysis on the Qualitative/quantitative observations on the 3 existing and two new BPI Models of Sigpao

Indicators	Barangas "Sigpao"	Pangasinan "Sigpao"	Rizal "Sigpao"	BPI "Sigpao" Model I	BPI "Sigpao" Model II
1. Ease of Handling (Operation)	Light weight	Moderate weight	Very light weight	Heavy weight	Light weight
2. Effectiveness	Suitable for all picking positions	Suitable for all picking positions	Suitable for all picking positions	Suitable for all picking positions	Suitable for all picking positions
3. Time spent in picking	3.58 min.	4.34 min.	5.38 min.	4.3 min.	2.32 min.
4. Weight of mango picker	1.10 kg.	1.15 kg.	0.75 kg.	1.35 kg.	1.20 kg.
5. Fabrication materials	- Bamboo handle - Nylon net - Ordinary round bar	- Bamboo handle - Nylon net - Ordinary round bar	- Bamboo frame - Bamboo handle - Bamboo ring - Fishnet	- Aluminum handle - Ordinary round bar - Nylon net	- Aluminum handle - Stainless round bar - hacksaw blade - nylon net
5. Ring Diameter	27 cm.	26 cm.	21 cm.	26 cm.	25 cm.
6. Price	P 120.00	P 120.00	P 80.00	P 133.00	P 458.40
7. Cost of pickers	Affordable	Affordable	Affordable	Affordable	Affordable
8. Mean Losses	1.60%	1.94%	3.02%	2.47%	0%

Table 7. Bill of Materials for BPI Sigpao Model I

Materials	Specification	Cost in Php
Round bar	25 cm x 5 mm Ø	35.00
Bamboo	3 m x 2.5 cm Ø	60.00
Nylon Cord	No. 12, 32.8 ft	10.00
Welding Rod	1/8 in. Ø	6.00
Total		111.00

Table 8. Bill of Materials for BPI Sigpao Model II

Materials	Specification	Cost in Php
Stainless Steel Frame	6.2' x 1/8" Ø @ 8.50 /ft	52.70
Aluminum tube	10' x 1 Ø @ 25.00/ft	250.00
Nylon Cord	No. 12; 32.8 ft	10.00
Stainless Blade	1.5" x 4 "	20.00
Holder		
Blade	1" x 5.25"	50.00
Rubber	@ 10/pc	10.00
Welding Rod for Stainless	1/8 in. Ø x 2 pcs. @ 10/pc	20.00
Total		382.00

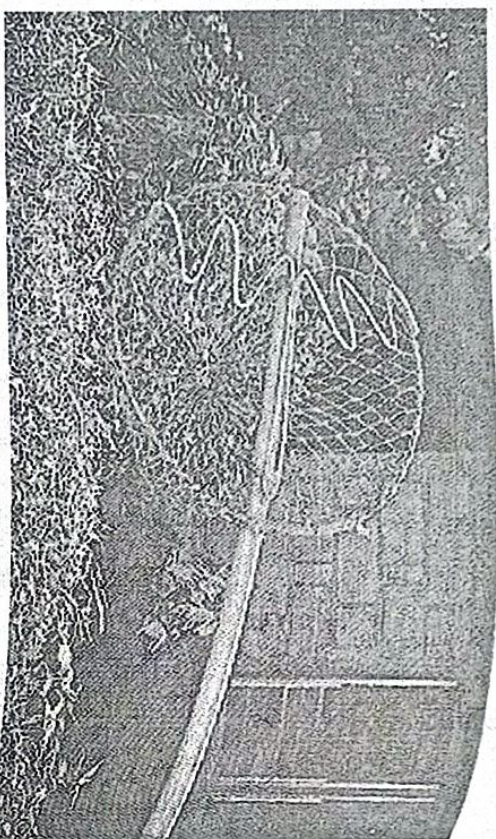


Figure 1. Batangas "Sigpao" Model



Figure 1a. Batangas "Sigpao" Model in the actual field operation

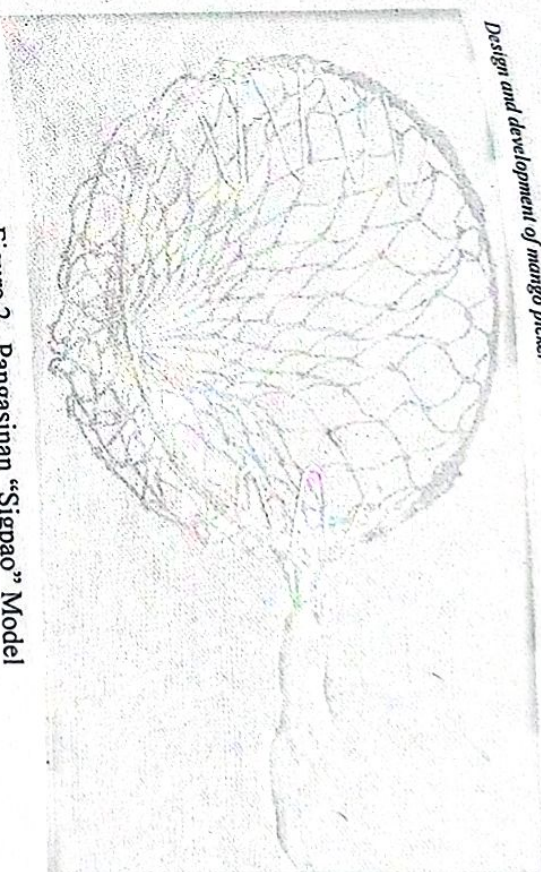


Figure 2. Pangasinan "Sigpao" Model

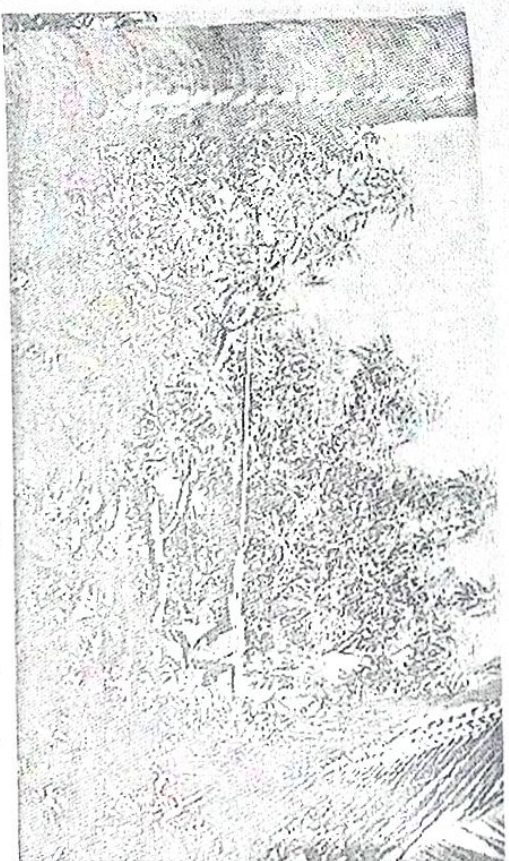


Figure 2a. Pangasinan "Sigpao" Model in the actual operation



Figure 3. Rizal "Sigpao" Model



Figure 3a Rizal "Sigpao" Model in the actual operation



Figure 4. BPI-AED "Sigpao" Model I.

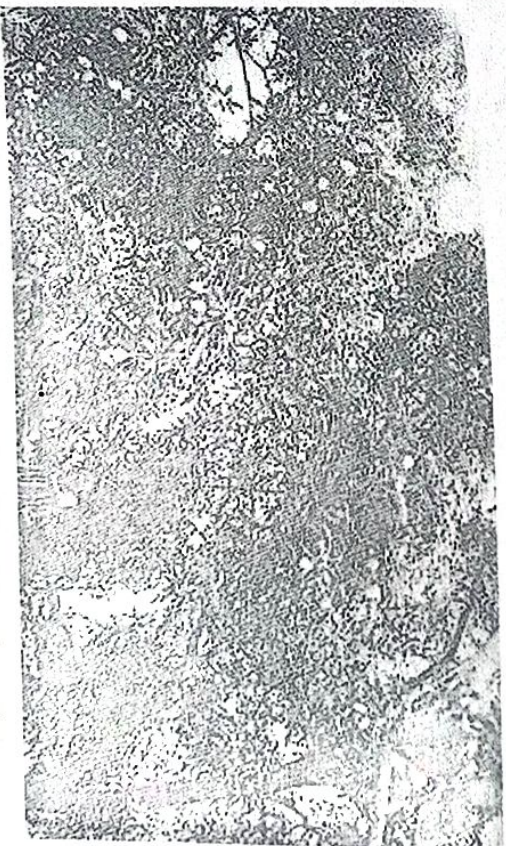


Figure 4a. BPI-AED "Sigpao" Model I in the actual operation



Figure 5. BPI-AED "Sigpao" Model II.

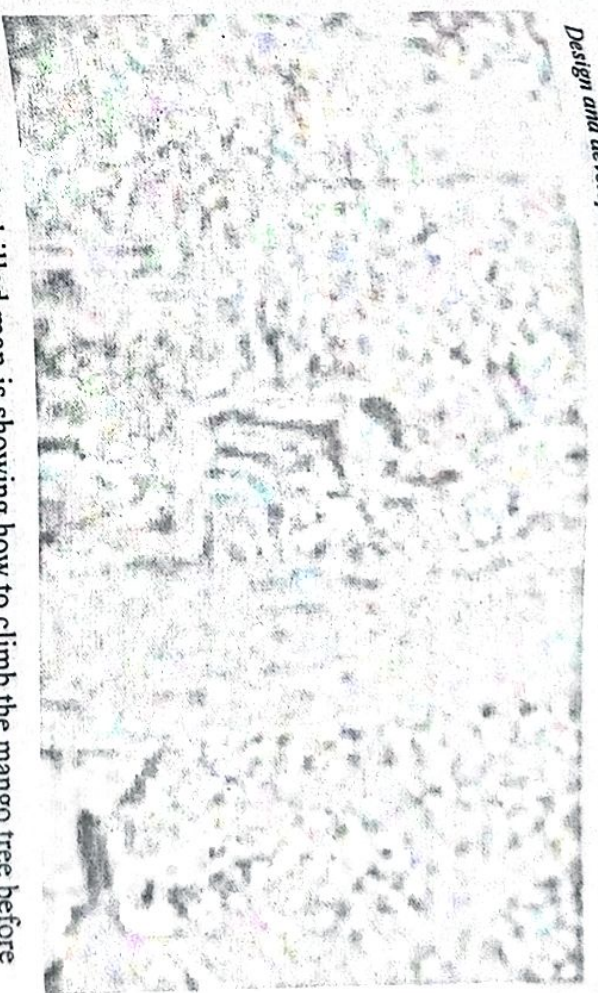


Figure 6. A skilled man is showing how to climb the mango tree before picking.



Figure 5a. BPI-AED "Sigpao" Model II in the actual operation



Figure 7. The harvested mango fruits.