ECONOMIC IMPACT OF IMPROVED HARVEST AND POST-HARVEST PRACTICES ON THE HAITIAN MANGO INDUSTRY

By

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To my parents and Haitian mango industry stakeholders

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AMS	Agricultural Marketing Service
ANAPROFOURMANG	Association Nationale des Producteurs et Fournisseurs de Mangues (National association of mango producers and suppliers)
ANEM	Association Nationale des Exportateurs de Mangues (National association of mango exporters)
APHIS	Animal and Plant Health Inspection Service
ASPVEFS	Association des Producteurs et des Vendeurs de Fruits du Sud (association of Southern producers and sellers of fruits)
CETPA	Centre de Stockage et de Transformation et de Produits Agricoles (a center for storing and processing agricultural products)
COEPDA	Comité Evangélique pour le Développement Agricole (an evangelical committee for the Development of Agriculture)
COPACGM	Coopérative de Production Agricole et de Commercialisation de Gros-Morne (a cooperative of Gros-Morne's agricultural production and marketing)
COPCOMF	Coopérative des Producteurs pour la Commercialisation de Mangues Francisques (a cooperative of producers involving in the trade of Francisque mango)
DEFI	Programme de Développement Économique des Filières Rurales (a program for economic development of rural channels)
DPV	Direction de Protection des Végétaux (Plant Protection Direction)
FAES	Fonds d'Assistance Économique et Social (Funds for economic and social aids)
FAMV	Faculté d'Agronomie et de Médecine Vétérinaire
FENAPCOM	Fédération Nationale des Associations de Producteurs pour la Commercialisation de Mangues (National Federation of mango producer associations)
GPS	Global Positioning System
IHSI	Institut Haïtien de Statistique et d'Informatique (Haitian institute of statistiques and data processing)

ITECA	Institut de Technologie et d'Animation (technology and animation institute)
MARNDR	Ministère de l'Agriculture des Ressources Naturelles et du Développement Rural is the Haitian Department of Agriculture involving in the protection of Natural Resources and Rural Development)
NMB	National Mango Board
NMC	National Mango Council
ORE	Organization for the Rehabilitation of the Environment
PPQ	Plant Protection Quarantine
RAPCOM	Rassemblement des Producteurs pour la Commercialisation de mangues (a group of farmers for the marketing of mangos)
SAPKO	"Sosyete Agrikòl pou Pwodiksyon ak Komesyalizasyon" (an association involving in the production and the trade of mangos)
WINNER	Watershed Initiative for National Natural Environmental Resources

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Mango, *Mangifera indica, L*, is the second largest Haitian export crop after coffee, and annually nets more than ten million dollars to the Haitian economy. Yet, only 21% of all mangos harvested reach export markets because of excessive losses caused by poor harvesting and transport practices. The objectives of this study were to estimate the economic impact to growers and suppliers that could result from the adoption of cutting poles in field harvest, pack frames with field crates for animal transport, and crate loading for truck transport.

The work carried out in this study consisted of two field trips to Haiti. The first provided data with which to characterize the current mango industry, while the second field trip provided data from field experiments designed to measure mango yield distribution by tree category, harvest worker productivity with picking and cutting poles and the effect of cutting poles on rejection rates.

The results show that adoption of cutting poles would have little impact on net income to growers. Nevertheless, additional benefit would be realized further down-stream in the distribution channel by reduced rejection rates from latex burn. Adoption of animal pack frames with field crates for animal transport could be expected to

improve net income to first-level suppliers, and replacing bulk loading of trucks with crate loading should also increase net income to second-level and independent suppliers. The combined effect of these improvements should increase mango exports to the USA from 21% to 28%, (from 10,000 to 13,300 metric tons).

CHAPTER 1
INTRODUCTION

Background

Mango, *Mangifera indica, L*, is the second largest Haitian export crop after coffee and annually nets ten million dollars to the economy. During harvesting periods mango consumption helps to mitigate the problem of food insecurity in Haiti. Additionally, mango trees contribute to soil preservation and environmental protection. The Organization for the Rehabilitation of the Environment (2012) reported that mango is Haiti's most popular tree, estimated at about ten million trees (USDA, 2010). About 150 varieties throughout the country were identified, among them the Francisque variety, estimated at one million trees, which is the sole commercial variety formally exported as fresh fruit (USDA, 2010).

Besides the economic, nutritional, and environmental importance of mangos, Haiti wants to increase their exports for two other reasons. First, the country wants to recover its position in the US mango import market by increasing its market share to raise its export revenues and reinforce its bargaining power. Unfortunately, the country's market share had declined while other countries like Mexico, Brazil and even the Dominican Republic have increased their market shares with a steadily growing international demand for mangos. Smucker et al. (2005) reported that Haiti's market share in the US dropped from 46 percent in the 1980s to 16 percent, and now remains stable at around 4 percent. Even though the Haitian mango is pleasing to consumers and importers because it is organic, and has high quality, taste and flavor, its limited availability in small quantities over short time periods, prevents it from competing with other varieties that are available in larger quantities over longer periods on the market.

During the National Mango Forum held in Port-au-Prince on April 20 and 21, 2010, attended by the USDA/APHIS and the USA National Mango Board, representative mango stakeholders committed to expanding the volume of exports from 2.5 million to 5 million cases of 4.5 kg each (22,500 metric tons) in five years. However, volume of exports has not increased sufficiently to achieve that five-year objective. The USDA market news reported that the country exported 6,458 metric tons of mangos in 2010, 9,874 in 2011 and 7,870 in 2012. With an export volume well below 22,500 metric tons, stakeholders are concerned that they will not meet their 2015 goal of exporting 22,500 metric tons of mangos annually to the United States. Since it is well known that national consumption is well below actual production[1], the Haitian mango industry will have to take initiatives to significantly reduce mango losses and rejection rates throughout the export channel in order to increase the likelihood of meeting the targeted volume of export.

Justifications

The USAID (2010) estimated mango rejection rates to be about 40% of total production of Francisque mangos. However, Medlicott (2001) estimated the rate to be between 60% and 70% and offered several recommendations for reducing the problem. Nevertheless, both sources agreed on certain causes of rejections, such as immaturity, pests and diseases, spots, and poor harvest and post-harvest handling. Together they recommended the use of cutting poles instead of picking poles to reduce rejections due to latex burn, the use of pack frames with plastic field crates instead of woven straw bags in animal transportation of mangos from field harvest to collection centers, and the

[1]Certain associations of Mirebalais and Saut-d'Eau reported having lost about 35 metric tons of mangos in 2008 (Personal communication, 2010).

use of crate loading instead of bulk loading transportation of mangos by truck from collection centers to packinghouses.

There are costs associated with the adoption of the proposed changes in the way mangos are harvested and transported. Stakeholders need to know to what extent these changes will lead to an increase in mango exports and increase in stakeholders' income. However, these increases may not necessarily mean that agents will be willing to integrate the proposed changes in their business. In an environment where agents care mostly about their profit, they will accept the changes only if the benefits outweigh the costs.

Hypotheses and Study Objectives

Three specific hypotheses were formulated for this research. First, the adoption of a cutting pole leads to a reduction in mango rejection rates caused by latex burn, and increases stakeholder net returns. Second, the use of a pack frame system with plastic field crates will lead to a decrease in mango rejection rates caused by mechanical damage, thus increasing first-level suppliers' net return from the animal transportation between harvest sites and collection centers. Third, the adoption of plastic field crates in truck transportation from collection centers to packing houses will lead to a decrease in mango rejection rates from mechanical injury, that would be caused by bulk loading, thus increasing second-level supplier's net return from the truck transportation of mangos in plastic field crates outperforms that derived from the bulk loading. These hypotheses were followed by three specific objectives:

1. Characterize current harvesting and transport practices in the Haitian mango industry;
2. Determine yield tree distribution and harvest worker productivity with picking and cutting poles;

3. Determine the economic impact to stakeholder net incomes from adoption of cutting poles for harvesting and plastic field crates in the transport of mangos by animal and truck.

CHAPTER 2
LITERATURE REVIEW

This chapter provides an overview on mango and includes fruit varieties, causes for rejections and their rates around the world and Haiti in particular. It also describes different mango byproducts and potential business opportunities from mangos for Haiti.

Overview

The mango has been said to be the “most attractive tropical fruit” (Maqbool et al, 2007). It is known by the same name in English and Spanish, but different terms for the fruit and tree are used in French. Indeed, the tree is called “manguier” and the fruit “mangue”. Mango originates from India. In the 16th century Portuguese explorers brought mango to Latin America and the Caribbean countries. The tree finally reached Haiti from Jamaica in the 1780s (JWK International Corporation, 1976).

Mango trees can grow to great heights. Morton (1987) reported trees of 100 feet (30 meters) in height. Vieux (1990) also reported 30-meters tree heights in Haiti. However, short trees are preferable because it is easier to harvest shorter than taller trees. Trees may also have big trunks and large canopies. A canopy covering 2,700 square yards (2,318 m^2) in East Punjab, India was reported by JWK International Corporation (1976). With age, the broad rounded canopy may reach as much as 100–125 feet (30–38 m) in diameter (Morton, 1987). As a result, mango trees require certain spacing to avoid tree canopies from overlapping and compete for sunlight. The recommended planting distance is 12 x 12 m in a humid environment, and 10 x 10 m in a dry environment (Medina and Garcia, 2002). Mature mango trees can thrive without irrigation because their taproot extend deep into the soil and capture ground water. However, irrigated trees at proper critical stages will produce greater yield and better

quality fruit than non-irrigated ones. Mango trees also have a long life span, and certain specimens can live for more than 300 years old and still bear fruits (JWK International Corporation, 1976). Grafted trees live up to 80 years old while those grown from seedling can live for over 100 years (Medina and Garcia, 2002). However, grafted trees start producing fruit 2 to 3 years earlier than those grown from seedling.

Mango colors vary with tree varieties and fruit development stages. Mango peel may be green at maturity and become yellow, red or purple when approaching ripeness. Wide variations can be noted in the size, shape, and quality of the fruit. For example, mangos can be round, oval, ovoid-oblong or having a somewhat kidney and lop-sided shape (Medina and Garcia, 2002).

Mango is a perishable product and should be maintained in proper storage conditions at cool temperatures (10^0C–15^0C) and a relative humidity between 85% and 95% to extend the shelf life of green mangos from two to four weeks (Kitinoja and Kader, 2003). Otherwise modified atmosphere, containing higher concentrations of carbon dioxide, should be used to delay mango ripening (Kader and Ben-Yehosua, 2000). Mature green mangos suffer chilling injury under 13^oC (55^oF) while partially ripe suffers chilling under 10^oC (50^oF) (Kader and Mitcham, 2008). As a climacteric fruit, mango produces natural ethylene and undergoes climactic ripening at 18^0C–24^oC (Kimaro and others, 2008). Mango postharvest shelf life stored at 10^0C–12^oC is up to three weeks (Medina and Garcia, 2002; Kimaro and others, 2008). It is also a sensitive fruit that can be easily damaged by shock and vibration; therefore, the fruit should be carefully handled to reduce mechanical injury.

Mango constitutes an excellent source of vitamin A, essential for good vision. It protects the “skin and body against lung and oral cavity cancers and contains a certain quantity of B vitamins, calcium, iron, phosphorus and carbohydrates necessary for the growth and development of the human body” (Nutrition and You, 2009). In addition, mangos help to mitigate the problem of food insecurity in Haiti. Nearly 80% of the population live on less than $2 USD per day. It is well known that during the mango harvest season hospitals register fewer cases of malnutrition.

In addition, mango has been called super fruits for its special organoleptic characteristics and health quality benefits; food processors utilize the fruits as a common ingredient in “new functional foods” (Nutrition and you, 2012). Nicknamed the “king of fruits” in comparison to its composition to other fruits, mango not only possesses a unique fragrance, savor and flavor, but also constitutes a great source of nutrients. Literature indicates that mangos contain higher vitamin C than citrus fruits, and helps maintain the immune system (Nutrition and you, 2012).

Varieties

More than 1000 varieties of mango exist around the world, but only about 150 are in Haiti (Kriminac, 1998; Francois, 2008; USAID, 2010). Among all those varieties, only the Francisque variety, also called Francine, Madame Francisque, and Madame Francique, is formally exported as fresh produce. Vieux (1990) mentioned that carotte, blanc and fil varieties are informally exported at immature stages to be processed into pickles. Producers prefer selling mangos at immature stages to earn money quickly and minimize future loss caused by pest damage, disease, black and brown spots, physical damage, and other causes of mango rejection from the export channel.

The Francisque mango is the most important mango variety in Mirebalais, Saut-d'Eau and Gros-Morne areas of Haiti. It is the only variety exported fresh from these areas. Mango tree yields vary with cultivars and the age of the trees. A tree may produce 200–300 kg (440–660 lb) of mangos in a good season and only 5 kg (11 lb) in an unfavorable season (Bally and Ian, 2006). Between 10 and 20 years of age, a good mango tree variety may bear 200–300 fruits per tree while the production may double between 40 and 60 years (Morton, 1987). Farmers have reported harvesting more than 1000 mangos from old trees. Experiments with mango trees 50 years old revealed that they yielded as many as 900 mangos per tree.

Mango trees can be found growing everywhere in Haiti; however, certain regions are more well-known for mango production and certain varieties are specific to certain zones. For instance, the Artibonite department is the leading department of mango production. In this department, Gros-Morne is the leading city, followed up by Passe-Reine and Saint-Marc (Vieux, 1990). Mirebalais and Saut-d'Eau are the leading cities for the Central department. Arcahaie, Cul-de-Sac, Carbaret including Casales are well known for mango production in the West department. Table 2-1 provides specific mango varieties found in the main mango production areas.

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 losses from harvest, through post-harvest handling up to consumer tables vary with cultivars, varieties and country practices. Ravindra and Goswani (2007) reported a reasonable range of 25–40% rejection of production throughout the supply chain in India. Iksan (2000) and Iqbal (2008) also estimated

India's mango losses at 25–40% while Pathak (2007) mentioned 25–30%. Losses in other countries like Tanzania and Pakistan exceeded Ravindra and Goswanni's range and were estimated at 60% and 69%, respectively (TFC, 2008; Iqbal, 2008 and Iksan, 2000).

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. The country's mango rejection rates and losses overpassed the normal rejection rate of 25–40% in other countries. Researchers disagreed about the exact percent mango losses and rejection rates. Daynac (1986) estimated combined mango losses from producers and suppliers in Haiti at 60–65%. Medlicot (2001) in his study entitled "Postharvest improvement program for the Haitian mango industry" declared the percentage of mango rejection 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 30–40%, 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 Bainet and La Vallée de Jacmel, in the Southeast of 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, use harvest-aids with cutter blades to leave stems on the fruit and minimize latex burn losses, apply water thermal treatment to the fruits to control subsequent development of anthracnose, use of proper truck transportation, transport fruits early in the morning and late in the night, and to store fruit under the shade to reduce sunburn postharvest losses (Brecht, 2010; Iksan, 2000, Iqbal, 2008, Kimaro and others, 2008). Medlicott (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 post-harvest materials and equipment to ten 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 packing houses. This technical and material assistance allows farmers to increase their revenues and improve their living conditions.

Stakeholder Profit Margins

Table 2-2 shows the profit margin of certain stakeholders in the Haitian mango industry based on export prices for a 4.5 kg box of Francisque mangos. The overall stakeholders' profit margins reported by KRIMINAC (1998) were greater than those reported by Jean (1998) during the same year. In three separate findings, exporters earned the highest profit margin (around 35%) from an export Francisque mango box of

4.5 kg. Producers came in second position (around 10%) and suppliers in third position. There are substantial differences among profit margins of suppliers during the three years under analysis. There are three different types of suppliers: first, second and independent. It may be important to know the profit margin of which type of suppliers. The profit margin of independent suppliers should exceed those derived from the first and second-level suppliers because independent suppliers cut out the middlemen in the export distribution channel. Exporters support the heaviest part of investment compared to other stakeholders.

Byproducts

A crucial lack of mango processing can be noted throughout the country, despite the abundance of production and the high percentage of mango losses and rejections during the harvesting seasons. Few companies are involved in mango processing. One company, Delicious Fruit, processes mangos into dried slices, and another, Famosa, into nectars. ORE is an NGO that also processes mangos into dried slices. Some NGOs have funded certain associations to process mangos into jam, jellies, dried slices and wine. The “Sisters of the Incarnation” called in French “Petites Soeurs de l’Incarnation” is a congregation of Catholic Churches funded in Hinche in 1985. The organization 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. Recently, USAID has funded and inaugurated in November 2012 a processing plant in Mirebalais with a drying capacity of 6,000 lbs of dried fruit per quarter (Haiti Info Plus, 2012; Michel, 2012), and the European Union also funded another drying plant in Gros-Morne.

Despite these initiatives, “the king of fruit” is under exploited, and the Haitian mango industry needs entrepreneurs to invest and earn profits from a valuable

resource, which is wasted. It should be noted that 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. There is also a large market for canned mango products in Haiti, frozen and dried slices, condiments, etc. where investors should appreciate profit margins. Figure 2-1 shows different sortings of mangos and worthy business investment opportunities for mango byproducts.

Summary

The Haitian mango industry is confronted with several problems: pest and disease, spread of disease and infestation among trees, land tenure, poor harvest and handling practices, and so on. Spread of 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. In addition, picking poles used to harvest mango trees are obsolete, and increase the risk of mango rejection from 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. The use of cutting poles to harvest mangos with stems intact to reduce rejection from latex burn, and plastic field crates to protect mangos during transport should be tested to find out their contribution in the reduction of mango losses and economic feasibility for good decision-making.

Table 2-1. Specific mango varieties produced by various departments in Haiti (Adapted from USDA, 2010 and others)

Region ----------	Artbonite	Central Plateau	West	South & Southeast	North
Cities ----------	Gros-Morne, Passe-Reine, Saint-Marc,	Mirebalais, Saut-d'Eau,	Arcahaie, Carbaret, Cul-de Sac, Leogane	Aquin, Saint Louis & Saint Jean du Sud, Camp-Perrin, Les Cayes, Les Anglais, Jacmel, Bainet, La Vallee	Terrier-Rouge, Sainte-Suzanne, Mombin Crochu,
Variety:					
Francisque Blanc		X	X		X
Baptiste		X			X
Corne	X			X	
Doudouce					X
Fil	X	X	X	X	
Francisque	X	X	X	X	
Jean-Marie	X	X	x	X	
Labiche	X			X	
Musca	X	X		X	
Rosalie	x				x
Rond				X	

Table 2-2. Stakeholders' profit margin for a 4.5 kg box of Francisque mangos (Adapted from Norvilus and Jean Baptiste, 2008 and Jean, 1998)

	Jean, 1998		KRININAC, 1998		HAP, 2004	
	USD	%	USD	%	USD	%
Producers	0.43	7.80	0.50	9	7.80	12
Suppliers	0.27	4.80	0.70	13	0.06	1
Exporters	1.75	31.75	1.83	33	2.10	39

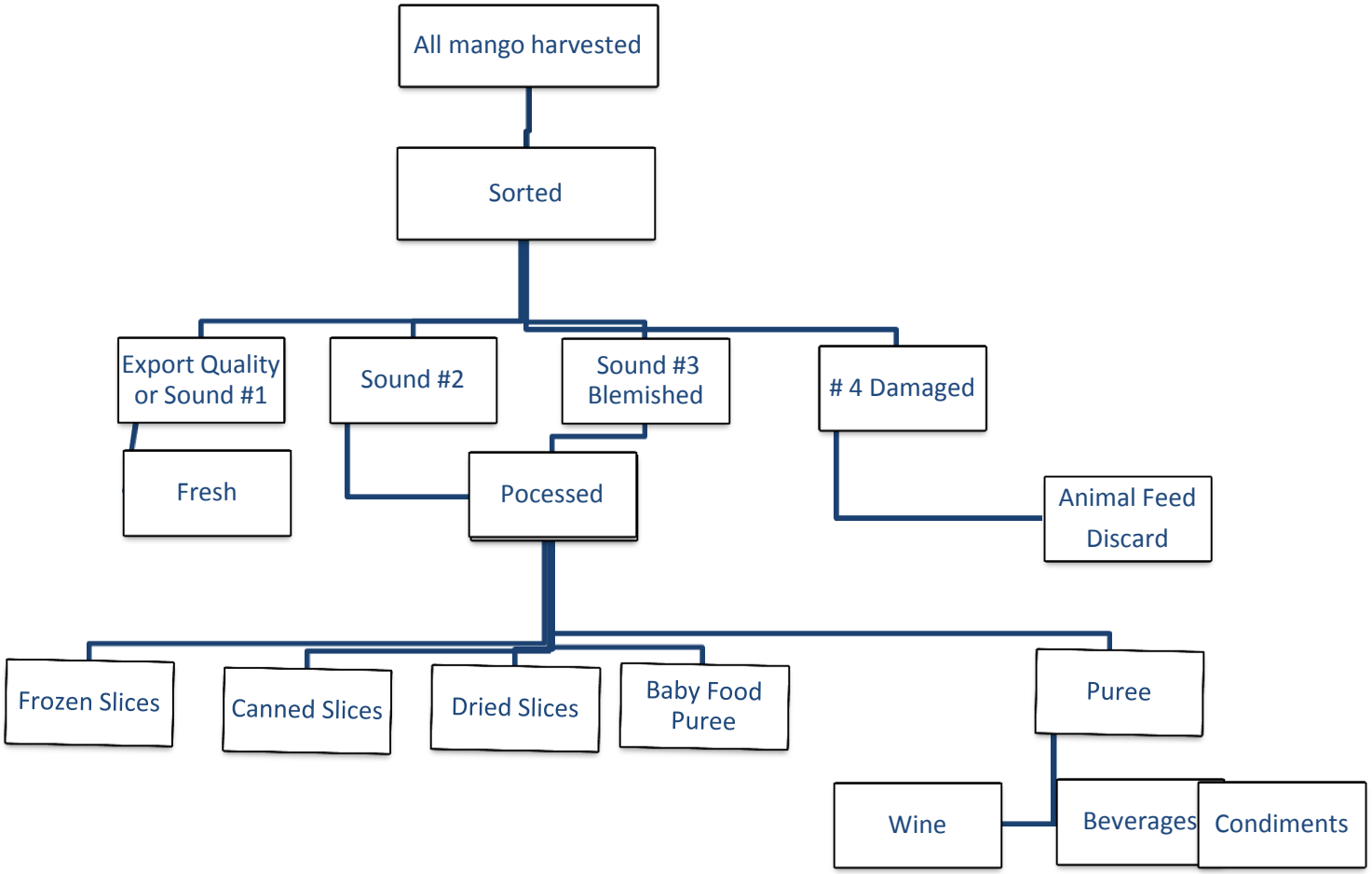


Figure 2-1. Mango by-products and business opportunities

CHAPTER 3
CHARACTERIZATION OF THE CURRENT HAITIAN MANGO INDUSTRY

This section describes the Haitian mango industry and uses data collected during the first field trip taken to Haiti specifically in Mirebalais and Saut-d'Eau, two cities of Central Plateau, the second leading Haitian department of mango production accounting for 20% of the export production, and Gros-Morne, the leading Haitian city for mango production accounting for 50% of the total mango production (Raphael, 2009). Understanding the background of Mirebalais and Saut-d'Eau, including the similarities and differences of the two cities toward the mango industry, is important for the purpose of this study; therefore, an appropriate discussion of each city is provided.

Description of the Study Area

The cities of Mirebalais and Saut-d'Eau share certain similarities and differences. Both cities contain four communal sections. For instance, Crete Brulée, Gascogne, Sarazin and Boucan Carré are within to Mirebalais; Rivière Canot, La Selle, Coupe Mardigras and Montagne Terrible are within to Saut-d'Eau. Moreover, mango trade constitutes the main economic activity of both cities. Several mango associations and foreign independent suppliers advance money to producers for mangos in those cities prior to the mango-harvesting season to ensure high production rates. In this area, every household owns at least one Francisque mango tree in their yard, garden or farm. In addition, both city climates are humid and their annual rainfall exceeds 1500 millimeters of rain (FAES, 2008). Similarly, their annual average temperature is 25^0 C, and exceeds the required storage temperature for mangos, which is between 13^0C and 15^0C (Kitinoja and Kader, 2003). Because the industry does not use a system of refrigeration, mangos in Haiti retain their market quality only for two weeks.

Among the differences between Mirebalais and Saut-d'Eau is that they differ in topography. Mirebalais contains more flat plains than Saut-d'Eau, which contains more mountains. Mirebalais is almost twice the size of Saut-d'Eau in land area, and measures 330 square kilometers, while Saut-d'Eau measures 180 square kilometers (IHSI, 1998a; IHSI, 1998b). The climate in Saut-d'Eau is drier than Mirebalais and Saut-d'Eau offers more appealing mangos in marketplaces because of less rain and more sun during the harvest season. Figure 3-1 points out the Central Plateau where Mirebalais and Saut-d'Eau are located on the Haitian Francisque mango map.

Methods and Procedures

Characterization of the Haitian mango industry was needed in order to have a baseline upon which to compare the outcomes of employing the improved harvest and postharvest practices put forth in the study hypotheses. The objective of the first field trip to Haiti was to collect data on the management conditions of the industry, identify points of mango rejections along the distribution channel, determine stakeholders' involvement, cultural practices in the harvesting and transporting of Francisque mangos, and others, which can be considered as important parameters of an industry characterization.

Data collection on industry characterization. The first task undertaken was to explore the study area to track mangos from field harvest to packinghouses and consumer tables for an understanding of how the industry was managed. Tracking mangos allowed the identification of the points of mango rejection and stakeholders involved in the export channel, including harvesting, handling and distribution. Several visits were made to farms to observe mango trees in their growing environment, tree-harvesting methods, mango sorting and sales. Other visits to collection centers and

Port-au-Prince packinghouses permitted observations of the mango selection procedures, as well as treatments before export shipping. Observations were also made of the transportation of mangos by animal in woven straw sacs from field harvest to collection centers and by bulk-loaded trucks from collection centers to Port-au-Prince packinghouses to gain an understanding of the transportation conditions under which mangos are handled that could lead to potential physical damages.

The second task was to meet producers, harvest workers, suppliers, exporters, executives of Haitian Department of Agriculture and USDA inspectors to discuss industry management practices and current issues. Several discussion meetings with focus group meetings were held with mango stakeholders in the Mirebalais and Saut-d'Eau areas, in Gros-Morne and Pont Sondé, both cities located in the Artibonite department, the leading Haitian department of mango production, and in Port-au-Prince, the Haitian capital, where most of packing houses are located.

An excel spreadsheet was divided into four parts related to four target mango stakeholders (producers, first-level suppliers, second-level suppliers and exporters) and used throughout the investigation. Please see in appendix A the inquiry form used during the characterization of the Haitian mango industry.

Mango producers/growers in Mirebalais, Saut-d'Eau and Gros-Morne were interviewed on mango cultivation practices, planting distances, agricultural practices, varieties, harvesting methods, tree production and value, causes of mango rejection at field harvest, and current issues and solutions. First-level suppliers in the same region were interviewed on tree harvesting costs, purchase costs of mangos at harvest sites,

methods of transporting mangos, costs from harvest sites to collection centers, rejection rates, losses, and prices.

Members and executives of six second-level suppliers were also visited. These suppliers were represented by two associations located in Mirebalais (COEPDA and CETPA), two associations located in Saut-d'Eau (SAPKO and RAPCOM) and two cooperatives located in Gros-Morne (COPACGM, and COPCOMF). These second-level suppliers were also interviewed on rejection rates of mangos transported by animal from harvest sites to collection centers, mangos transported by truck in bulk loading and plastic field crates from collection centers to packing houses, costs by transportation method and selling prices. They also provided data 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, costs, current issues and solutions. In addition to information gathered through discussions, data were also obtained from records supplied by SAPKO, COEPDA and RAPCOM.

There was also the opportunity to visit and participate in the inspection of the Fruit & Legume (F& L) packinghouse, the only mango packinghouse positioned outside of Port-au-Prince, specifically in Pont Sondé, a city in the Artibonite department. At that time, F & L constituted the unique packinghouse, which most efficiently managed energy consumption by surrounding the perimeter of the area containing mangos in plastic crates with foam insulation during the hot water treatment required by USDA protocol (USDA, 2010). Discussions on mango traceability, rejection rates, export volumes and prices also took place with the owner of the F & L packinghouse and the

supervisor of packinghouses within the Haitian Department of Agriculture of the Plant Protection Office.

In Port-au-Prince, meetings with the director and assistant director of the Plant Protection Office of the Haitian Department of Agriculture took place to discuss current issues facing the Haitian mango industry. These meetings yielded key information on the industry and the country's strategic plan as well as copies of official documents. Other meetings took place with exporters and executives of the National Association of Mango Exporters (ANEM) on mango export volumes, prices, rejection rates, transportation methods, quality control and diseases. Several meetings with US and Haitian Departments of Agriculture inspectors involved in mango exports provided key data on mango rejection rates at packinghouses.

Thirty mango farmers were interviewed and data were collected from association records, Haitian and US Departments of Agriculture inspector records, exporters and executives of the ANEM, personal communication with workers at packinghouses, collection centers and field harvesters, online documentation and in Haitian libraries were used in the characterization of the Haitian mango industry.

Results

This section provides the principal results from the first trip taken to Haiti. It includes the history of the Haitian mango industry, its organization, stakeholders involving in the export and domestic distribution channels, international trade, demand for Francisque mangos, production harvesting and transport methods.

History of Haitian Mango Export Industry

Four exporters started exporting 13 metric tons of fresh Francisque mangos in 1958 (JWK International Corporation, 1976). Ten years later, the USA and Bahamas

markets accepted the fruit, and the number of exporters increased up to 17. ASDEM, the association of mango exporters created after 1970, regrouped exporters that have facilities to sort, wash, fumigate and pack mangos. This association reported that 3.6 million, representing 1.5% of 240 million mangos, were shipped by air freight to the USA, and 120 metric tons were also shipped by boat to the Bahamas in 1974. The exportation of Haitian mangos to the United States was developed with the creation of ASDEM currently called ANEM (National Association of Mango Exporters).

Mangos must be fumigated to be sold to US markets. At that time ASDEM was the only institution to own a fumigation chamber; therefore, the association automatically held the monopoly of mango exports to the USA. Nowadays the high cost of establishing packing house facilities with thermal tank constitutes an entry barrier for potential small exporters. Existing installations have to deal with increased USDA/APHIS fees, transportation and energy costs. Nowadays ANEM is responsible for distributing and collecting USDA fees for inspection (USDA, 2010). There were ten facilities (packing houses) exporting mangos to the USA in 2011, but only nine of them exported mangos during 2012. Haiti exports fresh mangos to five countries: USA, Dominican Republic, Turcs and Caicos Islands and Bahamas (Raphael, 2009; Francois, 2008), and the industry provides more than 2000 jobs during peak harvest periods (Tardieu, 1998).

Organization of the Haitian Mango Industry/Mango Distribution Channels

The Haitian mango industry contains two distribution channels, 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 3-2 identifies the main stakeholders in the Haitian mango industry along the two separate marketing channels, while Figure 3-3 pertains only to the export channel showing points of rejection from sorting locations along the way.

Mango comes in second position after coffee as the leading export crop of the Haitian economy. Because Haiti imports almost everything and exports nearly nothing, any increase in exports would reduce the huge gap between imports and exports. Thus, Haiti needs to handle carefully the export channel of the mango industry to ensure and secure the entrance of foreign currency to redress the deficit of balance of payment.

Stakeholders

The main stakeholders involved in the export channel distribution from field harvest to packing house consist of growers/producers, first-level suppliers, second-level suppliers and independent suppliers. Each stakeholder and their involvement are described below.

Growers

Growers constitute the primary link of the mango industry. They own mango trees, take care of them and sell their production output either to first-level suppliers or independent suppliers during the first of the two mango tree harvest seasons. The second harvest season is only to supply domestic markets because exporters stop buying mangos during August month caused of the buildup of flies. They may sell the tree production before the harvest period to first-level or independent suppliers who are willing to advance them the money.

Growers sell their mangos in units of lots, which may consist of a different number of mangos per lot depending on the area for different prices per lot. For

instance, a lot of mangos in Mirebalais and Saut-d'Eau areas contains 15 mangos, and sells for US 63 cents (about 4 cents per mango). In contrast, a mango lot in Gros-Morne, the leading city in the mango-production area, varies from 18 to 21 mangos and sells for US 60 cents (about 3 cents per mango). 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. These suppliers are described below.

First-level Suppliers

First-level suppliers purchase selected mangos for export from growers, and transport them whether by mule or donkey in woven straw sacs from harvest sites to collection centers. They also pay 12.5 cents per lot of mangos transport by persons who carry them over their head in woven wood baskets or aluminum containers. In the Central Plateau the cost of a mango transported by a person is equal to the animal transport cost of 0.83 cent per piece. First-level suppliers sell selected mangos at collection centers to the second-level suppliers and the rejected ones to stakeholders of the domestic channel distribution at this level, which will be explained later in the description of 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 of their decision to harvest the trees when mangos are ready to be harvested. Both the mango owner (producer/grower) and the first-level suppliers, accompanied by the harvest labor team

of a picker and a catcher, go to the farm to harvest the trees. Harvest team workers may harvest trees for the farm owner or the first-level suppliers.

If first-level suppliers purchased the output of the tree production prior to the mango harvest season, they request the harvest of all mangos, even immature ones, pay the harvest team workers for marketable mangos, sell domestic quality mangos to stakeholders in the domestic distribution channel involved at this level, and transport export quality mangos to collection centers to sell to second-level suppliers. In contrast, if mango owners pay for harvesting the trees, they request the harvest of mature mangos. Immediately after the harvest mangos are controlled, the first-level suppliers receive mangos equivalent to the sum advanced to growers. If the tree production exceeds the advanced sum, the rest of export quality mangos are still sold to first-level suppliers. If the tree bears less mangos for the equivalent sum advanced to growers, which seldom happens, growers are responsible to provide additional mangos to first-level suppliers to make up the difference.

Second-level Suppliers

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. Producers may decide to form a group to defend their interests or become a member of an existing association or cooperative. Second-level suppliers usually find NGOs and government supporters to help provide them with free training programs, social advantages and realize some projects with less self-finance requirements. Frequently, they face economic issues, and do not have enough money to buy mangos during the harvest season.

Independent Suppliers

Independent suppliers walk 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 saras who are further explained.

Exporters

Exporters purchase mangos from independent suppliers and the 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 packing house, 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.

Organization of 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 answer to the problem of identification of suppliers. FENAPCOM is a national federation of 16 producer associations for marketing mangos.

The 17 packing houses that exported mangos to the USA in 1970 were reduced to ten in 2011, and further reduced to ten in 2011. Appendix B provides useful data on

the existing 10 packing houses. The combined capacity of current packing houses 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 sara for distribution to domestic market channels at distressed prices. Sometimes, they lose money due to ripening and/or over ripening of otherwise premium export quality mangos. Figures 3-4 through 3-8 shows some shots of packing house facilities and collection centers of the export distribution channel.

Domestic Channel Distribution

Like the export distribution channel, the domestic channel contains several different stakeholders, such as rural retailers, saras and Port-au-Prince retailers and consumers. Please see Figure 3-9 the organization of the domestic channel distribution. Mango growers are common to both distribution channels. In general mangos which 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 those mangos to local consumers, rural retailers and 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 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 travel 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 packing shed or collecting points. They work as well for the second level 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 Sara 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 wood 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. Madame Saras play a key role in mango trade and well manage their bargaining power. With exception for 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 seven to ten metric tons of mangos. Figures 3-10 and 3-11 picture madame sara and truck used to transport mangos from rural areas to Port-au-Prince marketplaces.

International Trade and Price Trends

There are two big importers of mango around the world: the USA and European countries, which purchase more than 75% of all exported mangos. Each of the two markets has their own buying criteria. For instance, European markets prefer organic products, are less stringent in terms of visual appearance and do not mandate thermal

treatment because of Haiti's different climates and environmental conditions potential biological hazards would not survive and be a source of health concern. USDA/APHIS requires for safety purpose the thermal treatment of all mangos from Haiti to be sold on US territory because of certain climatic similarities between the country and the Southern of the USA. The US Agriculture Marketing Services (AMS) has developed three US standards grades for mangos: Fancy, US number one and number two and mangos destined to US market should fall in one of the these three grades. AMS indicates the characteristics of export quality mangos and sets the tolerance level of skin breaks, damage and other criteria that mangos should meet like definite shape, certain size and weight. In addition, mangos should be mature, ripe, free from insect larvae and decay.

Haiti had exported 10,000-15,000 metric tons of mangos to five countries: USA, Dominican Republic, Turcs and Caicos Islands, Canada and Bahamas from 1997 to 2002 (Raphael, 2009; Norvilus and Jean Baptiste, 2008; Francois, 2008). However, the USA purchases around 75% of the total export volume. Dominican Republic mostly purchases Jean-Marie, blanc, doucouce, Rosalie varieties (Raphael, 2009, Bellande and Bizono, 2009). Until 1997 Haiti was in second position in the USA market after Mexico. With time, the country was overpassed by Ecuador, Brazil, Peru and Guatemala (Raphael, 2009, USDA, 2010). It is crucial for the country to better manage the industry and develop a strategy to improve its shares in international markets.

Demand for Francisque Mango

Many documents from FAO, USDA, US National Mango Board and others confirm the steadily growing demand for mangos, as well as Tanzania Federation of Cooperatives which also added Middle East demand (TFC, 2008). The National Mango

Board reported in 2007 that US consumers doubled their mango consumption at restaurants, and US mango consumption rose 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 over the Mexican and Brazilian competitors' varieties (USDA, 2010).

Prices

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 (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 micro climates, allowing mangos to be harvested in lower quantities at certain periods when prices are high for mangos.

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. The transport cost can encourage or dissuade traders involved in the trade of goods. According to certain saras, the mango supply from either Gros-Morne or Port-de-Paix is less beneficial than that derived from the Central Plateau.

Production

Mango trees are mostly grown throughout the tropics and subtropics, and are native to India and Southeast Asia. Over 90 countries around the world produce mango.

Asia produces 77%, Central America 13%, Africa 9% and the rest from others (FAOSTAT, 2007). India is the world leader in mango production and produces 41% of world's production (Ilyas, 2010). Mexico is the largest exporter of mangos to the United States, which is the biggest buyer of Haitian mangos (USAID, 2010). Haiti was third position after Brazil and Mexico as the top mango producing countries in the Americas (Vieux, 1990; Raphael, 2009). The world mango production was estimated by FAO (1999) at 22.8 million metric tons, accounted for 40% of the total fruit production and was in third after citrus and pineapple.

The number of mango trees in Haiti is estimated at ten million (USDA, 2010), and constitute the most popular tree of Haiti. Approximately one million of these trees (10%) produce the Francisque variety, which is the only variety selected for export. Although mango trees constitute the largest tree population grown throughout the ten (10) departments of Haiti, they largely grow in the wild, and the planting of managed groves has only just begun to take hold. Table 3-1 shows the main Haitian mango production regions with the dates of their harvest season, while table 3-2 shows how the harvest seasons coincide with rainy season. Haiti benefits from almost year-long harvest due to different micro-climates, and exports mangos during 10 months out of the year to the United States with variability in production depending on the harvest season.

It is important to note that Haiti's export of Francisque mangos excludes the production of certain departments, like the Southeast and quasi production of the South because of long distances to packing houses, poor road conditions, and incapacity to absorb the volume of export quality mangos in peak harvest seasons. Among the ten packing houses of the country, nine are located in Port-au-Prince (Cul-de-Sac plain).

Only one {Fruits & Legumes (F& L) S.A} is strategically positioned in Pont-Sondé, in the Artibonite department, the leading department of mango production.

Generally, producers do not grow mango trees in managed groves but in fields mixed with several other trees and crops like citrus, avocado, papaya, okra and plantain. There are five commercial mango plantations between 50 and 160 acres which occupy less than 740 acres in the Central Plateau region. The biggest grove covers 160 acres and is located about 35 kilometers (30 minutes) northeast of Mirebalais and belongs to the owner of the F& L's packinghouse. Damais and Bellande (2004) estimated mango production between 200,000 and 400,000 metric tons to production was estimated at 261,000 metric tons (Fransen, 2007). Analysis of export data from USDA market news from 2005 to 2012 indicated that the national volume of Francisque mango production should be around of 47,500 metric tons.

Mango varieties should meet certain characteristics to be eligible for export. Among those characteristics are that the mangos' skin should be thick, have a uniform fruit pulp texture and be free from fibrous tissue , have a small seed pit, and transport well for long shelf-life. They should also be of medium to large sizes and weigh between ¾ and 1 ¼ pounds, and ripen well when picked (JWK International Corporation, 1976).

Harvesting Methods

Harvesting mangos is carried out with picking poles, either from the ground or climbing the tree to drop mangos to a catcher standing under the tree. In most other mango-producing countries, mangos are harvested with a "cutting" pole (equipped with a cutting blade). In Mirebalais, Saut-d'Eau and Gros-Morne areas, people use poles without a cutting blade. Because pickers using picking poles to pull mangos from branches, most of the mangos come without stems, allowing the latex to spew out and

drip onto the mango fruit peels. Several problems can be noted at this point. The first problem is the shock and impact damage caused by the distance that mangos had been dropped by the catcher to the ground. Sometime catchers miss the fruit. The second problem is the sap burn issue due to the latex dripping on the mango's peel, which burns the mango's epidermic cells with time causing "latex burn". Because mangos are often laid down on the ground the latex that drips onto the peel can come into contact with the soil. The soil then sticks to the peel and creates a sandpaper effect that scratches the mangos' skins. In general, Francisque mango trees are harvested with a picking pole (Figure 3-12). Pickers pull mangos from branches, then mangos drop into the picking pole bag fruit-to-fruit, and latex at the same time drips out on the mango peels. Those mangos become highly susceptible to rejection downstream for latex burn because of unavailability of water at numerous mango farms in Haiti to immediately wash mangos and remove the latex. Figure 3-13 shows how mangos are washed in harvest sites.

In the study area mango trees are more likely to be harvested 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 K. Adel, 2003).

Maturity standards have been determined for many fruits, vegetables and floral crops. Harvesting crops at the proper maturity allows handlers to begin their work with the best possible quality produce. Produce harvested too early may lack flavor and may not ripen properly, while that harvested too late may be fibrous or overripe (Kitinoja and Kader, 2003.

Transportation Methods

Transport is one of the key constraints of the mango supply chain. There is in Haiti a lack of transport infrastructure. In mountainous zones like Gros-Morne and Saut-d'Eau, losses due to transport can easily reach 30% with time, road conditions and distances. Figures 3-14 through 3-17 show how mangos are transported from fields through roadsides to collecting centers or packing sheds and from collection centers to rural and Port-au-Prince markets onto packing houses. Depending on mango market destination, mangos can be transported from fields to collecting points for domestic channel or collection centers for export channel. For the export market, mangos can be transported over people's head in wood or aluminum baskets and on animal's back from field harvest to packing shed.

For the domestic market mangos can be also transported over people's heads in sack, animal's backs from field harvest to collecting points and in bulk inside small trucks from field to neighborhood marketplaces. Mangos destined to domestic consumption are also transported by truck in bulk to reach certain rural markets and wood baskets to reach Port-au-Prince markets. Table 3-3 shows the transport cost of small trucks of mangos.

Mangos are transported from fields to collection centers or packing sheds in woven straw bags 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 lbs is equal to 10 lots of 15 mangos, for a total of 150 mangos;
2. On a mule's back, 255 lbs is equal to 15 lots or 225 mangos.

Harvested mangos are first sorted at the field location into three market categories: 1) export; 2) domestic and 3) unmarketable due to defects and damages. Selected mangos for export are sent in woven straw bags on animal back whether to packing sheds (collection centers) for export markets, or collecting points for the domestic market. At the packing sheds mangos are washed, wiped and sorted into two market categories: 1) export and 2) domestic. Most of the time latex burn is not yet visible at field harvest; as a result, growers are able to sell affected mangos. By the time mangos reach the packing shed, latex burn has developed and can be seen. If latex is visible at the collection center/packing shed affected mangos will be rejected.

Selected mangos for export are sent from the packing sheds in bulk trucks to the packing house. At the packing house, mangos are washed and sorted into the export and domestic markets. Selected mangos for export are placed in plastic crates and dumped into a hot water tank kept between 43^0C and 48^0C (115^0F-120^0F) during 60–90 minutes depending on shape, size and weight of mangos to control fruit flies and injury in compliance with USDA/APHIS treatment protocol (USDA APHIS PPQ, 2010).

Second level suppliers and the majority of mango associations and cooperatives prefer shipping mangos in bulk on trucks, instead of into 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 side of truck in order to absorb and reduce some physical impact damage to the mangos. The transport cost of a wooden basket of 50–60 mangos is $1.25 USD.

Summary of Findings

Data collected from survey and association records report that a first-level supplier supplies to second-level suppliers an average of 1500 mango lots equivalent to 22,500 fruits 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 210,000 mangos to exporters. The independent supplier almost doubles the number of mangos supplied by the second-level supplier and provide around 400,000 mangos to exporters.

Table 3-1. Harvest season of main area of Francisque mango production (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

Table 3-2. Harvest mango season coincides with rainfall of Mirebalais and Saut-d'Eau (Adapted from FAES, 2008)

City		Jan	Feb	March	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Mirebalais	Rainfall	R	R	R								R	R
	Harvest Season				H	H		H					
Saut-d'Eau	Rainfall					R	R+	R	R+	R	R		
	Harvest Season				H	H		H					

Table 3-3. Transport costs of mangos by trucks

	Distance (Km)	Transport cost of small truck (USD)
Gros-More_Gonaives	30	50
Gros-Morne-Port-de-Paix	50	63–75

Figure 3-1. Map of the Haitian Francisque mango production areas (Buteau, 2005)

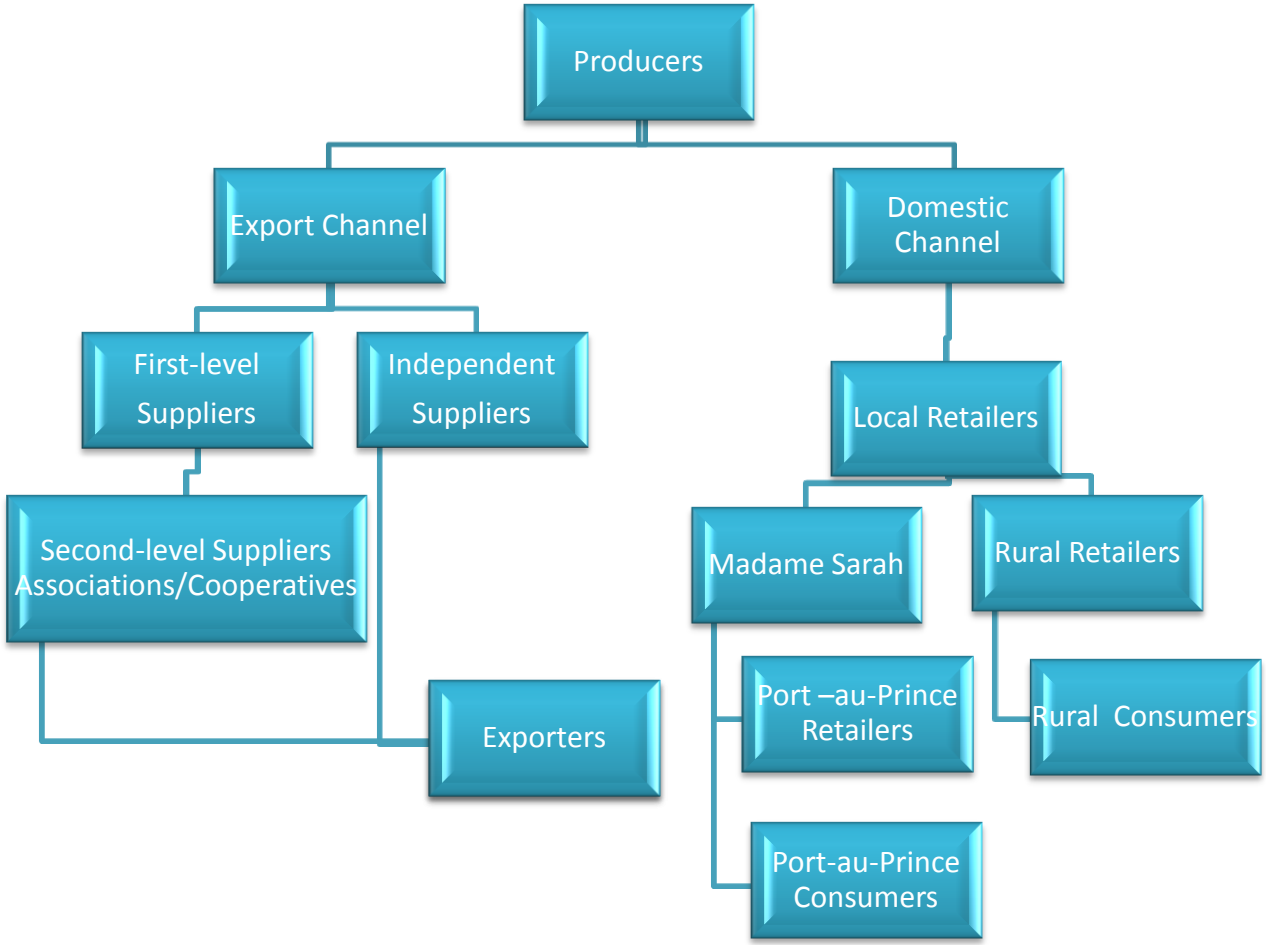


Figure 3-2. Main stakeholders of the Haitian mango industry

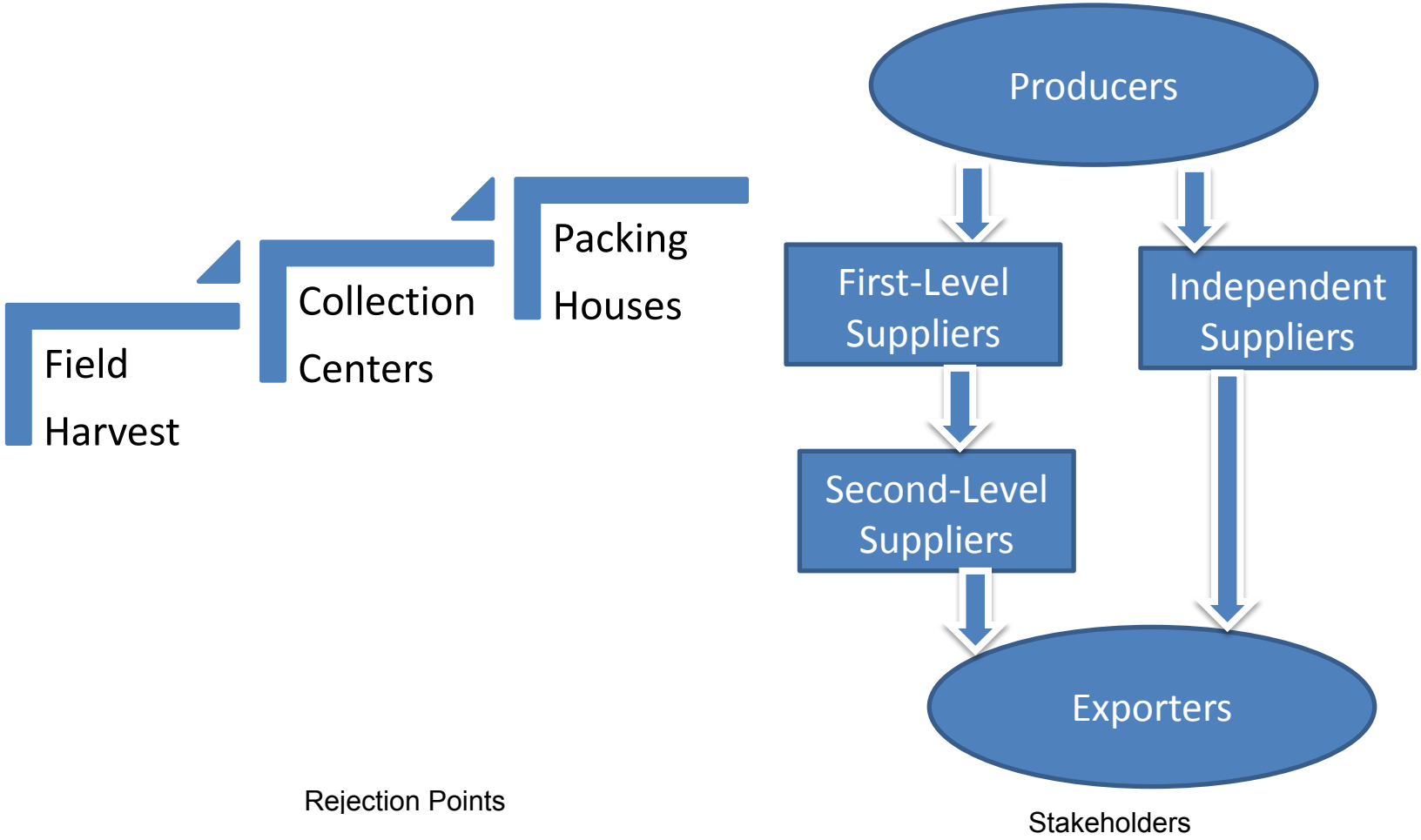


Figure 3-3. Export channel distribution

Figure 3-4. Mangos before washing at packing houses

Figure 3-5. Mango sorting at JMB packing house

Figure 3-6. Mobile collection centers funded by WINNER project_USAID

Figure 3-7. Common collection center

Figure 3-8. The unique packing shed

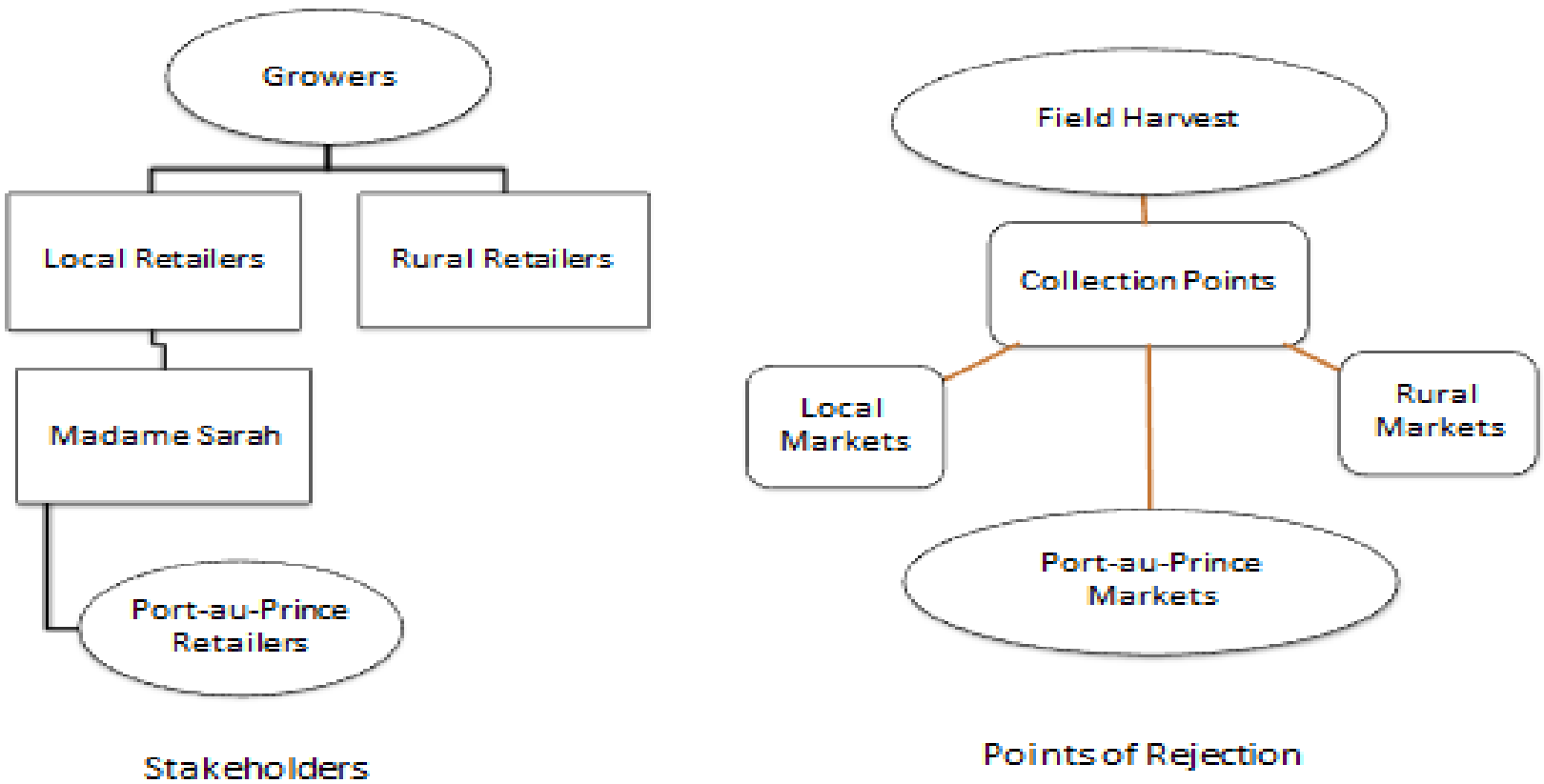


Figure 3-9. Organization of the domestic channel distribution

Figure 3-10. Filling wooden baskets with mangos by madame sara for Port-au-Prince markets

Figure 3-11. Mangos transported by truck in wooden baskets for domestic markets

Figure 3-12. Harvesting mangos with traditional picking pole

Figure 3-13. Washing mangos at field harvest when water is available

Figure 3-14. Mangos transported over human's head

Figure 3-15. Mangos transported by animal in narrow mountainous road

Figure 3-16. Carriers sat over mangos transported by animal

Figure 3-17. Loading mangos to be shipped to packing house facilities

CHAPTER 4
METHODS AND PROCEDURES

The second field trip taken to Haiti focused on conducting experiments for determining mango rejection rates and losses stemming from the traditional and proposed improved harvest and transportation practices. Data collected from these experiments were used to test the study hypotheses and achieve specific objectives.

Second Field Trip

During the second field trip to Haiti experiments were conducted with implementation of improved methods side-by side with traditional methods. Tree yield distributions, harvest worker productivity were also collected for subsequent economic analyses. Economic data on cost of materials and fabrication of needed implements for the improved practices were also obtained to estimate changes in net returns of mango stakeholders.

Field Harvest

Two experiments were conducted during field harvest, which constituted the first identified point of mango rejections. The first experiment examined mango yield distributions by tree category and measured worker productivity using the traditional picking pole and the improved cutting pole. The second experiment consisted of measuring the number of mangos harvested with and without stems from the use of picking and cutting poles.

Mango tree categorization

Substantial variability in yield exists among tree categories for mangos intended for export. Mango trees are classified into three different categories, 1) very suitable, 2) suitable and 3) not suitable. In Mirebalais and Saut-d’Eau areas, professional suppliers

and connoisseurs of mangos determine if they are willing to advance money for the output of a given tree, and the inverse as well. Below is the description of the three categories of Francisque mango trees:

Very suitable. The very suitable category includes young trees in the age range of 8 to 20 years old that were planted in well-designed groves. These groves allow for spacing between trees from 10 X 10 to 8 X 8 m, and do not compete for light. These trees also benefit from good grove management practices, such as applying compost and pruning tree limbs. Mango suppliers are very interested in the “very suitable” tree category and are willing to advance cash to secure the output rate.

Suitable. The suitable category includes the most popular trees from the Mirebalais and Saut-d’Eau areas, and constitutes the typical mango tree of such area. These trees were planted with lack of respect for the recommended 10 X 10 m planting distance. They can also be very tall with their canopy reaching as much as 38 meters (Morton, 1987). One of the consequences of lack of proper spacing is that trees and their output may compete for sunlight. Mangos developing in the shade and under canopies of other trees in addition to climatic factors, such as temperature and humidity, display a poor visual aspect, which constitutes one of the causes of mango rejection from the export channel distribution. Trees in the “suitable” category are often spaced from 7 X 5 to 4 X 3 m, and range in age from 20 to 50 years. They sometimes compete for sunlight, and barely receive any pruning or fertilizer (manure). Some suppliers are also interested in this tree category, and will advance money for the output of these trees.

Not suitable. The “not suitable” tree category includes very old trees of more than 50 in age, and some of them are more than 100 years old. These trees grow in the wild and are densely and/or randomly spaced with no regard for planting distance, and their canopies often touch together. Those trees do not receive any care. Most of the time they are harvested without use of the traditional picking pole, but with cheaper and more expedient harvesting methods, such as “shaking the mango tree limbs”, which causes high loss due to physical damage as fruit fall to the ground. Those trees bear mangos with low market value, and suppliers are not interested in and do not advance money for them.

Tree yield distribution

Four representative mango trees were randomly selected from each of tree category at different locations in the Mirebalais and Saut-d’Eau areas. One to three harvesting teams (depending on tree size) were recruited to harvest each tree with the traditional picking poles. A harvest team included two people, a picker and a catcher. Pickers climbed specific trees and grabbed poles. The catcher stood under the tree holding a small tarp made from a sac supported by two pickets or stakes, one on each side of the sac. After harvesting three to five mangos, the picker would drop the mangos one by one to the catcher. The number of mangos harvested from each tree category was measured and recorded, as well as the number selected for export market, domestic market, and discarded. Figure 4-1 shows a photo of harvesting mangos from one tree with two teams.

Harvest worker productivity with picking and cutting poles

In subsequent experiments, the number of mangos harvested within a given time provided a measure of productivity in terms of number of fruit per minute. Teams started

and stopped harvesting trees at the signal of the researcher. In general, harvesting intervals varied from 10 to 40 minutes without stop, and timed with a stopwatch.

These productivity experiments were carried out in each of the three different tree categories. In one set of experiments, harvest workers used the traditional picking poles, and in another they used the new cutting poles (Figures 4-2 and 4-3). Several precautions were taken to minimize bias risk. A short training was provided to pickers to learn how to best use the new cutting poles. Three harvesting teams were ontracted, and moved together during three consecutive days to maintain consistency with respect to determining the impact of using new cutting poles could have on worker productivity. Precaution to use the same type of poles during harvesting mango trees was taken when experiments were run with more than one team. For instance, all pickers used picking poles when experiments were run with picking pole, and all pickers used cutting poles when experiments were run with cutting poles. Harvest teams were randomly distributed around the trees, and their harvest output was kept separate from each other. In this way, the harvest yield from each tree category could be quantified.

Cutting pole performance compared with picking pole

The performance of the cutting pole was evaluated by comparing the percentage of mangos harvested with stem intact from each type of pole. When the stem remains intact on the fruit, latex cannot escape to cause latex burn on the outer surface of the fruit. Fruits with latex burn are rejected from those intended for export. The traditional picking pole pulls the fruit from the tree branch, often leaving the stem behind, which allows latex to escape and uncontrollably drip onto the outer surface of the fruit.

Field experiments were conducted with traditional picking poles and new cutting poles to compare the percentage of mangos harvested with and without stems from

each pole (Bonicet, 2013). The number of mangos harvested with and without stems from each type of pole ws recorded to determine the percentage of mangos harvested with and without stems.

Only mangos harvested without stem are capable of developing latex burn. Therefore, the economic benefit of harvesting with cutting poles was estimated by tracing the distribution of only mangos without stem. Experiments were carried out to accomplish this objective. All the mangos harvested from ten trees by one grower (5,360) were harvested with traditional picking poles, and followed from field to packing house. The number of mangos rejected because of latex burn was recorded at each step along the way. An additional 5,360 mangos were harvested with cutting poles by another grower, and followed in the same way.

Animal Transportation

Collection centers constitute the second point of mango rejections. Mangos selected to go forward from field harvest are transported to collection centers by pack animals (donkeys or mules) carrying woven straw sacs filled with mangos. The objective of this task was to determine and compare rejection rates at the collection centers from mangos transported in woven straw sacs with those transported in plastic field crates with the prototype pack frame.

Two models of pack frames were developed, a four-crate model for use on donkeys, and a five-crate model for use on mules. The four-crate model carried 150 mangos, equivalent to the number of mangos transported by a donkey or a mule in woven straw bags. The five-crate model carried about 200 mangos, close to 225 mangos (heaviest load) carried by mule. The donkey model was used in this study. A total of eight trips of 150 mangos were transported by animal in woven bags and pack

frame with four plastic field crates from field harvest to collection centers on a distance range up to 2.5 km (Figures 4-3 and 4-4). Similar experiments were conducted by Bonicet (2013) with the pack frame with five plastic field crates on longer distances up to 4 km. Because the industry carries mangos over 10 km, experiments on longer distance were used for economic analyses. A GPS device (Garmin GPS) was used to measure distances between harvest sites and collection centers. The number of mangos rejected for mechanical injury, latex burn and other causes (immaturity, black, dark and brown spots, misshapen, under and overweight) were recorded for both modes of animal transportation.

Truck Transportation

Mangos destined for export are transported from collection centers to packing houses by truck. Packing houses constitute the third point of mango rejections. When trucks arrive at the packing house, mangos are washed and sorted to reject those with defects prior to any further processing. Mangos accepted for processing are sorted once again after the heat treatments required by USDA. Rejection rates at that point are unrelated to mode of truck transport.

Mangos were transported from collection centers to Port-au-Prince packing houses using trucks with two different methods of loading. Half of the mangos were transported in trucks that were loaded in bulk in the traditional way (bulk loading), while the other half was transported in trucks that were loaded with mangos contained in plastic field crates (crate loading). Data from experiments conducted by Bonicet (2013) were used in the economic analysis.

At the packinghouse, mangos were first sorted into two categories, export and domestic. Those in the domestic category were further sorted into three rejection sub categories (mechanical injury, latex burn and others).

Prices Paid to Growers and Suppliers

Data on prices paid to growers by first-level suppliers, and those paid to first-level suppliers by second-level suppliers, as well as those paid to second-level suppliers by exporters were obtained from meetings and discussions with various stakeholders in the Mirebalais and Saut-d'Eau areas. In those cases where data from different sources contradicted each other, further investigation was pursued until the contradiction could be explained and resolved.

Economic Impact

Three steps were followed in the estimation of the economic impact of adopting improved methods of harvest and transport practices. First, estimate the separate effect on rejection rates of adopting the cutting pole in harvesting, pack frame for animal transport, crate loading for truck transport and combined effect of all tree improvements. Second, estimate the added cost of implementing each of the separate adoptions. Third, estimate the expected change in net income to growers and suppliers if each of the improved methods were to be adopted separately, as well as all together.

Figure 4-1. A shot of an experiment conducted on a tree harvested with two harvest teams

Figure 4-2. A shot of a traditional picking pole

Figure 4-3. A shot of an improved cutting pole

Figure 4-3. Mangos transported by donkey in woven bag

Figure 4-4. Mangos transported by mule in pack frame of four and five plastic field crates

Figure 4-5. Bulk loading

Figure 4-6. Crate loading

CHAPTER 5
RESULTS & DISCUSSIONS

This chapter provides evidence for determining whether to accept or to reject hypotheses based on technical performance and economic analyses of certain proposed improved methods targeted at reducing mango rejection rates from the export channel distribution. Based on this evidence, export channel mango industry stakeholders should be able to decide whether to harvest mango trees with the proposed cutting poles or picking poles; whether to transport mangos on mule and donkey in pack frame sets or in woven straw bags; and whether to transport mangos by truck in plastic crates or bulk loading. This chapter is divided into two sections. The first section displays data collected from investigation and experiments; the second section displays economic impact of improvements.

Presentation of Data

The experimental condition in this study involved using poles in harvest sites, donkey and mule to transport mangos from field harvest to collection centers using either pack frames or woven straw sacs and using either plastic crates or bulk loading of mangos in truck transportation from collection centers to packinghouses were used in the economic analysis. Data are presented in three sets based on field experiments.

Field Harvest

The purpose of experiments at field harvest was to figure out mango tree-yield distributions by tree category, percentages of mangos harvested with and without peduncle (stems), and worker productivity by tree category and selected pole. A total of 6133 mangos were harvested and tested to assess if there were any difference between picking and cutting poles and further used in economic analyses.

Yield distribution by tree category

Yield distribution by tree category is shown in Table 5-1. Fruit were harvested from four trees in each category and sorted according to those with quality suitable for export, domestic markets, and not suitable for consumption (discarded). The table 5-1 shows that yields of export quality fruit are highly dependent on tree category. Note that percent of export quality fruit from very suitable trees is more than three times that from not suitable trees. These data make a strong case for the establishment of well managed new mango groves throughout the industry.

Harvest worker productivity with picking and cutting

Table 5-2 compares harvest worker productivity when using the picking pole with that from using the cutting pole for each tree category, as well as for all three categories combined. Productivity was measured by counting the number of fruit harvested in a given period of time.

This table reveals that tree category has essentially no effect on productivity, and the difference in productivity between poles is no greater that the tree-to-tree variability found with either pole. Therefore, it would be difficult to say that the cutting pole will slow down productivity to any significant extent. Moreover, any difference would soon disappear as harvest workers improved their skill with the cutting pole. Therefore, a productivity of ten fruits per minute would be assumed in subsequent data analysis.

Cutting pole performance

The cutting pole was introduced in the hope it would leave the stem on the fruit by cutting the stem from the tree. When the stem remains intact on the fruit, latex cannot escape to cause latex burn on the outer surface of the fruit. Fruits with latex burn are rejected from those intended for export. The traditional picking pole pulls the fruit

from the tree branch, often leaving the stem behind, which allows latex to escape onto the outer surface of the fruit. Bonicet (2013) reported that 15% of mangos were harvested with stems from the use of picking pole in contrast to 66% from the uses of cutting poles. Subsequent percent mangos harvested without stems are useful to determine the contribution of cutting pole in the reduction of postharvest losses of mangos caused by latex burn.

Animal Transport from Field to Collection Centers

Proposed improvement to the method of field transport by pack animal was to replace woven straw sac over an animal's back with plastic field crates supported by a pack frame mounted on the animal's back. The rigid plastic field crates were expected to provide greater protection from mechanical injury that would otherwise occur when fruits were compressed against each other within the straw bags causing bruising and impact damage from the animal's movements. Rejection rates of mangos transported by animal in woven straw bags versus rigid plastic field crates reported by Bonicet (2013) and association records are shown in Table 5-3.

The first observation that can be seen in Table 5.3 is that mean rejection rates due to mechanical injury showed the greatest decline (61.57%), from 8.04% to 3.09%, when transported in field crates. Rejection rates due to latex burn also fell significantly as a result of transport in rigid field crates (35.97%) from 4.17% to 2.67%. This was somewhat surprising because there was no expectation that field crates would have any effect on latex burn. The expectation was that latex would drip from openings left by missing stems whether in crates or in woven bags. One plausible explanation was that fruits were less likely to experience any change in orientation within the field crates, while this could more likely to occur in the woven bags. Data from association records

reported 19.3% in 2011 and 19.2% in 2012 for the total rejection rates of mangos transported by animal in the traditional woven bag (Tables C-2 through Table C-5 in Appendix C). The average rejection rate of 12.81% with plastic crates represents a decrease of more than one-third from the 19.26% rejection rate reported in association records for the traditional animal transport in woven bags. Other causes of rejection including immaturity, black and brown spots, misshape, over and under weight and size were also derived from Bonicet's data and associations' records. These "other causes" were unaffected by the mode of transport and accounted for about 7.05%.

Truck Transportation from Collection Centers to Packing Houses

Rigid plastic field crates were also expected to provide greater protection from mechanical injury when used to load mangos onto trucks (crate loading) for truck transport from collection centers to packing houses. With traditional methods of truck transport, mangos are loaded into the bed of the truck in bulk (bulk loading), and often with other cargo resting on top of the bulk load of mangos. Table 5-4 compares rejection rates of mangos transported by trucks with bulk loading and with crate loading obtained from field experiments conducted by Bonicet (2013), as well as mango association records.

In contrast to data in Table 5-3 for animal transport those in Table 5-4 show the latex burn rejection rates showed the greatest decline (76%) from 6.25% to 1.50% when transported in crate loading. Mean rejection rates due to mechanical injury significantly decreased by 53.55% (from 15.5% to 7.2%) as a result of transport in rigid field crates. Rejection rates due to "other causes" (5.71%) were unaffected by the mode of loading. The total average rejection rate dropped by 47.52% (from 27.46% for bulk loading to 14.41% for crate loading). This average slightly exceeded (less than 2%) the total

average rejection rate of mangos transported by truck in crate loading reported in association records (13.82%). Indeed, associations reported 11.68% in 2011 and 15.97% in 2012 (SAPKO, 2011; 2012; COEPDA, 2011; 2012; RAPCOM, 2011; 2012).

Prices Paid to Growers and Suppliers

Data obtained in the Mirebalais and Saut-d'Eau areas revealed that mango prices per unit vary with stakeholders and their position in the mango industry. 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 ($0.0625) for the same quantity of domestic quality mangos. First-level and independent suppliers will purchase lots of 15 export quality mangos from growers for $0.63 per lot, while rural retailers will 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.

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 and 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 5-5, and reduced to unit price per mango at each step along the distribution chain.

Economic Impact

The present economic analysis uses data gathered from survey during the characterization of the Haitian mango industry and results from experiments conducted with traditional and improved harvest and transport practices to determine the impact of the adoption of new practices in term of reduction of mango rejection rates and costs associated with the adoption of the proposed improvements on stakeholders' net incomes.

Impact from Rejection Rates

This section provides results from comparing rejection rates between those obtained from traditional practices with those to be expected from adoption of improved practices. The se improved practices include adoption of cutting pole for harvesting, pack frame for animal transport, and field crates for truck transport.

Cutting pole

Recall that the benefit of adopting the cutting pole was to increase the number of mangos harvested with stems intact in order to minimize down-stream rejection due to latex burn. Time is required for the latex burn to appear on the surface of the fruit, and is not evident at the time of harvest. Moreover, not all mangos without stem develop latex

burn. Some first-level suppliers and collection centers are equipped with washing facilities to wash the mangos soon after harvest to remove latex. Of course, this introduces added cost of time and labor that is neither quantified nor recorded. Only mangos harvested without stem are capable of developing latex burn. Therefore, the economic benefit of using cutting poles when harvesting mangos can be estimated by tracing the distribution of only mangos without stem.

Experiments were carried out to accomplish this objective. Based on experiments, the average number of mangos of a typical tree of the study area is 536. All mangos harvested from ten trees by one grower (5,360) were harvested with traditional pulling poles, and followed from field to packing house. Assuming mangos were only rejected for latex burn. The rejected ones were recorded at each step along the way. An additional 5,360 mangos were harvested with cutting poles by another grower, and followed in the same way. Results from this work appear on the flow diagram shown in Figure 5-1, which shows the mass balance and fate of mangos harvested without stem (peduncle) as they travel through the distribution chain.

Figure 5-1 reveals that out of the initial 5,360 selected mangos harvested with the traditional picking pole, 8.69% were rejected because of latex burn, while only 3.58% were rejected from the same number of mangos harvested with a cutting pole, indicating nearly 60% reduction in rejection rate by adopting the cutting pole.

Animal pack frame

The impact on rejection rates from adopting the pack frame with field crates for animal transport is illustrated in Figure 5-2, which presents the data taken from Table 5-3 in the form of a flow diagram. The percent rejection due to latex burn taken from Table 5-3 was reduced by one-third to reflect the impact of the pack frame taken from Figure 5-1.

Out of 22,500 mangos transported by each mode, 19.26% were rejected from woven straw bag transport, while only 12.81% from pack frame with field crates, indicating a 33.49% reduction in rejection rates by adopting the pack frame with field crates.

Crate loading with truck transport

The impact on rejection rates from adopting crate loading in truck transportation in place of traditional bulk loading can be seen in Figure 5-3, which presents the data taken from Table 5-4 in the form of a flow diagram. Again, rejection rate due to latex burn in Table 5-4 was similarly adjusted to reflect the impact of the cutting pole taken from Figure 5-1. Out of 210,000 mangos transported by each mode, 27.46% were rejected from bulk loading transport, while only 14.41% from crate loading transport, indicating an additional 47.52% reduction in rejection rates by adopting crate loading.

The impact on rejection rates from each of the three improved practices (cutting pole, animal pack frame and crate loading for truck transportation) are summarized in Table 5-6.

Combined effect from field harvest to export

Flow diagrams showing the combined effect of all three practice improvements (cutting pole, animal pack frame and crate loading on trucks) are given in Figures 5-4 and 5-5 for current practices and improved practices, respectively. Each diagram shows the distribution of 100 mangos at identified rejection points of the export channel: field harvest, collection centers and packing house. These flow diagrams used the yield distribution of the suitable tree category, the typical tree of the current Haitian mango industry. From 100 mangos harvested at field harvest, 47 were suitable for export market, 49 for domestic market and four were unmarketable and either left on the ground to decay or fed to animals. At collection centers 19.26% and 12.81% mangos

(Table 5-3) were rejected from the export market and sold to the domestic prior and after improvements, respectively. The percent discarded at such centers was less than one percent and considered negligible.

The total average rejection rates of improved practices were derived from association records and Bonicet (2013) for animal transport to collection centers and truck transport to packing houses. At the packing houses, a second sorting of mangos occurs downstream along the packing line and provides further rejections. These rejection rates were derived from US and Haitian Departments of Agriculture shown in Tables C-6 through C-9 in Appendix C. For instance, the current total rejection rate from animal transport sorted at collection centers was 19.26% in woven straw bag compared to 12.81% in pack frame set. Likewise, rejection rate from bulk loading in truck transport was 27.46% compared with 14.41% from crate loading. Under current practices, only 21% of all mangos harvested are exported, 74% are locally consumed and 5% are discarded or fed to animals. With adoption of all improved practices combined, 28% could be exported, reflecting a 33% increase in exports, while 67% would be locally consumed, and the same 5% discarded or fed to animals.

Added Cost of Implementation

The economic impact of adopting improved harvest and handling practices must take into account the added cost involved in adopting the new practices. In most cases this added cost is usually the amortized cost of initial capital investment in the purchase of new equipment, such as the cutting poles, pack frames and field crates. In the case of the cutting poles, there could also be added cost if productivity of harvest workers were to decrease because of extra time needed to harvest with a new type of pole. Data on harvest worker productivity with picking and cutting poles by tree category were

presented earlier in Table 5-2, and showed that productivity with both poles was essentially the same at approximately 10 fruits per minute. Therefore, only the amortized cost of a new cutting pole would contribute to any added cost of harvesting.

Cutting pole

The traditional picking pole used by harvest workers is inexpensive, easy to fabricate and not counted as a cost item by the harvest workers, who absorb the cost of making their poles. Please see in Appendix D a breakdown of the traditional picking pole. In contrast, the purchase price of a well-made cutting pole quoted by members of the WINNER project team is $37.50. Cutting poles have a long history of use in harvesting mangos in many parts of the world, and their useful life is taken to be 1,000 trees with an average of 536 mangos per tree. Therefore, a cutting pole can be assumed to harvest 536,000 mangos during its useful life at an amortized cost of $0.00007 per mango. This can be compared with the price paid to harvest workers of $0.0083 per mango presented earlier in Table 5-5, reflecting less than 1% increase in cost to the harvest worker.

Pack frame and field crates

The extra costs associated with the use of the improved animal transportation method will consist of the amortized cost for the purchase of four plastic field crates and the pack frame. The cost of field crates is $11.00 per crate, and the cost of a pack frame fabricated as a duplicate of the prototype developed and used in this study would be $176. The key to amortize these costs is to obtain reasonable estimates of the useful life of the field crates and pack frame in terms of years in order to obtain the amortized cost per mango. The useful life of a pack frame fabricated to the design of the prototype used in this study is four years (Steven Feagle, Agricultural Biological Engineering-

University of Florida, personal communication 18 February 2013). The lifetime expectancy of a rigid plastic field crate can also be assumed to be four years or about 1000 proper uses (Maulik Radia, Plastitech Solution SA, 25 February 2013). Therefore, the initial cost of plastic crates and pack frame can be summed together as a single initial cost to be amortized over four years. The steps taken to convert useful life into amortized cost per mango based on a Central Plateau mango harvest season are shown in Table 5-7.

Crate loading on trucks

The added costs associated with truck transport of mangos packed in field crates will consist of the amortized cost for the purchase of plastic field crates plus the extra cost that will result from delivering fewer mangos in each truck load for the same cost of transportation. A truck load of mangos packed in field crates will hold 302 crates with an average of 37 mangos in each crate for a total of 11,174 mangos. A truck load of mangos carried in bulk will hold 14,286 mangos. The steps taken to determine the amortized cost of the field crates is shown in Table 5-8.

The transportation cost of one truck load of an Isuzu W5500 model is $200 (regardless of loading method). Therefore, the transportation cost per mango from bulk loading is ($200/14,286) = $0.014, and for crate loading is ($200/11,174) = $0.018. The added cost per mango for adoption of crate loading is ($0.018-$0.014) = $0.004. The total added cost per mango due to purchase of crates and fewer mangos per load will be ($0,003 + $0.004) = $0.007.

Impact on Stakeholder Net Incomes

This section estimates the impact of adopting the improved practices on stakeholders' net income. It provides the economic impact of cutting poles on growers

and suppliers, pack frame set on first-level suppliers and crate loading on second-level suppliers and independent suppliers.

Growers/Producers

Adoption of cutting poles would affect net income of growers or producers. Earlier results have shown that adoption of cutting poles would have negligible effect on harvest worker productivity, and that the amortized cost of a new cutting pole would also be negligible. However, the follow-up of mangos harvested without stem in Figure 5-1 shows the adoption of cutting pole should reduce first and second level suppliers' losses of revenue caused by latex burn by 59%. This resulting gain in revenue would have to be passed down to growers/producers and harvest workers by paying them a proportionately greater price per mango in order to have an incentive for adoption of the cutting pole. The percent increase in revenue to first and second level suppliers attributed only to the adoption of cutting pole will be determined in subsequent sections.

First-level Suppliers

Three different suppliers are involved in the distribution channel for exported mangos: 1) first-level suppliers who transport harvested mangos from the field to collection centers by pack animals, 2) second-level suppliers who transport mangos by truck from collection centers to packing houses, and 3) independent suppliers who independently transport mangos from field harvest to packing houses.

Data gathered from mango associations' records and interviews with first-level suppliers revealed that first-level suppliers transport an average of 1500 mango lots at 15 per lot (22,500 mangos) to collection centers per mango season.

The seasonal impact on net income to a first-level supplier resulting from adopting the pack frame with field crates can be estimated by determining revenue and

expenses to be realized from both modes of transport. The harvest season revenue to first-level suppliers from animal transport of mangos using woven bags vs. plastic field crates on pack frame is tabulated in Table 5-9, while expenses are tabulated in table 5-10. A comparison of net income from both modes of transport is shown in Table 5-11. Table 5-11 suggests that net income to first-level suppliers could increase by 45.45% with the substitution of woven straw bags with field crates and pack frame for animal transportation from field to collection centers. Note first-level suppliers should nearly earn $200 instead of $99 obtained in Table 5-11 because they mostly purchase the production of trees at the blossom stage for nearly 50% of mango values as risk management of uncertainty in agriculture and harvest cost.

Figure 5-6 displays the distribution of the 22,500 mangos supply by a first-level supplier to a second-level supplier transported by animal in the traditional woven straw bag from harvest sites to collection centers. This figure indicates the adoption of cutting pole should reduce first-level suppliers' mango rejection for latex burn by 60%. That figure was used in the determination of the impact of cutting pole on first-level suppliers' incomes. Because of no significant difference in harvest worker productivity with the use of cutting pole, the same harvest cost of 8.33 cent was maintained. All mangos were transported by animal in the traditional woven bag. Prior first-level suppliers' expenses ($1,132) that can be seen in Table 5-10 were used to determine the impact of cutting pole on first-level suppliers' net income. Revenues and incomes can be seen in tables 5-12 and 5-13, respectively. Table 5-13 infers that first-level suppliers should increase their income by nearly 2% with the replacement of picking pole by the cutting pole. This

could translate into a 2% increase in prices paid to growers as an incentive to adopt cutting poles.

Tables 5-14 and 5-15 contain first-level suppliers' revenues and incomes directly affected by the mode of animal transport from harvest sites to collection centers. Table 5-15 shows that first-level suppliers could increase their revenues and expenses by 3.52% and 1.41%, respectively and improve their incomes by 15.12% with the substitution of woven straw bags by pack frame with plastic field crates.

Second-level Suppliers and Independent Suppliers

Second-level and independent suppliers transport mangos by truck from collection centers to packing houses, and could experience some impact on net income by replacing bulk loading of trucks with crate loading. The seasonal impact on net income to a second-level supplier resulting from adopting the crate loading of trucks can be determined by estimating revenue and expenses to be realized from both modes of transport. The harvest season revenue to second-level suppliers from truck transport of mangos using bulk loading and crate loading is tabulated in Table 5-16, while expenses are tabulated in Table 5-17. A comparison of net income from both modes of transport is shown in Table 5-18. Table 5-18.suggests that second-level suppliers' net income could considerably increase by 148.24% with the replacement of bulk loading by trucks with crate loading.

Figure 5-7 displays the distribution of the 210,000 mangos supply by a second first-level supplier to an exporter transported by truck in the traditional bulk loading from collection centers to packing houses. This figure indicates the adoption of cutting pole should reduce first-level suppliers' mango rejection for latex burn by 60%. That figure was used in the determination of the impact of cutting pole on second-level suppliers'

net incomes. The total expense of $18,648 for the transport of the 210,000 mangos supplies to exporters by second-level suppliers during a harvest mango season were used in the determination of second-level suppliers' net income. Revenues and incomes can be seen in tables Table 5-19 and 5-20 respectively. Table 5-20 suggests that second-level could increase their income by 12% with the adoption of cutting pole.

Table 5-21 and 5-22 display the second-level suppliers' revenues and net incomes directly involve in the adoption of crate loading to transport mangos by trucks. Table 5-22 infers that truck transport cost of mangos in plastic field crate exceed the second-level suppliers' revenues. However, the combined effect of crate loading with the reduction of latex burn and the contribution of other causes of rejection in table 5-18 should more than double second level suppliers' incomes.

Table 5-23 summarizes the impact on net income to growers and suppliers resulting from adoption of all three improved mango harvest and transport practices.

Note that impact on independent suppliers' net incomes is not presented here. However, independent suppliers' net incomes should exceed those of second-level suppliers because independent suppliers purchase mangos directly from growers at lower prices and sell them directly to exporters at higher prices than second level suppliers. These price advantages to independent suppliers occur because exporters advance money to independent suppliers to purchase mangos for them as an incentive bonus. As such, independent suppliers circumvent the practice of price negotiations that takes place between first and second level suppliers.

Table 5-1. Mango yield distribution by tree category from four trees in each category.

Tree Category	Total Fruit Harvested	Export		Domestic		Discarded	
		(Pc)	(%)	(Pc)	(%)	(Pc)	(%)
Very Suitable	1432	1104	77.11	288	20.1	40	2.78
Suitable	2142	1011	46.93	1041	48.9	90	4.17
Not Suitable	2559	673	25.84	1757	69.2	129	4.95

Note: Raw data collected from experiments conducted in field harvest for determining mango tree yield distribution by tree category can be seen in Table D-1 of appendix D.

Table 5-2. Worker productivity with picking and cutting poles by tree category

Tree Category	Picking Pole			Cutting Pole		
	Total Fruit Harvested	Time (Min)	Fruit Per Minute	Total Fruit Harvested	Time (Min)	Fruit Per Minute
Very Suitable	694	70	10	738	78	10
Suitable	951	105	9	1,191	161	8
Not Suitable	1,167	110	11	1,392	145	10
Total All Trees	2,812	285	10	3,321	384	9

Note: Raw data collected from experiments conducted in field harvest for determining harvest worker productivity by tree category and selected pole can be seen in Table D-2.

Table 5-3. Rejection rates of mangos transported by mule in woven straw sacs and plastic field crates with pack frame for pack loads of 210 fruit per load from field harvest sites to collection centers (Bonicet, 2013)

	Mechanical Injury (%)	Latex Burn (%)	Mechanical Injury & Latex Burn (%)	Other Causes (%)*	Average total Rejection rate of association records (2011, 2012) (%)
Woven Straw Bag	8.04	4.17	12.21	7.05	19.26*
Pack Frame Set	3.09	2.67	5.76	7.05	12.81***

*Derived from Bonicet (2013) and association records
**Please see [Tables C-4 and C-5 of the Appendix C]
*** Also derive from Bonicet and association records.

Table 5-4. Rejection rates for truck transport in bulk and crate loading (Bonicet, 2013)

	Mechanical Injury (%)	Latex Burn (%)	Mechanical Injury & Latex Burn (%)	Average total Rejection rate of association records (2011, 2012) (%)
Bulk Loading	15.00	6.25	21.75	27.46
Crate Loading	7.20	1.50	8.70	13.82

*Please see association records at [Appendix Tables C-2 and C-6]
**Please see association records at [Appendix Tables C-3 and C-5]

Table 5-5. Prices paid per mango to growers and suppliers throughout the distribution chain

Payer	Payee	pc/lot	Price/lot ($USD)	Price/pc ($USD)
Growers/Suppliers	Harvest Worker	15	0.125	0.0083
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 (packing houses)	Second-level Suppliers	13	1.50	0.1154
Exporters (packing houses)	Independent Suppliers	13	1.60	0.1231
Port-au-Prince Retailers (Domestic)	Second-level and Independent Suppliers	12	0.38	0.0317

Table 5-6. Summarized impact of improved practices on rejection rates

	Current Practice	%	Improved Practice	%	Impact
Harvest Pole	Picking	8.69	Cutting	3.58	59%
Animal Transport	Woven straw sac	12.21	Plastic Field Crate & Pack Frame	5.76	53%
Truck Transport	Bulk Loading	21.75	Plastic Field Crate	8.70	60%

Table 5-7. Steps taken to convert useful life into amortized cost per mango transported in plastic field crates on a pack frame set

Factors considered	Cost of Pack Frame Set $176
Trips per day	8
Days per harvest season	52
Harvest seasons per year	1
Lifetime expectancy	4 years
Number trips per lifetime	(8x52x1x4) = 1,664
Number crates per trip	4
Number mangos per crate	37
Number mangos per trip	148
Number mangos per lifetime	(148x1,664) = 246,272
Amortized cost per mango	($176/246,272) =$0.0007

Table 5-8. Steps taken to convert useful life into amortized cost per mango for using crate loaded trucks

Factors considered	Cost of Field Crates (302 @ $11) = $3,322
Crates per truck load	302
Mangos per crate	37
Mangos per truck load	11,174
Truck loads every two days	1
Days per season	52
Truck loads per season	26
Lifetime expectancy	4 years
Truck loads per lifetime	104
Number mangos per lifetime	(104 x 11,174) = 1,162,096
Amortized cost of crates per mango	($3,322/1,162,096) = $0.003/mango

Table 5-9. Harvest season revenue to first-level suppliers from animal transport of 22,500 mangos using woven bags vs. plastic field crates on pack frame

	Prices/pc	Woven Bags			Field Crate with Pack Frame		
Market	(USD)	Number Mangos	%	Revenue (USD)	Number Mangos	%	Revenue (USD)
Export	0.0628	18,167	80.74	1,141	19,618	87.19	1,232
Domestic	0.0208	4,333	19.26	90	2,882	12.81	60
Total		22,500	100.00	1,231	22,500	100.00	1,292

Table 5-10. Harvest season expenses to first-level supplier from animal transport of 22,500 mangos using woven bags vs. plastic field crates on pack frame.

Number mangos transported by one supplier during one harvest season 22,500	Cost/pc (USD)	Woven Bags Cost/season (USD)	Field Crates with Pack Frame Cost/season (USD)
Purchase	0.042000	945	945.
Transport	0.008330	187	187
Amortized cost of crates and frame	0.000700		16
Total season cost		1,132	1,148

Table 5-11. Comparison of first-level suppliers' net income from both modes of transport

	Woven Bags (USD)	Plastic Field Crates and Pack Frame (USD)
Revenues	1,231	1,292
Expenses	1,132	1,148
Incomes	99	144

Table 5-12. First-level suppliers' revenues from a harvest season of 22,500 mangos harvested with picking and cutting poles

		Picking pole			Cutting pole		
Market	Prices/pc (USD)	Number Mangos	%	Revenue (USD)	Number Mangos	%	Revenue (USD)
Export	0.0628	21,702	96.45	1,363	22,181	98.58	1,393
Domestic	0.0208	798	3.55	17	319	1.42	7
Total		22,500	100.00	1,380	22,500	100.00	1,400

Table 5-13. Comparison of first-level suppliers' net income from picking and cutting poles

	Picking Pole (USD)	Cutting Pole (USD)
Revenues	1,380	1,400
Expenses	1,132	1,148
Incomes	248	252

Table 5-14. First-level suppliers' revenues from a harvest season of 22,500 mangos transported by animal in woven bags and pack frame set

		Woven Bags			Pack Frame Set		
Market	Prices/pc (USD)	Number Mangos	%	Revenue (USD)	Number Mangos	%	Revenue (USD)
Export	0.0628	20,691	91.96	1,299	21,805	96.91	1,369
Domestic	0.0208	1,809	8.04	38	695	3.09	14
Total		22,500	100.00	1,337	22,500	100.00	1,384

Table 5-15. Comparison of first-level suppliers' net incomes from a harvest season of 22,500 mangos transported by animal in woven bags and pack frame set

	Woven Straw Bags (USD)	Plastic Filed Crates and Pack Frame (USD)	Improvement (%)
Revenues	1,337	1,384	3.52
Expenses	1,132	1,148	1.41
Incomes	205	236	15.12

Table 5-16. Harvest season revenue to second-level suppliers from truck transport of 210,000 mangos using bulk loading vs. crate loading

		Bulk Loading			Crate Loading		
Market	Prices/pc (USD)	Number Mangos	%	Revenue (USD)	Number Mangos	%	Revenue (USD)
Export	0.1154	152,334	74.02	17,579	180,978	87.94	20,885
Domestic	0.0317	53,466	25.98	1,695	24,822	12.06	787
Total		205,800*	100.00	19,274	205,800	100.00	21,672

* Two percent (4,200) of all mangos are withdrawn at packing house for testing.

Table 5-17. Harvest season expenses to second-level suppliers from truck transport of 210,000 mangos using bulk loading vs. crate loading

Number mangos transported by one supplier during one harvest season 210,000		Bulk Loading	Crate Loading
Cost Item	Cost/pc (USD)	Cost/season (USD)	Cost/season (USD)
Purchase of mangos	0.0628	13,188	13,188
Transport Cost	0.014	2,940	2,940
Other*	0.012	2,520	2,520
Added Cost of crate loading	0.007		1,470
Total season cost		18,648	20,118

* Include load and unload costs, graders, storage place

Table 5-18. Comparison of net income between bulk loading and crate loading of trucks

	Bulk Loading (USD)	Crate Loading (USD)
Revenues	19,274	21,672
Expenses	18,648	20,118
Incomes	626	1,554

Table 5-19. Second-level suppliers' revenues from a harvest season of mangos harvested with picking and cutting poles

		Picking Pole			Cutting Pole		
Market	Prices/Pc	Latex burn rejection rate = 5.31%			Latex burn rejection rate = 2.12%		
	USD	Number mangos	%	Revenue (USD)	Number mangos	%	Revenue (USD)
Export	0.1154	198,844	94,69	22,947	205,538	97.88	23,719
Domestic	0.0317	11,156	5.31	354	4,462	2.12	141
Total		210,000	100.00	23,300	210,00	100.00	23,861

Table 5-20. Comparison of second level suppliers' net income between picking pole and cutting pole

	Picking pole (USD)	Cutting pole (USD)
Revenues	23,300	23,861
Expenses	18,648	18,648
Incomes	4,652	5,213

Table 5-21. Second-level suppliers' revenues from a harvest season of 210,000 mangos transported by truck in bulk loading and crate loading

		Bulk Loading			Crate Loading		
Market	Prices/pc (USD)	Number Mangos	%	Revenue (USD)	Number Mangos	%	Revenue (USD)
Export	0.1154	177,450	84.50	20,478	194,880	92.80	22,489
Domestic	0.0317	32,550	15.50	1,032	15,120	7.20	479
Total		210,000	100.00	21,510	210,000	100.00	22,968

Table 5-22. Comparison of second-level suppliers' net incomes from a harvest season of 210,000 mangos transported by truck in bulk loading and crate loading

	Bulk Loading (USD)	Crate Loading USD	Improvement %
Revenues	21,510	22,968	6.78
Expenses	18,648	20,118	7.88
Incomes	2,862	2,850	-0.42

Table 5-23. Summary of impact on net income to growers and suppliers resulting from adoption of improved mango harvest and transport practices

	Traditional Practices (USD)	Improved Practices (USD)	Percent Change
Cutting Pole			
First-level suppliers	248	252	2%
Second-level Suppliers	4652	5213	12%
Animal Transport with Pack Frame with field crates			
First-level Suppliers	99	144	46%
Crate-loading in truck transport			
Second-level Suppliers	626	1,554	148%

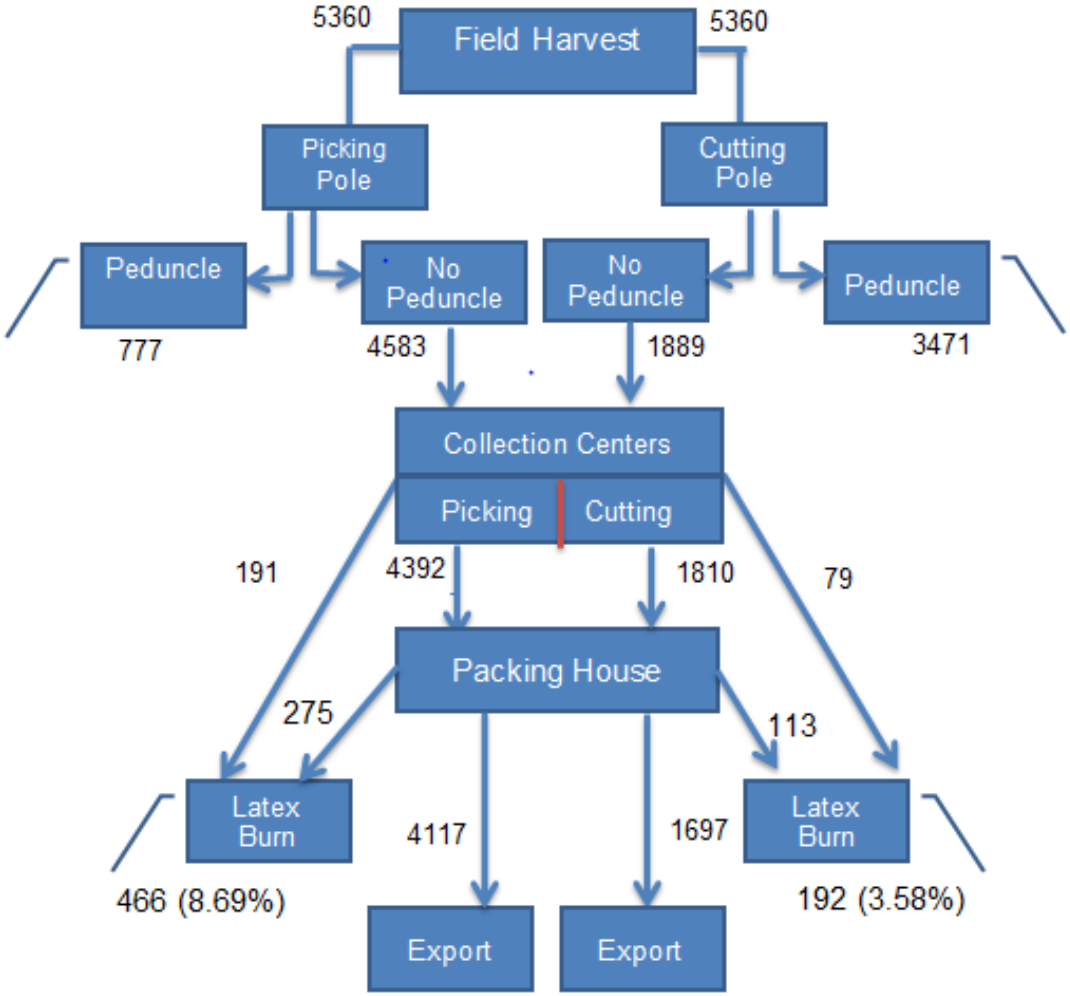


Figure 5-1. Fate of mangos harvested without stem (peduncle) from both cutting and picking poles, and rejected for latex burn as they travel through the distribution chain.

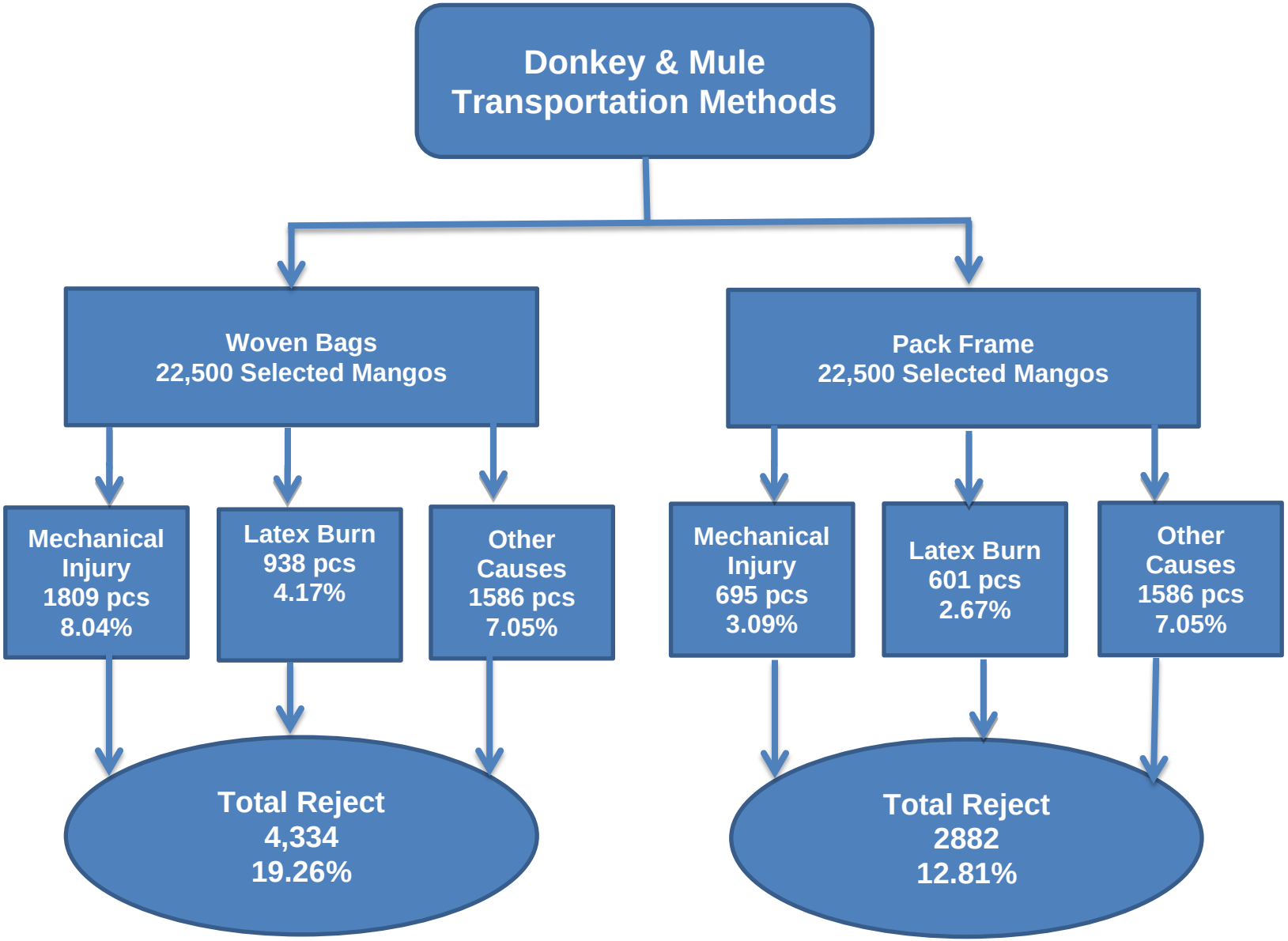
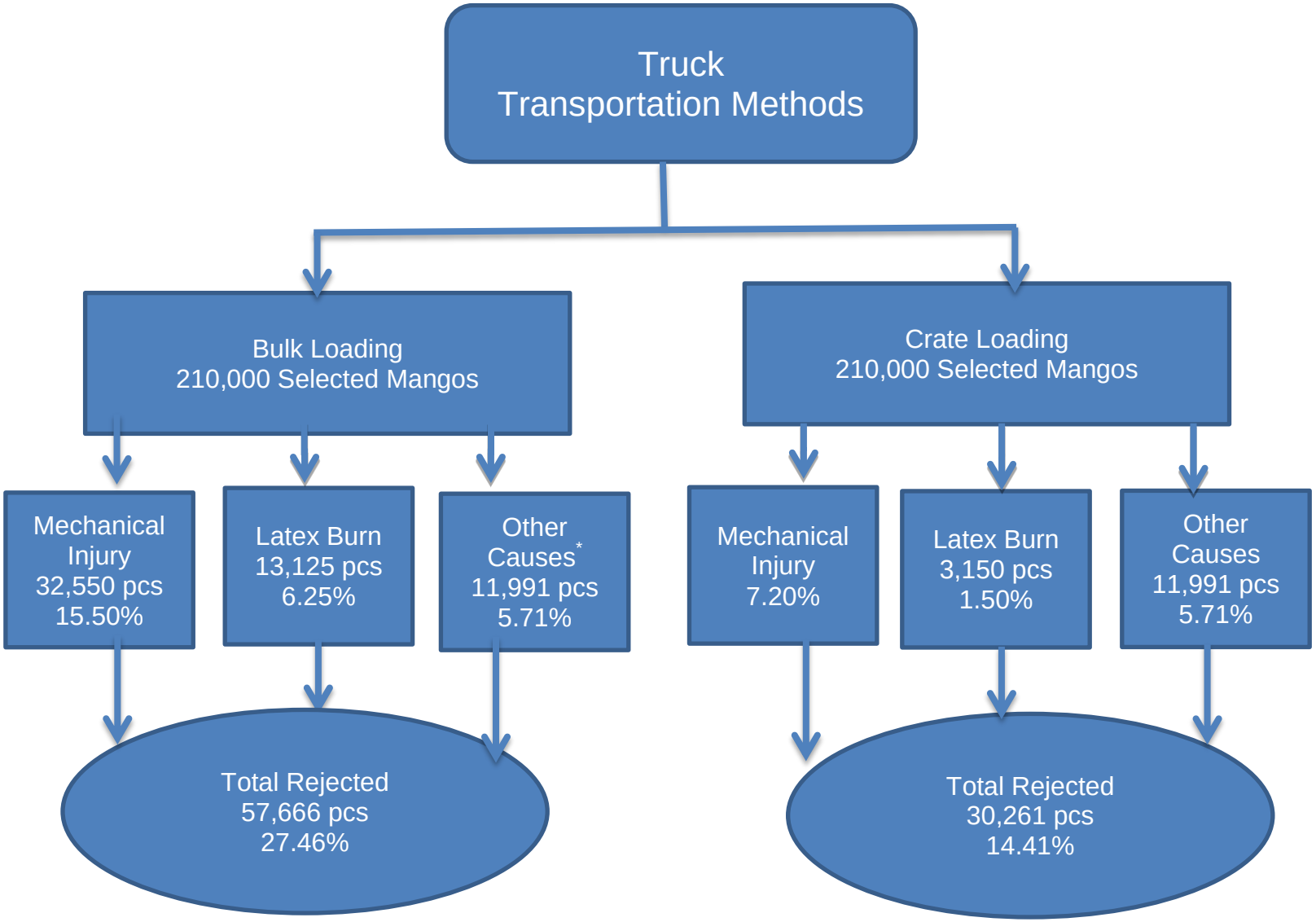


Figure 5-2. Impact on rejection rates from adopting the pack frame with field crates for animal transport



*Other causes include mangos rejected for immaturity, misshape, over and under size and weight, black and brown spots.

Figure 5-3. Truck loading effect on rejection rates at packing house

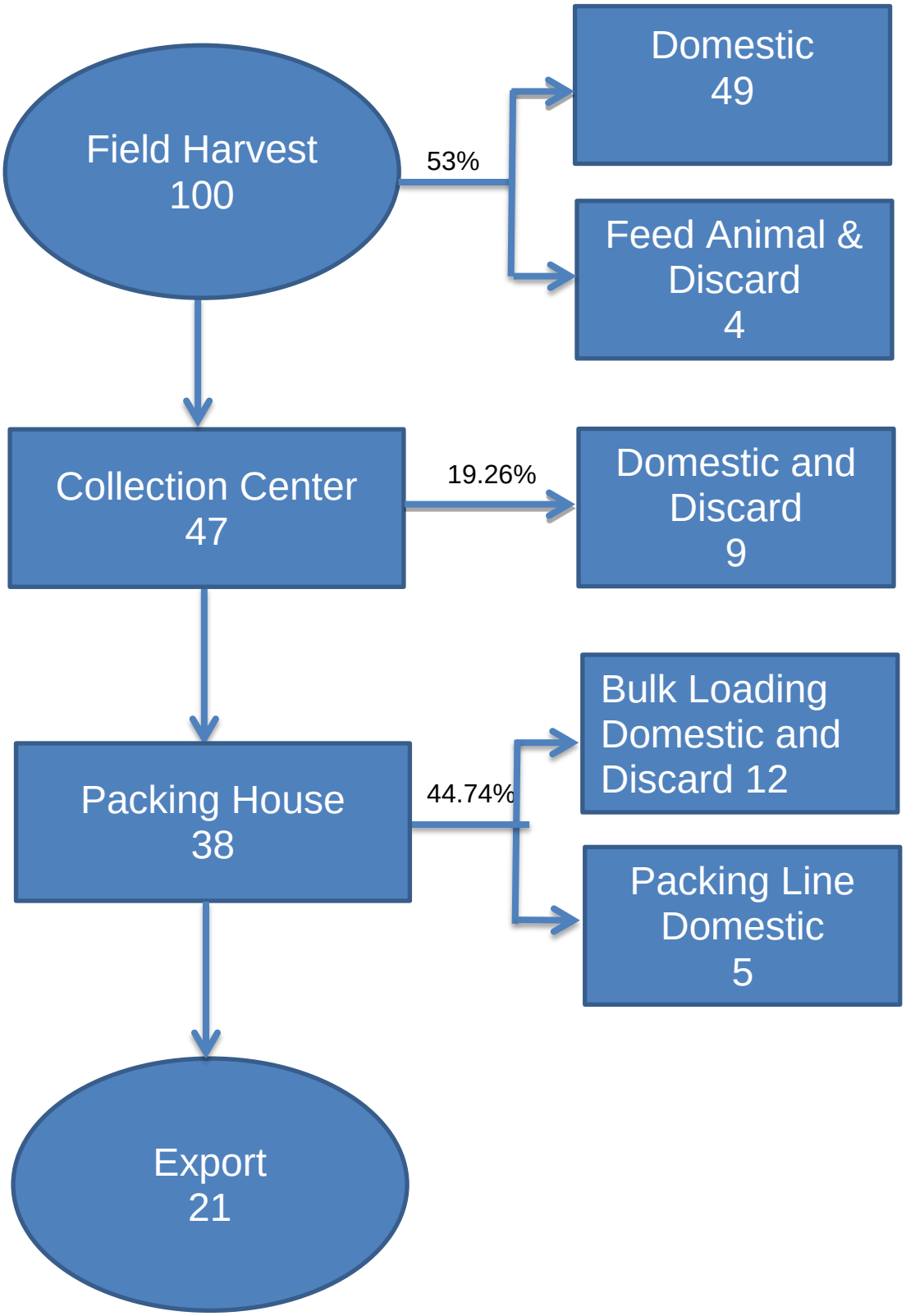


Figure 5-4. Current rejection rates from traditional practices for 100 mangos harvested

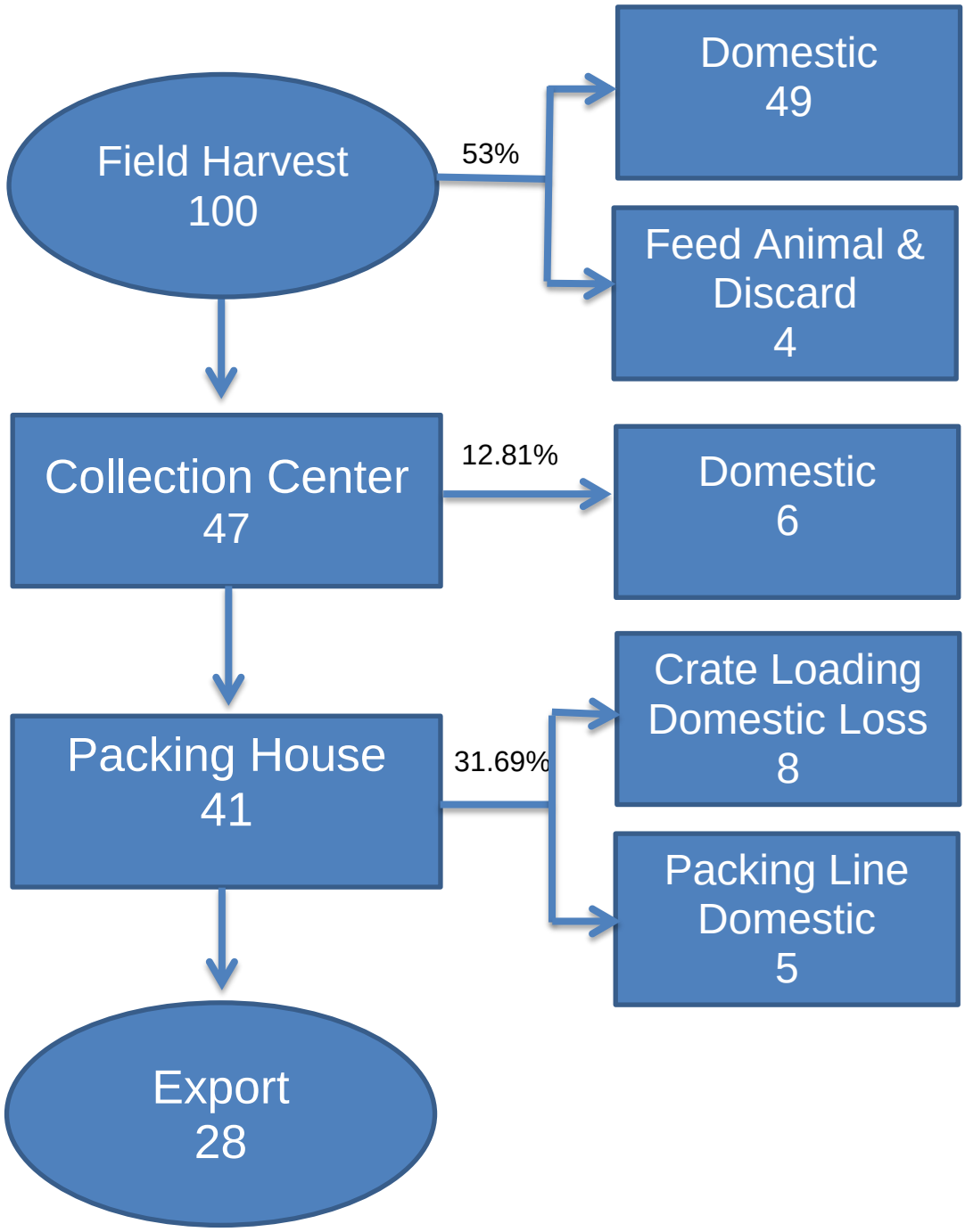


Figure 5-5. Expected rejection rates from adoption of improved practices for 100 mangos harvested.

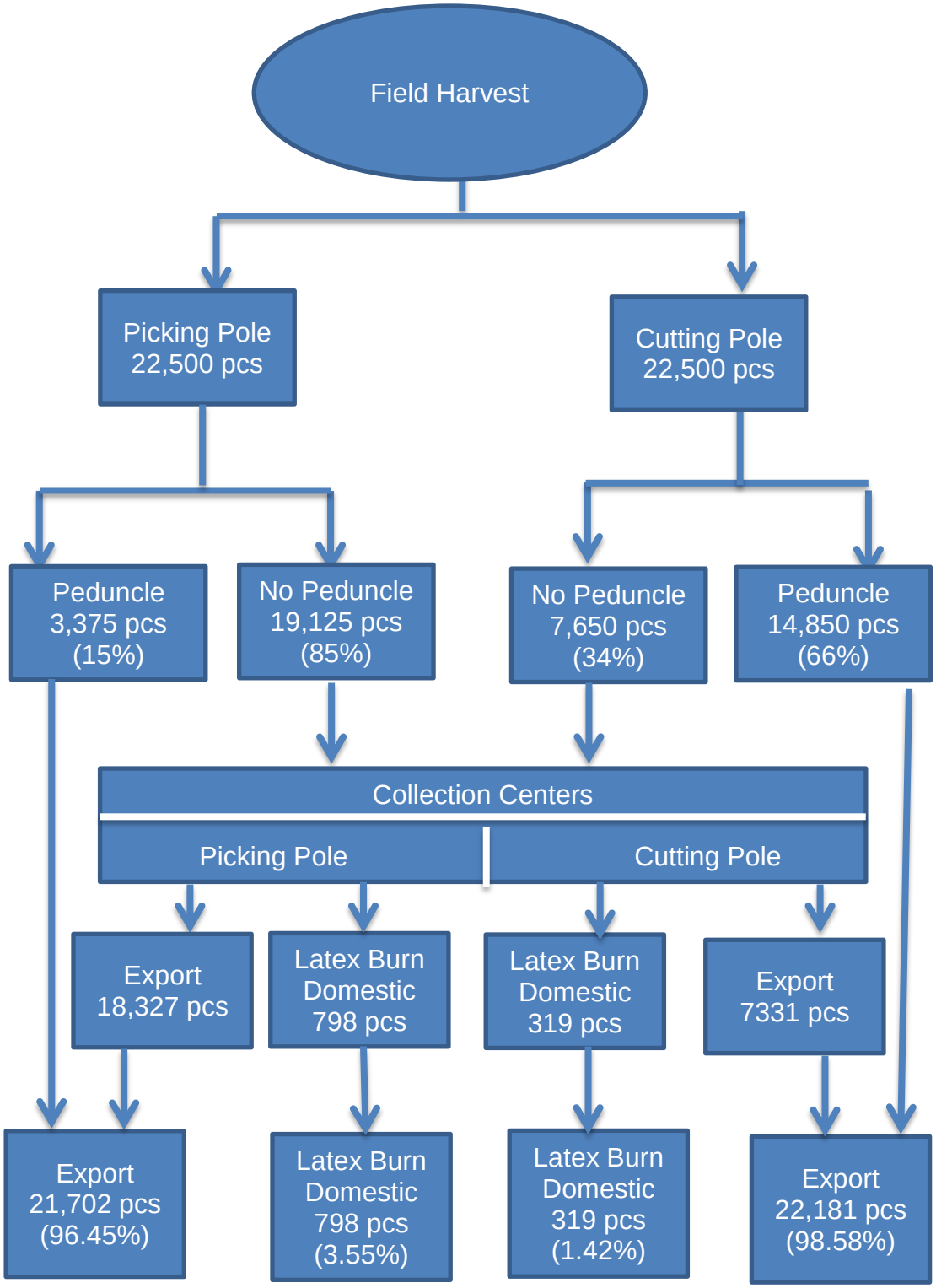


Figure 5-6. Fate of mangos harvested without stem (peduncle) from picking and cutting poles, and rejected for latex burn on first-level suppliers

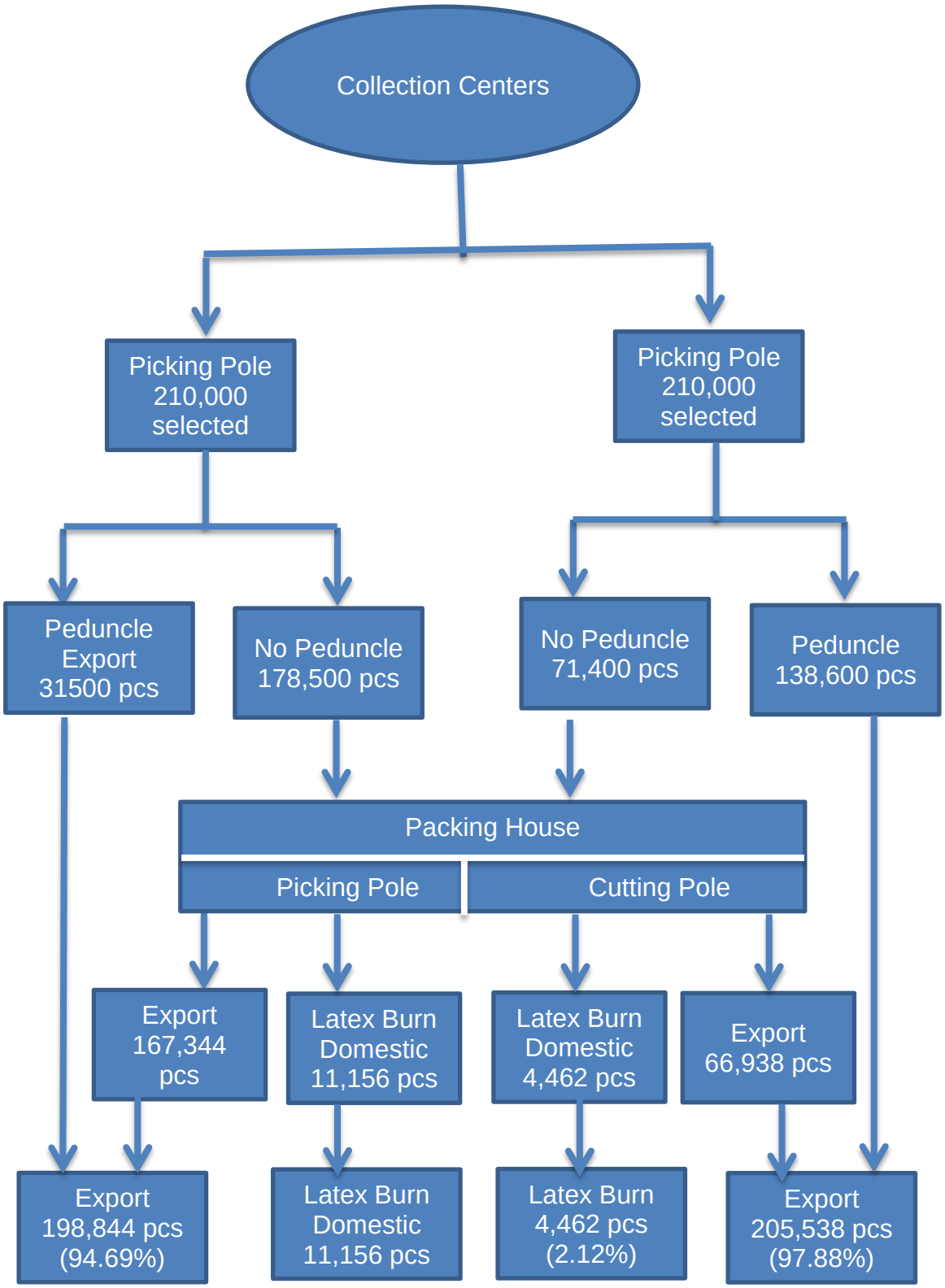


Figure 5-7. Fate of mangos harvested without stem (peduncle) from picking and cutting pole, and rejected for latex burn on second level suppliers

CHAPTER 6
CONCLUSIONS

The objectives of this study were to characterize the industry and determine yield distribution by tree category, to calculate and compare rejection rates of harvest with picking poles to rejection rates of harvest with cutting poles, to compare animal transport with woven bags to animal transport with pack frame and plastic field crates, and to compare truck transport with bulk loading to transport with crate loading. A second set of objectives was to estimate impact on net income to growers and suppliers of the adoption of improved harvest and transport practices. Results from this work suggest that the following conclusions can be drawn:

1. The yields of mango trees of export quality fruit are highly dependent on tree category. Percent of export quality fruit from very suitable trees is more than three times that from not suitable trees. These findings make a strong case for the establishment of well managed new mango groves throughout the industry.

2. The first hypothesis of the research study is justified because adoption of cutting poles could reduce the industry latex burn rejection rates by 59%, improve second-level suppliers income by 12% and first-level suppliers' income by 2%. This increased income should be expected to translate into higher prices paid to growers and harvest workers for mango harvested with cutting poles and act as an incentive.

3. The second research study hypothesis is also justified because the use of animal pack frame with field crates not only reduces mango rejection rates for mechanical injury but also increases net income to first-level suppliers by 46%.

4. The third research study hypothesis is justified because the average rejection rate of mangos transported by truck in crate loading decreases by 53.55% and net income to second-level and independent suppliers could more than double (148% increase) by replacing bulk loading of trucks with crate loading.

5. The adoption of all three improved harvest and transport practices would increase mango exports from Haiti by 29%. This means that current exports from Haiti to the USA could increase from the current 10,000 metric tons to 13,300 metric tons. However, this is still short of meeting the goal of exporting 22,500 metric tons to the USA by 2015.

In order to realize this potential to export 12,000 metric tons of mangos to the USA, the Haitian mango industry should adopt the use of cutting poles to harvest mangos, transport mangos by animal in pack frames with plastic field crates and transport mangos by truck in crates. To do this, equipment and materials should be available and accessible to stakeholders in mango producing areas. Thus, the following recommendations to the Haitian mango industry are proposed,

1. Encourage Government and NGOs involved in the mango industry and entrepreneurs to build or reinforce existing metal workshops in mango production areas that are able to fabricate cutting poles and/or add cutting blades to traditional picking poles in order to reduce the initial investment cost of a cutting pole, which may constitute a barrier for harvest workers who cannot fabricate their own;

2. These metal workshops should also fabricate animal pack frames following the design developed by the University of Florida. This would enable mango associations and cooperatives to rent pack frames, and animal owners to sell the service to first-level suppliers and independent suppliers;

3. Provide training to harvest workers on handling of cutting poles and identification of mature mangos on trees;

4. Second-level suppliers should share their 12% increase in net income from the use of cutting poles with first-level suppliers, who should proportionally share their increase price for mangos harvesting with cutting poles and their additional 2% net income improvement associated with cutting poles with growers, who at the end, should proportionally share their increase price with harvest workers.

5. Independent suppliers should directly increase the price paid to growers and or harvest workers just as the first-and second-level suppliers do.

APPENDIX A
CHARACTERIZATION OF HARVEST AND TRANSPORT OF HAITIAN MANGO INDUSTRY INQUIRY FORM

Facility Identification

Type: Farm/collection center/packing house/other_____
Name:_____
Phone:_____E-mail:_____
Date_____Time _____

Localization

City:_____ Specific name of the area_____

Identification of Interviewee

Name:_____Gender: Female/male
Function at the facility_____:Phone #:_____

Specific Questions to Growers/Producers

Number trees own: ☐ Francisque: ☐ Other varieties ☐
List of other varieties:_____

Cultural Practices

Grove with only mango tree/mango trees associated with other cultures:_____
Planting distance: 10x10m /8x8m/8x 6m/4x4m les than 4x3 m
Fertilizer: yes/no if yes: organic (compost)_____ Chemical:_____
Irrigation during: blossom stage: yes/no maturity stage: yes/no
Pruning after each harvest season: Yes/no sometimes never
Rainy period: Start_____ End_____
Harvest period: Start_____ End_____

Mango Buyers

Export quality: first-level suppliers/second-level suppliers/independent suppliers/
Domestic quality: local and rural retailers/Sara
Issues and solutions_____
_____

Questions to Growers and Suppliers

Harvest period Begin:_____End:_____
Harvesting methods:_____
Shaking branches/hand picking/picking pole/cutting pole/other_____
Same harvesting methods for all varieties: yes/no
Specific harvesting methods for Francisque variety:_____
Harvest maturity indices: Shape/size/weight/peel color/flesh color/others_____

Starting harvest: anytime/early in the morning with dew point/morning after evaporation of dew point/other_____
Harvest time per tree category for export:
Very suitable____Suitable _____Not suitable _____
Number of harvest workers per tree_____
Payment conditions of harvested mangos:
Pickers_____catchers_____
Francisque variety_____ Other varieties_____
Average tree that can be harvested per day by a harvest team worker_____
Tree production: number lot of _____/unit
Price range by tree category: very suitable____suitable_____not suitable_____
Field harvest sorting:
% export_____ % domestic_____ % discard_____
Causes of rejection: immaturity/size/weight/spots/latex burn/others_____
Causes of losses: Immaturity/cut/ pest damages/decay/other defects_____
Where do you wash mangos? Harvest site/collection centers
Mangos wash at farm: yes/no
Estimated time before washing mangos_____
Latex management: _____
Issues and solutions_____

Specific Questions to Frst-level Suppliers

Transport methods: people's head/donkey/mule transport/other_____
Transport cost from harvest sites to collection centers:
People: cost per lots of _____mangos and distance_____km for_____Haitian unit
Animal trip: number of mango lots/units_____Distance_____Cost_____
Animal transport rejection rate_____

Questions to Second-level Suppliers and Independent Suppliers

Do exporters lend you money for mangos? Yes/no
Do you advance cash to growers for mango? Yes/no
In which type of trees are you interested? Very suitable/suitable/not suitable
How do you buy mangos? Rent tree production/per lot of _____/wooden basket of _____/per tree based on estimation at blossom stage
Causes of rejections: bruises/latex burn/ripeness/size/hape/weight/immaturity/spots/
Rejection rates_____
Issues and solutions _____
_____

Specific Questions to Second-level Suppliers

Buying prices of export quality mangos from first-level suppliers at collection centers_____Haitian unit per lot of ___mangos
Selling prices of export quality mango at packing houses_____ per lot of _____
Selling price of rejected mangos from packing houses (domestic quality)__per lot of ___

Specific Questions to Independent Suppliers

Buying prices of export quality mangos from growers at field harvest
Rejection rates at collection centers_____/packing house_____
Selling prices to exporters _____ per lot of _____
Transport methods of mangos from harvest sites to collection centers and collection Centers to Packing house:_____

Questions to Second-level Suppliers and Independent Suppliers

Truck transport methods: bulk loading/crate loading
Number lots of mangos _____ per truck in bulk loading_____and in crate loading_____
Truck transport cost by distance: bulk loading_____ Crate loading
Other expenses:
Load/unload truck____Collection center rent_____Sorting costs of mangos_____
Others_____
Current issues and solutions_____

Exporters

Volumes received at packing houses_____
% export_____% reject_____% withdraw for quality testing_____
Causes of rejection: bruises/latex burn/flies/disease/spots/ripeness/others_____
Buying prices of _____mangos for _____
FOB prices of export quality Francisque mango box of 4.5 kg _____
Packing house capacity_____
Mango process at packing house:sorting/grading/washing/warm water treatment/cooling/packing
Number treatments:_____Number sorting_____
Water temperature set point(s) per mango weight _____Duration: _____min
Surplus management_____
Importance of mango for Haiti_____USD entry in the economy/jobs_____

APPENDIX B
USEFUL DATA

Table B-1. List of the 10 mango packinghouses in Haiti

#	Packing House	Addresses	Comments
1	Finca SA	19 Santo 14, Croix-des-Bouquets Email: lafinca_haiti@hotmail.com Phones: (509)36505000/36503000 37022525/37025554	Owners: Jose Pablo Sylvain, Jean Jacques SYLVAIN Since June,1990 Import/Export, mango, fruit & vegetables
2	Carifresh SA	Santo 17, Croix-des-Bouquets Email: c.reimers@hotmail.com Phone: 50938144541/3437-2800	Production of mangos, peas and corn Export mango Since January, 1983
3	Agropak, Fruit & Vegetables	Santo 25, Croix-des-Bouquets Email: sandy@agropak.com Phone: (509)35111477 Fax: (509)22573886	
4	Germain Paul Import Export	49 Boulevard 15 Octobre, Tabarre, Port-au-Prince Phone: 305 549-7722	
5	HB Plant Import Export	25, Route Nationale #1, Sarthe, Impasse Cazeau Phone: 56-73-560500 FAX: 56-73-381681	
6	Golden Crown	Drouillard, Rue Duvivier, Sarthe Http://www.goldencrownproducehaiti.com Email: renervarela@gmail.com Phone: (509)37691446	
7	Ralph Perry Import and Export, S.A.	Route de l'Aéroport PO Box 1757 Port au Prince, Haïti Email: perryexport@hotmail.com Phone:(509)25107083	
8	Tropical Trading	Plaine de Cul de Sac, Carrefour Lizon	Called "Madame Marcel"

Table B-1 Continued.

#	Packing House	Addresses	Comments
9	JMB S.A.	Impasse Cazeau, Route Nationale #1 Email: jmbuteau@mango-haiti.com bcraan@mango-haiti.com Phone: (509)37014050/35139135	Jean Maurice Buteau
10	Société d'Exportation de Fruits & Légumes (F& L)*	Route Nationale #1, Pont Sondé, Saint Marc, Haïti Phone:(509)34159509/37256869 25580521/37209039 Claude.derenoncourt@agrotechnique.com	Located in Pont-Sondé, Artibonite department

*F& L is the only one mango packing house located out of Port-au-Prince.

Table B-2. Institutions and agents involving in mango industry in Haiti

Name	Institution	Location	Phone
Craan Julien	ANEM	Port-au-Prince	
	ANAPROFOURMANG	Port-au-Prince	
	FENAPCOM	Mirebalais	
Louis Estiverne	CETPA	Mirebalais, Devarieux/ 1125 NW 144th Street, Miami, Fl 33168	50934045578/34456441 Marie Rose Louis Jeune
Fritnel	CETPA's member	Mirebalais, Devarieux	50936736844
Fistel Cénord	COEPDA	Mirebalais	50936184175
Blaise Bien Aimé	SAPKO	Saut d'Eau	5093640894
Hilaire Jean Fleurimond	RAPCOM	Saut d'Eau	50936825302
Thierry Desnord	COPAG	President, Gros Morne	50937974463
Berlus Thomas	COPCOM	Control committee, Gros-Morne	50937805037
Vilton Charles	COPCOMG	President, Gros Morne	50938741248
Renaud Joseph	ASVEFS	South	50928104321/37719715
Robert Métayer	ITECA ORE	Gros Morne Camp-Perrin, South	5093864702 50937921717/37587565 Email:mail@oreworld.org
Renaud Joseph	ASVEFS	Camp-Perrin,	50938680231/37719715 Email:asvefs@yahoo.fr

Table B-3. Estimate cost of a picking pole

Components	Quantity Pcs	Cost USD	Value USD
Sack	2	0.25	0.50
Stake	1	0.50	0.50
Motorcycle tire inner tube	1/6	7.00	1.17
Iron	1/4	2.00	0.50
Subtotal			2.67
Labor 40% subtotal			1.07
Total cost of a picking pole			3.74

Mango pickers reported using the same picking pole during more than three mango season and had harvested about 350 mango trees per season. Therefore, the picking pole can be amortized over 1000 trees. That gives $0.00374 or $3.7^-03.

APPENDIX C
MANGO INDUSTRY RECORD KEEPING

Mango Distribution from Harvest Sites through Collection Centers until Packing Houses in 2011

Data collected from associations records in a two-year period report the total mango rejection rates from harvest sites to collection centers is around of 19%, 27% from mangos transported by truck in bulk loading and 13.83% in plastic field crates from collection centers to Port-au-Prince packing houses in Mirebalais and Saut-d'Eau areas. Table B-1 shows COEPDA shipments of mangos by truck in bulk loading from Mirebalais to Port-au-Prince packing house in 2011.

Table C-1. COEPDA's shipment of mangos transported by truck in bulk loading from Mirebalais collection centers to Port-au-Prince packinghouse in 2011 (COEPDA Records, 2011)

Shipment	Date	Receipt	Packing houses Select		Reject	
#		(Pcs)	(Pcs)	(%)	(Pcs)	(%)
1	4/11/2011	5908	4680	79.21	1228	20.79
2	4/13/2011	6930	5112	73.77	1818	26.23
3	4/16/2011	6146	4728	76.93	1418	23.07
4	4/18/2011	7854	6768	86.17	1086	13.83
5	4/20/2011	13160	10704	81.34	2456	18.66
6	4/21/2011	13160	9288	70.58	3872	29.42
Sum		53158	41280		11878	
Mean		8860	6880	78	1980	22
SD			2570	5.54	1050	5.54
Min		5908	4680	70.58	1086	13.83
Max		13160	10704	86.17	3872	29.42

Table C-2. Distribution of mangos purchased and sold by RAPCOM association in Saut-d'Eau in 2011 (RAPCOM records, 2011)

Ship-Ments #	Date	Collection Centers					Packing Houses				
		Receipt	Select		Reject		Receipt	Select		Reject	
		(Pcs)	(Pcs)	(%)	(Pcs)	(%)	(Pcs)	(Pcs)	(%)	(Pcs)	(%)
1	5/1/2012	14812	11872	80.15	2940	19.85	11872	11011	92.75	861	7.82
2	5/1/2012	5656	4564	80.69	1092	19.31	4564	4147	90.86	417	10.06
3	5/2/2012	10794	8470	78.47	2324	21.53	8470	7644	90.25	826	10.81
4	5/4/2012	14854	12390	83.41	2464	16.59	12390	10075	81.32	2315	22.98
5	5/8/2012	14238	11424	80.24	2814	19.76	11424	10049	87.96	1375	13.68
6	5/9/2012	13371	10934	81.77	2437	18.23	10934	8490	77.65	2444	22.35
7	5/10/2012	7140	5600	78.43	1540	21.57	5600	4573	81.66	1027	22.46
8	5/12/2012	15008	11592	77.24	3416	22.76	11592	10084	86.99	1508	14.95
9	5/14/2012	15694	12278	78.23	3416	21.77	12278	10348	84.28	1930	18.65
10	5/16/2012	17640	14714	83.41	2926	16.59	14714				
11	5/17/2012	16688	13412	80.37	3276	19.63	13412				
12	5/18/2012	19418	15946	82.12	3472	17.88	15946				
13	5/20/2012	17080	13832	80.98	3248	19.02	13832				
14	5/21/2012	15512	12082	77.89	3430	22.11	12082				
15	5/23/2012	14112	11774	83.43	2338	16.57	11774				
16	5/24/2012	16156	13132	81.28	3024	18.72	13132				
Sum		228173	184016	1288.11	44157	311.89	184016	76421		12703	
Mean		14261	11501	80.51	2759.81	19.49	11501	8491	85.97	1411	15.97
SD				2.03	697	2.03		2555	5.07	702	5.85
Min		5656	4564	77.24	1092	16.57	4564	4147	77.65	417	7.82
Max		19418	15946	83.43	3472	22.76	15946	11011	92.75	2444	22.98

Table C-3. Distribution of mangos purchased and sold by SAPKO association in Saut-d'Eau in 2011 (SAPKO records, 2011)

Date	Collection Centers					Packing Houses				
	Receipt	Select		Reject		Receipt	Select		Reject	
	(Pcs)	(Pcs)	(%)	(Pcs)	(%)	(Pcs)	(Pcs)	(%)	(Pcs)	(%)
4/27/2011	16506	14070	85.24	2436	14.76	14070	12870	91.47	1200	8.53
4/28/2011	15568	13202	84.80	2366	15.20	13202	11882	90.00	1320	10.00
5/04/2011	11396	8848	77.64	2548	22.36	8848	7982	90.21	866	9.79
5/04/2011	22064	19558	88.64	2506	11.36	19558	17394	88.94	2164	11.06
5/06/2011	15008	12782	85.17	2226	14.83	12782	11258	88.08	1524	11.92
5/07/2011	21098	15694	74.39	5404	25.61	15694	13403	85.40	2291	14.60
5/10/2011	16296	12950	79.47	3346	20.53	12950	11362	87.74	1588	12.26
5/10/2011	14196	11648	82.05	2548	17.95	11648	10192	87.50	1456	12.50
5/11/2011	26362	22148	84.01	4214	15.99	22148	19578	88.40	2570	11.60
5/13/2011	13496	10738	79.56	2758	20.44	10738	9295	86.56	1443	13.44
5/14/2011	16590	13902	83.80	2688	16.20	13902	12116	87.15	1786	12.85
5/17/2011	16114	13300	82.54	2814	17.46	13300	11336	85.23	1964	14.77
5/22/2011	26824	22750	84.81	4074	15.19	22750	19734	86.74	3016	13.26
5/23/2011	10276	8288	80.65	1988	19.35	8288	7488	90.35	800	9.65
5/25/2011	6888	5516	80.08	1372	19.92	5516	4849	87.91	667	12.09
5/27/2011	4270	3528	82.62	742	17.38	3528	3198	90.65	330	9.35
5/29/2011	8204	6958	84.81	1246	15.19	6958	6032	86.69	926	13.31
6/04/2011	3472	2968	85.48	504	14.52	2968	2691	90.67	277	9.33
Sum	264628	218848		45780		218848	192660		26188	
Mean	14702	12158	82.54	2543	17.46	12158	10703	88.32	1454.9	11.68
SD			3.41	1213	3.41	5675.9	4960	1.89	754.83	1.89
Min	3472	2968	74.39	504	11.36	2968	2691	85.23	277	8.53
Max	26824	22750	88.64	5404	25.61	22750	19734	91.47	3016	14.77

Mango Distribution from Harvest Sites through Collection Centers to Packing Houses in 2012

Table C-4. Distribution of mangos purchased and sold by RAPCOM from Saut-d'Eau to Port-au-Prince packing houses in 2012 (RAPCOM records, 2012)

Shipment	Date	Collection Centers					Packing houses				
		Receipt	Select		Reject		Receipt	Select		Reject	
		(Pcs)	(Pcs)	(%)	(Pcs)	(%)	(Pcs)	(Pcs)	(%)	(Pcs)	(%)
1	5/10/2012	16100	12796	79.48	3304	20.52	12796	11245	87.88	1551	12.12
2	5/23/2012	23100	19530	84.54	3570	15.45	19530	10569	54.12	8961	45.88
3	5/23/2012	20650	16324	79.05	4326	20.95	16324	11050	67.69	5274	32.31
Sum		59850	48650		11200		48650	32864		15786	
Mean		19950	16217	81.02	3733.30	18.97	16217	10955	69.90	5262	30.10
SD		3552	3368	3.06	530.22	3.06	3368.3	347.94	16.99	3705	16.99
Min		16100	12796	79.05	3304	15.45	12796	10569	54.12	1551	12.12
Max		23100	19530	84.55	4326	20.95	19530	11245	87.88	8961	45.88

Table C-5. Distribution of SAPKO mangos purchased, transported by trucks in crate loading from Saut-d'Eau to Port-au-Prince packing houses and sold by SAPKO packing shed to in 2012 (SAPKO records, 2012)

Ship-Ments #	Date	Collection Centers					Packing Houses				
		Receipt	Select		Reject		Receipt	Select		Reject	
		(Pcs)	(Pcs)	(%)	(Pcs)	(%)	(Pcs)	(Pcs)	(%)	(Pcs)	(%)
1	5/1/2012	14812	11872	80.15	2940	19.85	11872	11011	92.75	861	7.82
2	5/1/2012	5656	4564	80.69	1092	19.31	4564	4147	90.86	417	10.06
3	5/2/2012	10794	8470	78.47	2324	21.53	8470	7644	90.25	826	10.81
4	5/4/2012	14854	12390	83.41	2464	16.59	12390	10075	81.32	2315	22.98
5	5/8/2012	14238	11424	80.24	2814	19.76	11424	10049	87.96	1375	13.68
6	5/9/2012	13371	10934	81.77	2437	18.23	10934	8490	77.65	2444	22.35
7	5/10/2012	7140	5600	78.43	1540	21.57	5600	4573	81.66	1027	22.46
8	5/12/2012	15008	11592	77.24	3416	22.76	11592	10084	86.99	1508	14.95
9	5/14/2012	15694	12278	78.23	3416	21.77	12278	10348	84.28	1930	18.65
10	5/16/2012	17640	14714	83.41	2926	16.59	14714				
11	5/17/2012	16688	13412	80.37	3276	19.63	13412				
12	5/18/2012	19418	15946	82.12	3472	17.88	15946				
13	5/20/2012	17080	13832	80.98	3248	19.02	13832				
14	5/21/2012	15512	12082	77.89	3430	22.11	12082				
15	5/23/2012	14112	11774	83.43	2338	16.57	11774				
16	5/24/2012	16156	13132	81.28	3024	18.72	13132				
Sum		228173	184016	1288.11	44157	311.89	184016	76421		12703	
Mean		14261	11501	80.51	2759.81	19.49	11501	8491	85.97	1411	15.97
SD				2.03	697	2.03		2555	5.07	702	5.85
Min		5656	4564	77.24	1092	16.57	4564	4147	77.65	417	7.82
Max		19418	15946	83.43	3472	22.76	15946	11011	92.75	2444	22.98

Table C-6. Distribution of Haitian Francisque mangos at packing houses in 2010-2011 (USDA Record_Mango Program/Technical Report _FY 2010-2011)

Packing Houses	Total Fruit Received	Export (Pcs)	Export (%)	Reject (Pcs)	Reject (%)
1	4240145	2186193	51.56	2053952	48.44
2	5038878	2656773	52.73	2382105	47.27
3	3665870	2175628	59.35	1490242	40.65
4	2669615	1783546	66.81	886069	33.19
5	3812172	2447947	64.21	1364225	35.79
6	4321746	2810624	65.03	1511122	34.97
7	3681210	2083419	56.60	1597791	43.40
8	3950362	2163437	54.77	1786925	45.23
9	2382341	1736343	72.88	645998	27.12
10	2694133	2044616	75.89	649517	24.11
Sum	36456472	22088526		14367946	
Mean			61.98		38.02
Standard Deviation			8.38		8.38
Min	2382341	1736343	52	645998	24
Max	5038878	2810624	76	2382105	48

Table C-7. Distribution of mangos from Mirebalais at Packing houses in 2011 (MARNDR records, 2011)

Lot	Zone Code	Total Fruit Received	Export		Reject	
			(Pcs)	(%)	(Pcs)	(%)
1	6675	17407	10099	58.02	7308	41.98
2	6666	16900	4748	28.09	12152	71.91
3	6679	18850	2886	15.31	15964	84.69
4	6679	15600	7013	44.96	8587	55.04
5	6657	19500	11152	57.19	8348	42.81
6	6640	18460	3620	19.61	14840	80.39
7	6639	17212	9933	57.71	7279	42.29
8	6639	19500	15756	80.80	3744	19.20
9	6665	11700	7584	64.82	4116	35.18
10*	6699	22100	0	0.00	0	0.00
11**	6497	1400	18200	NA	NA	NA
12	6496	6500	1077	16.57	5423	83.43
13	6497	5590	2023	36.19	3567	63.81
14	6695	5200	3560	68.46	1640	31.54
15	6695	14300	9995	69.90	4305	30.10
16	6695	18200	9350	51.37	8850	48.63
17	6675	11700	5360	45.81	6340	54.19
18	6675	15600	13538	86.78	2062	13.22
19	6668	20072	16245	80.93	3827	19.07
20	6668	18200	15500	85.16	2700	14.84
21	6563	5590	3500	62.61	2090	37.39
22	6675	18330	10985	59.93	7345	40.07
23	6657	12688	7800	61.48	4888	38.52
24	6659	15964	5356	33.55	10608	66.45
25	6657	10400	5355	51.49	5045	48.51
26	6594	16250	10782	66.35	5468	33.65
27	6694	5200	1242	23.88	3958	76.12
28	6673	10400	450	4.33	9950	95.67
29	6595	11700	2313	19.77	9387	80.23
30	6591	8060	1755	21.77	6305	78.23
31	6590	5382	1719	31.94	3663	68.06
32	6544	16250	1008	6.20	15242	93.80
33	6590	1326	855	64.48	471	35.52
34	6607	8450	2952	34.93	5498	65.07
35	6544	15600	9648	61.85	5952	38.15
36	6607	11609	6552	56.44	5057	43.56
37	6590	3250	1575	48.46	1675	51.54

Table C-7. Continued

Lot	Zone Code	Total Fruit Received	Export		Reject	
			(Pcs)	(%)	(Pcs)	(%)
38	6607	13000	8982	69.09	4018	30.91
39	6590	4810	1530	31.81	3280	68.19
40	6599	9750	4626	47.45	5124	52.55
41	6605	16900	3231	19.12	13669	80.88
42	6607	15392	5400	35.08	9992	64.92
43	6605	10400	7542	72.52	2858	27.48
44	6606	8450	4284	50.7	4166	49.3
45	6594	9100	3555	39.07	5545	60.93
46	6495	9789	7735	79.02	2054	20.98
47	6695	17850	3572	20.01	14278	79.99
48	6615	19306	11899	61.63	7407	38.37
49	6695	20160	2106	10.45	18054	89.55
50	6695	17500	4906	28.03	12594	71.97
51	6615	17150	9237	53.86	7913	46.14
52	6594	16912	8924	52.77	7988	47.23
53	6491	17220	4716	27.39	12504	72.61
54	6491	13538	834	6.16	12704	93.84
55	6575	4270	1236	28.95	3034	71.05
56	6574	10668	6188	58.01	4480	41.99
57	6574	18200	10587	58.17	7613	41.83
58	6615	16800	9769	58.15	7031	41.85
59	6695	20300	6866	33.82	13434	66.18
60	6615	16800	8514	50.68	8286	49.32
61	6695	18900	1907	10.09	16993	89.91
62	6595	16800	12776	76.05	4024	23.95
63	6594	8540	4307	50.43	4233	49.57
Sum		799869	365001	2742.9	434892	
Mean		13039	5939	45.06	7100	54.09
SD			4060	21.54	4363	21.72

*Shipment 10 was rejected due to depict of living larvae.

**In the MARNDR record this information was not found. It seems that shipment arrived at packing house but was not purchased for unknown reason. Sometimes, packing house run out their capacity limit and are not able to receive more mangos.

NB: Mirebalais Code: 6491-6700

Table C-8. Distribution of mangos from Saut-d'Eau at packing houses in 2011 (MARNDR, 2011)

Lot	Zone Code	Total Fruit Received	Export		Reject	
			(Pcs)	(%)	(Pcs)	(%)
1	6781	11505	8036	69.85	3469	30.15
2	6780	20800	8889	42.74	11911	57.26
3	6781	18200	12034	66.12	6166	33.88
4	6780	19292	15840	82.11	3452	17.89
5	6780	10400	9097	87.47	1303	12.53
6	6781	15600	11958	76.65	3642	23.35
7	6725	15054	9197	61.09	5857	38.91
8	6704	6994	2547	36.42	4447	63.58
9	6718	17576	6900	39.26	10676	60.74
10	6744	8450	4433	52.46	4017	47.54
11	6745	16094	7722	47.98	8372	52.02
12	6741	20150	8407	41.72	11743	58.28
13	6718	7150	3852	53.87	3298	46.13
14	6744	12805	10520	82.16	2285	17.84
15	6744	17290	11350	65.64	5940	34.36
16	6746	7644	6595	86.28	1049	13.72
17	6709	16705	10250	61.36	6455	38.64
18	6744	15600	9350	59.94	6250	40.06
19	6708	18317	13117	71.61	5200	28.39
20	6709	18148	13247	72.99	4901	27.01
21	6729	17147	12935	75.44	4212	24.56
22	6773	16250	11622	71.52	4628	28.48
23	6758	15210	12766	83.93	2444	16.07
24	6729	22399	17992	80.33	4407	19.67
25	6725	18200	5931	32.59	12269	67.41
26	6776	6500	3078	47.35	3422	52.65
27	6751	13000	3699	28.45	9301	71.55
28	6717	4550	2529	55.58	2021	44.42
29	6704	14300	10134	70.87	4166	29.13
30	6776	10725	7380	68.81	3345	31.19
31	6776	6500	2709	41.68	3791	58.32
32	6704	13650	7929	58.09	5721	41.91
33	6712	14300	9464	66.18	4836	33.82
34	6695	19600	7619	38.87	11981	33.82
35	6708	9800	4576	46.69	5224	61.13
36	6745	6440	2109	32.75	4331	53.31
37	6744	17570	6522	37.12	11048	67.25

Table C-8. Continued

Lot	Zone Code	Total Fruit Received	Export		Reject	
			(Pcs)	(%)	(Pcs)	(%)
38	6744	3780	3716	98.31	64	62.88
39	6744	6272	2824	45.03	3448	1.69
40	6708	17080	3920	22.95	13160	54.97
41	6744	18200	8043	44.19	10157	77.05
Sum		565247	330838		234409	55.81
Mean				58.6		40.8
SD				18.8		41.2
Min				23.0		18.6
Max				98.3		1.7

NB: Saut-d'Eau Codes vary from 6701 to 6810.

Table C-9. Distribution of mangos from Central Plateau at packing houses in 2012 (USDA's records, 2012)

Date	Reception	Export		Total Reject	
		(Pcs)	(%)	(Pcs)	(%)
5/3/2012	9100	4830	53.08	4270	46.92
	8932	6321	70.77	2611	29.23
	3906	2198	56.27	1708	43.73
5/1/2012	9884	5897	59.66	3987	40.34
5/1/2012	13482	9502	70.48	3980	29.52
5/1/2012	10206	7461	73.10	2745	26.90
5/9/2012	23800	16718	70.24	7082	29.76
5/9/2012	23800	15568	65.41	8232	34.59
5/10/2012	22400	11297	50.43	11103	49.57
5/11/2012	15400	7747	50.31	7653	49.69
5/12/2012	23100	13635	59.03	9465	40.97
5/6/2012	16800	10679	63.57	6121	36.43
5/7/2012	25480	19307	75.77	6173	24.23
5/7/2012	16800	5673	33.77	11127	66.23
5/7/2012	4200	1262	30.05	2938	69.95
5/7/2012	25480	8415	33.03	17065	66.97
5/7/2012	28000	19134	68.34	8866	31.66
5/8/2012	16800	9262	55.13	7538	44.87
5/5/2012	12600	5440	43.17	7160	56.83
5/5/2012	25480	20160	79.12	5320	20.88
5/5/2012	18550	9377	50.55	9173	49.45
5/5/2012	22750	12169	53.49	10581	46.51
5/5/2012	25200	4319	17.14	20881	82.86
5/5/2012	15568	8389	53.89	7179	46.11
5/5/2012	14000	3244	23.17	10756	76.83
Sum	431718	238004		193714	
Mean	17269	9520	54.36	7749	45.64
SD	7076	5375	16.66	4421	16.66
Min	3906	1262	17.14	1708	20.88
Max	28000	20160	79.12	20881	82.86

APPENDIX D
DATA FROM FIELD HARVEST EXPERIMENTS

Table D-1. Raw data of yield distribution of mangos by tree category

Tree		Export		Domestic		Damage	
Category	#	(Pcs)	(%)	(Pcs)	(%)	(Pcs)	(%)
Very Suitable	1	194	77.29	48	19.12	9	3.59
	2	186	80.17	43	18.53	3	1.29
	3	176	75.54	51	21.89	6	2.58
	3	178	75.74	50	21.28	7	2.98
	4	184	78.63	41	17.52	9	3.85
	4	186	75.30	55	22.27	6	2.43
Sum		1104	77.11	288	20.10	40	2.78
Mean		276	77.11		20.10		2.78
Standard Deviation			1.97		1.97		0.92
Suitable	5	204	48.00	201	47.29	20	4.71
	6	79	38.35	117	56.80	10	4.85
	6	62	35.23	105	59.66	9	5.11
	7	124	56.62	87.00	39.73	8.00	3.65
	7	107	54.59	81.00	41.33	8.00	4.08
	7	99	50.51	91	46.43	6	3.06
	8	101	46.98	104	48.37	10	4.65
	8	105	43.39	129.00	53.31	8.00	3.31
	8	130	48.69	126	47.19	11	4.12
Sum		1011	422.35	1041	440.10	90	37.55
Mean			46.93	115.67	48.90	10.00	4.17
SD			7.01	36.14	6.62	4.03	0.72
Not Suitable	9	96	21.48	320	71.59	31	6.94
	10	120	26.91	304	68.16	22	4.93
	11	114	29.53	250	64.77	22	5.70
	11	150	35.21	259	60.80	17	3.99
	12	58	21.72	194	72.66	15	5.62
	12	57	19.26	227	76.69	12	4.05
	12	78	26.80	203	69.76	10	3.44
Sum		673	180.91	1757	484.42	129	34.67
Mean			25.85	251.00	69.20	18.43	4.95
SD			5.52	47.90	5.25	7.18	1.22

Table D-2. Harvest labor productivity by tree category and selected pole

Tree		Picking Pole			Cutting Pole		
Categories	No.	Total fruit harvested	Time (Min)	Fruit per minute (Pcs/min)	Quantity (Pcs)	Time (Min)	Fruit per minute (Pcs/min)
Very Suitable	1	129	15	9	122	15	8
	2	114	15	8	118	15	8
	3	105	10	11	128	12	11
	3	113	10	11	122	12	10
	4	119	10	12	115	12	10
	4	114	10	11	133	12	11
Sum		694	70		738	78	
Mean				10			10
Suitable	5	183	25	7	242	40	6
	6	98	10	10	108	20	5
	6	64	10	6	112	20	6
	7	93	10	9	126	12	11
	7	99	10	10	97	12	8
	7	98	10	10	98	12	8
	8	97	10	10	118	15	8
	8	121	10	12	121	15	8
	8	98	10	10	169	15	11
Sum		951	105		1191	161	
Mean				9			8
Not Suitable	9	197	20	10	250	30	8
	10	210	20	11	236	30	8
	11	180	20	9	206	20	10
	11	206	20	10	220	20	11
	12	118	10	12	149	15	10
	12	127	10	13	169	15	11
	12	129	10	13	162	15	11
Sum		1167	110		1392	145	
Mean				11			10
Overall Mean		2812	290	10	3321	384	9

Table D-3 Cutting pole insignificantly reduces harvest labor productivity

Source	Degree of freedom	Sum square	Mean square	Fisher	P-Value*
Tree category	2	14.4618	7.23089	2.89	0.082
Poles	1	7.0814	7.08144	2.83	0.110
Interaction	1	1.1123	0.55615	0.22	0.803
Error	18	45.0553	2.50307		

*P significant at 0.05.

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BIOGRAPHICAL SKETCH

Lidwine Hyppolite was born in Les Anglais, in the south of Haiti. She graduated from the State University of Haiti in Port-au-Prince with a bachelor degree in economics sciences in 2001 and another bachelor degree from Quisqueya University in agriculture sciences specifically in environmental protection in 2005. She worked for five years at several institutions in Haiti: (1) Unibank as a teller, (2) consultant in agronomy at the SETCOM INVEST SA, (3) Center of Study and International Cooperation (CECI_Haiti) where she was responsible for economic initiative and gender, (4) United Nation Development Program (UNDP) as gender responsible of the Local Development Program in the northeast of Haiti. She obtained a scholarship from the USAID/WINNER project to study food engineering in the United States of America. She received her M.S degree from the University of Florida in the spring 2013. She believes in the possibility of creating wealth from the efficient management of available resources and hard labor. She is a member of several farmers' associations and wants to contribute to improving the living conditions of farmers through conservation, preservation and the processing of agricultural products.