GROWING BANANAS IN AMERICAN SAMOA

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TABLE OF CONTENTS

1. Introduction
2. Land Preparation
3. Spacing
4. Planting
5. Fertilizing of Bananas
6. Control of Nematodes
7. Protecting the Banana Leaves
8. Control of Bunchy Top
9. Banana Scab Moth
10. The Number of Plants in a Mat (Density)
11. Removing the Flower
12. Harvesting the Bunch
Introduction

As with all our agricultural endeavors, the limited amount of land area available in the Territory for agricultural production behooves us to strive for maximum yield from every square foot of land we put under cultivation.

Table 1 below shows us clearly how increased yields can bring increased incomes. However, before these desirable income increases can occur, we must follow cultural practices that have been found to work well elsewhere in boosting banana production.

The following brochure attempts to describe the various facets of banana production. But, it must always be kept in mind that all the facets are essential to the success of the production process. To omit any one facet is to subject the entire process to the possibility of failure.

<table>
<thead>
<tr>
<th>No. of Plants per acre @ 10'X10'</th>
<th>No. of Bunches per acre per yr @ 2 bunches per mat</th>
<th>Ave. wt. per bunch (lbs.)</th>
<th>Total lbs/acre/year</th>
<th>Total Annual Income @ 25¢/lb.</th>
<th>Total Annual Income @ 30¢/lb.</th>
<th>Total Annual Income @ 35¢/lb.</th>
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<tr>
<td>435</td>
<td>800</td>
<td>50</td>
<td>40,000</td>
<td>$10,000</td>
<td>$12,000</td>
<td>$14,000</td>
</tr>
<tr>
<td>435</td>
<td>800</td>
<td>60</td>
<td>48,000</td>
<td>12,000</td>
<td>14,400</td>
<td>16,800</td>
</tr>
<tr>
<td>435</td>
<td>800</td>
<td>70</td>
<td>56,000</td>
<td>14,000</td>
<td>16,800</td>
<td>19,600</td>
</tr>
<tr>
<td>435</td>
<td>800</td>
<td>80</td>
<td>64,000</td>
<td>16,000</td>
<td>19,200</td>
<td>22,400</td>
</tr>
<tr>
<td>435</td>
<td>800</td>
<td>90</td>
<td>72,000</td>
<td>18,000</td>
<td>21,600</td>
<td>25,200</td>
</tr>
<tr>
<td>435</td>
<td>800</td>
<td>100</td>
<td>80,000</td>
<td>20,000</td>
<td>24,000</td>
<td>28,000</td>
</tr>
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1. Land Preparation

One of the most important practices that can contribute to the maintenance and improvement of soil fertility is the continued incorporation of organic matter in the soil. A good tractor, equipped with appropriate implements, can greatly simplify this task.

If the plot of land to be planted with bananas has thick vegetation on it, the tractor with a disk harrow can quickly chop and shred that vegetation. When the chopping and shredding is done, the tractor, equipped with a moldboard plow, will turn the soil over. The soil will then be disked again to break up big clods and to smooth the surface in preparation for the making of drainage ditches and planting.

If the plot of land does not contain adequate vegetation, it is very desirable that the land be properly disked and a "green manure" crop consisting of "Sunn Hemp" be sown on it. In 45 to 60 days, the crop (green manure) will be ready for incorporation into the soil, as described above.

However, before planting begins, there is another beneficial practice that must be done, if at all possible. This is the digging of drainage ditches that are spaced 20 feet apart. The ditches should be at least 1½ feet deep and 1½ feet wide. Figure A below shows a cross-section of the ditches.
II. Spacing

A. The Importance of Spacing

Optimum spacing involves the planting of the maximum number of plants in a given area to provide the greatest yield possible without reducing ventilation and without increasing humidity and temperatures, which are conditions that favor the occurrence of diseases.

Optimum spacing means also that each plant has access to an adequate amount of sunlight which it needs to produce its food.

Optimum spacing also means the absence of over-crowding, that each plant has access to an adequate amount of nutrients and water. It also means adequate space to carry out cultural practices that promote the productive life of the plants.

B. Spacing for Bananas

Given the conditions above, a plant spacing of 10 feet by 10 feet is adequate. The distance between rows is 10 feet and the distance between plants is 10 feet. Straight rows are not only attractive but also make maintenance work efficient. Using a string, measuring tape, and stakes to layout the field would be helpful. See Figure B below.

Number of plants per acre = \( \frac{43,560 \, \text{sq ft} / \text{acre}}{10 \times 10 \, \text{sq ft} / \text{plant}} \)

= 435 plants/acre

![Figure B](image-url)
A. Dimensions of the Planting Hole

1. Diameter of the planting hole = 15 inches
2. Depth of the hole = 15 inches

B. Planting Instructions (also see Figure C)

1. Put 3 inches of rotted manure, when available, in bottom of the hole.
2. Sprinkle a handful of 10-5-48 fertilizer on top of the manure.
3. Cover with 3 inches of soil.
4. Place the banana bit (laufasi) in the hole.
5. Apply ¼ TBS (tablespoon) of the nematicide Furadan around the banana bit (as close to the wall of the hole as possible); apply also a handful of fertilizer in a similar manner.
6. Fill the hole with soil, and water (if available).

C. Pre-plant Treatment of the Laufasi (banana bit)

1. Preparation of the Chemical Dip:
   Mix: 4 gallons water
   6 TBS (tablespoons) Diazinon 20% EC
   2 TBS Benlate or Manzate or Mancozeb
   ½ TBS Furadan (nematicide)
2. Soak laufasi for at least 15 minutes then plant.
A. The Importance of Fertilizers

Very few farmlands today exist where native soil fertility will produce crop yields large enough to make production profitable. Agricultural soils must frequently be fertilized to increase yields, and additions of lime are often necessary in humid regions to correct soil acidity. Production of crops and animals at profitable levels is dependent on the maintenance of soil productivity and the wise management of land.

Although the use of fertilizers is now nearly universal, a great many farms are still being operated at such low levels of soil fertility that production is limited to the point of little or no net profit.

Any system of cropping or gazing removes substantial amounts of nutrients from the soil each year. Unless these withdrawals are restored by applications of fertilizers, crops and pasture growth will decline. Furthermore, the nutrient supplies in the soils must be raised to the point where plant growth can make full use of sunlight, rain and warmth.

B. The Important Stages of Banana Growth

1. From Planting to Bunch Initiation:

Bunch initiation begins at about the twentieth leaf stage. The bunch is formed at the corm of the banana and travels upward through the stem until it finally emerges through the top of the banana plant. The banana plant at the time of bunch initiation should have at least 12 or 13 healthy leaves.

The growth and health of the banana plant from the time of planting to the time of bunch initiation determines how large the bunch will be, that is, how many hands the bunch will have. After bunch initiation, nothing more can be done to alter the size of the bunch that will finally emerge.

It is very important, therefore, to follow cultural practices that will ensure the vigorous health and growth of the banana plant during this initial period of its existence.
2. **Bunch Emergence to Bunch Maturity:**

This period is variable in its duration; it can be long or it can be shorter, depending on how fast or how slow, the fingers of the bunch can be filled up. The faster the fingers are filled, the faster is maturity reached. Again, the filling process is dependent upon the health and vigor of the plant in terms of the number of healthy leaves present during the filling period, the effective control of the burrowing nematodes, and the provision of adequate fertilizer as well as regular de-suckering.

3. **Bunch Maturity to Bunch Ripening:**

The period of time from bunch maturity to bunch ripening is very critical for marketing purposes. The sooner the bunch matures, the more time there is available to market the bunch before ripening occurs. The longer it takes for the bunch to mature, the shorter the marketing time.

C. **Fertilizer Recommendations**

Fertilization is only one part of a total management approach to banana production. Other facets of the production process include disease control, insect control, nematode control, weed control, regular pruning or de-suckering, proper field preparation and planting techniques, etc. Maximum utilization of applied fertilizer by the banana plant will only occur when all the facets of production are performed properly and in a timely manner.

The following fertilizing guidelines were formulated for Hawaii banana growers with the assistance of the University of Hawaii plant scientists. Plant tissue analyses were used to determine element levels in banana plants over predetermined periods of time, and these levels were then compared to elemental standards developed by University scientists. These standard levels are shown in the table on the next page:
TABLE 2

Plant tissue standard element level in Banana developed by UH Scientists.

<table>
<thead>
<tr>
<th>Element</th>
<th>Level</th>
<th>Element</th>
<th>Level</th>
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<tbody>
<tr>
<td>Nitrogen</td>
<td>2.8 to 3.0%</td>
<td>Iron</td>
<td>50 to 100 PPM</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>.18 to .20%</td>
<td>Manganese</td>
<td>30 to 100 PPM</td>
</tr>
<tr>
<td>Potassium</td>
<td>3.0 to 3.4%</td>
<td>Copper</td>
<td>.10 to 15 PPM</td>
</tr>
<tr>
<td>Calcium</td>
<td>.5 to .8%</td>
<td>Zinc</td>
<td>25 to 40 PPM</td>
</tr>
<tr>
<td>Magnesium</td>
<td>.3 to .5%</td>
<td>Boron</td>
<td>5 to 15 PPM</td>
</tr>
</tbody>
</table>

Table 3 represents standard element levels and three banana tissue analyses that were done on a farm in Hawaii at 6 months intervals. The tests covered macronutrients and micronutrients.

TABLE 3

Banana Tissue Analyses for three six-month periods

MACRONUTRIENTS - ELEMENTS (%)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>S</th>
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<tr>
<td>Standard</td>
<td>2.90</td>
<td>.20</td>
<td>3.20</td>
<td>.70</td>
<td>.40</td>
<td>.20</td>
</tr>
<tr>
<td>Jan 1979</td>
<td>3.03</td>
<td>.18</td>
<td>2.75</td>
<td>.64</td>
<td>.34</td>
<td>.22</td>
</tr>
<tr>
<td>July 1979</td>
<td>2.70</td>
<td>.18</td>
<td>2.50</td>
<td>.70</td>
<td>.39</td>
<td>.17</td>
</tr>
<tr>
<td>Jan 1980</td>
<td>3.10</td>
<td>.19</td>
<td>3.10</td>
<td>.65</td>
<td>.39</td>
<td>.21</td>
</tr>
</tbody>
</table>

MICRONUTRIENTS

<table>
<thead>
<tr>
<th></th>
<th>Fe</th>
<th>Mn</th>
<th>Cu</th>
<th>Zn</th>
<th>B (in PPM)</th>
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<tbody>
<tr>
<td>Standard</td>
<td>75</td>
<td>50</td>
<td>15</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Jan 1979</td>
<td>116</td>
<td>808</td>
<td>12</td>
<td>24</td>
<td>13</td>
</tr>
<tr>
<td>July 1979</td>
<td>113</td>
<td>794</td>
<td>8</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td>Jan 1980</td>
<td>225</td>
<td>960</td>
<td>9</td>
<td>26</td>
<td>12</td>
</tr>
</tbody>
</table>

Based on their interpretation of the data in Table, the following guidelines were determined by the plant scientists.

a. Bananas need and consume a great deal of potash (K₂O)
b. Phosphate is not very critical (P₂O₅)
c. It is easy to over-fertilize with Nitrogen (N).
d. Micronutrient deficiencies are easily corrected by adding chelated micro-nutrients to the fungicide solution which is sprayed on the foliage.
D. Recommended Fertilizer and Application

Based on research and actual field work, it is recommended that a compound fertilizer with an N-P-K analysis of 10-5-48 be used also in American Samoa. We have been using a similar fertilizer in the past for our taros and bananas, the only difference being that the $K_2O$ percentage was 20% instead of 48%.

The total amount of this fertilizer to be used per year is 5220 pounds or approximately 2.61 tons per acre.

The rate of application is one (1) pound of fertilizer per plant (or mat) per month. It would be ideal if the fertilizer application coincided with rain. It will not do the banana any good if the fertilizer sits high and dry on top of the soil without any water to dissolve it.
A. The Burrowing Nematode

1. Disease Symptoms

"Radopholus similis" is the most important nematode pest of banana in the South Pacific. The various chemicals used to control burrowing nematodes will also help control the other parasitic nematodes of lesser importance but which are also commonly found in banana within the region.

Nematode activity within cortical areas of roots causes the reddish brown to black elongated lesions which are easily observed with the naked eye. Entire segments of roots eventually blacken and die. Infections and consequent rotting may extend an inch or more into the corm, causing the condition known as blackhead.

The presence of nematodes in banana plantations often is not detected until stools are blown over and the roots exposed. Nematode feeding and burrowing activities, combined with the effects of secondary rot organisms, destroy or weaken much of the root systems, leaving plants liable to toppling under pressure from wind or rain.

DISEASED PLANTS ARE UNABLE TO ACQUIRE NUTRIENTS, RESULTING IN LACK OF PLANT VIGOR AND POOR FRUIT PRODUCTION.

2. When Burrowing Nematodes are controlled

When burrowing nematodes are controlled, high plant density is maintained, bunch weight is increased, the number of production cycles is increased, frequent planting is reduced, INCREASE IN YIELD IS OFTEN 30% - 60% or more!

B. Application of Nematicides

1. Nematicides are very poisonous, so they must be handled with great care. Always use rubber gloves when applying this chemical.
2. The two nematicides recommended for the control of nematodes are:
   a. Furadan 10% Granular
   b. Mocap 10% Granular

3. Application and Rates:
   a. Furadan
      (1) At planting time, as explained in IIB5 and shown in Fig. B.
      (2) 1 TBS around the base 2 months after planting.
      (3) 1 TBS around the base every 4 months thereafter.
   b. Mocap
      (1) At planting time, as with Furadan, except use 2 TBS.
      (2) Six months later, apply 60 grams (3TBS) Mocap in a radius 3/4 meter around each producing stem, or 2 ounces (3TBS) of Mocap in a radius of 30 inches. Before application, remove ground litter from area to be treated and apply granules evenly.
      (3) Apply Mocap every six months thereafter
      (4) For best results, apply just before irrigation or a rainy period. If application is made during a dry period, mix granules into the top inch of soil with a rake.

C. Nematode-free Planting Material

1. When starting a new banana plantation on old land, it is important that old banana plants be killed and the stumps removed so that nematodes do not continue to feed and reproduce.

2. Care must be exercised in selecting healthy planting materials.

3. Whether using laufasi (banana bits) or young suckers, always clean off dirt and dead material, and use the chemical dip described in IIC. Soak the planting material for a sufficient period of time to ensure penetration of chemicals.
   CAUTION: Use long rubber gloves when dipping planting material into the chemical mix.
VI. PROTECTING THE BANANA LEAVES

A. Why Healthy Leaves are Important

Leaves are the "factories" in which carbohydrates are manufactured by the plants through the process of photosynthesis. After the carbohydrates (sugars and starches) are manufactured in the leaves, they are then stored in the fruit, corm, or tuber. Without big healthy leaves, therefore, the plants cannot effectively perform their work of food production.

For bananas to produce big, good quality bunches of fruit, plants should have at least 13 healthy leaves at the time of flowering. At the time of harvest, at least 4 leaves, preferably more, should still be present.

With the reduction in leaf numbers and leaf health, the yield of fruit is also reduced and the quality of the fruit is consequently poor.

B. Black Leaf Streak -- The Most Serious Leaf Infection

Infection: Black Leaf Streak is caused by a fungus now called "phaerella fijiensis".

Two types of spore are produced by the fungus. The conida of its CERCOSPORA state develop on the early reddish-brown streaks mainly on the lower leaf surface.

The ascospores of the Mycosphaerella state of the fungus are produced from the older diseased leaves.

Infection by both spore types occurs usually on the third or fourth youngest leaves as, or shortly after, they unfurl.

Rapid development of the disease is favored by warm (23°-28°C), rainy and humid weather.
C. Control of Black Leaf Streak

1. Cultural Methods

Cultivation practices which tend to increase humidity and reduce ventilation in the plantation such as close planting, excessive weed and grass growth, and too may suckers per plant should be avoided and so should infertile and badly draomed soils.

2. Resistant Cultivars

There is on-going research to find banana cultivars of the Cavendish variety that are resistant to black leaf streak. This research work is being done in Australia, and Western Samoa will soon receive several resistant cultivars for field testing.

3. Chemical Control

Until resistant cultivars are generally available, we have to resort to chemical controls to combat black leaf streak.

One important concern that must be mentioned at the outset is that the farmer should try to avoid spraying continuously with just one fungicide but to alternate the use of at least three different chemicals. This will be a guard against the rapid development of resistance in the organism to the chemicals.

a. **Benlate Mix:** 12 liter or 2½ gallon Mistblower

   Benlate 50% Wt  ............... 11 TBS
   Misting Oil ................... 2.3 liters (½ gallon)
   Spreader Sticker ............... 37 ml (2 TBS)
   Water .......................... 9.5 liters (2.1 gallons)

Mixing Instructions:

Bucket #1: Pour in 3 or 4 liters of water; Add 11 TBS Benlate; Stir

Bucket #2: Pour in 2.3 liters (½ gal) misting oil; Add 2 TBS of spreader sticker; Stir

Pour Benlate-Water mix (bucket #1) into bucket #2, stirring while pouring.
When ingredients are well mixed, pour into mist-blower and use the remaining water to rinse out the buckets and add the rinsings to the mist-blower tank.

b. Mancozeb Mix: (same as Dithane M-45)
Mancozeb 80% WP .......................... 45 TBS
Misting Oil ............................. 2.3 liters
Spreader Sticker ....................... 37 ml (2 TBS)
Water ...................................... 9.5 liters (2.1 gallons)

Mixing Instructions:
Same as for Benlate

c. Calixin Mix
Calixin 75% EC ....................... 180 - 200 ml (12 - 13 TBS)
Misting Oil ............................. 1.3 liter (0.28 gal)
Spreader Sticker ............... 12 - 25 ml (1.5 TBS = 1½ TBS)
Water ............................... 10.5 liters (2.3 gal)

Mixing Instructions:
Bucket #1: Pour in 12.0 liters water; Add 12 - 13 TBS of Calixin; Stir
Bucket #2: Mix 1.3 liters Misting Oil and 1½ TBS of Sticker; Stir

Pour the Calixin-Water mixture into Bucket #2 containing oil and sticker, stirring well while pouring.

Pour the spray-mix into the mist-blower tank.
CAUTION: Do not add Calixin directly to misting oil as it will form a thick solution which will not mix with water.

d. Dithane M-45 80W Mix
Same instructions as for Mancozeb

e. Bravo Mix
Bravo ................................. 6 fluid ounces (12 TBS)
Misting Oil ......................... 1.3 liters (0.28 gal)
Spreader Sticker .............. 2 TBS
Water ........................... 10.5 liters
G. Punch 40 Mix

Punch 40 .......................... 40 mls per tank  
Misting Oil ........................ 1.3 liters  
Spreader Sticker .................... 2 TBS  
Water ............................... 10.5 liters

D. Frequency of Spraying

Although we do have distinct wet and dry seasons, it is in our interest as banana planters to maintain a two week interval between sprayings, throughout the year.

NOTE: TRITON B-1956: A water-dispersible resin-based non-ionic surfactant which resists re-wetting and removal by rain. This may be the best surfactant for Samoa, in view of our high rainfall. Price FOB = $25.10 per gallon.
A. Banana Bunchy Top is caused by a virus.

B. Infection and Spread of the Disease

The banana aphid, PENTALONIA NIGRONERVOSA, is the vector that spreads the virus from plant to plant. When infections aphids transmit the disease to new plants, the virus enters the sap stream and spreads all through the plant and into the corm and suckers.

Spread with planting material:

Even though they may not show symptoms (in which case the virus is said to be "latent"), suckers taken from infected plants will almost certainly have the virus within them and eventually develop bunchy top symptoms; so also will suckers growing from pieces of corm from infected plants. The use of such infected planting material is a common way for the disease to be spread. Another way is for infectious aphids to be carried to new sites on planting material.

C. Control Measures:

1. Production of virus-free suckers in a nursery, if possible.

2. Planting material should be taken from plantations which are relatively free of the disease and where infected plants have been regularly rogued out (i.e. removed and destroyed). The suckers and the plants from which they are to be taken should be inspected for the symptoms of the disease especially the dark green hooks running into the midrib.

3. Destruction of diseased plants:

Plants found to be infected must be destroyed immediately upon detection.

First of all, the infected plant must be thoroughly sprayed with insecticide to kill any aphids present.

All the plants in the mat (pupu fa'i) must then be dug out and cut into small pieces to ensure that no regrowth can occur.
4. Maintain a virus-free plantation.
5. Spray young suckers which may be infested with aphids.

VIII. BANANA SCAB MOTH

A. The scab moth is very destructive at times to bananas, specifically the fruit. The larvae of the moth feed on the skin of the young fruit. When the skin heals, scabs are formed on the fruit. Sometimes, the damage extends into the flesh of the fruit, rendering it unfit for sale and even consumption.

B. Control

Use Lepidex 60% EC or Dicidex 60% EC
Rate: 1 TBS per 1 gallon of water
Application: Use Banana Injector Sprayer

Inject a total of 40 milliliters (ml) of the insecticide solution into the fully exposed upright flower.

Inject half of the solution (20 ml) into the lower right, and the other half into the lower left half of the flower. Ask for an actual demonstration.

A single treatment is all that is required.

IX. NUMBER OF PLANTS IN A MAT

A. At any time, there should be only three (3) banana plants growing in a mat. See Figure C.

B. Desuckering

The removal of excess banana suckers from the mat should be carried out regularly. Remember, only three (3) plants should be left in the mat.

C. Failure to de-sucker leads to over-crowding, which limits the amount of sunlight available to each plant and restricts the free movement of air among the plants. Consequently, there
ture which favors the growth of fungal organisms that affect the health of the banana plants, particularly the leaves.

D. The 3rd plant in the mat is always the offspring of the 2nd plant, never of the 1st plant. And the 4th plant should be the offspring of the 3rd, etc.

X. REMOVING THE FLOWER
The purpose for cutting off the flower is to fatten the fingers of the last hand of the bunch. By leaving at least two fingers of the cutoff hand, nutrients are encouraged to flow into the last good hand and fill up the fingers.

XI. HARVESTING THE BUNCH
When the banana bunch is harvested, do not cut down the stem. Leave the stem standing. Remove only the bunch and the leaves. The water and nutrients in the harvested plant will flow into the succeeding plant.