Vacuum Packing: Preservation of Peeled Green Bananas and Fresh Fruits for the Domestic Value–Added Banana Industry
The price paid and total income of JMS $446,000 per week is outlined in Table 5.
Temporary text placeholder
Fruits* | Pricing Units | Unit Price | Total Income (JMS) per week | Total Cost (US$) per week
--- | --- | --- | --- | ---
Green Banana* | Lb (400g) | 16.00 | 128,000 | 2,560
Green Plantain* | Lb (400g) | 18.00 | 72,000 | 1,440
Orange | 5 lb bags (2.27 Kg) | 300.00 |
Cantelope* | 5lb bags (2.27 Kg) | 500.00 | 100,000 | 2,000
Water Melon* | 5 lb (2.27 Kg) | 500.00 | 100,000 | 2,000
Honey Dew Melon | 5lb bags (2.27 Kg) | 530.00 |
Pumpkin* | Lb (400g) | 23.00 | 46,000 | 920
Pineapple | 5lb (2.27 Kg) | 530.00 |
Grapefruit | 5lb (2.27 Kg) | 330.00 |
Callaloo | Lb (400g) | 40.00 |
**Total** | | **$446,000** | **$8,920**

*Purchase of these fruits was irregular.

**Total Weekly Budget** | **JMS per Week** | **US$ per Week**
--- | --- | ---
Income | 446,000 | 8,920
Recurrent Cost | 265,000 | 5,300
Profit | $181,000 | $3,620

ACKNOWLEDGEMENTS

This manual was produced as part of the collaboration between the Research Department of the Banana Export Company (on behalf of the Government of Jamaica) and the European Union Banana Support Programme. It was developed to provide appropriate information on diversification technologies for farmers, workers and small business operators in the Jamaican Banana Industry.

The information was documented based on the research and experiences of the staff of the Research Department of the Banana Export Company and Banana Board, as well as from other institutions, both international and local. Special thanks to Mr. Leroy Pounall for sharing his business experiences and Mr. Leslie Rodney and Mr. Clifton Wilson for assisting with the information gathering.

The authors wish to thank the management of the European Union Delegation in Jamaica, The Banana Export Company and EUBSP for their support namely: Mr. Gerd Jarchow, Miss Katrine Smith, Mr. Vincent Evans, Mr. Vincent Thompson and Mr. Zeki Murad, for their support of the project.

Funding which was provided by the European Union is appreciated greatly.
Inconsistent availability of green fruit for the banana and plantain chips industry was identified as a limiting factor to production and safe guarding the export market share in the banana chips industry. The preservation of banana and plantain by vacuum packing during known periods of plenty is seen as one method of alleviating this problem. Market for the product could also be expanded to peeled green bananas for housewives, schools, airlines, restaurants, hospitals, hotels and other domiciliary institutions. Further value-added can be derived by using the same facilities and method to preserve other fresh fruits for the food industry.

Information on relevant procedures on preservation was lacking. The manual provides information on why, how and when the vacuum packing operation can be successfully carried out in the diversified domestic banana and plantain market. The instructions and recommendations made were based on the experiences of the Research Department of the Banana Export Company, farmers and small business operators in Jamaica.

It is the opinion of the Banana Export Company and the Banana Board that when the recommendations and instruction of the manual are followed, successful and profitable businesses will be realised.

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**Table 3. Estimated Weekly Recurrent Cost of Operations.**

- **Raw Materials**

  The average expenditure for raw material was approximately **JMS 200,000.00 or US$ 4,000 per week.** Table 4 details the cost of raw materials at the upper limit of fluctuating prices.

**Table 4. Quantities and Prices of all Prices of Fruits Purchased Weekly During Non-concurrent Low Supply Periods (prices during peak supply may be as much as 50% of those quoted).**
The total operational cost for one very successful operation was approximately **JMS 265,000** or **US$ 5,300** per week in December 2002.

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Rate</th>
<th>Total Cost (JMS) per week</th>
<th>Total Cost (US$) per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peellers</td>
<td>2.50 / lb (400 g)</td>
<td>20,000</td>
<td>500</td>
</tr>
<tr>
<td>Drivers x 2</td>
<td>2,000/ trip / driver</td>
<td>12,000</td>
<td>240</td>
</tr>
<tr>
<td>Processors x 5</td>
<td>2500 / week</td>
<td>12,500</td>
<td>250</td>
</tr>
<tr>
<td>Side-men x 2</td>
<td>500 / day /man</td>
<td>5,000</td>
<td>100</td>
</tr>
<tr>
<td>Cellular telephone allowance (drivers)</td>
<td>250/ week/ man</td>
<td>500</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$ 50,000</strong></td>
<td><strong>$1,000</strong></td>
</tr>
</tbody>
</table>

Expenditures include raw materials, wages, overheads and consumables (Table 3).

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Rate</th>
<th>Total Cost (JMS) per week</th>
<th>Total Cost (US$) per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity¹</td>
<td>20,000 /month</td>
<td>5,000</td>
<td>100</td>
</tr>
<tr>
<td>Water</td>
<td>10,400 / month</td>
<td>2,600</td>
<td>52</td>
</tr>
<tr>
<td>Maintenance of trucks</td>
<td>88,400 / year/truck</td>
<td>1,700</td>
<td>34</td>
</tr>
<tr>
<td>Maintenance of cool room</td>
<td>5,600/ 2 months</td>
<td>700</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$ 10,000</strong></td>
<td><strong>$200</strong></td>
</tr>
</tbody>
</table>

1 **INTRODUCTION**

The Jamaican Banana Industry is undergoing a period of transition. The once booming export industry has contracted in the wake of international market forces and an increasing domestic trade, which includes fresh green and ripe fruits, as well as by-products. However, much of the supply for the domestic market is generated and continue to be provided by registered export farms, which has resulted in periods of under supply for both domestic and export fruit. At other times when the demand on the domestic market is low, fruits, which cannot satisfy the high quality requirements of the export trade, have to be dumped. It is proposed that fruits that would be wasted during low-demand periods be vacuum-packed, refrigerated and preserved for use later in peak demand periods for chips production. This enterprise is ideal and very feasible when complemented by banana production for the ripe trade; and vacuum packing of peeled green bananas, plantains and other ripe tropical fruits, for the domestic market, which remains under-supplied. It promotes diversification of the Jamaican Banana and Plantain Industry; prevents waste of food products; creates new enterprises, jobs and sustainability of farm families and communities that currently depend on banana production.
2. JUSTIFICATION AND BACKGROUND

The relationship between Jamaica and banana production dates back to the 1541 when the crop was introduced and used for domestic consumption. Arguably, connoisseurs and costumers attest to the superior taste of Jamaican bananas on the export market, which Jamaica has supplied since 1866 (to the USA) and 1895 (to Britain).

The value of banana production as Jamaica’s second largest export agricultural industry to the nation at large is often disregarded, in light of the decline in recent years. In 1996, 87,000 tonnes was exported from 5,000 hectares and in 2002, 40,000 was exported from 2,600 hectares. However the economic viability of the farming communities and dependence of some 40,000 farm-families, on the income and foreign exchange derived, cannot be under-stated. More importantly however, the banana industry is the supplier of a significant food source to the Jamaican people since the fruit was introduced in the island.

Consumption of banana was estimated to be 80,000 tonnes in 1996 and in 2002 the steadily growing domestic market was conservatively approximated to be 110,000 tonnes. It is difficult to determine precise consumption because of: poor record keeping by farmers; inadequate monitoring and many informal outlets of domestic markets; and equally many preparations for the diet.

The fresh ripe banana fruit is widely appreciated as dessert, snack, baby food and an important component of breakfast and lunch for all Jamaicans, but especially those in the urban areas and the more health

<table>
<thead>
<tr>
<th>Fruits</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Cost (JMS)</th>
<th>Total Cost (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Banana</td>
<td>10,000 lb (4546 Kg)</td>
<td>3.50</td>
<td>35,000</td>
<td>700</td>
</tr>
<tr>
<td>Green Plantain</td>
<td>4,000 lb (1818 Kg)</td>
<td>10.00</td>
<td>40,000</td>
<td>800</td>
</tr>
<tr>
<td>Orange</td>
<td>80 boxes</td>
<td>300.00</td>
<td>24,000</td>
<td>480</td>
</tr>
<tr>
<td>Cantelope</td>
<td>4,000 lb (1818 Kg)</td>
<td>35.00</td>
<td>140,000</td>
<td>2,800</td>
</tr>
<tr>
<td>Water Melon8</td>
<td>8,000 lb (3636 Kg)</td>
<td>25.00</td>
<td>200,000</td>
<td>4,000</td>
</tr>
<tr>
<td>Honey Dew Melon</td>
<td>8,000 lb (3636 Kg)</td>
<td>35.00</td>
<td>280,000</td>
<td>5,600</td>
</tr>
<tr>
<td>Pumpkin</td>
<td>4,000 lb (1818 Kg)</td>
<td>8.00</td>
<td>32,000</td>
<td>640</td>
</tr>
<tr>
<td>Pineapple*</td>
<td>15.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grapefruit*</td>
<td>250.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Callaloo*</td>
<td>10.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$751,000</strong></td>
<td><strong>$150,020</strong></td>
</tr>
</tbody>
</table>
Capital Cost of Establishment

The cost of construction of the factory facility; installation of electricity, water and cooling systems (including water storage tanks); capital cost of equipment and a 5% contingency, will require a total capital expenditure to approximately JMS 3,150,000 or US$ 63,000 (Table 2). Major construction may not be necessary at existing established chips factories, commercial sites, and farm or home businesses. However, modifications may be necessary.

<table>
<thead>
<tr>
<th>Production Items</th>
<th>Cost (JMS) per Week</th>
<th>Cost (US$) per Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Materials</td>
<td>200,000</td>
<td>4,000</td>
</tr>
<tr>
<td>Wages</td>
<td>50,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Overheads</td>
<td>10,000</td>
<td>200</td>
</tr>
<tr>
<td>Consumables</td>
<td>5,000</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$265,000</strong></td>
<td><strong>$5,300</strong></td>
</tr>
</tbody>
</table>

conscious. Hence, the formal domestic fresh fruit market targets the food service industry and all consumers of urban areas. Ripe bananas are also dried naturally (using kilns or solar energy) and used as a component of fruit snack packs. Other preparations of the ripe fruits (such as pastry, figs, raisins, jams and wines) exist in very small specialized and health food markets in Jamaica.

Cooked green banana is eaten in all native households and is the most inexpensive and always available starch or carbohydrate source for all Jamaicans. Throughout Jamaica’s history and during periods of crises (such as national economic decline of the 1970s and the world wars) when importation or accessibility of other imported cereal-based starches were interrupted, boiled green banana remained the major carbohydrate source, which was suitable for all three main meals in the day. Currently, a healthy “Jamaican cooked breakfast” (which is traditional daily in rural households and on weekends in urban areas) is seldom prepared without boiled bananas. Boiled banana is the unmentioned companion of the national dishes: ackee and salt fish, curried goat, “mannish water” and “run-down”. More recently, green banana chips have become the most popular snack for school children in Jamaica arguably. The exportation of banana chips from Jamaica is increasing also. The nutritive value of the banana and plantains is well documented and summarized in Table 1.
Table 1. Nutritional values of Banana and Plantain compared with other starchy Staples (per 100 grams raw edible portion)

<table>
<thead>
<tr>
<th>Nutritive Content</th>
<th>Banana</th>
<th>Plantain</th>
<th>Sweet potato</th>
<th>Potato</th>
<th>Cassava</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (g)</td>
<td>74.3</td>
<td>65.28</td>
<td>72.84</td>
<td>78.96</td>
<td>59.68</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>92</td>
<td>122</td>
<td>105</td>
<td>79</td>
<td>160</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>1.03</td>
<td>1.3</td>
<td>1.65</td>
<td>2.07</td>
<td>0.36</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>0.5</td>
<td>0.37</td>
<td>0.30</td>
<td>0.10</td>
<td>0.28</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>23.43</td>
<td>31.89</td>
<td>24.28</td>
<td>17.98</td>
<td>38.05</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>6</td>
<td>3</td>
<td>22</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>0.31</td>
<td>0.6</td>
<td>0.59</td>
<td>0.76</td>
<td>0.27</td>
</tr>
<tr>
<td>Potassium (mg)</td>
<td>396</td>
<td>499</td>
<td>204</td>
<td>543</td>
<td>271</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>1</td>
<td>4</td>
<td>13</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>9.1</td>
<td>18.4</td>
<td>22.7</td>
<td>19.7</td>
<td>20.6</td>
</tr>
<tr>
<td>Thiamine (mg)</td>
<td>0.045</td>
<td>0.052</td>
<td>0.066</td>
<td>0.088</td>
<td>0.087</td>
</tr>
<tr>
<td>Riboflavin (mg)</td>
<td>0.100</td>
<td>0.054</td>
<td>0.147</td>
<td>0.035</td>
<td>0.048</td>
</tr>
<tr>
<td>Niacin (mg)</td>
<td>0.540</td>
<td>0.686</td>
<td>0.674</td>
<td>1.484</td>
<td>0.854</td>
</tr>
<tr>
<td>Vitamin A (IU)</td>
<td>81</td>
<td>1127</td>
<td>20063</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Saturated fats (g)</td>
<td>0.185</td>
<td>0.143</td>
<td>0.064</td>
<td>0.026</td>
<td>0.074</td>
</tr>
<tr>
<td>Monounsaturated fats (g)</td>
<td>0.041</td>
<td>0.032</td>
<td>0.011</td>
<td>0.002</td>
<td>0.075</td>
</tr>
<tr>
<td>Polyunsaturated fats (g)</td>
<td>0.089</td>
<td>0.069</td>
<td>0.132</td>
<td>0.043</td>
<td>0.048</td>
</tr>
</tbody>
</table>


6. BUDGETARY REQUIREMENTS
Currently, Jamaican farmers produce bananas commercially mainly for the domestic and overseas ripe fruit trades. Fruits that cannot achieve the high quality standards for the ripe trade are sold for use as boiled green bananas for households or to factories for the processing of chips. While many rural households grow a few plants for their own subsistence needs, commercial banana and plantain farms that are dedicated solely to supply the growing green fruit trade, exist in inadequate numbers or size. It is not surprising therefore, that the increasing demand for green bananas in particular, is not being satisfied by existing production levels. To exacerbate the problem the demand for green fruits, specifically for chips, is seasonal, because it corresponds with the school sessions. Unfortunately, the season for peak demand corresponds with that for ripe fruits on the local and export markets. Subjected to the law of demand and supply, the farm gate price of all domestic bananas is increased during peak demand periods.

In the off-seasons however, farmers are unable to find adequate market for the third grade (after premium export and domestic fruit for ripe trade) fruits used for chips. During this period, the fruits are wasted and dumped, which explains the reason for farmers being reluctant to grow commercial-sized plantations of bananas solely for green fruit, in spite of the lower cost of production and minimal quality standards required, compared to ripe fruits.

There are several options for satisfying the high demand for green fruits on the domestic market, which are:

1) Plant new acreages or farms that are dedicated to the green fruit trade.

Sanitization of Processing Plant at the End of the Day’s Operation

1. All knives, cutting boards, towels and equipment must be washed and sanitized and kept in clean sanitized water overnight.
2. Towels and aluminium containers must be washed, sanitized, and dried or drained over night (Figure 21).
3. Counters and refrigerators must be wiped after each day’s operation.
4. Sweep and mop floor with clean solution of detergents.
5. Add six (6) ounces of bleach to one full sink of water (5-6 gallons) for sanitizing purposes.
6. Solid waste placed in covered bins during operation (Figure 22) must be removed at the end of each day.

All procedures must be followed and maintained in order to prevent the spread of bacteria, other microbes and food contamination.
2) Increase the sizes and production of the existing farm holdings or encourage new production for the ripe trade.
3) Import the raw material for chips.
4) Import the chips.
5) Preserve the fruits that would be dumped in the low-demand seasons to be used for chips later when raw material supply is low.

Solutions 1 and 2 require significant capital and recurrent costs; has an uncertain sustainability associated with the world export market; and will result in more fruits being dumped in the off-season. The third solution is least costly in the short term but consists of the greatest long-term risk, as importation of Moko disease (SFR strain), Banana Bunchy Top (BBTV) and other viral diseases could devastate the industry, even when bananas are peeled and semi-preserved. Other disease and pests of quarantine importance that are not yet in Jamaica (ex. episomal Banana Streak Virus, more virulent forms of black Sigatoka and post harvest diseases and pink mealy bug, that are capable of being transferred on the peel) would significantly increase the cost of production and threaten the viability of the export and domestic industries. Currently, the domestic and export banana industry cannot afford to court such high risks. The fourth option would and is making more chips available on the local market at low costs; however it: does not solve the problem of waste from local production; increases the import to export ratio and deprives Jamaicans of jobs and foreign exchange. The fifth solution is environmentally and economically feasible; would prevent unnecessary water throughout processing. Sanitized water must be changed every two (2) or three (3) hours or as soon as the water becomes soiled.

![Vacuum packed fruits](Figure 20. Vacuum packed fruits)

**Vacuum Pack Operation for Other Fruits and Vegetables**

Other fruits such as, plantains, melons, cantelopes and pumpkins and vegetables (for example calaloo) can be preserved using the same vacuum sealing technique as that described above. However, similar to oranges, the peeling and chopping of these ripened fruits must take place in the highly sanitized environment of the factory processing room (Figure 19). When refrigerated immediately after packaging, the finished products remain fresh, delicious and delightful in

![Washing and drainage of towels and containers after processing](Figure 21. Washing and drainage of towels and containers after processing)

![Solid waste must be disposed of during operation](Figure 22. Solid waste must be disposed of during operation)
3. Fill three sinks with water (Figure 17a):
   - sink number 1 must be used to wash the produce (fruits)
   - sink number 2 must be used to sanitize produce (84 ml bleach to 19-23 litres of water or 3 oz bleach to 5-6 gallons of water)
   - sink number 3 must be used to rinse produce (Figure 17b)
4. Oranges (which must never be treated with citric acid or metabisulphate) must be washed, sanitized and rinsed before peeling.
5. The peeling and bagging procedure is shown in Figure 18.
6. All fruit segments must be bottled and stored before the pulp temperature rises.
7. Knives and towels must be kept in sanitized waste; provide jobs; foreign exchange and a sustainable solution when coupled with options 1 or 2.

   The most appropriate method of preservation is to vacuum pack peeled and treated green bananas, which can be stored refrigerated for up to four months. Vacuum-packing entrepreneurs could benefit from sales during the high demand periods. The processors of banana chips could purchase raw material cheaply during the glut and carry out their own preservation and storage for peak demand periods. Further value-added could be realised if the other consumer niche markets for peeled green bananas are explored aggressively. Busy, housewives working mothers and urban consumers in general, find the process of peeling green bananas tedious and unattractive. The availability of vacuum packed green bananas in the grocers’ freezer should be very welcome. The vacuum-packing facility and process for plantains and bananas is identical to that of other fresh fruits, which can be marketed to the airlines, hotels and other food service industries, schools, domiciliary institutions and food processing factories. This publication serves as a guide to establish and operate a vacuum-packing factory as a cottage industry.

3. VACUUM PACKING

   Vacuum packing became commercial in the 1960s. At the time it was space age technology for retailers of meat in particular to be able to present to consumers fresh and hygienic products, in spite of long
transportation. The process was so successful it allowed Australian beef to be exported to Japan in excellent condition. It became possible to export fresh products throughout the world. Vacuum packing lengthens the edibility quotient of food in all its varieties. Produce can be delivered to homes and export markets with guaranteed freshness and minimum waste and spoilage.

Food is protected from air and moisture, as vacuum-packing locks in freshness and prevents freezer burn. Food remains fresh for three to five times longer. Meats and poultry last up to three years in the freezer. For up to two years, cheese will stay fresh in the refrigerator, lettuce stays crisp and crackers and cookies stay crunchy, flour and sugar dry and insect free. Fruits also remain fresh for long periods but relatively short compared to the foods mentioned above. However, peeled green bananas, which would normally lose freshness in minutes, stay fresh up to four months in the freezer.

**How Vacuum Packing Works**

Oxygen causes food to spoil. Vacuuming removes the air from the container. Sealing the container prevents air from entering. Containers are usually bags, which are triple-layered and made of polyethylene (a type of plastic) with an outer layer of nylon. The materials prevent gases from passing through. The lack of oxygen has specific benefits:

- Foods that are high in fats and oils won’t become rancid, as there is vacuum packed and held at 6°C, can be stored for approximately four months.

**Vacuum Packing Oranges and Other Citrus Fruits.**

1. Oranges must be stored in refrigerator (Figure 16) for one and a half hours before use to maintain desired temperature, which is 6°C (Celsius).

2. All bottles must be washed, sterilized and sanitized before use.
4. Seal plastic bags with vacuum pack equipment (Figure 14). Simultaneous vacuum and sealing takes approximately 20 seconds.

5. Place packages in cold storage immediately for holding and throughout transportation (Figure 15). Properly processed bananas that are no oxygen to cause rancid taste and smell.
   - Lack of oxygen prevents oxidation or discoloration, as is usually seen on green bananas and latex within minutes of being exposed to air.
   - Insects cannot grow, survive or hatch.
   - Enjoyment or availability of favourite or special foods all year, even out of season.
   - Possibility to freeze favourite fruits and vegetables to eat, cook or process later when they cannot be found.

4. **MAJOR REQUIREMENTS OF THE VACUUM-PACK FACTORY**

The Main Factory Building

The main factory facility must consist of three basic areas:

1. The outdoor area or factory yard for receipt of fruit. The area must be large enough to accommodate vehicles and an unloading area for fruits. Temporary, but shaded outdoor space should be provided for storage and yard should be paved to allow for washing during clean up. A discreet area of the yard must be selected for solid waste (garbage) bins or skip. Bins must have lids.

2. The preparation or peeling room where green bananas are peeled. This room must have seats (chairs, benches or stools for workers);
should be adequately ventilated for the moderate comfort of workers and must be paved to permit washing.

3. The processing plant or production area (room) is a sterile area that is enclosed so that all entrances and openings (windows and doors) are kept closed at all times and must have mesh screens to prevent entry to insect and dust. Additional ventilation, such as fans or air conditioning may be necessary. Floors and walls must be concreted, painted, covered or tiled with suitable materials to allow for frequent cleaning with bleach.

**Storage Facilities**

All raw materials and processed fruits must have adequate and appropriate storage, such as follows:

1. Without a consistent and reliable supply, there must be storage of fresh and potable (drinkable) water for food processing operation (Figure 1). Water treatment may be

   ![Water Storage Tanks](image1)

   **Figure 1. Water Storage Tanks**

   **Figure 2. Instruction for water treatment**

2. Preservation Operation for Green Bananas: Vacuum Pack

   1. Dip to cover fruits in citric acid for at least ½ hour, then remove and place in aluminium or stainless steel containers (Figure 12a and 12b).

   ![Figure 12](image2)

   **Figure 12. Instruction for water treatment**

   2. Place required quantity in vacuum pack plastic bags (three-ply and pre-sealed on three sides) (Figure 12c).

   ![Figure 12](image3)

   **Figure 12. Instruction for water treatment**

   3. Weigh with a calibrated scale (Figure 13) to achieve the correct weight of the package. Scale must be stainless steel preferably and certified by the

   ![Figure 13](image4)

   **Figure 13. Scales for weighing processed fruits must have stainless steel platforms or pans, calibrated frequently and be certified by the bureau of Standards.**
5. Sanitize counters, knives and cutting boards (Figure 11).

6. During the processing operation, solid waste must be accumulated in covered bins for removal at the end of each day.

2. Fruit raw material can be stored outdoors for a few hours if conditions are cool and shaded (Figure 3); but ideally fresh fruits are best stored refrigerated (Figure 4). Refrigeration is necessary before processing citrus and for storage of all fresh fruits over long periods of time. Cool storage is essential for all preserved fruits. Small portable thermal units (igloos) are useful for very small operations or necessary to improve water quality (Figure 2) if supply is not guaranteed drinkable.
temporary holding of fruits (Figure 4a). A factory or large household refrigerator is always useful (Figure 5a). Avoid refrigerators and appliances that corrode when wiped with bleach. Refrigerated trucks that are used to transport large quantities can also be used for temporary storage during processing. Permanent refrigerated rooms are ideal and appropriate for large factories (Figure 5b). Opening of refrigerated room doors must be infrequent to maintain uniform temperatures and minimise electrical consumption and the associated cost.

Figure 4b. Temporary storage in igloos

Figure 5a. Indoor refrigerator (above) and refrigerated truck (below).

7. Alternatively, the colour of the bananas can be preserved also in 0.0005% (5 ppm) metabisulphate (11 grams in 20 litres of water).

8. Place peel in bags for animal feed or easy removal to compost site or land fill (Figure 10). Bagging is necessary for sanitation in the factory environment.

9. Peeling room must be cleaned and sanitized after every operation.

Proper Cleaning and Sanitizing Procedures for Processing Plant

1. Before entering the production area hair must be properly covered with protective head wear and all jewellery must be removed.

2. Always wear protective clothing: preferably clean laboratory coats or an apron over clothes at all time.

3. Wash hands and put on protective gloves (Figure 10a and 10b).

4. When leaving the work area to go the restroom, gloves must be disposed of and upon returning a new set of gloves must be used.
- Make another longitudinal cut in the middle of remaining peel and remove the two remaining quarters of the peel (Figures 8e to 8h).
- Remove any remaining peel from pulp by scraping or cutting (Figure 8i).

6. Place banana pulp in 0.0014 % (14 ppm) citric acid (28 grams citric acid to 20 litres water) (Figure 9) to prevent oxidation and preserve fresh colour.

Figure 8. Sequence of the peeling process for maximum speed of operation

Figure 5b. Commercial refrigerated room. The sign on the door is a constant reminder to prevent energy wasting and the related cost at the time of installation.

The major tools and equipment are detailed in the capital expenditure (Chapter V Table 2).

3. Packaging materials like plastic vacuum bags and bottles, as well as utensils and containers must be stored in clean, organized and pest free cupboards or room, within or attached to the processing room.
3. Accumulated in tubs; and

4. Separated into fingers.

5. Peel bananas (Figure 7) using the following process:
  - Cut (to the depth of the peel) lengthwise along one side from neck (pedicel) to the tip end (Figure 8a), and then up along the adjacent side, back towards the tip, (Figure 8b) removing a wedge of skin by pulling back with the knife (Figure 8c)
  - Approximately 1/3 of the skin would be removed (Figure 8d).

**Banana Peeling Procedure**

Peelers must wear protective headgear (hairnets), rubber aprons, water boots and gloves. Removal of banana skin is carried out in the peeling room. Green banana fruits:

1. Arrive from the field, are stored temporarily in the shaded factory yard and selected by hands or cluster;
2. Washed;
3. Accumulated in tubs; and

Business persons can source individual pieces of equipment by way of the Internet.

**INSTRUCTIONS FOR OPERATING A VACUUM-PACKING FACTORY**

**Figures 6. Preparation of bananas for peeling**

**Figures 7. Peeling operations**