HILLSIDE AGRICULTURAL PROGRAM

## TECHNICAL STUDY

# Preliminary Diagnostic of Haitian Yellow Yam (*Dioscorea cayenensis-rotundata*) and Malanga *(Xanthosoma spp.)* Cropping Systems

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## I. INTRODUCTION

There are approximately 600 species of yams (*Dioscorea* spp.) and 3 of them (*D. alata, D. cayenensis - rotundata, and D. trifida*) can be considered the principal yams consumed in the Tropics.

The main objectives of this diagnostic were to briefly characterize the yellow yam production systems within the North and Southeast Regions of Haiti and also to evaluate the quality of yellow yam for international markets. The consultant's terms of reference also included a brief description of malanga (*Xanthosoma spp*.) cropping systems along with quality parameters for international markets. This preliminary study was carried out from April 9-20, 2001.

## II. GENERAL CHARACTERISTICS

This crop is widely cultivated on Haitian hillsides and because of its multipurpose uses; it occupies a principal place within farming systems. An average farm size is 1 hectare (ha), while the average yam production area may vary from 1/10 to 1/3 hectare. Intercrops with yam as the principal component are highly demanding in soil nutrients. In the Southeast Region, yam is often intercropped with beans, corn, taro, cassava, sweet potato and other crops. The yam-based intercrop is generally cultivated at the start of the crop rotation following a variable number of seasons in fallow in order to assure maximum potential for yam development and yield. Stakes are used for plant support and development. In the North, yam is primarily cultivated within agroforestry systems, where it is intercropped with coffee, cacao, various fruit trees, forestry species with diverse uses, as well as with taro and other yam species. In this system with shaded under story, trees are used as stake support. Yam is produced for sale at local markets in both regions.

## III. SOUTHEASTERN REGION YAM PRODUCTION SYSTEMS

In this region, 3 production areas were visited: Blockhauss, Cap-Rouge and Katich-Tombeau.

Characteristics of the yam cropping system in sites visited in the Southeastern Region:

### 1. Soils

Specific information on soil texture and fertility was not readily available during the consultant's first trip to these production areas. However, soils on which yam is cultivated range from ultisols, with clay texture with high stone content to highly eroded oxisols with variable clay and stone content.

### 2. Land preparation

Land is prepared by hand through the construction of 50-60 cm height mounds. Available organic matter is incorporated into the mounds to improve soil texture, soil fertility, soil-plant moisture conditions and to improve tuber shape, as well as to facilitate harvesting operations.

### 3. Varieties

There are at least 2 varieties of yellow yam cultivated in the locations, which were visited in Southeast Region of Haiti. One has a cylindrical shape, light yellow flesh, with rhizomes that are small and thin. Another variety has a deformed, potentially larger and heavier rhizome with dark yellow flesh.

### 4. Planting material (Seed)

Farmers utilize the proximal end of the rhizome, or a whole rhizome ranging from 0.7 to 3 kg as planting materials. Even though the propagule showed serious infestation of nematode, fungus and insect larvae, none of the growers use chemicals for seed tuber treatment. In the Blockhouss area there is a program to supply sprouted planting materials to local farmers. Although, it has an excellent infrastructure to sprout yam sets, the methodology used is incorrect because available chemicals are not used for treatment of planting sets. According to farmers, a yam propagule could cost US $ 0.33 and therefore the seed is the highest cost input in Haitian yam production systems.

### 5. Planting

Planting is done by hand, placing 3 propagules per mound. Yams are usually planted just before sprouting has begun. There are between 3000 and 4000 mounds/hectare, providing plant densities ranging from 9000 to 12000 plants/ha. The planting period is from February to April.

### 6. Support system

Farmers are using individual stakes (approximately 2 meters high) as the vine support system with one stake per mound. The wood used for stakes comes from trees in the area and probably increases the rate of deforestation. Yam stakes are also another very expensive input of the production system in the Southeast Region. According to farmers visited, stakes could cost US $ 0.2 and could be used for 2 years.

### 7. Weed control

Weeding is done by hand, up to 3 times a year.

### 8. Fertilization

Most of the farmers do not use fertilizer in their yam plantations. However some farmers in Cap-Rouge may apply some urea fertilizer (46-0-0) on yam-based intercrops.

### 9. Pest and disease

An insect larva that feeds on the yam rhizome and nematodes are the 2 main pests observed. In the Katish-Tambeau area, another serious pest are slugs, which feed on yam rhizomes.

The two main diseases, which were observed, are dieback or anthracnose, caused by *Colletotrichum gloesporioides* and a Fusarium infection (*Fusarium* spp.).

## 10. Harvest

Yam is harvested by hand. According to the collected data, to harvest a 12 months old mound with 3 plants could take between 5 to 10 minutes. Therefore, this cultural practice requires the highest labor input. The time requirement for the first (nondestructive) harvest was not available. It is assumed that the first harvest of the mounds requires more time than does the second harvest, however.

In the Southeast Region, yam is harvested twice during its growth cycle. The first harvest begins 6 to 10 months after planting (September-December). It is a non-destructive harvest where the mounds remain intact. Rhizomes harvested at this time are immature, small (30-40 cm long), have cylindrical shape and are less affected by insect larvae. These rhizomes could be used as a planting material or as food source. The second harvest begins 12 months after planting. The rhizomes are too mature, greater than 40 cm in length, have irregular shape, and often show serious quality defects due to infestation of insect larvae. Rhizomes from the second harvest can also be used as planting material (the proximal end of the rhizome) or as a food source.

During this study, a preliminary evaluation on yellow yam production was done at the Blockhauss area. Two, 12 month old plantations were selected and 5 mounds were harvested per plantation. The data collected (Table 1) showed that mound yield was between 8 and 10 kilograms and therefore, a yam plantation could produce around 31,000 kg/ha. However, only 15-25% of the total yield could be considered as a high quality material for export to international markets. Hence, the exportable yield could be from 4,600 to 7,700 kg/ha following sorting operations in the field or at the CBO. As much as 50% of 4,600 to 7,700 kilograms of the sorted yams for export may be lost due to damages occurring during the post-harvest period. These include mechanical injuries during transport, diseases (rot) and water loss from the rhizomes. These factors may reduce exportable yam yields to a thin 2,300 to 3,850 kg/ha. According to this analysis, 75-125 farmers, each with 700 $m^2$ of yellow yam production, may be needed to produce 20,000 kg (1 container) of exportable yam.

**Table 1. Mound density, yield/mound and the exportable yield percentage in two 12- month yam plantations in the Blockhauss area.**

| Plantation | Mounds/ha (number) | Yield/mound[1] (kg) | Exportable yield[2] (%) |
|---|---|---|---|
| 1 | 3,086 | 10.06 | 25 |
| 2 | 3,846 | 8.06 | 15 |

[1]Average of 5 mounds
[2]Rhizomes with cylindrical shape, between 35 and 45 cm long and no injures.

### 11. Production cost

Table 2 shows the yam production cost in the Cap-Rouge area according to farmers. Seed value, staking and mound construction are the most expensive inputs in the production system. Similar information could be collected in the other production areas.

**Table 2. Production cost per hectare of yam plantation in the Cap-Rouge area.**

| Input | Cost (US $) |
|---|---|
| 1. Land preparation (labor) | 151.70 |
| 2. Mound construction (labor) | 269.60 |
| 3. Planting material | 3,370.00 |
| 4. Planting | 33.70 |
| 5. Staking material | 505.50 |
| 6. Labor for staking | 67.40 |
| 7. Weed control (labor) | 58.93 |
| 8 Fertilizer (nitrogen) | 26.96 |
| 9. Fertilizer application | 16.85 |
| 10. First harvest | 168.52 |
| 11. Second harvest | 168.52 |
| Total cost | 4,837.68 |
| Total cost without seed | 1,467.68 |

## IV. NORTH REGION YAM PRODUCTION SYSTEMS

Four production areas were visited in the North (Cap Haitian) Region, including Camp Coq, Marteneau, Pilate and Port Margo. Three different production systems were identified.

### Production System A (Marteneau)

One of the main characteristics of this production system is the construction of terraces[1] to reduce soil erosion. The space between terraces is from 5 to 6 m and this area is prepared to produce high quality yellow yam for international markets, and other crops (plantain and bean) for local markets. Terraces here resemble raised beds.

The soil could be classified as clay texture with high stone content and with a slope above 30%. Land preparation consists of weeding the area between terraces, then constructing mounds, which are 40 to 50 cm high. In addition to mound construction, some farmers dig a 1 m deep hole to remove stones and roots that may affect the rhizome shape. Then, the hole

[1] The term 'terrace' here refers to relatively recently introduced soil conservation structures which are commonly referred to as 'food bands' constructed as raised beds of 1.0 to 1.5 meters width, installed along the contours, with 5-6 meters between bands. 'Food bands' are planted with stabilizing plant materials, as well as cash crops, such as yams and malanga. They are referred to as 'bann manje' in local language.

is filled with a mixture of soil and green organic material until the mound is completed. The main objective of this agricultural practice is to produce a well-formed rhizome for international market. The mound density in this system depends on the number of trees available in the production area because farmer use them as live stakes. The planting material is a section of the proximal end or a whole rhizome. Seed weight varies according to where it will be planted. Within crop bands, seed weight varies from 2-3 kg and in alleys between terraces, it could weigh from 1-2 kg. None of the farmers use seed treatment to reduce or prevent pest and disease infestations.

In Marteneau, yams are planted between February and March and a first non-destructive harvest is conducted between October and December. A second harvest is done on April. Table 3 shows the total and the exportable yields from yams planted between the terraces and in the terraces. Yams planted between terraces yield 89.6% higher than those planted in the terraces, but they have less export yield (22%) compared to terraces with 34% export yield.

**Table 3. Twelve-month yam yields between terraces and within terraces in Marteneau.**

| | Between terraces (kg/mound) | In terraces (kg/plant)[2] |
|---|---|---|
| Total yield | 14.43 | 7.61 |
| Exportable yield (% of total) | 22% | 34% |

### Production system B (Pilate)

The typical *grand bois* agro-forestry yam production system is widely practiced in Pilate. This is an incredibly diverse intercrop production system where the upper canopy is filled with forestry and various fruit species. The second intermediate story is filled with coffee (or cacao) and various bananas, including plantain. In addition, several yam species are grown on mounds, including *Dioscorea trifida*, *D. alata*, *D. rotundata* and *D. cayenensis*.
The soil type and characteristics are very similar to the Marteneau area. The land is prepared making a mound (40-50 cm height) or digging a hole. The mound density depends on the number of trees because they are used as a living support. The number of mounds per tree also varies according to tree density. If there is high tree density, 2 mounds per tree, but if tree density is less, more than 4 mounds could be set up for each tree. One of the main problems with this system for export quality is the deformed rhizome due to the roots from trees and also from the coffee plants reducing its quality. However, it showed the highest yield per mound (25.6 kg) at 12 months after planting.

The planting material used by farmers is the same as in other production systems described above, with seed weight above 2 kg. The planting time is between February and March. The

[2] The raised bed structure of the 'food band' provides the seed bed for yam, while mounds are constructed in the alleys for yam production. Caution must be made in comparison of yield data taken from single plants within the 'food band' and that taken from the yam mound in the alley that have up to three plants per mound.

first harvest is from September to December and the second one in March. However, farmers could harvest the same plant several times a year. Approximately, 60 minutes were required to harvest one mound in this system.

The yellow yam price at the local market of this region was between US $ 0.21 and $ 0.30 per kg of product.

**Production System C (Pilate)**

This is similar to system A. However, yams are only planted in the terrace with other crops, such as sweet potatoes or cassava, while the area between terraces is planted with corn, beans and other crops.

Yam is planted in the terrace or raised bed. Seed weight was found to be between 0.6-0.8 kg and the distance between plants was 0.5 m. Distance between terraces was approximately 5 meters. Therefore, the yam density is around 4000 plants per hectare. At this farm, a non-living stakes were used (bamboo), one stake per plant. During harvest at 12 months of age, rhizomes were cylindrical with good shape, their weight was an average of 2 kg and they measured between 36-40 cm long. Planting and harvesting times were similar to other zones, which were visited.

## V. RECOMMENDATIONS

The yam production systems which were observed in both the Southeast and North Regions of Haiti could be improved, but it depends on the market requirements (local or international). My recommendation is to focus on producing high quality yellow yams for international market.

### 1. Data collection

Local staff was unable to provide sufficient information about soil characteristics (chemical and physical), weather conditions through the year (rain, temperature, photoperiod), yam production requirements (plant growth, pest and disease problems, plant nutrient requirements, seed treatment, post harvest problems and production cost) and market information (local prices throughout the year, local demand, international markets and prices, and product quality). Besides that, there has not been a feasibility study to support the idea to export yellow yam to United States market.

I recommend that HAP begins to collect soil and weather data and also international requirements for yellow yam as soon as possible.

### 2. Training the local staff

The local HAP staff requires training in yam agronomy and production practices. This background training would support the project's need for the generation of information on current yam production so that HAP may put into place a strategy for exploiting the export potential. Therefore, a training course should be set up to support the fieldwork of HAP staff.

### 3. Cultural techniques

**Land preparation**

Soil texture and soil preparation affect the morphology of the rhizome. Rhizomes grow longer, thinner and deeper in light soil than in heavy soils (clay texture). Soils from both regions (North and Southeast) have the following characteristics: hard subsoil; and high stone or root contents that may induce horizontal growth or deformed rhizomes. Consequently, subsoil plowing may be desirable. Using animal traction could do it. However, in some farms, it could not be done because of steep slopes. An alternative to solve the hard subsoil problem is to dig the hole and fill it with a mixture of soil and sufficient green material so a mound could be formed with loose soil.

Observations made during the consultant's visit confirm that deformed rhizomes are produced using mounds. This is because the mound is not high enough. Therefore, it has to be combined with subsoil plowing or making a hole in order to loosen the soil to allow rhizome growth.

**Planting material or seed**

The seed is a piece of the proximal end of the rhizome or a small whole rhizome, ranging from 0.6 to 4 kg. This propagation system allows the dissemination of pests and diseases that reduce the seed quality and yield. Hence, seed must be treated with a fungicide-insecticide-nematicide product(s), allowing complete drying under shade conditions before planting. If HAP continues to supply seed to farmers in order to increase the production area, the yam seed must be treated before it goes to farmers and the treatment has to be done by an agronomist and not by farmers. Some recommended fungicides are Benomyl, Mancozeb, TCMTB, Carboxin+Captan and Captan. The following insecticides may be recommended: Oxamyl and Malathion.

Farmers are using planting materials which weigh more than 0.6 kg in order to have a good yield. In this type of production system where no fertilizer is applied, the yield depends on seed weight. There is a positive correlation between propagule weight and yield because plants grow better with large seed sizes. Therefore, the propagule size is a barrier to crop expansion. The set and miniset technology could be an alternative to solve this problem. I recommend using yam sets greater than 200 g, but an evaluation on seed size has to be set up as soon as possible to determine its effects on yield and potential farmer adoption of this practice. There is a program on set technology at the Blockhouss area that was set up by M.Sc. Ricot Scutt. Therefore, I recommend that HAP supports this program and M.Sc. Scutt`s work on this topic. In addition, similar facilities could be established in other production areas. Even though set technology could solve the problem on seed availability, yields per land unit area will decrease. Therefore a fertilization program (organic, inorganic or both) has to be developed for each area and it will depend on soil fertility status, soil structure and weather conditions.

**Plant density**

The plant density in the Southeast Region varies from 9,000 to 12,000 plants/ha, while it is unknown in the North Region at this time Therefore, I recommend determining plant densities in the different production areas of the North Region, in order to have a clearer idea about yield parameters there.

Plant density affects the rhizome size and also the yield. High plant density produces more and smaller rhizomes than low plant density. If there is no modification of seed size, I recommend increasing to 4 or 5 seed per mound. If seed size is modified (200g), I recommend using the same plant density that farmers are using at this time.

**Support system**

Vine support should be provided as soon as plants begin to grow. There is a positive correlation between stake height and yield. However, stakes are one of the most expensive inputs in Haiti yam production. In the Southeastern Region, farmers are using a non-living stake, such as branches from surrounding trees. In this area there is not enough trees. Consequently, an increase in yam production area may also increase the deforestation rate. Hence, a new source of staking has to be found in the area, such as bamboo or living stakes. New support systems, such as a vine system, may prove to be viable for farmers in the Southeast. Given both alternatives, I would recommend looking for a new source of stakes. Farmers in the North Region are using mainly live stakes, such as fruit trees or other types of trees. In that case, yam plant density depends on tree density, so an alternative to increase plant density in this area is to increase the number of mounds per tree.

**Fertilization program**

Yam requires a high content of potassium, nitrogen, calcium, magnesium and phosphorus to produce a good yield, but the Haitian soils have a low content on those elements. The large propagule (seed) is the main source of those elements and therefore the yield depends on it. If a small seed is used, an appropriate fertilization program has to be developed.

**Pest and disease**

The main problems on both regions were nematodes and marocas (*Curculionides* and/or *Scarabeides*) insect larva. The nematode problem could be resolved by treating the seed with a nematicide product. Potential solutions to reduce insect larva populations include crop rotation and harvesting before yellow yams reach 10 months. I cannot recommend using any chemical product at this time to control this larva because of potential residues on plant parts.

**Harvesting**

There are 2 harvesting times. The first one is between September and December and a second one from March to April. Rhizomes from the first harvest are immature, small and weigh less than those from the second harvest. Immature rhizomes, or conversely, rhizomes which are too mature, may not fulfill export quality standards. Therefore, it is possible that 10-month rhizomes may reach export standards, but I recommend evaluating when is the right time for yam harvesting.

Yam is a perishable commodity and it is very sensitive to mechanical injury. Most of the farms are located far away from roads that are often in poor condition. Consequently, a high percentage of yams may be lost during post-harvest handling between field and market.

## 4. International markets

One of the main HAP objectives is to export yellow yam to USA, through Miami and New York markets. However, these markets are controlled by Jamaican product. At this time, there is not a study to evaluate the possible effect of the Haitian yam on those markets. Therefore, I recommend evaluating the market conditions in order to find when is the right moment to send product to those markets.

One of the main problems with the yam production on Haiti is its seasonality, and thus the non-availability of high quality product throughout the year. According to the data collected from different production areas, high quality product could only be supplied from November to December. However, yam is harvested early, starting in September, but it does not have a good quality because it is too immature. In addition, yam is also harvested from March to April, but rhizomes from this harvest are too big, deformed and have pest problems. An alternative may be to plant throughout the year in order to produce a high quality product. This alternative requires in-depth knowledge of weather conditions, particularly rainfall frequency and amount, throughout the year. Another alternative would be to produce yam on lowlands using irrigation systems that that are available in some areas of the Southeast Region. Either of the two production alternatives might produce high quality yam which would make product available when there is a high international price, from July to October. I recommend that HAP staff continue to discuss this alternative that may be a complement of hillside yam production .

In addition to yellow yam production, I recommend a feasibility study of production of other yam species, such as white yam (*Dioscorea alata*) and also cush–cush (*D. trífida*). Furthermore, other regional markets should be evaluated, such as Puerto Rico, for example. This market is mainly for white yam and it is very close to Haiti.

## VI. MALANGA PRODUCTION SYSTEMS

Malanga and cocoyam (both, *Xanthosoma* spp) are both tropical root and tuber crops that are very important cash crops for some countries, including Costa Rica, Jamaica and also Nicaragua. There are 2 main edible species: *X. sagittifolium*, known as white malanga, yautía, tannia and cocoyam *and X. violaceum*, known as purple malanga.

Three production areas were visited, including Katich-Tombeau (South), as well as the hillside production areas in the North of Grande Riviere and Dondon. In the Southeast Region, we were not able to observe large malanga plantations because it appears to be crop produced in gardens close to houses (limited areas). Several species and varieties were observed and collected where they are intercropped together. In North Region, Malanga plantations were on small areas. Corm sections were used as the propagating material which was not treated to control the spread of pests and diseases. In Grande Riviere, malanga was grown on raised beds as an intercrop with yellow yam, white yam, sugar cane and plantain. In the Dondon zone, malanga was grown on flat areas. In the hillside areas, it was planted in un-prepared soil. There was a disease problem at the Grande Riviere and hillside plantations. Disease symptoms were root rot, small plants and deficient foliar growth and development. These symptoms are similar to a disease known as Mal Seco or rot root disease. The malanga crop cycle is one year and it is planted in April and harvested one year later.

## VII. RECOMMENDATIONS (for Malanga)

1. Malanga production should be done on lowland areas (flat)

2. Land preparation, such as subsoil plowing and raised beds are required agricultural practices. Malanga does not grow well in saturated soil. Therefore, well-drained soil is needed.

3. Corm sections and cormels (secondary corms) could be used as planting materials. All of them, however, must be treated against pests and diseases. Seed should be selected from healthy plantations. I recommend using 100 g seed pieces.

4. Malanga should not be intercropped with other root and tuber crops, or with plantain because those crops have even higher nutrient requirements.

5. In Haiti, there are white and purple malanga. I recommend producing both species.

6. Malanga coco or taro *(Colocasia esculenta* var *esculenta*) is another aroid, which is accepted on different international markets, such as Miami and New York. It has a better tolerance of saturated soil than *Xanthoxoma* and there are taro plantations in both regions. Therefore, I recommend evaluating this crop as an alternative for export.

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## VIII. Recommendation for contract agreement modification

According to the contract agreement I signed with FINTRAC, the consulting assignment was to be carried out in 3 different visits over a 3-month period with a total of 40 workdays. I recommend expanding the period of time to one year in which the assignment is to be carried out. My next visit to Haiti could be between September and October, and the next one in December. In that case, during the September-October visit I can evaluate the quality of the yam at 6 or 7 months after planting, while in December, I can evaluate the best quality.