



Characterization of the Haitian Mango Industry

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Mangos (*Mangifera indica* L.) constitute the second largest export crop for Haiti, but little more than 20% of all mangos harvested are shipped by exporters. Rejection rates along the distribution chain are very high because of inadequate harvesting and transport practices. A first step in addressing this situation was to understand fully how the current mango industry in Haiti is organized and operated. The purpose of this paper is to present a characterization of the current mango industry in Haiti. Statistics on numbers and types of trees, varieties, annual production, exports, international trade and price trends are given. Also given is a description of how the industry is organized along the distribution channels for both export and domestic markets. Harvest seasons and current harvesting practices are described, as well as methods of animal transport from fields to collection centers, and truck transport from collection centers to packinghouses. Stakeholders at every link along the chain are identified, as well as the role they play and how they relate to each other. Moreover, prices paid per mango to growers and suppliers along the distribution chain are given.

The annual world mango (*Mangifera indica* L.) production was estimated by FAO (1999) at 22.8 million metric tons, accounted for 40% of the total fruit production, and was in third position after citrus and pineapple. Mango trees are grown throughout the tropics and subtropics, and are native to India and Southeast Asia. More than 90 countries produce mango. Asian countries collectively produce 77% of the world supply with 13% and 9% coming from Central America and Africa, respectively (FAOSTAT, 2007). India is the world leader in mango production and produces 41% of the world's supply (Wang, 2010). Haiti was in third position after Brazil and Mexico as the top mango producing countries in the Americas (Raphael, 2009; Vieux, 1990).

Mango is the second largest Haitian export crop after coffee and annually nets more than 10 million dollars to the economy. The biggest buyer of Haitian mangos is the United States (USAID, 2010). During harvesting periods mango consumption helps to mitigate the problem of food insecurity in Haiti. The number of mango trees in Haiti is estimated at 10 million (USDA, 2010). Approximately 10% of these trees produce the Francisque variety, which is the only variety selected for export.

Mango trees constitute the largest tree population grown throughout the Haitian countryside and contribute to soil preservation and environmental protection. They are not, however, grown in managed groves but in fields mixed with several other trees and crops like citrus, avocado, papaya, okra, and plantain. There are some managed commercial groves, but they are young and less than 10 years old. Damais and Bellande (2004) estimated mango production between 200,000 and 400,000 metric tons; Franssen

and Audate (2007) estimated annual total production at 261,000 metric tons. Analysis of export data from USDA market news from 2005 to 2012 indicated that the national volume of Francisque mango production should be around 47,500 metric tons.

Haiti benefits from almost year-long harvest due to different microclimates, and exports mangos during 10 months out of the year to the United States with variability in production depending on the harvest season. Table 1 shows the main Haitian mango production regions and their harvest periods. Haiti's export of Francisque mangos excludes the production of certain departments, like the Southeast and production of the South because of long distances to packinghouses, poor road conditions, and the fact that existing packinghouses lack the capacity to absorb the volume of export quality fruit during the peak harvest seasons. Mango varieties need to meet certain characteristics to be eligible for export. Among these characteristics are: thick skin, uniform fruit pulp free from fibrous tissue, small seed pit, and not bruised for long shelf-life. They should have medium to large sizes, weigh between ¾ and 1¼ lb, and ripen well after picking (JWK International Corporation, 1976).

Table 1. Harvest seasons for main production areas of Francisque mango in Haiti. (Adapted from JMB, S.A.)

| Production area | Start | End |
|-----------------------------|--------------|-------------------|
| Leogane | October | December |
| Plaine du Cul-de-Sac | November | February |
| Arcahaie and Carbaret | January | March |
| Artibonite | April | June |
| Central Plateau | End of April | Beginning of June |
| Gros-Morne and Port-de-Paix | May | September |
| South and Southeast | March | May |

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The purpose of this paper is to describe the current Haitian mango industry including its stakeholders, industry organization, traditional harvest methods, transport practices from trees to packinghouses, and other valuable information. In particular, the paper will focus on points along the distribution channel where fruit is rejected. Mangos are an important export crop for Haiti. Any increase in mango exports increases the flow of valuable foreign currency and reduces the country's balance of payments deficit.

Materials and Methods

A field trip to Haiti was conducted in May 2011. The purpose of this trip was to collect data for characterizing the current Haitian mango industry, focusing on 'Madame Francisque' variety, the primary export variety. Information was collected in three regions: 1) the northern municipality of Gros-Morne, the leading Haitian city for mango production accounting for 50% of the total mango production (Raphael, 2009); 2) Mirebalais and Saut-d'Eau, two municipalities in the lower Central Plateau, accounting for 20% of the export production; and 3) Port-au-Prince, the capital of the country where most of the packinghouses are located. During this trip mangos were tracked from farms to packinghouses and Port-au-Prince markets for an understanding of the industry management. A specific goal of this investigation was to identify the points of mango rejection along the distribution channels. Four principal stakeholders were identified: 1) growers, 2) first-level suppliers, 3) second-level suppliers, and 4) exporters. An Excel spreadsheet was divided into four parts to follow each stakeholder group throughout the investigation.

Thirty mango farmers and 40 workers at eight packinghouses, four collection centers and field harvesters were interviewed. Additional data were collected from COEPDA and CETPA, two associations located in Mirebalais, SAPKO and RAPCOM, two other associations located in Saut-d'Eau and COPACGM and COPCOMF, and two cooperatives located in Gros-Morne. These interviews and organizations provided information on volume of mangos purchased at collection centers and sold at packinghouses for each mango harvest season, average volume of mangos collected from first-level suppliers, and fruit prices at each distribution point. Meetings with the director and assistant director of the Plant Protection Office of the Haitian Department of Agriculture in Port-au-Prince on industry current issues and solutions yielded key information on the industry and the country's strategic plan as well as copies of official documents. Other meetings with executives of the National Association of Mango Exporters (ANEM), US and Haitian Departments of Agriculture inspectors involved in mango exports provided key data on mango rejection rates at packinghouses, export volumes. In addition, public information both online and in Haitian libraries were used in the characterization of the Haitian mango industry.

Results and Discussion

Organization of the Haitian mango industry/mango distribution channels

Growers constitute the primary link of the mango industry. They supply to both export and domestic markets. They own mango trees and take care of them. They may sell the tree production before the harvest period either to first-level suppliers or independent suppliers who are willing to advance them the money. Producers mainly sell their production output to suppliers during the first of the two mango tree harvest seasons. The first big season extends

from April to June, and the second small season extends from mid-July to the end of August. Several activities are organized before the beginning of the first harvest mango season. Several meetings with NGO employees involved in the mango industry, farmers, associations, suppliers, and exporters were organized to setup the opening of the campaign. During these meetings, the official starting week for harvesting mango trees is done. Associations' agents and suppliers tried to find funds for the campaign from exporters, NGOs, or financial institutions. Farmers and members of farmer associations, suppliers receive trainings on harvest and postharvest handling and transport of mangos. Harvest workers prepare their cutting poles and certain associations receive some postharvest materials and equipment. The second harvest season mostly supplies domestic markets because exporters stop buying mangos during the month of August because of the buildup of fruit flies. Growers sell their mangos in units of lots, which may consist of a different number of mangos per lot depending on the area. Small producers own one to three Francisque mango trees, while other big producers called "Grand Don" may own more than 100 trees. A "Grand Don" is well known in their community and especially by first- and second-level suppliers and independent suppliers as well. Producers own on average 10 trees based on a prior survey conducted by RAPCOM association and other institutions.

Harvesting methods

Harvesting mangos is carried out with traditional picking poles, either from the ground or climbing the tree to drop mangos to a catcher standing under the tree. In Mirebalais, Saut-d'Eau, and Gros-Morne areas, workers use picking poles without a cutting blade (Fig. 1). As a consequence mangos are harvested without stems, allowing the latex to spew out and drip onto the mango fruit peel. Several problems are associated with this harvest method and leads to many fruit being rejected. First is fruit bruising caused by the shock and impact damage caused by the pole detaching the fruit, followed by the distance that mangos are dropped to the catcher on the ground. Sometimes catchers miss the fruit. A more serious problem is latex burn, which results from latex dripping on the mango's peel and burning the mango's epidermal cells. If mangos are laid on the ground, the latex sap can come into contact with the soil, thereby creating a sandpaper effect that scratches the mangos' skins. Mangos with latex burn become highly susceptible to rejection at downstream points in the distribution channel. Immediate washing of fruit removes any latex (Fig. 2). However, a good source of water is not readily available at most harvesting sites.

In the study area mango trees are more likely to be harvested



Fig. 1. Harvesting mangos with traditional picking pole.



Fig. 2 Washing mangos at field harvest.

by first-level suppliers and independent suppliers who purchase the production on tree and request the harvest of all mangos without care for immature ones; however, it is recommended that growers support the harvest cost and practice multiple harvests to reduce mango losses due to immaturity. The more growers sell mangos after harvest, the lower is the loss for immaturity. “With many horticultural crops, if you harvest all at once you are sure to have many fruit that are either under-mature or over-mature” (Kitinoja and Adel, 2003).

Once fruit is harvested, it moves through the Haitian mango industry in one of two channel distributions, one for export and the other for domestic markets. Both channels share certain similarities and differences. They differ with respect to organization, management, marketplaces and certain stakeholders, which are mentioned during the description of the two separate channel distributions that follow. Figure 3 identifies the main stakeholders in the Haitian mango industry along the two separate distribution channels, while Figure 4 shows the industry points of rejection from sorting locations along the way.

Transportation methods

Mangos are transported from fields to collection centers or packing sheds in woven straw bag slung over the back of mules and donkeys. These animals carry mangos in two typical quantities:

1. On a mule or donkey’s back, 170 lb is equal to 10 lots of 15 mangos, for a total of 150 mangos;

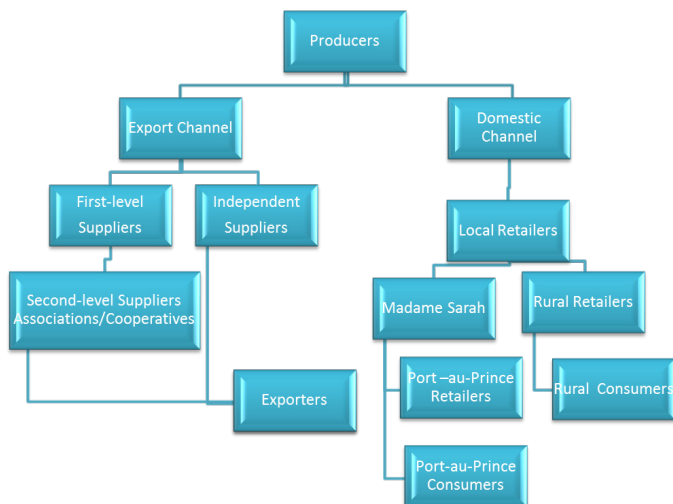


Fig. 3. Main stakeholders of the Haitian mango industry.

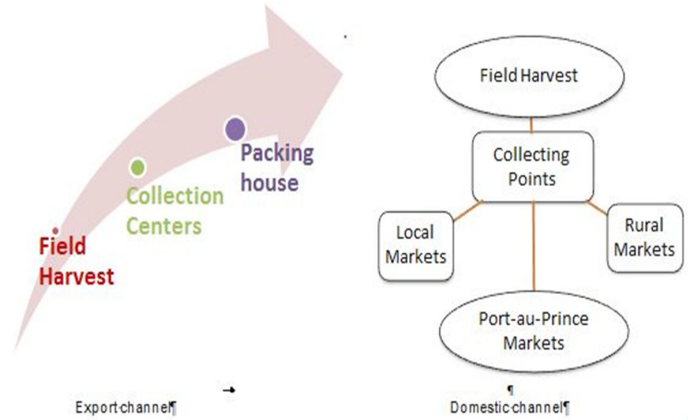


Fig. 4. Industry points of rejection.

2. On a mule’s back, 255 lb is equal to 15 lots or 225 mangos. Mangos are generally transported by trucks from collection centers to packinghouses. Some second-level suppliers, associations, and cooperatives shipped mangos in bulk inside the truck. They place a mat on the truck bed and sides to cushion the fruit from shocks during transport. Others ship mangos inside large crates that contain 900 to 1200 mangos (80 to 100 dozen mangos). A truck can carry 12 to 16 of these crates. Another crate used by one exporter was medium-sized, holding from 3 to 5 dozen mangos. Mango losses vary with transport ways, road condition, time of day, and distances. It is important to mention that some associations and cooperatives who possess medium crates don’t ship their mangos in crates because these crates reduce the volume of transported mangos and there is a cost to return empty crates from the packinghouse.

Transport is one of the key constraints of the mango supply chain. In mountainous zones like Gros-Morne and Saut-d’Eau, fruit damage during transport can be responsible for up to 30% of rejections. Figures 5 through 9 show how mangos are transported from fields through roadsides to collection centers (or packing sheds) and from collection centers to rural and Port-au-Prince markets and to packinghouses. For the domestic market, mangos can be also transported on people’s heads in sacks or baskets, on animal’s backs from field harvest to collecting points and in



Fig. 5. Human transport of mangos.



Fig. 6. Mangos transported by a mule in a woven bag on narrow mountainous roads.



Fig. 7. Mangos transported in wooden baskets by a truck for Port-au-Prince markets.



Fig. 8. Bulk loading for export market.

bulk by small trucks from field to neighborhood marketplaces. Mangos destined for domestic consumption are also transported by truck in bulk to reach certain rural markets and wood baskets to reach Port-au-Prince markets.

Selected mangos for export are sent from the collection centers in bulk trucks to the packinghouse. At the packinghouse, mangos are washed and sorted for the export and domestic markets. Se-



Fig. 9. Crate loading for export market.

lected mangos for export are placed in plastic crates and immersed into a hot water tank kept between 43 and 48 °C (115 to 120 °F) during 60–90 min depending on shape, size, and weight of the mangos to control fruit flies in compliance with USDA/APHIS treatment protocol (USDA APHIS PPQ, 2010).

Second-level suppliers (see below) prefer shipping mangos in bulk on trucks, instead of in plastic crates in order to send more mangos to packinghouses for the same transportation cost because the same truck can carry more mangos when loaded in bulk than when loaded by crates, and avoid paying for transporting back empty crates. They put plantain leaves and mats on the truck bed and the sides of trucks in order to absorb and reduce physical impact damage to the mangos.

Export channel distribution

In 1958 four Haitian companies exported 13 metric tons of fresh Francisque mangos (JWK International Corporation, 1976). Ten years later, the US and Bahamas markets accepted 100 metric tons and the number of exporters increased up to 17. There were 10 facilities (packinghouses) exporting mangos to the US in 2011, but only nine of them exported mangos during 2012. The export of Haitian mangos to the US was developed with the creation of ASDEM (National Association of Mango Exporters), an association of mango exporters created after 1970. This association regrouped exporters that have facilities to sort, wash, perform phytosanitary treatment, pack, and cool fruit. Currently ASDEM is responsible for distributing and collecting USDA fees for inspection (USDA, 2010). The main stakeholders involved in the export channel distribution from field harvest to packinghouse consist of first-level suppliers, second-level suppliers and independent suppliers, and exporters.

First-level suppliers purchase selected mangos for export from growers and transport them either by mule or donkey in woven straw bags from harvest sites to collection centers. First-level suppliers sell export grade mangos at collection centers to the second-level suppliers. Lower quality fruit is sold into the domestic channel distribution. First-level suppliers live in the mango production zone, develop strong relationships with growers, and may advance money to growers for ensuring purchase of the mango production. They inform mango owners on when mangos are ready to be harvested. Both the mango owner (producer/grower) and the first-level supplier accompany a harvest team of a picker and a catcher to the farm to harvest the trees. Harvest teams may be contracted by the farm owner, the first-level supplier, or an independent supplier who will be described later.

Second-level suppliers purchase mangos from first-level suppliers, and sell them to the exporters. They include mango associations and cooperatives involved in the marketing of mangos. Second-level suppliers usually find NGOs and government supporters to provide them with free training programs and social advantages and to realize some projects with fewer self-finance requirements. Frequently, they face economic issues and do not have enough money to buy mangos during the harvest season.

Independent suppliers travel from mango region to region throughout the country to purchase mangos. They arrive in the mango harvest period with money to buy mangos. They normally work for exporters who finance their mango purchases, and deal with growers by offering them money in exchange to rent their mango trees. There is competitive rivalry among second-level suppliers, independent suppliers, and Madame Saras, who are explained later.

Exporters purchase mangos from independent suppliers and second-level suppliers represented by associations and cooperatives. At the beginning of mango season, they often finance independent suppliers' purchase of mangos. They play an important role in the pricing of mangos. They receive mangos at their packinghouse, treat and ship them to international markets (most of the time to the USA). They must meet USDA requirements in order to sell their crop on US territory. To sum up, the export distribution channel has its own stakeholders, who differ from stakeholders in the domestic distribution channel.

The combined capacity of the existing 10 packinghouses is insufficient to absorb all the export quality mangos harvested during peak harvest periods. During these periods exporters cannot accept all available mangos, and second-level suppliers are obliged to sell them to Madame Saras for distribution to domestic market channel at distressed prices. Sometimes, they lose money due to ripening and/or over ripening of otherwise premium export quality mangos. Figures 10 through 14 show examples of collection centers and packinghouses that are used along the export distribution channel. Several institutions are involved in the export distribution channel): Haitian Department of Agriculture, USDA, ANAPROFOURMANG, and FENAPCOM associations. ANAPROFOURMANG was created to identify suppliers. FENAPCOM is a national federation of 16 producer associations created to market mangos.

Domestic channel distribution

Like the export distribution channel, the domestic channel contains several different stakeholders: rural retailers, Madame Saras, Port-au-Prince retailers and consumers. Mango growers are common to both distribution channels. In general mangos that



Fig. 11. Mobile collection centers funded by WINNER project_USAID.



Fig. 12. Unique packing shed in packinghouse, Saut-d'Eau, Central Plateau.

do not meet export standards are sold to the domestic channel, if possible. Local retailers are equivalent to first-level suppliers in the export market, and should live in the mango production city. They buy rejected mangos from the export market channel from growers and have the possibility to sell these mangos to local consumers, rural retailers and Madame Saras. Local retailers sell mangos at different markets throughout the same city. Rural retailers buy mangos from local retailers and sell them to rural consumers in neighborhood cities. The difference between the local and rural retailers is that rural retailers move from city to



Fig. 10. Common collection center.



Fig. 13. Mangos at Port-au-Prince packinghouse.



Fig. 14. Mango sorting at Port-au-Prince packinghouse.

city, and may spend one or two nights at a city. In contrast, the local retailers only sell at different markets within their own cities, and return home after markets close.

First-level suppliers in the domestic channel are made up of women living in the same areas as the growers, or traveling short distances within cities. In fact, rural retailers buy not only green and/or ripe mangos from growers, but also rejected mangos at lower prices from second-level suppliers at either collection centers or collecting points. They work as well for the second-level Madame Saras by buying and/or reserving mangos for them. Both rural retailers and/or first-level suppliers pay growers in advance for mango trees.

Madame Saras, also called Saras, purchase mangos either from local retailers or first-level suppliers. There are some cases where Saras buy mangos directly from growers. This group is made up of women who have cash, and frequently travel over long distances. They manage their time in buying, selling, and traveling. Saras buy wooden baskets of capacity 48, 60, and 240 mangos for the prices of \$0.75, \$1.25, and \$3.13 and sell them to retailers at Port-au-Prince markets. Saras play a key role in the mango trade and possess considerable bargaining power. With the exception of immature and overripe mangos, Saras purchase all rejected marketable mangos from the export channel, and are capable of purchasing huge quantities of mangos. Therefore, they impose their prices for mangos. Bellande and Bizono (2009) reported that one to four Saras are capable of collecting truckloads of 7 to 10 metric tons of mangos. Figure 15 pictures a Madame Sara filling mangos in woven baskets for Port-au-Prince marketplaces.

International and national trade and price trends

The USA and the European Union collectively account for more than 75% of all exported mangos worldwide. Haiti exports 10,000–15,000 metric tons of fresh mangos to five countries: USA, Dominican Republic, Turks and Caicos Islands, Bahamas, and Canada (Francois, 2008; Norvilus and Jean Baptiste, 2008; Raphael, 2009). It is important to note that Haitian mango export to Turks and Caicos is informal. USA purchases around 75% of Haiti's total export volume and nearly all exports to the USA are Francisque mango. Dominican Republic mostly purchases Jean-Marie, Blanc, Doucouce, and Rosalie varieties (Bellande and Bizono, 2009; Raphael, 2009). Until 1997 Haiti was second to Mexico in total mangos exported into the USA market. Since then, however, Haiti's export volumes have been surpassed by Ecuador, Brazil, Peru, and Guatemala (Raphael, 2009; USDA,



Fig. 15. Madame Sara fills wooden baskets with mangos for Port-au-Prince markets.

2010). The Haitian mango industry provides more than 2000 jobs during peak harvest periods (Tardieu, 1998). It is crucial for the country to better manage the industry and develop a strategy to improve its share in both the USA and other international markets.

Studies from FAO, USDA, US National Mango Board and others confirm a steadily growing demand for mangos; the Tanzania Federation of Cooperatives also added Middle East demand (TFC, 2008). The National Mango Board (2012) reported that the percentage of mango buyers increased from 35% in 2007 to 46% in 2011. During that same time period, the percentage of USA mango consumers increased from 67% to 78%. In the USA, the high demand for mangos is centered in Latino-American and Asian diets, specifically in California, Texas, Florida, Chicago, and New York (Norvilus and Jean Baptiste, 2008). The volume of mango exports from Haiti is less than the demand for the niche market and the Francisque variety benefits from premium prices as compared to varieties exported by the other exporting countries (USDA, 2010).

Prices fluctuate with demand and availability of the commodity on markets. Markets in the USA pay higher prices for mangos during the months of February to April, and lower prices in June when greater volumes of fresh fruit enter the markets. The average FOB price per 4.5-kg box is between \$5 and \$6 (US dollars) (USDA, 2010). Haiti exports mangos from the end of March to the beginning of August with a peak in May. However, this period does not constitute the only Haitian mango harvest period. The country benefits from different microclimates, allowing mangos to be harvested in lower quantities at certain periods when prices are high for mangos.

Data obtained in the Mirebalais and Saut-d'Eau areas revealed that mango prices per unit vary with stakeholders and the position in the distribution channel. In general, premium prices are paid for an export quality mango and lower prices for a domestic quality mango. Also, the number of mangos per lot differs from stakeholder to stakeholder. Growers will pay harvest workers \$0.125 per lot of 15 export quality mangos and half the premium price (\$0.063) for the same quantity of domestic quality mangos. First-level and independent suppliers purchase lots of 15 export quality mangos from growers for \$0.63 per lot, while rural retailers purchase domestic market quality mangos in lots of 60 for \$0.60 per lot. Second-level suppliers will purchase export quality mangos from first-level suppliers in lots of 14 at \$0.88 per lot, while rural retailers will purchase domestic quality mangos from first-level level suppliers in lots of 60 at \$1.25 per lot. In a similar fashion, second-level suppliers sell their export quality mangos to exporters in lots of 13 mangos each at \$1.50 per lot,

while independent suppliers sell their export quality mangos to exporters at \$1.60 per lot of 13 mangos each. There are price differences among regions. For instance, a lot of mangos in Mirebalais and Saut-d'Eau areas contains 15 mangos, and sold for \$0.63, about \$0.042 per mango. In contrast, a mango lot in Gros-Morne varies from 18 to 21 mangos and sells for \$0.60, or about \$0.03 per mango.

Independent suppliers purchase mangos directly from growers and sell them to exporters who advance them the money to pay the growers at the beginning of mango season. In addition, independent suppliers obtain a higher price than second-level suppliers from exporters for export quality mangos because exporters are more willing to do business with independent suppliers, who are more flexible and do not deal with associations and cooperatives as do second-level suppliers. These associations and cooperatives may serve as bargaining units that control negotiations with exporters. Independent and second-level suppliers compete with each other for mangos and use different strategies to retain their customers or win new ones. However, both suppliers receive the same price for domestic quality mangos. These various prices paid to various stakeholders for various quality fruit are summarized in Table 2, and reduced to unit price per mango at each step along the distribution chain.

Data collected from survey and association records report that a first-level supplier supplied to second-level suppliers an average of 1500 mango lots equivalent to 12.38 tons per harvest season in Mirebalais and Saut-d'Eau areas, and a second-level supplier supplied an average of 15,000 mango lots equivalent to 115.5 tons to exporters. The independent supplier almost doubled the number of mangos supplies by the second-level suppliers and provided around 220 tons to exporters.

For domestic consumption, mango prices vary with zones and the position in the distribution channel. In general, urban consumers pay more for mangos than those living in rural areas.

In the Central Plateau the cost of a mango transported by a person is equal to the animal transport cost of \$0.0083 per piece (Table 3). The transport cost of a wooden basket of 50–60 mangos equivalent to 25–30 kg is \$1.25 USD. The transport cost of a mango from Gros Morne to Port-au-Prince (\$0.028) is double the transport cost of a mango from Mirebalais or Saut d'Eau to Port-au-Prince (\$0.014) due to distance and the state of the road. The transport cost can encourage or dissuade traders involved in the trade of goods. According to Saras, the mango supply from either Gros-Morne or Port-de-Paix is less profitable than that derived from the Central Plateau.

Rejection rates

Several causes may be responsible for mango losses: inadequate harvest-aid, rough harvest, handling and transport, improper storage conditions, pest damages, disease, and so on. Mango post-harvest losses vary with cultivars, varieties and country practices. Ravindra and Goswani (2007) reported a reasonable range of 25% to 40% rejection of production throughout the supply chain in India. Iksan (2000) and Iqbal (2008) also estimated India's mango losses at 25% to 40% while Pathak (2007) mentioned 25% to 30%. Losses in other countries like Tanzania and Pakistan exceeded Ravindra and Goswani's range and were estimated at 60% and 69%, respectively (Iksan, 2000; Iqbal, 2008; TFC, 2008).

In Haiti, mangos rejected from the export channel are sold to domestic markets. As such, two rejection rates are normally reported, the rejection rate from the export channel and the total mango rejection rate from all losses in both export and domestic distribution channels. Researchers disagreed about the exact percent mango losses and rejection rates. Daynac (1986) estimated combined mango losses from producers and suppliers in Haiti at 60% to 65%. Medlicot (2001) estimated higher losses and in the "Postharvest improvement program for the Haitian mango industry" declared the percentage of mango rejection

Table 2. Prices paid per lot or piece to mango growers and suppliers throughout the distribution chain.

| Payer | Payee | Pieces/lot | Price/lot (\$USD) | Price/piece (\$USD) |
|---|--|------------|-------------------|---------------------|
| Growers/suppliers (export market) | Harvest worker | 15 | 0.125 | 0.0083 |
| Growers/suppliers (domestic market) | Harvest worker | 15 | 0.063 | 0.0042 |
| First-level and independent suppliers (export market) | Grower | 15 | 0.63 | 0.0420 |
| Rural retailers (domestic market) | Grower | 60 | 0.60 | 0.0100 |
| Second-level suppliers (export) | First-level suppliers | 14 | 0.88 | 0.0628 |
| Rural retailers (domestic) | First-level suppliers | 60 | 1.25 | 0.0208 |
| Exporters (packinghouses) | Second-level suppliers | 13 | 1.50 | 0.1154 |
| Exporters (packinghouses) | Independent suppliers | 13 | 1.60 | 0.1231 |
| Port-au-Prince retailers (domestic) | Second-level and independent suppliers | 12 | 0.38 | 0.0317 |

Table 3. Transport costs for Haitian mangos by method and production zone.

| Method | Zone | Distance (km) | Quantity (piece) | Cost (\$US) (lot) | Cost (\$US) (piece) |
|-------------|--------------------------------------|---------------|------------------|-------------------|---------------------|
| Human | Mirebalais/Saut d'Eau/Gros Morne | 5–10 | 75 | 0.62 | 0.0083 |
| Donkey | Mirebalais/Saut d'Eau | 5–10 | 150 | 1.25 | 0.0083 |
| Mule | Mirebalais/Saut d'Eau/Gros Morne | 5–10 | 225 | 1.88 | 0.0083 |
| Small truck | Gros Morne/Gonaïves | 30 | 2000 | 50 | 0.0250 |
| Small truck | Gros Morne/Port de Paix | 50 | 2000 | 75 | 0.0375 |
| Large truck | Mirebalais/Saut d'Eau/Port-au-Prince | 55–60 | 14,250–14,300 | 200 | 0.0140 |
| Large truck | Gros Morne/Port-au-Prince | 170 | 18,000 | 500 | 0.0280 |

rate fluctuated between 60% and 70%. ORE (2002) estimated mango losses caused by immaturity and rough handling by use of the picking pole in field harvest at 30%. USAID (2010) stated that mango farmer losses fell into the range of 30% to 40%, and estimated rejection rates for the Francisque mango at 40% of its total production. Dieudonné (2007) estimated 35% of mango harvested are left on the ground to decay and/or fed to animals in the regions of Baint and La Vallée de Jacmel, in southeastern Haiti, while Raphael (2009) reported losses of 29% in Rivière Mancelle, the second section of the Gros-Morne municipality.

Several recommendations were made to lower these high rejection rates. Samson (1980) recommended field management to minimize postharvest losses caused by pests. Other recommendations included: harvesting mangos after morning dew had evaporated, using harvest-aids with cutter blades to leave stems on the fruit and minimize latex burn losses, applying water thermal treatment to the fruits to control subsequent development of anthracnose, using proper truck transportation, transporting fruits early in the morning and late in the night, and storing fruit under the shade to reduce sunburn postharvest losses (Brecht, 2010; Iksan, 2000; Iqbal, 2008; Kimaro et al., 2008). Medicott (2003) pointed out improper handling before, during and after harvesting practices as fundamental causes of postharvest losses, and recommended the use of cutting poles instead of picking poles, animal transport in plastic field crates instead of woven straw bags, and crate loading instead of bulk loading with truck transportation.

To date, the USAID/WINNER project has given postharvest materials and equipment to 10 producer associations (personal communication, 2012). This equipment consisted of 6,800 plastic field crates, 26 mobile collection centers, 26 sorting tables, 52 plastic drums, 10 scales and tarps. For example, the crates protect the mangos during animal transport, and reduce rejection rates at the mobile collection centers, as well as during subsequent transport by truck to packinghouses. This technical and material assistance allows farmers to increase their revenues and improve their living conditions.

Byproducts

Mangos can be processed into a wide range of products, including puree, juice and nectar, wine, dried and frozen slices, jam, marmalade, jellies and pickles. Despite the abundance of production and the high percentage of mango losses and rejections during the harvesting seasons, few companies have invested in processing facilities. One company (Delicious Fruit) and two organizations (ORE in Camp Perrin and UCOPEDSA in Saint Michel de l'Attaye) process mangos into dried slices. Another company, Famosa, produces mango nectars. Some NGOs have funded certain community associations to process mangos into jam, jellies, dried slices, and wine. For example, the "Sisters of the Incarnation," a congregation of Catholic churches founded in Hinche in 1985, trains women in agriculture, health and education. This congregation processes mangos into dried slices using solar energy, as well as creates jellies, jams and wine. In Nov. 2012 USAID funded a processing plant in Mirebalais with a drying capacity of 6,000 lb of dried fruit per quarter (Haiti Info Plus, 2012; Michel, 2012). The European Union funded another drying plant in Gros-Morne.

Summary and Conclusion

The Haitian mango industry is confronted with several problems, including pests, diseases, spread of infestation among

trees, land tenure, poor harvest and handling practices. Planting of established trees increases the state government's costs for control of fruit fly larva populations. Numerous farms are managed by indirect tenure, which limits long-term investment in the establishment of commercial groves.

Export and domestic channel distributions of the Haitian mango industry share certain common characteristics and differences. Picking poles used to harvest mango trees are obsolete, and increase the risk of mango rejection for latex burn. Likewise, the woven straw bag currently used to transport mangos by animal, from field harvest to collection centers or packing sheds, increases the risk for mangos to be rejected because of mechanical injury caused by bruises due to friction from fruit-to-fruit contact combined with vibration from animal movement on rough terrain. There are several advanced harvest tools and transportation methods around the world that have already been tested and proven to be effective. Further research should be done for finding improved harvest and transport tools economically viable.

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