

HILLSIDE AGRICULTURAL PROGRAM

TECHNICAL MANUAL

Mango Cultivation Short Course

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Introduction and Summary

This report serves to document the contents of a *short course* covering various mango production techniques presented by Dr. Tom Davenport. The course was designed for mango farmers and agricultural technicians. It was conducted on May 12, 2001 in farm fields in Peredo, near Jacmel. During the course, three essential cultural practices for mango production were elaborated:

1. Seed selection, namely, mango embryo selection for seedling production,
2. Seedling pruning practices,
3. Mature tree pruning practices.

The report has been prepared to disseminate the findings to a broader audience and has been structured to summarize the major lessons learned. Further detail relating to each lesson is documented in the body of text.

Summary of Lessons Learned:

1. Mango seed contain several embryos that are genetically identical to the tree that produced the seed. Knowing how to identify these embryos allows mango planters to skip the usual grafting phase in producing seedlings for plantation plantings. This approach substantially reduces seedling production costs and time.
2. Pruning planted-out seedlings in the prescribed manner brings the seedlings into commercial production in about one-half the time normally expected by Haitian mango producers. Additionally, the prescribed pruning shapes the tree to maximize mango production and reduce management and harvest costs. Mango production from a properly pruned tree is expected to be several times that of a similarly aged tree managed in the traditional Haitian fashion -- that is, no pruning.
3. Mango seedlings (at Peredo) appear to suffer from lack of micronutrients, specifically, zinc. Mature trees do not exhibit micronutrient deficiency.
4. Seasonal pruning of mature mango trees to stimulate, synchronize and time mango production can increase Haitian mango production and revenue several-fold; however, the pruning practice is impractical for most Haitian mango trees because the trees are too tall.
5. Because mango trees sprout and grow well from the stumps of cut-down mango trees, large trees can be cut down to a manageable size and shaped by pruning the re-growth to create manageable, highly productive trees.
6. Mango trees can be managed such that the harvest occurs earlier or later than normal to take advantage of higher-price marketing periods.
7. Spraying to control anthracnose can be very cost effective. Anthracnose destroys mango flowers. If all flowers are destroyed, the tree may set flowers again within a short period of

time. However, if only a portion of the flowers are destroyed, the tree will not set new flowers in the same season. The proportion of flowers lost without stimulating re-flowering can be quite large, even 80- 90 percent. Spraying to control anthracnose can save many mango flowers. The resulting production can be many times larger than it would have been otherwise.

Mango Embryo Selection and Planting

Mango seeds are poly-embryonic -- that is, each “seed” is actually a compact group of mango embryos. Each embryo can grow into an adult tree capable of producing fruit. Picture 1 shows how the seed looks after it has been removed from the mango fruit. The special characteristic of the mango seed is that most of the embryos it contains are genetically identical to the mother tree. The mature trees resulting from these special embryos will produce fruit that is exactly like the fruit produced by the mother tree. The new trees will also have the same resistance to disease as the mother.



Picture 1: Intact Mango "Seed"

Knowing which embryos are identical to the mother tree is important. The information allows the farmer to be certain that the tree planted today will produce the fruit desired when the tree matures in three to five years. Without this knowledge, Haitian farmers have either had to take the risk that the tree they plant today will produce high-value fruit several years from now or incur the extra investment of grafting the planted tree with a known variety of mango. Short course participants objected that un-grafted trees often take a year or two longer than grafted trees to begin producing fruit. Davenport explained that this problem could be solved by certain pruning techniques, which are discussed in the following section of this report.

Many mango seeds contain one sexually produced embryo among the several asexual embryos. Some contain no sexual embryo. The sexual embryo is not genetically identical to the mother. On the contrary, it is the result of the sexual combination of genetic material from the mother tree and another parent. Thus, the quality of the fruit the embryo will produce cannot easily be predicted. Because it carries a new combination of genes, the embryo is a new individual. The fruit it will produce may be better or worse than that of the mother tree. If the other parent contributing genetic material to this new individual is a different variety of mango, the resulting fruit will likely be of lower market value than that produced by the mother tree. Because of the longer period of time and related investment required before the quality of the fruit of a newly planted mango tree can be checked, most farmers may prefer to plant only the asexual embryos, whose fruit quality is known before planting, rather than plant the sexual embryo, whose fruit quality cannot be determined at planting.

Fortunately, there are major observable differences between the sexual and the asexual embryos. Davenport recommends that farmers not plant the sexual embryo. Identification of the sexual embryo is usually quite easy because it is generally much larger than the asexual embryos. Picture 2 shows the mango seed with the large sexual embryo separated from the small bundle of asexual embryos. Another characteristic of the sexual embryo is that it generally will split easily into two symmetric halves as will a bean seed.



Picture 2: Mango “Seed” with large sexual embryo separated from asexual embryos

The small bundle of asexual embryos should be planted under about 1 inch of soil in a plant nursery bed of well-prepared soil. Once the embryos have sprouted and grown about 4-5 inches in height, they should be gently separated and replanted in individual plastic sacks where they will remain until they are planted in the production field. Davenport noted that he saw evidence of zinc deficiency on newly planted mango (but did not observe the deficiency on the established older trees) and recommends adding a broad-range of micro-nutriments to the soil in the plant nursery. Agronomist Yves Gossin reminded the participants that micro-nutrient availability is related to soil pH and suggested that a soil test should be made to decide how to address the micro-nutrient deficiency problem. Davenport agreed, adding that if the soil pH is less than 7.0, commercially available minor element mixes containing zinc, boron, copper, calcium, and sulfur should be applied directly to the soil one time when planting in the seed bed and a second time when transplanting to individual plastic seedling sacks. If the pH is higher than 7.0, commercially available foliar sprays containing these elements are available. They should be spray applied every two weeks until transplanted into the field.

Mango Seedling Pruning Techniques

Pruning planted-out seedling-trees in this manner brings them into commercial production in about one-half the time normally expected by Haitian mango producers. Additionally, the prescribed pruning shapes the tree to maximize mango production and reduce management and harvest costs. Mango production from a properly pruned tree is expected to be several times that of a similarly aged tree managed in the traditional Haitian fashion – that is, no pruning.

Mango trees typically grow in spurts called flushes. Mangos in Haiti tend to grow vertically during the first several flushes. After this, the mango begins to send out lateral branches while continuing to grow vertically. This results in trees that have no lateral branches on the first two meters or more of tree trunk. Thus, the first fruit is set on branches that are too high off the ground for easy harvesting. More importantly, all other branches are even further off the ground. The trees are too tall to manage easily. That is, any pruning or spraying program the farmer

might want to apply to the adult tree is practically impossible to carry out because most of the tree branches cannot be reached without major effort. Thus, one purpose of the pruning described below is to develop mango trees that have branches relatively close to the ground so that they can be pruned and harvested at minimum cost. The second objective of this pruning is to develop mango trees with a relatively large number of branches to maximize its production of mango fruit.

Traditionally, Haitian mango growers never prune mango trees. Participants at the short course explained that farmers believe that mango trees must grow to a large size before they can begin producing mango. Additionally, the farmers fear that radically pruned mango trees may die. Farmers also believe that the value of production lost when mature trees are radically pruned will not be more than recovered through increased production value resulting from the pruning.

Planter Coleau, president of the local farmers' organization at Peredo and an experienced mango grower and technician, voiced this concern when Davenport advised Coleau to radically prune a four-year-old tree –that is, to cut the tree down at a height of about one meter. Coleau protested that the pruning practice would kill the tree and made other arguments why the tree should be pruned at a higher level. After assurances that the tree would recover and become more

productive than it would have been, Coleau agreed to test the pruning practice but, not on the tree close to a main path used by local farmers. Instead, he suggested using a tree that was in the back of his farm plot as the demonstration tree. Picture 3 shows Davenport and Coleau standing beside the radically pruned tree. As the tree was being cut, Davenport asked Coleau to count the number of branches on the young tree, explaining that the number of branches determined the number of mangos the tree would produce. Davenport noted that the unpruned tree had relatively few branches in comparison with the number it would have had if it had been properly pruned. He also asked Coleau to note how far off the ground the first branches of the tree were. He pointed out that any mango growing on these branches would be out of reach and would have to be harvested with a harvesting pole, complicating harvest and making it more expensive.



Picture 3 A Radically Pruned Mango Tree

Davenport explained that the purpose of the radical pruning was to bring closer to the ground the first branches that would produce mango fruit. This would make harvesting the mango easier. The tree would re-sprout from the stump, sending up perhaps 10-12 sprouts. Davenport recommended that Coleau should select 5 of the sprouts to be allowed to grow and should cut away all others. Further, each of these 5 sprouts should be pruned in the manner described below --that is, pruned in the same way a newly planted seedling should be pruned. This pruning would multiply the number of branches and increase the tree's capacity to produce a mango fruit.

Thus, the pruned tree would be easier to harvest and would produce several times more mangos than the un-pruned tree.

Steps in Pruning a Newly Planted Mango Sapling

Note that all pruning is done after a flush (period of rapid growth) and after the new leaves have turned dark green.

1. Allow the mango to grow to the height at which the farmer wants the first branches to grow laterally from the main trunk of the tree. Tom Davenport recommends that, for seedlings, this height should be about one meter.
2. Cut off the growing tip of the sapling or re-sprout.
3. Two or three sprouts will soon emerge from the severed tip. These sprouts will become the first lateral branches of the tree.
4. Allow the two or three new branch sprouts to grow for one growing period and allow the new leaves to become dark green; then cut off the growing tip of each branch sprout.
5. Each of the two or three severed branch sprouts will send out two or three sprouts. These new sprouts should be allowed to grow for one growing period. And, after the new leaves have turned dark green, the growing tips of each of these new sprouts should be cut off.
6. This process of allowing new branch sprouts to grow and then to cut off their growing tips after the leaves have turned dark green is repeated for two years.
7. The last tip pruning should occur five months before the farmer wants the tree to flower and nine months before the farmer wants the fruit ready for harvest. Note: as far as possible, this final pruning should be timed so that the mango fruit are ready for harvest when the market price is highest.

The following figure shows an idealized tree after three prunings. The numbers indicate the locations of the first, second and third pruning points. Notice how the number of branches increases algebraically by a power of three with each pruning cycle.

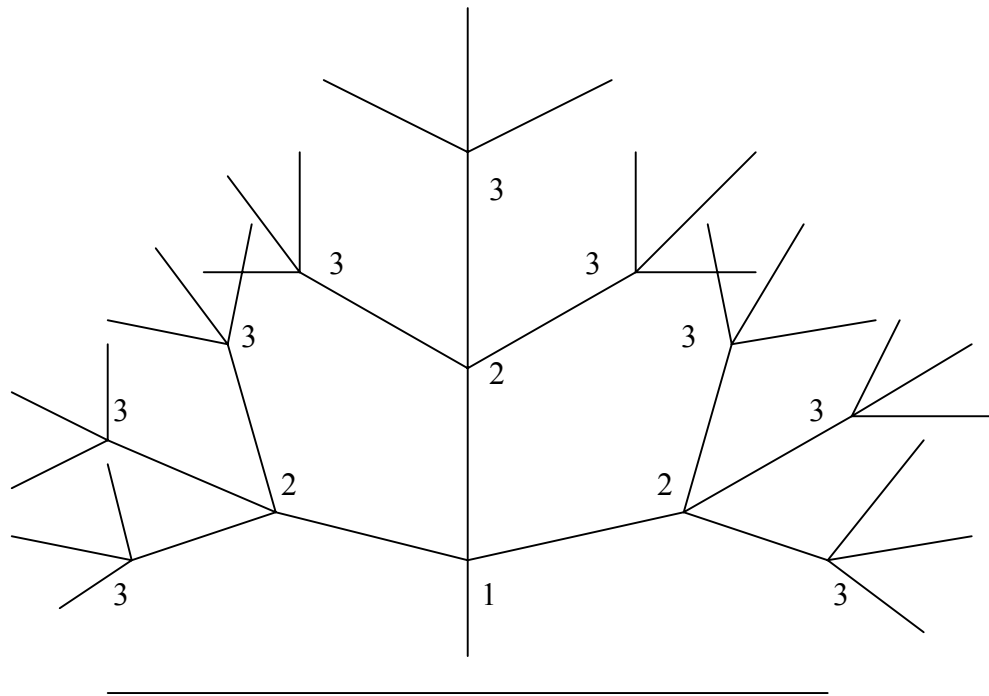


Figure 1: Idealized Tree Diagram Showing First, Second & Third Pruning Points and Re-Growth

Micro-Nutrient Deficiency

During the short course, Davenport observed indications of zinc deficiency on several of the newly planted mango seedlings. The young leaves of the plant were relatively small and were deformed horizontally into the shape of a washboard or a lateral section of a sheet of corrugated roofing material. Also, the lengths of the trunk of the young seedlings established during each growth period were much shorter than normal. The terminal segment of the young tree was less than an inch long when it should have been several inches long. These characteristics indicate zinc deficiency, and if the soil is deficient in zinc, it is also deficient in the other well-known micro-nutriments.

Davenport had not noted zinc deficiency indications on the adult trees in the area. Thus, he surmised that only the top layer of soil was micro-nutrient deficient, reasoning that the adult trees, with their longer roots, could reach necessary micro-nutrients, whereas the sapling, with its shorter roots, could not. He suggested the farmers be encouraged to add a standard formulation of micro-nutriments to the soil in the mango nurseries. This amendment would assist the mango seedlings in attaining normal growth rates until their roots developed sufficiently to reach micro-nutriments present in the subsoil of the production plots.

For information on how to apply the micro-nutriments, refer to the section entitled, “Mango Embryo Selection and Planting.” The standard formulation of micro-nutriments is available from:

John Frederick
Atlantic-Florida East Coast Fertilizer and Chemical Co.
Homestead, Florida
(305) 247-8800

Pruning Mature Mango Trees

Haitian farmers could double or quadruple their revenue from mango by actively managing their trees. Haitian farmers typically apply no management practices to their trees. They harvest whatever the trees happen to produce. Pruning is the most appropriate tool for use by Haitian farmers because it requires no imported inputs, other than technical assistance and a machete. More advanced management practices include spraying to stimulate flowering and spraying to control anthracnose. This section discusses pruning; a discussion of other practices follow the discussion of pruning.

Maximizing Production

Participants readily agreed that many Haitian mango trees do not produce fruit uniformly. That is, only certain branches of the tree produce during a given season. Often, trees have only a few fruit on some branches whereas most of the tree has no fruit. This means that the tree is not producing up to its potential. A well-managed tree produces fruit on all of its branches. Note that if the tree does not produce its maximum, this will not only reduce the revenue per tree, but will also increase the cost of harvesting as pickers must visit more trees to harvest a given amount of fruit.

Maximizing production is achieved by pruning, which stimulates all of the branches to flower and produce fruit together. This can be done because mango tree growth and flowering follow a known cycle. The length of time between growth periods determines whether the next growth will be foliage (only leaves) or inflorescences that will carry flowers and later fruit. If the period between growth flushes is less than five months, the new growth will usually be foliage. If the period is five months or more, the new growth will likely be inflorescences that will produce fruit four months after flowering. Cutting the tip of mango branches stimulates re-growth. Thus, farmers can use this information and knowledge of when the trees normally experience a five-month dormant or no-growth period to decide when to prune the tree to stimulate growth that will produce inflorescences rather than foliage.

Pruning all branches of a tree ensures that all branches will produce at the same time. Thus, proper pruning stimulates and coordinates or synchronizes production on all branches of the tree. Doing this to all trees in an area or a plantation can bring all the trees into harvest during a relatively short “window” of time and can significantly improve the efficiency of harvesting and marketing activities. Within time limits that can be enlarged using chemical sprays, farmers can

move the harvest “window” backward or forward in the season to take advantage of higher prices that occur at predictable periods of the season. We will discuss this spraying technique further below.

Also, some mango trees never produce fruit because the periods between growth periods is not long enough to stimulate the growth of inflorescences. In addition, fertilizing mature trees with nitrogen often stimulates the growth of foliage rather than inflorescences. Thus, this fertilization can be a waste of money if the farmer wants to stimulate production of fruit.

Davenport demonstrated the pruning technique to be applied to mature mango trees by quickly cutting off the tips of the mango tree’s branches with a machete. He noted that it would be impossible to perform this type of pruning on most Haitian mango trees because they are too tall to reach safely from the ground or even from ladders as is done in most other mango-producing countries. Haitian farmers therefore should consider reducing the size of their trees to manageable proportions. This practice will be discussed further below.

Picture 4 shows a worker on a ladder of the type used in Central American countries. Note the size of mango trees and the spacing used on intensively managed plantations in Central American countries.



Picture 4 Pruning mature trees in Central America

Radical Pruning to Reduce the Size of Mature Haitian Mango Trees

Pruning the tips of mango tree branches to maximize and synchronize production is practically impossible on most Haitian trees because they are too tall. The pruning technique requires that workers cut off the tips of all branches on a given tree with a machete. This is dangerous or even

impossible in the case of the typical Haitian mango tree because the workers cannot reach the branches, even with ladders. Haitian mango farmers should consider reducing the size of their mature mango trees to a size that will allow workers to reach all branches of the tree either from the ground or with the aid of a ladder that can be easily moved about the tree.

Naturally, there will be a significant drop in mango production with the radical pruning to reduce the height of the tree. This production will be lost while the tree re-grows enough branches to produce the quantity of mangos lost due to the radical pruning. Thus, the decision to radically prune a tree should be studied carefully from a financial point of view. Will the expected increase in harvest value more than offset the lost harvest value? Some of the value of this lost production will be recaptured through the sale of the wood cut from the tree. Davenport predicts that the pruned tree will produce several times more mangos than the un-pruned tree because it will have more branches capable of producing mango. Additionally, some lost harvest value may be recaptured through pruning practices applied to the re-grown tree to manipulate harvest times to capture higher priced markets. Davenport recommends radically pruning a few trees in each production zone as demonstrations to allow the farmers and project staff to observe the results.

Only those branches that are out of reach from a pruning ladder should be radically pruned. This method will reserve several branches for continued production. This will also imply that the main trunk of the tree will be severed at a height just above those branches reserved for continued production. The tree trunk should be severed at an angle that will encourage rainwater runoff; otherwise, water standing on the severed wood may encourage disease to the tree trunk. The severed surface of the tree trunk can be painted with a white latex paint. The surfaces of large branches newly exposed to the sun by the pruning should be painted with a light coat of white paint to prevent “sunburn” which could otherwise kill the newly exposed portions of tree branch.

After a period of time, the mango tree will re-sprout from the edge of the severed trunk. Of the several sprouts that emerge, the farmer should select five or six for cultivation and should cut away the other sprouts. Once the selected sprouts have stopped growing temporarily after the first growth period and the leaves of the sprout have turned dark green, the tip of the growing sprout should be cut off just as done to newly planted mango seedlings. The same pruning practices followed for seedlings (as described above) should be followed for the sprouts growing from the severed trunk. Farmers should stop pruning the sprouts after two years. Again, the last pruning should be scheduled with the desired time of flowering, as described earlier.

Manipulating Mango Harvests Times or “Timing” Harvests

Mango trees can be managed such that the harvest occurs earlier or later than normal to take advantage of higher-price marketing periods. Synchronizing and timing the harvest period of a group of mango trees may also be desirable to maximize the efficiency of marketing activities. For example, when larger volumes of fruit are ready for harvest at the same time, harvesters can make fewer trips to the trees or to the production zone to harvest fruit. Trucking the fruit to market can be more efficient because trucks are loaded more often to full capacity. Processing

facilities can improve the utilization of their capacity if managers can plan their processing activities around harvest dates.

Manipulating harvest periods can be done by pruning the mango trees on schedule to stimulate the growth of inflorescences, flowers and fruit so that the fruit is ready for harvest at the desired time. Basic pruning techniques are discussed above. Here, we emphasize that some manipulation of harvest time can be achieved via pruning alone. However, if the desired change in harvest period is significantly different by more than two months from the normal harvest period, then farmers must also spray the trees with 4% potassium nitrate. Clearly, this implies that the trees are of a size and height that will allow spray to reach all branches. Thus, this technique would be economically feasible only for application on trees that have been actively managed using the pruning practices described above.

The spray is applied to the underside of the leaves of the entire canopy about five months after the last pruning. The trees must not have grown more than one flush since the last pruning, or they will not flower. The potassium nitrate stimulates a new flush of growth. If the age of the last flush is at least five months old, the new flush will flower.

Maximizing Harvest Value Through Control of Anthracnose

Anthracnose is a fungus that reduces the number of mango fruit produced per tree and the value of individual mango fruit by marking the fruit with black spots and thus rendering the fruit inappropriate for export. Spraying the tree at critical times can effectively and economically protect the flowers and fruit from the disease.

Anthracnose destroys mango flowers. If all flowers are destroyed, the tree may set flowers again within a short period of time and seasonal production may not be significantly adversely affected, other than the delay caused by the later flowering. However, if only a portion of the flowers are destroyed, the tree will not set new flowers in the same season and seasonal production is likely to be reduced in direct proportion to the number of flowers lost. The proportion of flowers lost without stimulating re-flowering can be quite large, even 80-90 percent. Thus, spraying for anthracnose can save many mango flowers that will then produce mango fruit during the current season. The resulting production from the tree can be many times larger than it would have been otherwise. In fact, the production from protected trees is as much as 10 times greater than it would be without protection.

When spraying trees to control anthracnose, the spray must cover almost all of the leaves and flowers on the tree to be effective. This is practically impossible in the case of the very large mango trees typically found in Haiti. Thus, spraying is recommended only for mango trees that have been pruned to a height that will allow the sprayed chemicals to reach the all parts of the tree. Workers using manually pumped backpack sprayers can accomplish the spraying operation if the trees do not exceed 7 meters in height.

Timing of spraying is very important; thus, all materials and equipment necessary to accomplish the job must be on location before the expected use. Anthracnose does the most damage to

flowers after they have been wetted by rain. Farmers must decide either to treat the flowers by spraying before the rains occur or by spraying immediately after the first shower has wet the flowers. Obviously, this decision will depend on how certain is farmer that the flowers will be wetted by rain. If rainfall is relatively certain, pre-rainfall spraying is recommended. If rainfall is relatively uncertain, post-rainfall spraying is recommended because spraying will not be necessary unless there is rain.

The spraying is done in two applications. One application of Benlate or Bankit is applied when the inflorescences are half formed. The first spraying is followed in two weeks by a spraying application of Mancozeb. These chemicals are not registered for use on mango in the United States. They must be used with caution, not because they are dangerous, but because it is against U.S. law to use pesticides that have not been cleared for use. The problem is that these chemicals were once cleared but, because of the extraordinary cost to re-register products, chemical companies sometimes allow permits (allowing use of the chemical) to lapse on small-volume commodities such as mango.

Always follow label instructions to insure safety of the applicators and the surrounding environment.

The chemicals used can be obtained from Donovan Brown, who routinely supplies Central American growers with chemical and farm supplies. His telephone number is (941) 683-0071.