Food and Agriculture Organization of the United Nations

Food loss analysis: causes and solutions

Case study on the cassava farine, tomato and mango value chains in Saint Lucia

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Abbreviations and acronyms

AMIS	Agricultural Marketing Information System
CABA	Caribbean Agribusiness Association
CARICOM	Caribbean Community
CARIRI	Caribbean Industrial Research Institute
CARDI	Caribbean Agricultural Research and Development Institute
CLP	Critical Loss Point
CFL	Consolidated Foods Limited
XCD	Eastern Caribbean Dollar
FAO	Food and Agricultural Organization of the United Nations
fonCT	Fondo Concursable para la Cooperación Técnica
FSC	Food Supply Chain
GDP	Gross Domestic Product
GSL	Government of Saint Lucia
IDB	International Development Bank International Development Bank
IFAD	International Fund for Agricultural Development
IICA	Inter-American Institute for Cooperation on Agriculture
MAFPFRD	Ministry of Agriculture, Food Production, Fisheries and Rural Development
MALFF	Ministry of Agriculture, Lands, Forestry and Fisheries
MAP	Modified Atmosphere Packaging
NAREI	National Agricultural Research and Extension Institute
NARI	National Agricultural Research Institute
OECS	Organization of Eastern Caribbean States
SFA	Special Framework of Assistance
SLBS	Saint Lucia Bureau of Standards
SLMB	Saint Lucia Marketing Board
SLNRWP	Saint Lucia Network of Rural Women Producers
STABEX	Système de Stabilisation des Recettes d'Exportation
TT	Trinidad and Tobago
USAID	United States Agency for International Development
UWI	University of the West Indies
VS	Vascular Streaking

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Executive Summary

The Government of Saint Lucia in its effort to expand the agricultural sector and improve rural livelihoods has outlined a number of initiatives that are envisaged to impact positively on the agricultural sector. Among these initiatives the need to reduce post-harvest losses has also been recognized. This present report focuses on post-harvest losses in cassava, mango and tomato supply chains.

The unavailability of planting materials for the sustainable production of root crops (sweet potato, sweet cassava, tannia and yams) has resulted in shortages for local consumption and export. This situation has resulted in increased prices for planting material, thereby increasing the cost of root crop production and prices of the produce in the local market. To alleviate these problems, multiplication of root crop planting material for farmers was conducted by CARDI. Plots comprised 0.17 ha sweet potato, 0.21 ha sweet cassava, 0.17 ha tannia and 0.32 ha yam. Planting material that was distributed to 57 farmers included 300 kg of yams, 310 kg tannia, 48 bags of sweet potato slips and 8 000 sticks of sweet cassava.

Sweet cassava planting material was also given to the Belle Vue Famers' Cooperative to establish 1 ha of cassava under the Vigé Cassava Revitalisation Project (Pilgrim, 2012). According to Pilgrim (2012), CARDI also provided sweet cassava (M Col 22) roots to the Ministry of Agriculture to promote the consumption of cassava as a staple at the World Food Day exhibition on 16 October 2010. This was to promote the consumption of local agricultural produce, in order to reduce the increasing food import bill. The unavailability of fresh cassava in public markets, Agricultural Cooperatives, the Marketing Board retail market outlets and supermarkets made it impossible to evaluate post-harvest losses of this commodity. However, the value-added product, cassava farine was widely produced and marketed throughout the country and post-harvest losses associated with the processing operations from the fresh roots were measured.

Successful post-harvest handling of cassava faine, tomatoes and mangoes requires knowledge of the post-harvest physiology of these commodities, and an understanding of how this determines handling practices to maintain quality throughout the value chain. The post-harvest handling system used for each commodity depends on the marketing system in which the fruit will be sold. This includes factors such as distance to the market, the desires and expectations of the consumers in that market, and the availability of labour, technology, logistics management and infrastructure required for various handling options (Yahia, 2011).

Accordingly, successful post-harvest handling of the targeted commodities in this study involves managing the post-harvest handling system at each stage and avoiding quality losses at each stage. In the case of tomato and mango, both of which are climacteric, the fruit matures on the tree and begins to ripen, eating quality improves but potential marketable life decreases as it is difficult to control the ripening changes once they have been initiated.

In the Caribbean, including Saint Lucia, Trinidad and Tobago and Guyana there is a need to develop improved handling, storage and ripening techniques as well as safety for promotion of all agricultural commodities and their value-added products. Factors relating to causes, types, and magnitude of damage that lead to quality deterioration and post-harvest losses are significant for the growth and development of the cassava, tomato and mango industries in the Caribbean. Accordingly, FAO in collaboration with CARICOM initiated a project *Reduction of post-harvest losses along the food chain in the CARICOM subregion* and identified these three commodities for post-harvest loss measurement.

The main objectives of the investigation included an in-depth analysis of post-harvest handling practices of cassava, tomato and mango producers, retailers (roadside and mobile market vendors, municipal markets, supermarkets), wholesalers, exporters, processors for development of value-added products and consumers, to obtain a more complete understanding of the system-wide nature of quality deterioration and subsequent losses in order to formulate appropriate solutions for quality management and loss reduction strategies; analyses of the mango value chain as items for food consumption, with quality attributes that should be protected and enhanced in various marketing channels; examination of the significance of losses of both technological and socio-economic origins; identification of the links

between growers and provisions for transferring relevant research information on identified problems to producers, traders, processors; improved operations throughout the system were designed and evaluated along with alternative post-harvest handling systems; key factors affecting the logistics performance in the CARICOM Region have been described with particular emphasis being placed on the logistics that affect produce losses in the supply chain.

Post-harvest losses of mangoes and tomatoes were measured at three critical loss points (CLPs) after screening the value chains in Saint Lucia. The critical loss points were at agricultural cooperatives, where growers wholesale their commodities (CLP#1), the Marketing Board retail outlet (CLP#2) and the municipal market (CLP#3). Post-harvest losses in the development of cassava farine were also estimated at two processing facilities. Post-harvest losses for tomato and mango at the agricultural cooperatives (CLP#1) were an estimated 7 and 8 percent, at the Marketing Board retail outlet (CLP#2) losses were 8 and 13 percent and at the municipal markets (CLP#3) losses were at the lowest at 5 and 2 percent respectively.

Post-harvest losses for cassava farine, prior to processing were related to the removal of the skin and dirt and were 10 to 12 percent, similar to that estimated for Guyana. Physical damage from bruises, compression, stem end damage, punctures, and abrasions, physiological disorders because of heat stress, desiccation and internal breakdown as well as decay caused by fungal and bacterial diseases was consistent with tomato and mango at the various critical loss points identified above.

Proposals for the reduction of post-harvest losses of tomatoes and mangoes in Saint Lucia, which were also recommended for Trinidad and Tobago and Guyana include:

- harvesting at the appropriate stage of maturity to attain the best eating quality;
- handling fruit with care to minimize fruit damage;
- protecting harvested fruit from exposure to direct sunlight while awaiting transport to the packinghouse;
- preventing latex damage and stains on harvested mangoes and fingernail damage to tomatoes; and
- selecting a transport method that allows for ventilation of the produce during transit from field to packinghouse.

Further, proposals for the reduction of post-harvest losses of cassava prior to reception at the processing outlets include:

- Processors have stipulated that suppliers must deliver cassava roots already sorted according to cultivar, size and cleaned. This means without dirt and external fibres and with no evidence of desiccation, decay, insect and physical damage.
- All cutting tools and utensils should be sanitized and made of stainless steel with sharp cutting edges; peeled cassava roots should be immersed in potable water before grinding into paste.
- Sanitation of the entire processing facility during all stages of the process flow in order to reduce potential microbial problems.

In Saint Lucia, at CLP #1 the economic loss for tomatoes was estimated at USD 58 300. At CLP#2 the loss was USD 66 600 and at CLP#3 the loss was USD 41 700; hence the total economic loss for tomatoes in Saint Lucia in 2012 was calculated at USD 166 579. At CLP#1 the economic loss for mangoes was USD 28 700 and at CLP#2 and CLP#3 the economic loss was USD 46 600 and USD 7 200 respectively. Total economic loss for mangoes in Saint Lucia in 2012 was therefore estimated at USD 82 483. However, it is emphasized that these are estimates based only on the results of the percentage losses from the areas where the post-harvest lost assessment studies were carried out. The project did not cover the entire country.

Chapter 1
Introduction

Background information

A high incidence of post-harvest losses exacerbates the problems of low agricultural productivity and food security in the countries of the Caribbean Community (CARICOM). Post-harvest losses cause severe reductions in the quality and quantity of food, thereby affecting incomes and impacting on the rural poor in the region. The Food and Agriculture Organization of the United Nations (FAO) (2011) indicated that post-harvest losses are highest in developing countries. Fonseca and Vergara (2013) reported that in the Latin America and Caribbean (LAC) region 50 percent of the fruits and vegetables and 37 percent of roots and tubers are lost before they reach consumers and suggested that improving logistics systems and management would be an efficient approach to reducing losses throughout the supply chain. It was found that failure in logistics operations including product handling, precooling, packaging, storage, transportation, and inappropriate infrastructure, are among the most common reasons for the high food losses. These estimates do not include losses in quality, nutritional value and the health burden associated with consuming contaminated food products.

Several factors contribute to post-harvest losses along the supply chain such as preharvest factors, environmental hazards such as inadequate temperature and control of relative humidity, pests, diseases and senescence. Reducing the incidence of post-harvest losses along the food chain in the CARICOM subregion will contribute to improving food availability to address food insecurity; enhancing food quality through better packaging, handling and storage, increasing economic access to food through job creation and income-generation, development of efficient logistics systems to improve market access by delivering the right product at the right time.

Given the need to better understand the strengths and weaknesses of the post-harvest handling systems in CARICOM and to identify, plan and implement interventions policies and practices, two countries, Guyana and Trinidad and Tobago were initially identified by the FAO to conduct detailed value chain analyses pertaining to cassava, tomato and mango. This phase of the study intended to rapidly assess post-harvest losses in Saint Lucia.

Study objective

The overall project outcome is increased capacity of the CARICOM Member Countries to sustainably reduce post-harvest losses. The project outputs were to identify and promote appropriate and cost-effective technical solutions for reduction of post-harvest losses in the CARICOM Region; raise the awareness of the CARICOM Secretariat, national governments and institutions in the region about the need to address post-harvest losses; strengthen the capacity of chain actors and service providers and pilot their interventions, and establish and disseminate appropriate technologies and approaches to reduce post-harvest food loss emphasizing the regional priority crops diffused to stakeholders.

The specific objective of this consultancy was to undertake a rapid study of post-harvest losses in Saint Lucia in order to compare and verify the results obtained in Guyana and Trinidad and Tobago.

Chapter 2
Methodological approach

Selection of countries and subsectors

CARICOM Member Countries Guyana and Trinidad and Tobago were selected for this study based on the importance of the targeted subsectors, which are cassava, mango and tomato. In addition, the assessment was conducted in Saint Lucia, which is a CARICOM Member Country but also a member of the Organization of Eastern Caribbean States (OECS). The study in Saint Lucia was undertaken to compare and verify the results obtained in Guyana and Trinidad and Tobago.

Selection of food supply chains

Three subsectors are important in the CARICOM region, which had been identified during a preceding study. The identification of these priority crops followed an in-depth desk study to review available information on production, post-harvest handling including processing, marketing and export, concerning the main food crops in the CARICOM Region. Reports from previous studies conducted by the FAO, CARICOM, regional institutions and other national and international organizations were analysed. Several crops were identified that are important to the agricultural systems in the region. Cassava, tomato and mango, however, emerged as important food value chains and were therefore recommended as the priority crops for the present project to reduce food loss and waste in the CARICOM Region.

Selection of farmers, supermarkets and other stakeholders

The tomato, mango and cassava value chains include a highly diverse and complex number of producers (farmers) and traders (market types: farmer's or public municipal, roadside, mobile, supermarkets, processors etc.) characterized by widely scattered production areas and fragmented marketing facilities. This structural variety, coupled with widely differing post-harvest practices among participants posed considerable challenges for this investigation, which attempted to understand the entire value chain and its operations. Field observations and interviews were of paramount importance to the study to uncover the differences in post-harvest operations among the diverse range of producers and marketers, as well as those linked to cultural methods in different locations.

The techniques employed were based on the 4-S approach used by FAO. In Saint Lucia, discussions and observations on production were held with representatives of two of the foremost agricultural cooperatives on the island (Belle Vue and Blackrock) and private mango and greenhouse vegetable producers. Observations on marketing activity focussed on the Castries Public Market and the Castries retail outlet of the Saint Lucia Marketing Board. In addition, discussions were held with Consolidated Food Limited (CFL) management and observations were made at several outlets of the supermarket chain – SuperJ supermarkets; the Saint Lucia Marketing Board Management (SLMB); management of three processing factories based in different administrative regions of the country at Plas Kassav, Canaries; Fond Assau Agro Processing Plant; Dauphin Harvest, Monchy, Gros-Islet and covering the public and private sectors; as well as with two hotels Sandals and Saint James Morgan Bay. In each case, discussions focussed on the stages in the value chain where there was a potential for reduction of marketable quality and eventual manifestation of post-harvest losses, from the producer in the field, or from procurement in the case of a trader to the point of consumer purchase. This approach is referred to as the 'systems approach'.

Methodology and data collection

The methodology used for this study involved a literature review; collection and analysis of the documentation and technical information on cassava; selection of the specific supply chains to the study and justification for this choice; identifica-

tion of the 3 to 4 stages of the food chain where the losses are higher or have the greatest impact and selection of 1 to 2 for detailed analysis and participation and contribution to the development of a comprehensive approach, including appropriate tools for data collection and analysis identifying the scope and limitations of the study as well as gaps, to ensure that all marketing aspects, including handling and shipping are included. The Food Loss Assessments methodology, recommended by the FAO, was adopted as the implementation strategy for this study and, where necessary, it was adapted to the Caribbean situation. The FAO approach involves four stages: screening, survey, sampling and synthesis of the results.

Study execution approach

The present study has five components:

A **literature review** involved a search of previous studies documented by regional institutions such as FAO, CARDI, IICA, the University of the West Indies, University of Guyana, University of Trinidad and Tobago and other national institutions such as the respective Ministries of Agriculture, Central Marketing Agencies and stakeholders such as Agricultural Society of Trinidad and Tobago, National Food Crops Farmers Association, Trinidad and Tobago Agribusiness Association, Black Bay Small Farmer Association and the Belle Vue Farmers Cooperative was undertaken to identify ongoing work in the field of food losses and examine the completeness and gaps.

Selection of the specific supply chains and the geographical area (countries) of the study and justify the reasons for this choice – The main actors in the supply chain of each commodity in Saint Lucia included farmers, processors, retailers, wholesalers, supermarkets and associations. Selection was based on the identification by the MALFF in collaboration with the consultants of the principal stakeholders in each area of the value chain.

Conducting and managing field Interviews – Approximately 5 days were spent in the field for interviewing and data collection. In an effort to catalogue all the standard operating practices in the three value chains, a set of themes of inquiry was developed to guide the interviewing process and a questionnaire was compiled. Preliminary interviews were used to identify the themes for questioning. All interviewees cooperated, many enthusiastically, when the interview was conducted within their own work environment in a two-way fashion, that is, employing the 'mirror image technique'.

The main elements of the mirror image technique involve: dynamic, face to face interviews revealing an interpersonal process with the principal decision-makers associated with production, post-production, processing into value-added products, distribution and marketing functions; the consultants established a rapport with interviewees while marshalling an extensive complex of variables in an intensive environment; the consultants having the flexibility to switch from a non-directive role at the early stages of the interview to a more directive one afterwards; examining post-harvest practices with respect to each theme of inquiry; perceptions among farmers of the possible nature of post-harvest problems in terms of quality changes and losses for the identical theme examined; establishing automatic checks to avoid data collection errors arising from interviewees' bias, lack of knowledge of correct answer or deliberate falsification of data by tracing and tracking the original causal factor.

Management of the interviews varied from farmer to trader to processor. The Chief Technical Officer at the Ministry of Food Production, Fisheries and Rural Development made all necessary arrangements for field visits and visits to processing plants, marketing board, wholesale and retail outlets, hotels, wholesale storage facilities, supermarkets and agricultural cooperatives., A combination of methods was used with traders.

Supermarket retailers were informed by telephone to inform them of the survey, its potential objectives and uses. Interviews with wholesalers, public markets, mobile market and roadside market vendors were conducted at the actual location mostly without previous arrangement. Interviews almost always took place in the midst of the activity characteristic of post-harvest operations. As such the consultants were able to pose questions in the work environment and, in many cases, to actually witness the decision-making of the traders where and when it occurred. This great advantage, however, of being able to observe and record manifest behaviour that is pertinent to systematic processes needed to be tempered by the imperative that consultants retained their observational role. They did not introduce themselves into the process to the extent that they became a variable thereby altering, even imperceptibly, the decision-making environment. The consultants and technicians attempted to recognize their presence could have encouraged a typical response. These effects

were believed to be minimized after a thorough cross-checking of responses across a wide variety of outlets.

Identification of 3-4 stages of the food chain(s) where the losses are higher or have the greatest impact and detailed analysis of 1-2 – The critical loss points (CLPs) were identified from observation, the literature review, interviewing of experts, marketing quality assurance officers and field officers in each country. For each commodity supply chain one value-added product was followed at the particular processing facility be it village industry or larger scale processing company. For each commodity a flow diagram was prepared to pinpoint the CLPs, which were investigated in detail to identify causes and potential solutions. At least three stages were identified for detailed analysis during the systematic evaluation of losses in the entire post-harvest handling system of tomato and mango where there was a potential for post-harvest losses. As cassava was unavailable, the study of post-harvest losses for this commodity was not undertaken.

Description of the main activities of the study

The flow of the three commodities from the point of harvest to consumption for producers and traders was documented by observing and recording the duration of each component of the system, the time taken for the commodities to move from one stage to the next, including delays as well as measurable characteristics of the environment that is temperature, relative humidity and time of day. In addition, hands-on familiarization with the handling operations of the commodities provided the framework for examining typical patterns of decision-making and action taken by participants within their respective value chains. This also provided information about the dynamics of the value chain and allowed for their comprehensive mapping in Saint Lucia. By inserting the stages of the post-harvest handling system for each commodity within the value chain, this provided the template for tracking and tracing and, more importantly, identification of the Critical Loss Points (CLPs). The main activities carried out during the study are summarized below.

Screening identified what additional information or new information, survey and analysis would provide on food losses in the cassava, mango and tomato subsectors. Flow charts were used to show the various stages of moving the commodities from the farmer or producer to various market outlets such as farmer's, mobile, wholesale, supermarkets, roadside, export and processing plants for development of value-added products. The range of post-harvest losses at each stage along the commodity handling system was analysed in available studies and reports. Frequent meetings, short questionnaires through electronic process, face-to-face telephone interviews or actual site visits enabled the action plan.

Survey involved mapping the current state of knowledge of the selected commodity and how it is handled and marketed. Field data were collected from the point of harvest to the point of retail. Close attention was placed on the implications of indigenous handling practices on post-harvest losses and identification of best post-harvest practices to eliminate or reduce losses. The methodology used the 4-S approach: Screening, Sampling and Survey, and Synthesis for loss assessment based on the Food Loss Assessments methodology recommended by FAO as well as the diverse lessons learned by FAO's Rural Infrastructure and Agro-Industries Division.

Sampling was used in tracking and tracing the dynamic nature of the commodity handling system based on cultivar, season and market type, documentation of harvesting methods, harvesting techniques, maturity indices utilized, precooling practices, transport linkages to packinghouses, packinghouse design and process flow patterns. Thus all the steps indicated above covered environmental conditions, atmospheric composition, management practices to assist in determining the actual causes of quality deterioration at each step and the possible implication for cumulative losses. The questionnaire and site visits identified critical areas where post-harvest losses exist. By recording the above, then at harvest, the relationships between harvesting practices and post-harvest losses were assessed; identification of alternative methods for improving harvesting practices were determined as well as whether negative or positive effects from the harvesting tools that are derived were determined.

Tomato and mango samples were purchased at each critical loss point and at the exact location where the activity of that particular stage was observed. Each sampling consisted of three replications of 4 to 5 kg randomly selected, and representative of a market load.

Each cassava sample was examined for marketable quality on a scale of 1 to 9 based on a method established by Sherman (1982) with 1 = unusable,

3 = unsalable, 5 = fair (limit to marketability), 7 = good and 9 = excellent. Following this each cassava sample was examined for damage and classified into two broad categories: marketable and unmarketable, based on the severity of the damage. The unmarketable samples of each commodity were designated as the post-harvest loss, weighed and the percentage loss calculated against the original weight. To determine the nature of damage in the unmarketable category, samples were further subdivided into three categories according to the nature of the damage apparent at that location, that is, physical, physiological, pathological and entomological.

Physical damage included cuts, bruises, punctures, scratches, splits, crushes, abrasions and cracks. Physiological damage included moisture loss (wilting, shrinkage), heat injury, internal breakdown, puffiness, catfacing and blotchy ripening. Pathological and entomological damage included damage caused by fungi, bacteria and insects. The weights in each category of damage were recorded and the percentage of post-harvest loss was calculated for each category. Total post-harvest losses were obtained by summing the losses recorded at each CLP (Figure 1). Samples of tomato and mango were analysed and data on root dimensions, firmness and total soluble solids recorded.

Synthesis involved visits to centres or institutions such as the respective Ministries of Agriculture, marketing and research agencies for production and marketing data, farmer location and hectares of production and cropping practices. Further, the type of data and analytical procedures necessary to guide policy-makers to engage in strategic interventions to improve the post-harvest handling system for the selected commodity were determined. Policy options concerning the principal logistics in reducing post-harvest losses by applying simple inexpensive post-harvest innovative methods that could strengthen the post-harvest knowledge system were analysed and recorded. Costs were calculated for the respective volumes of produce associated with each value chain as well as for post-harvest losses as determined by the surveys.

Chapter 3
Situation analysis

RELEVANT INSTITUTIONS

The Ministry of Agriculture, Food Production, Fisheries and Rural Development (MAFPFRD) – is the principal public sector institution responsible for the implementation of the Government of Saint Lucia's agricultural policy in the sector. Its principal objective is to develop the agricultural sector, as indicated in its mission statement: "*The Ministry of Agriculture, Forestry and Fisheries is to develop the agricultural sector to ensure increased production of quality food and other commodities through environmentally sustainable management practices for the benefit of the entire population*". Specifically, the MAFPFRD role has been largely traditional and its responsibilities can be summarized as follows[1]:

The Ministry of Agriculture:

- Formulates, implements and coordinates the Government's policies, programmes and projects in the sector.
- Reviews, monitors and assesses the impacts and results achieved from policy implementation.
- Designs and executes programmes and projects to achieve specific policy objectives.
- Provides advisory services and recommendations to the government on policy implications for the sector.
- Coordinates and collaborates with public and private sector entities and other stakeholders in the sector implementation of the government's policies.
- Coordinates, implements and facilitates the government's agreements, mandates and obligations.
- Enhances relationships with regional and international organizations; and
- Provides disaster and emergency relief to facilitate recuperation from natural disasters.

Saint Lucia Marketing Board (SLMB) – "*In 1967, the Government of Saint Lucia established the Saint Lucia Marketing Board to stimulate, facilitate and improve the production, marketing and processing of produce on the island. Under the Saint Lucia Marketing Board Act (1967), the Board was given a wide-range of powers to ensure that it fulfils its mandate. However, after more than 40 years and numerous reviews, a current assessment of the Board describes its performance as mixed. It is now generally felt that in its current form the SLMB is not an effective instrument to facilitate and advance the Government of Saint Lucia agricultural diversification efforts.*"[2]

At the time of the study the basic functions of buying and selling were still being carried out, but at significantly reduced volumes, because the role of the organization was under review.

Fond Assau Agro Processing Plant – is one of the newest public agencies in the agricultural sector, having been established in 2011. The construction of the agro-processing facility was another component of the Government of Saint Lucia's efforts to promote agriculture diversification and to introduce new technologies to enhance the agriculture sector. It was a deliberate effort to add-value to local products. Locally grown breadfruit, dasheen, green plantain and green fig are being vacuum-packed and juices made from fruits such as mangoes, tamarind, citrus, guava and soursop are being manufactured, frozen and sold. To date, as a result of the small quantities being produced, all of the products are being sold on the domestic market.

[1] Five-Year Strategic Management and Action Plan for the Ministry of Agriculture.

[2] IICA's Contribution to the Development of Agriculture and Rural Communities, Saint Lucia Annual Report 2009.

FIGURE 1
Tunnel type greenhouses

©MOHAMMED AND CRAIG

Caribbean Agricultural Research and Development Institute (CARDI) – is the leading Agricultural Research and Development Institute in the Caribbean, particularly within the OECS. It was established in 1975 to serve the agricultural and development needs of the Member States of CARICOM. CARDI is governed by the Ministers of Agriculture of CARICOM Member States.

In an effort to increase and sustain the production of root crops (yam, tannia, sweet potato and sweet cassava) for local consumption and export, CARDI Saint Lucia had to address the shortage of root crop planting material. The shortage was affecting local production as a result of the increased cost of planting material, cost of production and the resulting higher prices for consumers. Therefore, in an effort to increase and sustain production, CARDI established root crop planting material multiplication plots at its Demonstration and Training Centre.

As a result of post-harvest concerns in the fruit and vegetable subsector in general, and the need to effect change, CARDI Saint Lucia focused on training farmers in production and post-harvest handling of a range of commodities inclusive of hot peppers, sweet pepper, tomatoes, cucumbers, passion fruit and pineapple. This was done with the intention of increasing the quantity, and improving the quality, of produce for both the domestic and export markets. To complement this effort, CARDI has been a major player in introducing 'Protected Agriculture' technology to Saint Lucia. The Unit evaluated the production of several vegetables under the 'Protected Agriculture' and 'Open Field' production systems.

Saint Lucia Bureau of Standards – is another institution with demanding responsibilities to facilitate the efficiency of the agricultural sector. The SLBS is a statutory body, established by the Standards Act No. 14 of 1990, which administers the Metrology Act No. 17 of 2000, with the responsibility to develop and promote standards and codes of practice for agricultural products and services for the protection of the health and safety of consumers and the environment in order to promote the enhancement of the economy of Saint Lucia. The Metrology Act gives SLBS the responsibility for legal metrology (weights and measures) and establishes SLBS as the national metrology institute (NMI).

According to the strategic plan, the SLBS is the national institution playing a leading role in the development and management of Saint Lucia's National Quality Infrastructure, including standards, conformity assessment and metrology. Quality infrastructure elements are essential for agricultural production and trade. Business and government use these elements to optimize production and assure quality.

Consolidated Foods Limited (CFL) – Mega J Supermarket – is part of a conglomerate company that includes Super J stores, which is the largest supermarket chain on the island with eight stores. This company is said to control at least 50 percent of the market share. CFL purchases produce from farmers wholesale, which is then distributed to its retail outlets. Most of the less perishable products are purchased at CFL's centralized warehouse but some of the more perishable produce is delivered by farmers directly to the individual supermarkets.

The volume of non-traditional crops, including herbs and spices, plantain, banana, fruit, tree crops and vegetables, purchased by supermarkets increased significantly, while declines were recorded within the hotel industry. The increased quantity of produce supplied to the supermarkets can be linked to CFL support programme for farmers, which contributed to the increased number of farmers supplying produce to the supermarket chain.[3]

Belle Vue Farmers' Cooperative – has a membership of over 200 small farmers. It markets over XCD 1.5 million of fresh produce including an organic line (primarily lettuce and herbs). The services offered to its members include: packinghouse, distribution, sales and marketing services (primarily hotels and supermarkets); sourcing of technical assistance (MAFPFRD, OXFAM, FAO, IICA, US Peace Corps); introduction of new technology including a demonstration farm; sale of inputs, including vegetable seedlings.

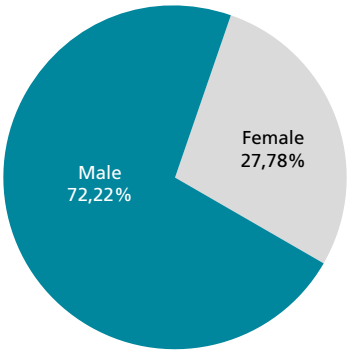
Black Bay Small Farmer Association – is a small cooperative with fewer than 100 members. The Cooperative negotiates markets for its members as well as non-members who may be recommended by members.

DESCRIPTION OF SUBSECTOR SUPPLY CHAIN WITH GENDER DISAGGREGATED DATA

The 2007 Saint Lucia Agriculture Census shows that the number of individual female landholders was 2 906 in relation to the 6 894 individual male landholders. This meant that in 2007, 42 percent of the landholders were women, which is significant.[4]

While gender disaggregated data specific to the three supply chains were not available for this study, there were general country data that can guide the thought process. Figure 2 shows that in 2013 in Saint Lucia 28 percent of the agricultural labour force were women.

FIGURE 2
Gender in Agricultural Labour Force



Source: FAOSTAT, FAO of the UN. Accessed on January 24, 2014 http://faostat.fao.org/site/550/default.aspx#ancor

In addition, Saint Lucia's 2010 Population Census[5] shows that the total resident population of Saint Lucia was comprised of 82 926 men and 83 600 women. While the Saint Lucia 2010 population census does not specifically make reference to the high proportion of women engaged in non-economic activities (unpaid), discussions with people in the field suggest that the situation in Saint Lucia is no different than that in Trinidad and Tobago and Guyana or indeed in the entire region. 'Home duties' are synonymous with small activities and this could include making farine and cassava bread, harvesting mangoes or tending to a tomato garden in order to supplement family income or to have a small income of their own.

Discussions while in the field with farmers and other market intermediaries along with empirical evidence suggests that, at the production end, 90 percent of those involved in the agricultural sector are men. However, gender roles are reversed for farine or cassava bread processing, as it was estimated that 90 to 95 percent of the activities are carried out by women. The May 2014 survey revealed that 11 of the 12 (92 %) people employed for fruit processing at the Fond Assau Agri-Processing plant were women. The lone man was the driver. In 2012, it was in fact higher, as 96 percent of the employees were women.

In recognition of the role that women have played and continued to play in the development of Saint Lucia in general and in expansion of the

[3] Ministry of Agriculture, Food Production, Fisheries and Rural Development, Saint Lucia Annual Agricultural Review 2012

[4] MALFF available at: http://www.malff.com/images/stories/Census%20Data/2007%20Census%20of%20Agriculture%20Summary%20Report.pdf.

[5] Saint Lucia Preliminary Census Report. (Avaialble at: http://204.188.173.139:9090/stats /images/OtherPublications/StLuciaPreliminaryCensusReport2010.pdf).

agricultural sector in particular, the Government has with support from the donor and technical assistance agencies such as the European Union, Government of Taiwan and IICA, initiated several women-oriented projects. IICA's 2013 Saint Lucia's Annual Report[6] states:

"IICA sees the vertical integration in the agriculture sector, especially through the promotion of value-added agroprocessing as an important means of keeping greater value in the rural economy". IICA has implemented its Fondo Concursable para la Cooperación Técnica (fonTC) Project, Working Capital Programme for Rural Women Entrepreneurs in the Caribbean, which facilitated strengthening the knowledge capacities of forty members (40) of the Saint Lucia Network of Rural Women Producers (SLNRWP) through training in business skills. Complementing the training course, the Project also established a small loans revolving fund.

The funds provided under the small loans revolving fund have enabled the members of the SLNRWP to overcome one of their immediate constraints, which was the ready access to affordable short-term financing to assist in the expansion of product lines and to undertake activities such as packaging and labelling to improve product quality and standards. The loan scheme has also facilitated procurement of semi-industrial equipment, which has not only positively impacted quality but has led to increased productivity for members of the Network. IICA has also collaborated with the Saint Lucia Social Development Fund (SSDF) to provide the SLNRWP with semi-industrial equipment and appliances with the aim of boosting productivity and improving the quality of the agro processing activities.

In Saint Lucia, while there are slight variations for some domestically produced commodities; the main players in the local food value chain are the public markets, cooperatives, SLMB, CFL, hotels and supermarkets.

Figure 3 shows a distinction between the sweet cassava and bitter cassava supply chain. During in field discussions it was suggested that there is not much production of sweet cassava and that this volume is probably less than 10 percent of total cassava production. Apart from what is consumed at home, most is sold through the public markets. On the other hand bitter cassava has been traditionally produced and used as input into farine and cassava bread production. Figure 3 shows that farine is readily available at public markets, SLMB, CFL and supermarkets but not at the main hotels. Cassava bread is less widely available in public places as sales seem to be restricted to the public markets and to specialized retail centres such as Plas Kassav.

Figure 4 shows the Saint Lucia mango supply chain. In addition to the public markets, cooperatives, SLMB, CFL, hotels and supermarkets farmers may choose to sell mangoes to the Fond Assau Agro Processing Plant or to exporters. As a result the difference between the bitter cassava value chain and the mango value chain is that the processing plant would then supply value-added pulps and juices to wholesale and retail buyers and exporters would send top quality fresh fruit to various overseas markets.

Finally the supply chain for tomatoes is less complicated as shown in Figure 5. In this case farmers supply tomatoes to the standard six channels of public markets, cooperatives, SLMB, CFL, hotels and supermarkets.

IDENTIFICATION OF ONGOING WORK TO REDUCE POST-HARVEST LOSSES

IICA conducted a screening survey in 2012-2013 to gather information from a sample of countries in the Caribbean and Latin America about the current situation regarding post-harvest losses (IICA, 2013). The results indicate a diversity of commodities affected by post-harvest loses from several sources.

The report points out that throughout the island of Saint Lucia, the bulk of post-harvest losses occur around the production of vegetables, pineapples, cocoa, cassava, and bananas. The problem is considered severe with unofficial estimates indicating that approximately 30 percent of total production is lost after harvesting. Post-harvest losses in the above-mentioned crops impact the various demographic groups in the country in varying ways. Smallholder and large-scale farmers are affected directly by the loss of income as a result of crops that cannot be sold. In the case of vegetables and pineapples, the country is negatively impacted by the loss of foreign exchange, because large volumes of imports are required to compensate for lower supply volumes.

In some cases, rural and urban populations are affected by higher prices paid for imported vegetables and pineapples, or for produce during acute

[6] IICA Saint Lucia Annual Report. (Available at: http://www.iica.int/Eng/regiones/caribe/ECS/ECSDocs/IICA%202013%20Saint%20Lucia%20Report.pdf).

FIGURE 3
Saint Lucia cassava supply chain

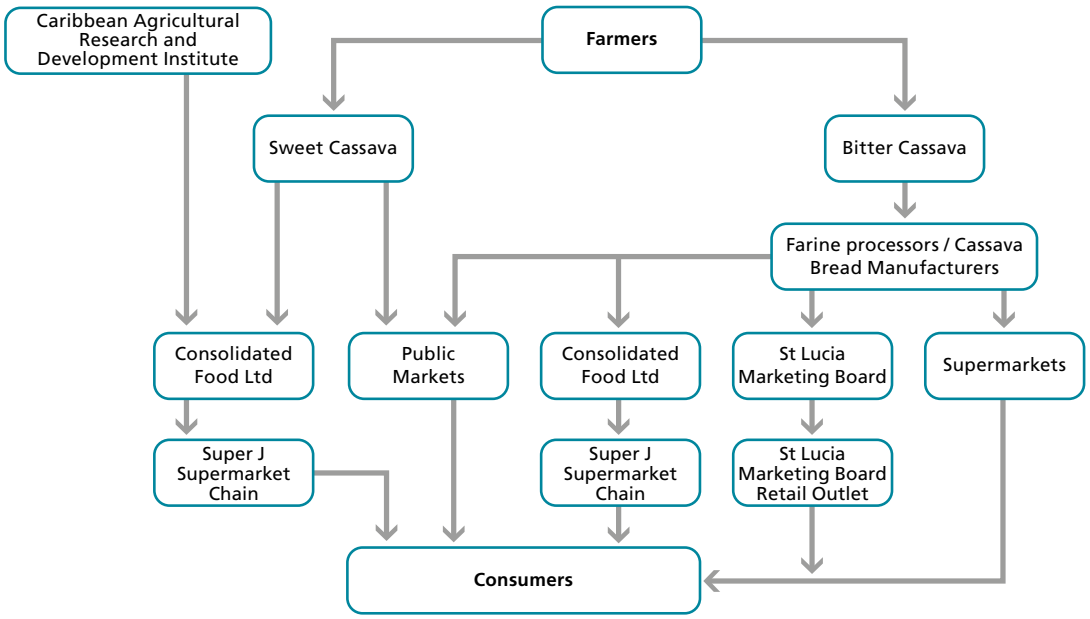
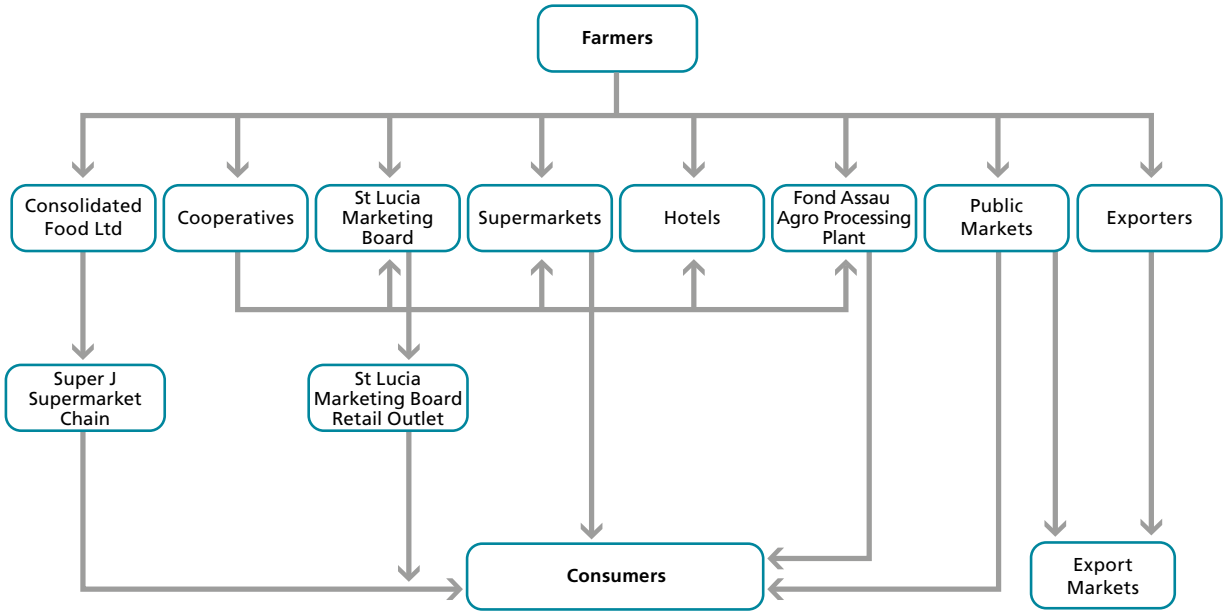
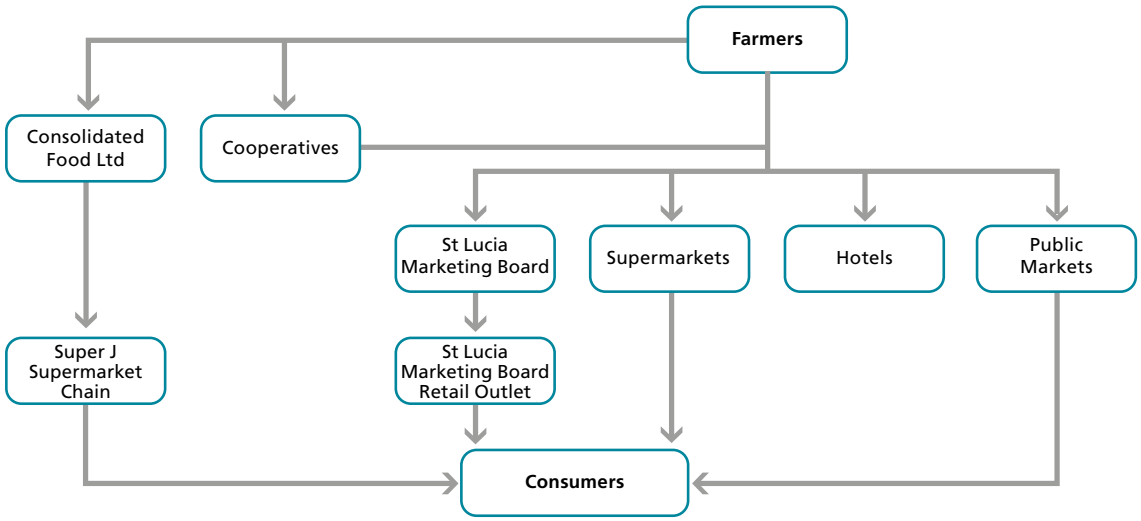


FIGURE 4
Saint Lucia mango supply chain



shortages. In the case of cocoa, cut flowers, cassava, and bananas, there are also indirect negative impacts such as reduced employment, especially in rural communities, because farmers are unable to maintain the profitability of their farms. While the post-harvest challenge has many facets, which vary from crop to crop, some critical aspects in Saint Lucia are consistent across all crops.

FIGURE 5
Saint Lucia Tomato Supply Chain



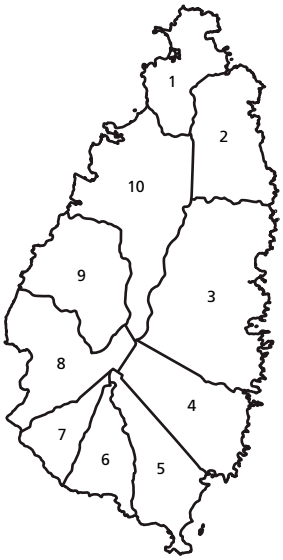
One of the main limitations is the lack of adequate storage facilities, refrigerated or otherwise, for agricultural crops after harvest. Most crops go directly from the field to the market and, as they are perishable, losses increase for the crops with shorter shelf lives. This problem negatively impacts export crops, which must await the arrival of transport carriers (by air or ship). Many losses are incurred when arrival is delayed since the crops are not in storage facilities. Most produce comes from smallholders who rely heavily on the seasons to schedule production. This means that most years are characterized by periods of scarcity and gluts, especially for vegetable crops.

Further, the survey notes that during periods of glut, post-harvest losses are particularly heavy because of the lack of adequate storage facilities. Post-harvest losses of cassava are particularly severe when the onset of early rains coincides with harvesting. In recent years, erratic rainfall has created enormous problems for cassava farmers and their communities. These problems are compounded by poor road networks in most rural areas, which cause bruising of harvested crops, and farmers' poor knowledge of post-harvest handling (packaging, control of temperature, humidity, etc.). The lack of any systematic gathering, analysis, and use of data complicates the implementation of immediate solutions to some post-harvest problems. Limited data on market demand makes it difficult for farmers to schedule production. Most farmers look for unscientific signals to determine when to produce any particular crop.

IICA has begun assisting Saint Lucia in the establishment of an Agricultural Marketing Information System (AMIS), but this is still a work in progress and funding for all its components has yet to be identified. Data is required for all aspects but primarily for production and marketing. There is also a need to establish an effective market surveillance system. Policy information and socio-economic measurements are readily available from the National Statistics Department. Human resources are readily available as the Ministry for Agriculture has research, propagation, and extension departments. There is also a statistics department and other support agencies for the agricultural sector, as well as a vibrant private sector for trade in agricultural produce.

The use of modern technologies still lags in many aspects, especially in relation to information and communication technologies, which can simplify and enable more efficient services from agricultural and rural service provider agencies to producers and rural and urban communities. There has been some training of farmers, agro-processors and agricultural technicians. There is a continuous need for more training, although financial resources are lacking. Plans already exist for the construction of a national clearing-house for agricultural produce but funding has not yet been identified.

FIGURE 6
Map of Saint Lucia showing the Administrative Quarters



Key: Names of the regions
1) Gros Islet
2) Dauphin
3) Dennery/Praslin
4) Micoud
5) Vieux Fort
6) Laborie
7) Choiseul
8) Soufriere
9) Anse La Raye
10) Castries

Source: https://www.google.gy/districts_

DESCRIPTION OF THE EXISTING MARKETING SYSTEMS

Cassava

Cassava is produced primarily in the following administrative quarters (Figure 6): 2 (Canaries), 4 (Choiseul), 5 (Dennery), 7 (Gros Islet), 8 (Laborie), 9 (Micoud) and 11 (Vieux Fort). Discussions with farmers and agricultural professionals and empirical evidence suggest that the demand for fresh cassava tubers (sweet cassava) is weak. This is part of the Saint Lucian tradition as the other root crops (dasheen, yam and sweet potatoes) are more popular. In recent years however, the supply is said to be growing in response to demand

FIGURE 7
Sweet cassava tubers at Castries public market

©MOHAMMED AND CRAIG, 2014

FIGURE 8
Farine products on sale in Saint Lucia

Farine from the manufacturer in La Borne ready for sale

Farine for sale at SLMB retail outlet in Castries

Farine for sale at Glace supermarket

©MOHAMMED AND CRAIG

FIGURE 9
Different Plas Kassava cassava products being marketed in Saint Lucia

Farine at a mega store – two pack set

Sweet, flavoured cassava bread

Casareep on sale

Sweet cassava bread on display

Smoked herring cassava bread

©MOHAMMED AND CRAIG

FIGURE 10
Equipment for making farine

©MOHAMMED AND CRAIG

from the Guyanese, Jamaican, Haitian, Cuban and other groups in the country. The production initiative is led by CARDI, which has introduced the MCOL variety over the last four years. Saint Lucian farmers have in fact traditionally produced bitter cassava that has been and still is used to produce farine and cassava bread. The specific varieties of bitter cassava are not readily available and do not appear to be known. Discussions with stakeholders suggest that they are merely referred to as 'bitter cassava'.

Figure 7 shows the lone parcel of sweet cassava tubers seen during the mission during a peak shopping period at the Castries public market. Figure 8 shows a range of farine products on

FIGURE 11
Mangoes and mango products in Saint Lucia

Preserved red mangoes on sale at SuperJ Supermarket

Mangoes and mango pulp at Fond Assau Agro processing Plant

Assortment of mangoes at Castries Public Market

Julie Mangoes at Super J

sale in Saint Lucia; while Figure 9 showcases specifically different Plas Kassav cassava products being marketed on the island. Further, Figure 9 shows some typical commercial farine-making equipment used in Saint Lucia. In comparison with Guyana, this is very sophisticated equipment as Guyana's farine industry is largely still based on traditional equipment made by the respective Amerindian tribes.

Mango

One of the most common mangoes in production is Dennery (Administrative Quarter No. 5 in Figure 6). The varieties include Graham, Julie, Long

FIGURE 12
Locally grown tomatoes at different points in the supply chain

Tomatoes at CFL

Tomatoes at SuperJ

Tomatoes at Super J

Tomatoes at Glace Supermarket

©MOHAMMED AND CRAIG

FIGURE 13
Imported fresh and dried tomatoes at SuperJ Supermarket

Imported vine ripe tomatoes

Imported cherry tomatoes

Imported sun-dried tomatoes

©MOHAMMED AND CRAIG

Tommy Atkins and Bridge and the two that have been the most commercialized are Long and Julie, which is mainly exported.

Figure 11 shows mangoes and mango products in Saint Lucia. Figure 11 (a) shows preserved red mangoes that are very popular in Trinidad and Tobago but are rare in Saint Lucia and Guyana. Figure 11 (d) depicts one of the newer products, mango pulp that is produced by the Fond Assau Agro Processing Plant.

Tomato

As for Guyana and Trinidad and Tobago, tomatoes are grown throughout the island but primarily in the following administrative quarters: 4 (Choiseul), 5 (Dennery) and 10 (Soufriere). The main varieties are Heatmaster and TX64 and TX100. However, other common varieties include Caraibe improved, Panther, Rodeo, Cobra and TX54, TX61 and TX 62.

Figure 12 shows top quality, locally grown tomatoes at the supermarkets while Figure 13 shows imported fresh and dried tomatoes at a SuperJ Supermarket.

Other observations of the cassava supply chain are:

- Crates were widely used at varying points along the tomato and mango supply chains in Saint Lucia.
- Most vegetables are grown open field but the greenhouse technology is being adopted as farmers become more convinced of its relevance.
- Farmers in Saint Lucia seemed to be better organized at the marketing end of the continuum than in Trinidad and Tobago and Guyana. Belle Vue and Black Rock Cooperatives, SLMB, a number of hotels and supermarkets seem very committed to working together with farmers and supporting local production and marketing.

Chapter 4
Study findings

SECONDARY DATA AND KEY-INFORMANT (EXPERT) INTERVIEWS

Literature review

Reference has already been made to the CARICOM-related studies in Trinidad and Tobago and Guyana in the FAO reports on post-harvest loss assessments for cassava, mango and tomato in Trinidad and Tobago and Guyana. However, the specific focus in Saint Lucia was to seek out any further information on post-harvest related studies in Saint Lucia or in the OECS, which was fruitful largely because of the work of the CARDI Saint Lucia Unit.[7] In addition, the literature review was useful in providing a number of policy-oriented documents that were related to the agricultural sector in Saint Lucia. These included: the National Food Production and Action Plan; National Agricultural Policy 2009 – 2015; National Policy and Strategic Plan – Summary Booklet 2006; Summary Budget Speech 2013 – 2014; Five-Year Strategic Management and Action Plan for the Ministry of Agriculture, Lands, Forestry and Fisheries; IICA's Saint Lucia – Annual Reports and CARDI's Saint Lucia – Annual Reports.

Review of the production and value of the cassava produced

The volume of local agricultural produce purchased by supermarkets increased considerably in 2012 by 97.5 percent to 2 950 tonnes, representing the highest quantity of produce purchased by supermarkets over the past five years. Significant increases for all produce were recorded for the review period compared to 2011, in particular, purchases of herbs and spices accounted for the highest percentage increase (159.7 percent). Musa species (bananas, plantain, macambou), which represents 41.3 percent of total agricultural purchases by supermarkets, grew substantially by 78.2 percent, Fruit and Tree Crops and Vegetables also posted triple digit growth of 108 percent and 122.4 percent respectively. Increased production in this subsector is attributed to the post-Tomas vegetable crop rehabilitation programme along with the CFL support programme. Despite the significant increase in supply, revenue generated increased by a mere 2 percent to USD 9.1 million compared to 2011, indicating a reduction in the unit prices of the commodities.[8]

Table 4.1 shows that during the 2009–2013 period, tomato production fluctuated between 189 tonnes in 2010 and 320 tonnes in 2009. Similar-

TABLE 4.1
Volume of tomato and mango produced in Saint Lucia; 2009-2013

	2009		2010		2011		2012		2013	
Crops	Tonnes	Value XCD'000	Tonnes	Value XCD'000	Tonnes	Value XCD'000	Tonnes	Value XCD'000	Tonnes	Value XCD'000
Tomato	319.7	2 356.17	188.5	1 640.50	256.7	2 028.30	288.1	2 248.83	274	2 248.92
Mango	323.2	659.60	518.9	1 086.87	300	628.00	555.5	968.00	530.7	937.00

Source: MAFPFRD; USD 1.00 = XCD 2.70

[7] CARDI. (Available at: http://www.cardi.org/wp-content/uploads/2011/02/St-Lucia-Country-Highlights-20101.pdf).

[8] MAFPFRD, Saint Lucia Annual Agricultural Review 2012.

TABLE 4.2
Volume and value of mangoes exported from Saint Lucia; 2009–2013

	2009		2010		2011		2012		2013	
Crops	Tonnes	Value XCD'000	Tonnes	Value XCD'000	Tonnes	Value XCD'000	Tonnes	Value XCD'000	Tonnes	Value XCD'000
Mango	32.39	65.70	44.17	93.43	27.98	56.95	47.03	71.75	12.78	18.17

Source: MAFPFRD; USD 1.00 = XCD 2.70

TABLE 4.3
Volume and value of tomatoes imported by Saint Lucia; 2009-2013

	2009		2010		2011		2012		2013	
Crops	Tonnes	Value XCD'000	Tonnes	Value XCD'000	Tonnes	Value XCD'000	Tonnes	Value XCD'000	Tonnes	Value XCD'000
Tomato	49.78	275.11	114.21	646.02	143.62	713.57	202.29	574.64	50.556	287.09

Source: MAFPFRD; USD 1.00 = XCD 2.70

ly, mango production ranged between 300 tonnes in 2011 and 531 tonnes in 2013. Production in 2013 was valued at XCD 2.2 million for tomatoes and XCD 937 000 for mangoes. Fond Assau Ago Processing Plant began operations in 2011 and is producing a range of fantastic pulps and juices including mango. However, no data was available at the time of the mission.

There is no record of sweet or bitter cassava production or purchases. Discussions with stakeholders indicate that bitter cassava is traditionally grown in the rural areas and used to make farine and cassava bread. These transactions have not entered official statistics but, while it will not be possible to easily measure the cassava produced and used at home (as is the case for the other root crops and other crops), empirical evidence of farine being sold outside supermarkets and at public markets, suggest that the volume and value may be significant enough to warrant recording. Discussions and observations suggest that casareep is produced and marketed in small quantities.

Discussions with stakeholders also suggest that sweet cassava has not been traditionally grown in Saint Lucia but that it is essentially a newer crop. During the mission only a very small quantity of sweet cassava was observed at the Castries Public Market during the peak trading period from 9.00 to 11.45 am on a Saturday.

In 2012, the major exports of agricultural produce (excluding bananas) were breadfruit and plantain, followed by mangoes and avocados. Breadfruit exports peaked at 422.11 tonnes earning revenue of USD 1.3 million, while plantains generated revenue of USD 400 710 with a corresponding 415.02 tonnes exported. Mango and avocado exports totalled 47.03 tonnes and 22.34 tonnes respectively during the review period.

As a result of low quantities of breadfruit on the market, breadfruit exports dipped by 6.21 percent or 27.95 tonnes in 2012. Despite the drop in breadfruit exports, revenue increased by 53 percent, indicating a 64.2 percentage increase in the unit cost of breadfruit. On the other hand, plantain exports decreased slightly by 0.03 percent or 0.12 tonnes, however, a 19.2 percent drop in unit cost for plantains was realized. Exports of mangoes increased by 68 percent or 19.05 tonnes while avocado exports declined by 19.2 percent or 5.32 tonnes.[9]

Of the three commodities in focus only mangoes (fresh) are officially exported. Table 4.2 shows the volume and value of mangoes exported from Saint Lucia during the 2009–2013 period. Exports increased from 32 tonnes (XCD 66 000) in 2009 to 47 tonnes (XCD 72 000) in 2012. However in 2013, exports decreased to approximately 13 tonnes valued at XCD 18 000. The general view is that mango products are not exported from Saint Lucia.

On the other hand, Table 4.3 shows the volume and value of tomatoes imported into Saint Lucia during the 2009–2013 period. Approximately 50 tonnes valued XCD 275 000 was imported in 2009. This eventually increased to 203 tonnes in 2012 valued at XCD 575 000 before decreasing drastically to about 51 tonnes valued at XCD 287 000.

Tables 4.4 and 4.5 show that across all three commodities for the entire review period, hotel

[9] MAFPFRD, Saint Lucia Annual Agricultural Review 2012.

TABLE 4.4
Average buying prices (XCD) per kg of selected agricultural produce purchased by selected supermarkets 2009–2013

Crops	2009	2010	2011	2012	2013
Graham mangoes	0.90	0.99	0.93	1.10	0.97
Julie mangoes	1.52	1.51	1.48	1.22	0.90
Tomatoes (local)	6.57	8.59	7.94	7.94	7.55

Source: MAFPFRD; USD 1.00 = XCD 2.70

TABLE 4.5
Average buying prices (XCD) per kg of selected agricultural produce purchased by selected hotels, 2009–2013

Crops	2009	2010	2011	2012	2013
Graham mangoes	-	4.40	4.94	4.40	4.40
Julie mangoes	3.21	3.88	4.46	3.97	4.45
Tomatoes (local)	8.15	8.59	9.08	9.45	9.93

Source: MAFPFRD; USD 1.00 = XCD 2.70

prices were significantly higher than supermarket prices. For this reason farmers seek to sell their better quality produce directly or indirectly through the cooperatives; first to the hotels, then to supermarkets and afterwards to SLMB and the public markets.

The principle supply chains according to the regional administrative quarters shown are:
Cassava: Administrative quarters 2 (Canaries), 4 (Choiseul), 5 (Dennery), 7 (Gros Islet), 8 (Laborie), 9 (Micoud) and 11 (Vieux Fort).
Mango: Administrative quarter 5 (Dennery).
Tomato: Administrative quarters 4 (Choiseul), (5 (Dennery) and 10 (Soufriere).

Tables 4.6, 4.7 and 4.9 provide detailed description of the supply chains.

HISTORY OF GOVERNMENT AND PRIVATE SECTOR INVOLVEMENT IN THE SUBSECTOR

The documents referred to in the Section '*Secondary data and key-informant (expert) interviews*' all show the links between the Government of Saint Lucia through the MAFPFRD and SLMB on the one hand and farmers, cooperatives, CARDI, IICA, CFL, hotels and supermarkets on the other. The Government of Saint Lucia carries out this work with the support from several donor and technical agencies. These issues have been discussed in previous sections. The Saint Lucia 2012 Annual Agricultural Review[10] observes that it was through this type of collaboration that in 2012 the Agriculture Sector showed signs of recovery by recording a growth of 8.4 percent, following significant declines over the 2010/2011 period. Thus, the sector's contribution to total Gross Domestic Product (GDP) moved from 2.8 percent in 2011 to 3.10 percent in 2012.

The volume of local agricultural produce purchased by supermarkets increased considerably by 97.5 percent to 2 950 tonnes in 2012, representing the highest quantity of produce purchased by supermarkets over the previous five-year period. Significant increases for all produce were recorded for the review period compared to 2011.

INVENTORY OF ACTIVITIES AND LESSONS LEARNED FROM PAST AND ONGOING INTERVENTIONS

Saint Lucia has several ongoing projects that target the agricultural sector. The main source of external funding has traditionally been from the European Union thorough the European Development Fund but in recent years Taiwan is emerging as a significant donor to the sector. Projects implemented over the last six years include: Giant African Snails Control Programme; Redevelopment of Agricultural Station at Union, Assistance for Greenhouse, Vegetable Production, Beausejour Station

[10] MALFF (Available at: http://www.malff.com/images/stories/agridigest/2012AgriReview.pdf)

TABLE 4.6
Detailed description of the cassava supply chains in Saint Lucia

Stage in food supply chain	Location	Months of the year	Number of actors	Products	Volume (tonne)	Facilities/ equipment	Duration/ distance	Inputs and Services	Cost of production (XCD)	Value of products (XCD)
Primary production	Canaries	Jan. to Dec.	7	Cassava tubers	100	Tractors and ploughs for land preparation; cutlass for cutting planting material; shovels for drains	Year-round	Planting material, labour for cleaning, weed control and drain maintenance, Weedicides used during land preparation to clear off weeds (product names include Basta and Touchdown	25 250/ha	
Harvest	Canaries	Jan. to Dec.	7	Cassava tubers	100	Forks, bags, cutlass	Year-round	Labour to harvest, bag and load roots into carts/ pickups	XCD 0.60/kg 42 500 kg/ha	0.75/kg
Post-harvest handling	From Canaries to Castries	Jan. to Dec.	7	Cassava tubers	90	Polypropylene bags, twine	In the Canaries area, produce travels 10-20 minutes from fields to processing facility located near Canaries (La Place Cassava) From La Bourne to central Market 21 minutes 15 km From Vieux Fort to Municipal market 75 minutes., 50 km From Saltibus to central Castries Market 90 minutes 73 km	Labour Packaging materials	Labour cost is XCD 7/ day	
Transportation	From Canaries to Castries market; to CFL Castries	Jan. to Dec.	7	Cassava tubers	80	Pickups, trucks, vans	Year-round	Driver, labour to load and unload	150/ tonne	
Retail market sales	Castries -Municipal market, Consolidated Foods	Jan. to Dec.	7	Cassava tubers	80	Covered and open air markets; open spaces at markets; display tables	Year-round	Driver, labour to load and unload, sell		150/kg

TABLE 4.6
(Continued)

Stage in food supply chain	Location	Months of the year	Number of actors	Products	Volume (tonne)	Facilities/ equipment	Duration/ distance	Inputs and Services	Cost of production (XCD)	Value of products (XCD)
Processing	Farine / cassava bread manufacturers in Canaries	Jan. to Dec.	2	Farine, cassava bread	47	Washing equipment, washing bins; pressing, grating sifting, drying equipment, worktables; plastic bag, labels, etc.	Farine is traditionally cooked in cauldrons formerly used on sugar estates. Cooking in these cauldrons using firewood takes about 60-90 minutes. Temperature varies from 100 to 130 °Celsius	Labour to wash, peel, cut cassava, press grated cassava, dry and sift farine	550/ tonne	1.30/kg
Transportation	From Canaries / La Bourne etc. (processing) to CFL / supermarkets in Castries	Jan. to Dec.	2	Farine	38	Pickup/van	La Bourne to Castries 21 minutes (15 km) Canaries to Castries 46 minutes 31 km	Driver, labour to load and unload, sell	150/ tonne	1.45/kg
Retailing	Supermarkets in Castries	Jan. to Dec.	6	Farine						10.00/kg

Note: Yield per acre – 37 400 lbs
Cost of production – XCD 10 100
Average farmgate price – XCD 0.75
Source: Agricultural Statistics, Agri-Enterprise Development Section, Ministry of Agriculture, 2009.

TABLE 4.7
Detailed description of the tomato supply chains in Saint Lucia (Region 5 – Black Bay / Vieuxfort)

Stage in food supply chain FSC Stage	Location	Months of the year	Number of actors	Products	Volume (Tonne)	Facilities/ Equipment	Duration/ Distance	Inputs and Services	Cost of production (XCD)	Value of products (XCD)
Primary production	Region 5 – Black Bay / Vieuxfort	January - December	25	Tomatoes	90	Tractors and ploughs for land preparation; cutlass, hoes, shovels	12 months	Seedlings, labour for land preparation, cleaning, weed control, staking, drain/crop maintenance, etc. Pesticides are used in the production of the crop including herbicides, fungicides, insecticides acaricides	XCD43 750/ha	
Harvest	Region 5 – Black Bay / Vieuxfort	January - December	25	Tomatoes	90	Crates, bags,	12 months	Labour to harvest, place in buckets, crates and load into carts/ pickups	XCD 2 625/ha	3.50/kg
Post-harvest handling	From farm to wholesale market / retail market; from farm to CFL; from CFL to supermarkets; Region 5 – Black Bay / Vieuxfort to Castries	Year-round	25	Tomatoes	72	Crates, also use cardboard cartons manufactured locally	Main producing areas Black Bay/ Vieux Fort, Choiseul, Soufriere, Babonneau, Millet, Vieux Fort to Castries 56km, 66 minutes	Labour to sort, pack and load as required	XCD 1 350/ tonne	7.00/kg
Other post-harvest handling	From Region 5 – Black Bay / Vieuxfort to Coop to Castries (hotels or supermarkets)	Year-round	5	Tomatoes	65	Crates, cartons	From Black bay to hotels in the north 56-66km; 66-75 minutes	Labour to sort , pack and load as required		7.70 kg
	From farm to Marketing board to hotels or supermarkets; Region 5 – Black Bay / Vieuxfort to Castries	Year-round	20				Distances are near the same as above. Marketing board does farmgate purchasing in Saltibus, Vieux Fort Micoud and Choiseul covering 66-80km up to five hours moving from farm to farm in any given purchase day		540/tonne	

TABLE 4.7
(Continued)

Stage in food supply chain FSC Stage	Location	Months of the year	Number of actors	Products	Volume (Tonne)	Facilities/ Equipment	Duration/ Distance	Inputs and Services	Cost of production (XCD)	Value of products (XCD)
Transportation	From Region 5 – Black Bay / Vieuxfort to Castries market / CFL, etc.	Year-round	25	Tomatoes	65	Pickups, vans	12 months	Driver labour to load and unload	175/tonne	
Wholesale/ retail Market sales	Several markets: municipal, hotels, supermarkets – Castries	Year-round	25	Tomatoes	61	Covered and open air markets; open spaces at markets	12 months	Driver, labour to load and unload, produce, sale display, package in polyethylene bags	540/tonne	10.00/kg (supermarket / hotel wholesale price)

Note: Yield per acre – 18 700 lbs
Price per lb of tomato at farmgate – XCD 2.50 to 3.50
Source: (Agricultural Statistics, Agri-Enterprise Development Section Ministry of Agriculture 2009)
Varieties grown; Heatmaster is losing popularity because it is highly susceptibile to curly leaf virus. More commonly used varieties include Caraibe improved, Panther, Rodeo, Cobra, TX series including TX 54, 61, 62. Most are produced by Agrinova Seed Company and Technisem
The following URL provides updated costs for tomato based on trials at the CARDI field station in Saint Lucia 2010. Pg 26 and 27 (Available at: www.cardi.org/wp-content/.../St-Lucia-Country-Highlights-20101.pdf).

TABLE 4.8
MANGO – Detailed description of the chain – Dennery

Stage in food supply chain	Location	Months of the year	Number of actors	Products	Volume (Tonnes)	Facilities/ Equipment	Duration/ Distance	Inputs and Services	Cost of production (XCD)	Value of products (XCD)
Primary production	Dennery	Dec. to July	175	Mangoes, cv long	125	Wacker, cutlass	8 months	Minimal inputs – maintenance of old trees	300/ha	USD 31 250
Harvest	Dennery	Dec. to July	175	Mangoes	125	Harvested by hand and by shaking; harvesting rod with pouch attachments, placed mostly in bags or buckets, crates or directly into trays of pickups; crates rarely used from farm to homestead or to market	8 months	Labour to harvest, and load up as required	800/ha	1.50/kg
Post-harvest handling	From Dennery to wholesale market/ retail market (Castries)	Dec. to July	175	Mangoes	100	Gloves, water for latex removal, clean boxes or crates, buffers such as paper to protect vibration damages	5 km from farm to homestead to wholesale and retail markets	Labour, packaging	1 150/ tonne	2.00/kg
Other post-harvest handling	From Dennery to processor (Barbanneau)	Dec. to July	175	Mangoes		Stainless steel cutting blades, tables and bowls. Food processor	8 months/ 27 km from farm to supermarket, municipal markets; about 40 minutes			
Transportation	From Dennery to municipal market (Castires)	Dec. to July	20	Mangoes	90	Pickups, vans, trucks		Driver, labour to load and unload	0.30/kg	
Retail market sales	Castries	Dec. to July	70	Mangoes	85	Covered and open air markets; open spaces at markets		Driver, labour to load and unload, sell	190/tonne	2.50/kg
Processing	Processing facility - (Barbanneau)	Dec. to Aug.	15	Mango icicles, juice	5	Processing facility, equipment; work tables, cleaning gear, bottles, caps, boxes, labels; Choppers to slice mango, food processor	15-20 km from farm to processing facility; 9 months	Labour to clean, chop, pack, label, load, unload boxes; brokerage services	960/tonne	5.00/kg

USD 1.00 = XCD 2.70 approximately

Development, Relocation and enhancement of the Agricultural Station at Roseau, Post Hurricane Dean Rehabilitation Programme, Assistance for Agricultural Feeder Road Rehabilitation, Production enhancement for Agro-processing, Tissue Culture Laboratory, Assistance for Agricultural Inputs (Taiwan); Agricultural Diversification Project (European Union); and Promotion of Domestic Agricultural Produce (FAO).

Saint Lucia's Five-Year Strategic Management and Action Plan for the MALFF[11] addresses some issues that pertain to lessons learned over the years. Those selected are:

- The lack of long-term strategy affects the MAFPFRD in a global way, especially with the programme design and implementation, as could be seen with previous Système de Stabilisation des Recettes d'Exportation (STABEX) and Special Framework of Assistance (SFA) programmes. One of the main weaknesses in the formulation of the Logical Frameworks, which reflects a gap between the proposal and the reality, limiting the internal monitoring of the programmes.
- Constraints to agricultural and economic diversification have not been clearly addressed. Saint Lucia has no comprehensible strategy for agricultural and economic diversification. The formulations of these programmes are often inadequate and lack cohesion between the objectives and the expected results. The proposed activities look like a list of various initiatives without a global strategy or coherence with the main objective.
- Diversification requires the adequate adoption of market standards and regular flows of production to meet the market requirements. This should have been highlighted through market segmentation studies that have not been properly carried out.
- A significant change has to be undertaken in the formulation of the projects, and certainly involving the private sector. Four parameters should be taken into consideration for diversification: the need to focus on market oriented activities; assessment of the market segments; reinforcement of local capacities to meet market standards; the need to measure the risks of natural disasters.
- There is an increasing demand on the domestic market for fresh and processed food products, crop, livestock and fish, especially from the tourism sector. However, there is a local inability to meet the market demand in terms of quality and standards.

CURRENT POLICY FRAMEWORK ON SUBSECTOR FOOD LOSSES

The agricultural policy objectives and strategic plan developed by the Government of Saint Lucia seeks to provide the framework and guidelines within which this is to be achieved over the 2009 to 2015 period and to create an environment that facilitates investments and long-term growth in agriculture.[12] They are intended to serve as a useful guide to the processes of allocations of social and economic resources.

The national policy and strategy take into consideration participation, obligations and commitments to the principal external agreements and conventions. These include the United Nations Millennium Goals (UNMDGs), Agro 2003-2025 Plan for improving agriculture and rural life in the Americas, the Caribbean Community Agricultural Policy of the Revised Treaty of Chaguaramas, the Regional Strategy to Alleviate Key Binding Constraints to Agriculture in CARICOM (Jagdeo Initiative) and the OECS Agricultural Policy and Strategic Plan.

In this regard the vision for the agriculture sector in Saint Lucia is: "*A vibrant agri-food chain or system that provides adequate supplies of safe, high quality, nutritious food and non-food products and services, at stable and affordable prices, that assure financial security to producers and is socially and environmentally responsible thereby, promoting development in rural areas and conservation of resources*".

The National Agricultural Policy 2009–2015 document (NAP) also notes that, "*this sector vision will be pursued within the broad framework of a globally competitive market, liberalized global trading environment and national economic and social imperatives in respect of rural prosperity, food and nutrition security, natural resource conservation and gender equity. The intention of the Government is to have a focused and targeted*

[11] MALFF (Available at: http://www.malff.com/images/stories/MALFF's%20Report/SECTION%20ONE%20-%20TECHNICAL%20DIAGNOSIS%20REPORT%20-%20INSTITUTIONAL%20AS.pdf).

[12] National Agricultural Policy 2009–2015.

approach to the long-term development of the agriculture, forestry and fisheries sectors enveloped in a comprehensive national development policy package. In effect, the sector-specific policies will be complemented and coordinated with other policy measures within the broader sustainable development policy framework of the country as a whole".

Saint Lucia's agricultural policy is in fact designed to achieve the following seven broad objectives.

- increase the efficiency and competitiveness of the island's agriculture;
- promote the generation, adaptation and adoption of improved and appropriate technology;
- expand the agricultural production and market base;
- rationalize the use of land in the country;
- enhance national food security;
- generate new opportunities for employment and income generation in rural areas; and
- protect, conserve and ensure sustainable use of natural resource.

The national food security objective makes specific reference to addressing post-harvest handling issues and is stated in the box.

PRELIMINARY ANALYSIS OF POST-HARVEST LOSSES (SCREENING)

The value chains for tomato and mango in Saint Lucia were screened and are shown in Figure 3. Both commodities had a similar flow of post-harvest activities within the value chain and the critical control points were similar. All farmers were involved in harvesting, handling and marketing both crops at the same time.

It was not possible to screen the fresh **cassava** value chain in Saint Lucia because at the time data was collected the value chain for this commodity was not functional. However production from the cassava farine value chain was screened and is shown in Figure 14.

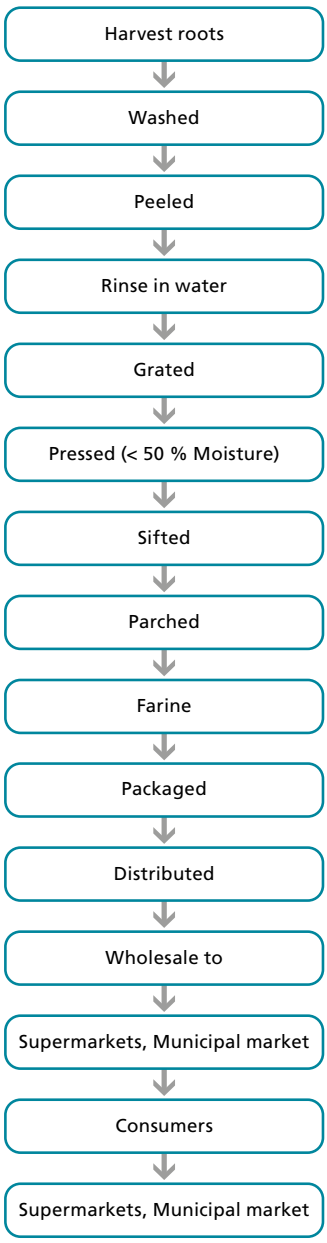
Tomato – Harvested tomatoes were placed in plastic crates. Some initial field sorting was done while harvesting by discarding fruits that had been damaged by birds, which was estimated by growers to be in the range of 20–25 percent. A significantly smaller percentage of fruits that had blossom end rot (2-3 %) were also culled at this point. Tomatoes contained in stackable plastic crates were then transported from the field to covered sheds often adjoining the house, in this case referred to as the packinghouse. The tomatoes were placed on newspaper or cardboard 1 or 2 layers on concrete floors and allowed to ripen. On a daily basis farmers would sort and remove decayed and unmarketable fruit. When the

"The Government is committed to national nutrition security. A well-nourished population is healthier, more productive and better able to learn. No child or needy family should be left behind for want of food. Recognizing that a major responsibility of agriculture is to produce food for the nation, a priority for the Government will be to simultaneously foster growth in food production and improved access to food. The food production objectives will be simultaneously addressed through emphasis on promising areas of commercial investment, in terms of developing a specific basket of crops, fisheries and livestock production to meet food and nutrition requirements.

Further, Government will ensure that each household has physical and economic access to food i.e. each household has the ability to produce or procure the food it needs. The access to food objective will be met through investment in post harvest handling, storage, preservation and distribution to reduce loss at all stages, strengthening local leadership, peoples participation and community involvement, incentives to promote processing at the local level and better utilization of indigenous foods and credit that combines small scale credit with technical advice and assistance will be promoted.

Further, great emphasis shall be placed on strategies that promote and influence the consumption of locally grown foods products. In pursuit of this objective the Ministry of Agriculture shall collaborate with various Ministries, in particular, Education, Health, Tourism, Finance and Social Transformation."

FIGURE 14
Cassava farine value chain in Saint Lucia



tomatoes were red ripe they were sorted according to size, placed in plastic crates, and either sold to wholesales, retailers, supermarkets, hotels or the country's largest perishables purchaser CFL. Tomatoes were also sold wholesale to Agricultural Co-operatives by growers who are certified members. CFL purchased fruit from certified and uncertified growers. A grower was classified as certified once he or she had attended a five-week training in post-harvest handling and quality requirements of fresh produce. CFL paid these certified growers an additional XCD 0.10 (Eastern Caribbean currency) per pound providing quality requirements were met. At CFL fruit was selected, weighed and graded.

Tomatoes meeting the highest grade were bought and placed in an air-conditioned room at 50–5 percent relative humidity to ripen and then transferred to a chill room at 5 to 7 °C and 65 to 75 percent relative humidity for no longer than 1 to 2 days and then distributed to their supermarket chain stores. Fruit that did not meet the quality requirements were then sold at the municipal markets, or the Marketing Retail Board outlet. Growers also sold their tomatoes wholesale to the agricultural cooperatives where the fruit was sorted, weighed and placed in plastic crates and sold to hotels, municipal markets and the Marketing Board Retail Outlet. However, unlike CFL, the cooperatives did not have refrigerated facilities.

In Saint Lucia, unlike Trinidad and Tobago and Guyana, the critical loss points were different. In Saint Lucia the CPL#1 was at the agricultural cooperatives, CPL#2 the Marketing Board Retail Outlet and CLP#3 was at the municipal market. At all three critical loss points identified above, refrigeration facilities were not available at the packinghouses or during transport and therefore maintenance of the cool chain, that had been so efficiently managed at CFL, did not prevail at these three critical loss points in the value chain.

Tomatoes are not processed in Saint Lucia as they are in Guyana. However, in Trinidad and Tobago, fresh ripe tomatoes are processed in households. The tomatoes are roasted or grilled, skin removed, macerated and spices added to make a processed product called tomato choka. The tomato choka is then sealed, packaged in polyethylene bags and frozen. Frozen tomato ckoka is then reheated prior to consumption.

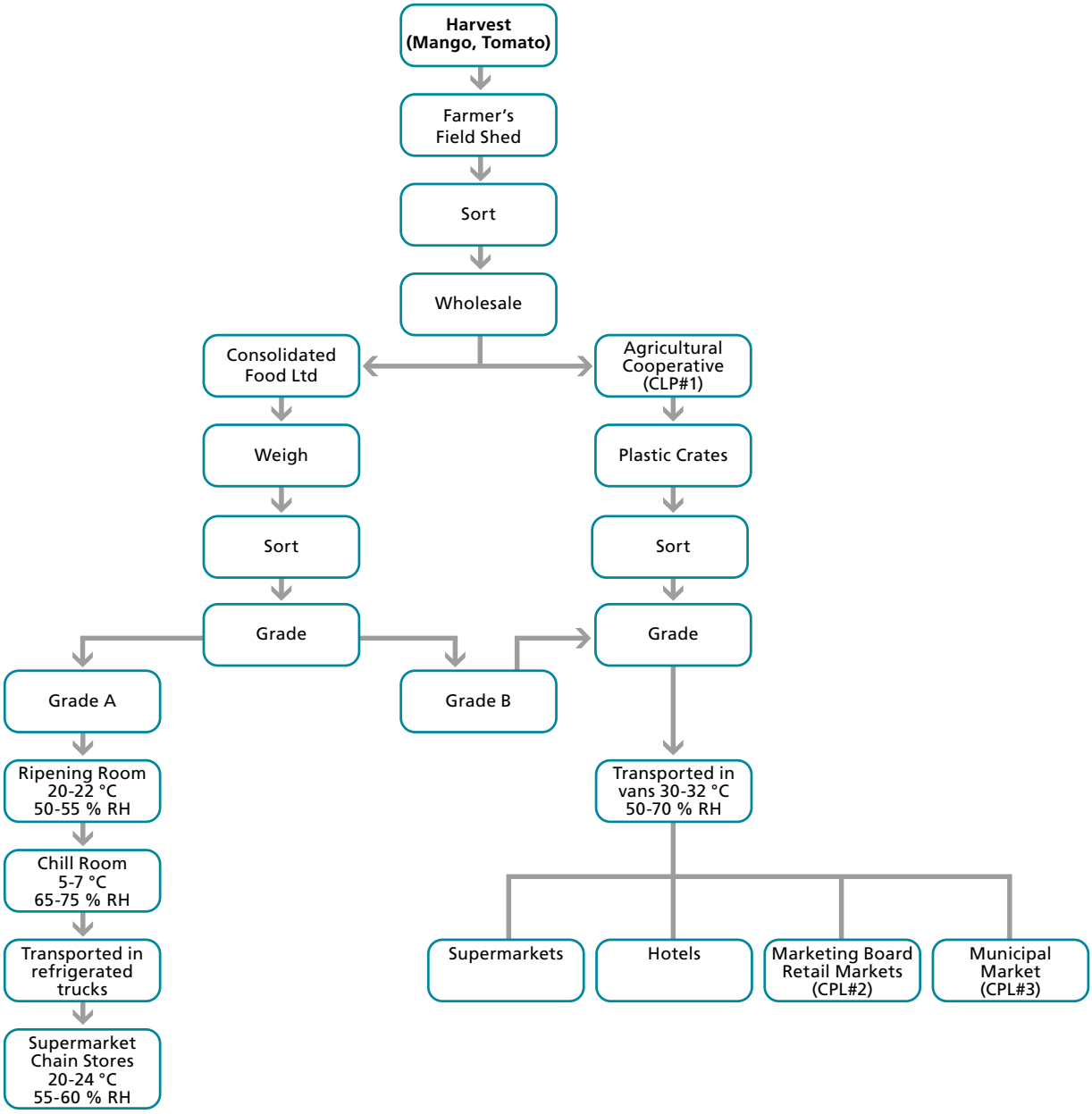
Mangoes are harvested at the turning stage of maturity to be processed into frozen mango juice by Fond Assau Agro Processing Plant, located at Babonneau in Saint Lucia. In Trinidad and Tobago and Guyana there is a more diverse range of value-added products made from mango including jams, nectars juices, kuchelar, amchar and chutney. The turning stage, as well as the tree-ripe stage of mature mangoes, was harvested for the fresh fruit market in Saint Lucia in all three countries. The popular cultivars include cv. Bridge, cv. Julie, cv. Long, cv. Tommy Atkins and cv. Graham. These cultivars are also found in Trinidad and Tobago unlike Guyana.

TABLE 4.9
Mango – Factors influencing preharvest and post-harvest defects

Factors influencing pre-harvest and post-harvest fruit defects	
Preharvest mango defects	**Harvesting and post-harvesting mango defects handling origin**
	▪ Bruising
▪ Anthracnose	▪ Decay
▪ Insect damage	▪ External (skin) discoloration (due to heat injury or chilling injury)
▪ Jelly seed	▪ Immature (poor quality when ripe)
▪ Lenticel damage (spots)	▪ Internal (flesh) discoloration (due to heat injury or chilling injury)
▪ Misshapen	▪ Not well trimmed (stem is longer than 12.7mm [0.5 inch])
▪ Scab	▪ Overripe (too soft)
▪ Scars (russetting)	▪ Sap burn
▪ Skin breaks and cracks	▪ Shrivelling (water loss)
▪ Stem-end cavity	▪ Sunken discoloured areas (due to chilling injury)
▪ Sunburn and sunscald	▪ Sunken shoulder areas (due to heat damage to the flesh below)
▪ Bird damage	▪ Uneven (blotchy) ripening (due to heat injury or chilling injury)
	▪ Void spaces in the flesh (due to heat injury or irradiation damage)

Mangoes are normally borne in clusters that are handpicked directly from the lower branches; a harvesting rod with a bag is used to collect fruit from the higher branches. Alternatively, mangoes are harvested by handpicking and a bag is used for collection, or branches with fruit clusters are shaken. Ripe fruit for the table are taken through a series of post-harvest packinghouse operations, as shown in Figure 15. The three critical loss points identified for tomato were also identified for mango with CLP#1 being the agricultural cooperatives, the Marketing Board Retail Outlet being CLP#2 and the municipal market being CLP#3. Table 4.9 shows the range of preharvest and post-harvest factors that were associated with mango defects in all three countries.

FIGURE 15
Tomato and mango value chain in Saint Lucia



Chapter 5

Food losses– Study findings and results

CRITICAL LOSS POINTS – TYPE AND LEVEL OF FOOD LOSSES

Measurement of qualitative and quantitative post-harvest losses in Saint Lucia was limited to tomato and mango. The third commodity, cassava, which was evaluated in Trinidad and Tobago and Guyana, could not be investigated because fresh cassava roots were unavailable. However, value-added products from cassava mainly farine, casareep were processed in small to medium cottage type industries throughout the island. Unlike Trinidad and Tobago and Guyana, the critical loss points for tomato and mango in Saint Lucia occurred when both commodities were wholesaled to the agricultural cooperatives: Belle Vue, Union Vale Farmer's cooperatives and designated CLP#1.

The Saint Lucia Marketing Board Retail Outlet (CLP#2) were recipients of produce that did not meet the quality requirements of the country's largest buyer and supplier of local perishables including tomato and mango (Consolidated Foods Limited and their supermarket chain stores). A similar situation existed when these commodities were supplied to specific all-inclusive hotels (Sandals, Saint James Morgan Bay). Saint Lucia municipal retail market was named CLP#3 (Tables 5.1 and 5.2) (Figure 16). The losses in Saint Lucia are shown in Table 5.1 and Table 5.2. Total losses for tomato in Saint Lucia were 20 percent and this represented as much as 14 percent lower than Guyana and 7 percent lower than Trinidad and Tobago. Post-harvest losses for mango in Saint Lucia were 23 percent, which was 9 percent lower than Guyana but 6 percent higher than Trinidad and Tobago.

FIGURE 16
Tomato in polyethylene bags and mango cultivars displayed for sale at Castries municipal market

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SAMPLE ANALYSIS

At each of the critical loss points, the average of three replicates with each replicate comprising 7 fruits per replicate were analysed for fresh weight, length, width, colour, pericarp thickness, number of locules, firmness and, for tomato, total soluble solids (Table 5.3). Quality attributes for mango are shown in Table 5.4. Variations in quality attributes for tomato between countries could be the result of cultivar differences, climatic conditions, stage of maturity at harvest and subsequent ripening conditions, duration and temperature dynamics when displayed for sale and handling procedures. Although the same cultivars of mango were analysed in Trinidad and Tobago and Saint Lucia, fruit weight and fruit dimensions were slightly more in the latter compared to the former. However, mango fruit from Saint Lucia was not as firm compared to Trinidad and Tobago and Guyana, but total soluble solids were consistently higher for fruit analysed in Saint Lucia compared to the other two countries. These differences could also be related to preharvest and post-harvest factors previously identified for tomatoes. (Table 5.2)

TABLE 5.1A
Tomato – Qualitative losses in the value chain

Food supply chain point	Quality reduction (%)
Harvesting method	5
Sorting	5
Transportation and unloading	3
Ripening	7
Wholesale to agricultural co-operative	8
Marketing board retail outlet	10
Municipal market	9

TABLE 5.1B
Tomato – Quantitative losses in the value chain

Critical Loss Points	Quantitative loss (%)
Wholesale to agricultural co-operative	7
Marketing board retail outlet	8
Municipal market	5
Total	20

TABLE 5.1C
Tomato – Qualitative and quantitative losses in the value chain

Stage in food supply chain	Quality reduction (%)	Quantitative losses (%)		
		Percentage handled	Percentage of losses	Percentage of weighed losses
Critical Loss Points (CLP)				
Wholesale to Agricultural Cooperative CLP#1	35	100	7.0	7.0
Marketing Board Retail outlet CLP#2	35	50	8.0	4.0
Municipal Market CLP#3	30	50	5.0	2.5
TOTAL			**20.0**	**13.5**

TABLE 5.2A
Mango – Qualitative losses in the value chain

Food supply chain point	Quality reduction (%)
Harvesting method	2
Sorting	5
Transportation and unloading	10
Ripening	4
Wholesale to agricultural co-operative	3
Marketing board retail outlet	5
Municipal market	7

TABLE 5.2B
Mango – Critical loss points, quantitative losses in the value chain

Critical Loss Points	Quantitative loss (%)
Wholesale to agricultural co-operative	7
Marketing board retail outlet	13
Municipal market	2
Total	23

TABLE 5.2
Quality attributes of tomato in Saint Lucia

Parameters	Wholesale at Co-operative CLP#1	Marketing Board Retail Outlet CLP#2	Municipal Market CLP#3
Colour	**Turning, Pink**	**Pink, Red**	**Red**
Avg. Fruit Weight (g)	40.4	38.9	38.1
Pericarp Thickness (mm)	0.47	0.46	0.47
Length (cm)	6.0	6.5	6.2
Width (cm)	6.0	6.2	6.0
Locule	3.0	4.0	3.0
Firmness g/force	81.4	74.1	77.5
Total Soluble Solids (%)	3.9	4.0	4.2
Marketable Quality	7.5	7.0	5.5

CAUSES OF LOSSES

Quality losses

Tomato – Saint Lucia growers usually harvest tomatoes manually as in Trinidad and Tobago and Guyana. The lack of skilled tomato harvesters is a significant problem in all three countries and this contributed to the 10 percent loss in quality based on the method used for harvesting. Tomatoes borne in clusters, with varying stages of maturity, were pulled from the plant often leading to de-capped pedicels and calyces, split pedicels and crushed fruit because of excessive squeezing and extensive fingernail damage (Figure 17).

Harvesters were paid according to the number of filled containers and they capitalized on this by trying to maximize the number of containers of harvested fruit. This promoted rough handling. Accordingly, containers of harvested fruit would normally include leaves, broken branches, immature fruit and flowers. Saint Lucia tomato growers who supplied fruit directly to the hotels, supermarkets and agricultural cooperatives were encouraged to harvest fruit that were preferably vine ripe. There were several quality-related problems that originated from preharvest losses resulting from bird damage, which could be as high as 25 percent. Rough handling of ripe softer fruit incurred latent damage such as shoulder scars. Shoulder scars were also associated with quality losses, as the slightly compressed regions became darker in colour thereby decreasing the cosmetic effect and overall appearance of fruits.

FIGURE 17
Fingernail damage eventually leading to decay

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FIGURE 18A
Transportation in deep plastic crates in uncovered vehicles

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FIGURE 18B
Rough unloading practices within retail market

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Before wholesaling tomatoes to supermarkets, hotels, cooperatives and Consolidated Foods Limited, farmers were required to sort to eliminate unmarketable fruit. Sorting was to remove fruit that were immature, undersized as well as fruit with bird damage and other types of physical damage that had been incurred during harvesting. Because of the relatively high incidence of unmarketable fruit after sorting, quality losses were as high as 25 percent and this is within the range and therefore consistent with tomatoes harvested in Trinidad and Tobago and Guyana.

Despite the widespread use of plastic crates in Saint Lucia throughout the supply chain, damage was still apparent as a result of the dark coloured crates that absorbed heat. Plastic crates were usually too deep (35 cm) and this resulted in compression from overhead weight, particularly for ripe softer fruit. The use of plastic crates in Trinidad and Tobago and Guyana was not as widespread as in Saint Lucia, as supply chain participants use large baskets, polypropylene bags, buckets and boxes. Qualitative losses in Saint Lucia during transportation and unloading of plastic crates from field to packinghouse, as well as other wholesale agents mentioned above, resulted in a 10 percent decline in quality. This is significantly lower than for tomato producers and marketers in Trinidad and Tobago and Guyana and could be related to the use of better ventilated plastic crates , are sturdy and stackable, thereby resulting in lower quality losses during transportation and unloading.

Tomato is a climacteric fruit that is capable of autocatalytic production of ethylene thereby stimulating the ripening process particularly with fruits harvested at the breaker and pink stages of maturity. Respiration is therefore enhanced when fruits are exposed to high ambient temperatures and, together with physical damage, induced stress ethylene production. In all three countries fruit was transported to value chain outlets in open trays that were exposed to high temperatures (Figure 18a and 18b.). This coupled with transportation over hilly terrain in Saint Lucia, and over uneven road surfaces in Trinidad and Tobago and Guyana, provided the environment for quality losses because of enhanced ripening and softening induced by stress ethylene and respiration production rates. Thus quality losses in all three countries averaged approximately 20 percent. Re-use of field containers used in the three countries without sanitizing to remove exudates from damaged and

TABLE 5.4
Mango – Quality attributes

Parameters	Wholesale at Co-operative CLP#1		Marketing Board Retail Outlet CLP#2		Municipal Market CLP#3	
	cv. Long	cv. Julie	cv. Long	cv. Julie	cv. Long	cv. Julie
Maturity at harvest	***Half-ripe***	***Half-ripe***	***Ripe***	***Ripe***	***Ripe***	***Ripe***
Fresh weight	679	756	677	802	668	799
Length (cm)	10.8	11.5	10.5	10.0	9.9	9.5
Width (cm)	7.0	7.4	6.9	7.8	7.5	8.0
Firmness (g/force)	26	24	22	20	21	18
Total Soluble Solids (%)	10.0	11.0	13.5	14.0	13.5	14.5

decaying fruit, leaves, calyces and peduncles from the previous harvest and transportation loads also induced ethylene production and enhanced fruit ripening and associated quality losses (Table 5.1).

Mango – Major qualitative losses of mango harvested and marketed in Saint Lucia were associated with maturity variation (20 %), sorting prior to marketing (30 %), transportation and unloading (25 %) and ripening and storage (25 %), see Table 5.4. Failure to select and harvest fruit within a cluster at the same stage of maturity because of lack of recognition of appropriate maturity indices resulted in poor taste and flavour. Immature mangoes for the fresh market have a thinner layer of natural wax coating on the skin, which led to higher moisture loss, shrivelling and poor external appearance. Latex stains on fruit skins were more prominent on immature fruit. Exposure of the fruit to latex at high temperature during field handling, transportation delays, and uncovered containers aggravated the condition thereby scars formed causing discolouration, which was often complemented by secondary infections and loss of quality when the fruit was sorted prior to marketing.

Gloves were not worn by workers to protect the mangoes from potential fingernail damage at any stage of the handling system in any of the three countries. The temperature of the mango fruit pulp was 35.5 °C when the harvested fruit was placed in plastic crates, which were exposed to direct sunlight for more than 3 hours. This resulted in accelerated ripening and quality losses and reduced shelf-life. Rough handling practices were observed during loading of the field containers on the transit vehicle and subsequent unloading at the packinghouse. Throwing of field containers and excessive drop heights were commonly observed more so in Saint Lucia and Guyana.

Quantitative losses

Tomato – Quantitative losses of tomato and mango that have been categorized as physical, physiological and pathological and entomological at the three critical loss points are shown in Table 5.5. Physical losses were incurred at CLP#1, which amounted to 2 percent for tomato (cv. Heat master), because of fingernails puncturing the flesh as no gloves were worn. Bruising frequently originated as a result of contact with the broken ends of adjacent fruit peduncles. Compression and abrasions were caused when fruit was thrown into too deep plastic field crates. Such losses were intensified for vine-ripened fruit because of their softer texture.

Most physical damage occurs during harvesting and transporting to cooperative packinghouses where multiple handling, associated with unloading, weighing, sorting and grading occurs while pulp temperatures are high. The Pulp temperature of fruit samples in the field averaged 35 °C, which increased to 36.5 °C during transit and at the cooperative packinghouse where neither precooling or low temperature storage facilities were available to remove field heat.

Widespread use of plastic crates, which had been provided to Saint Lucia's cooperative certified farmers at a subsidized price, provided a useful incentive to curb physical damage. This should be recommended for growers in Trinidad and Tobago and Guyana where large baskets, buckets, pails and polypropylene bags accounted for higher physical damage.

TABLE 5.5
Tomato and Mango – Types of post-harvest losses at critical loss points

	Types of post-harvest losses (%)					
	Tomato			Mango		
	CLP#1	*CLP#2*	*CLP#3*	*CLP#1*	*CLP#2*	*CLP#3*
Physical	2	3	3	3	4.5	0.5
Physiological	2	1.5	0.5	3	4	1
Pathological and Entomological	3	3.5	1.5	2	4.5	0.5
Total	**7**	**8**	**5**	**8**	**13**	**2**

CLP#1: Wholesale at Cooperative; CLP#2: Marketing Board Retail Outlet;
CLP#3: Municipal Market. Total post-harvest losses: Tomato = 20 %, Mango = 23 %

FIGURE 19
Uneven or blotchy ripening

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FIGURE 20
Catface in ripe tomato

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Although the cooperative farmers were encouraged to engage in field presorting, followed by a second sorting at the packinghouse, physical damage, as outlined above, increased to 3 percent at CLP#2 and CLP#3 respectively (Table 5.5). Cooperative certified members opted to sell their highest quality fruit based on uniform size, colour, shape, firmness and content of total soluble solids to the more lucrative purchasers such as hotels and supermarkets where premium prices could be obtained. Tomatoes that did not satisfy the hotels and supermarkets quality requirements were sold to the retail outlet of the Saint Lucia Marketing Board (CLP#2) and the municipal markets (CLP#3) where prices were lower but also where physical damage was higher.

Physiological disorders in tomato at CLP#1 amounted to 2 percent and this was associated with heat stress symptoms as there was no precooling to remove the field heat. Also the period when harvested fruit was left uncovered in the field prior to transportation to the packinghouse contributed to heat stress. Heat stressed fruit appears to have poor colour development such as uneven or blotchy ripening (Figure 19).

However the dominant physiological disorders were associated with catfacing. Tomatoes with catface ripened normally (Figure 20) but the cosmetic appeal factor required by hotels and supermarkets rendered these fruits unacceptable, unlike at CLP#2 and CLP#3 where these same tomatoes were considered saleable.

Fruit with evidence of puffiness, often characterized by smaller sized fruit with less jelly mass were considered marketable at CLP#2 and CLP #3 but not at CLP#1. Since tomatoes with catfacing and puffiness were still marketable at CLP#2 and CLP #3, the total post-harvest losses measured were two-fold less than the total percentages noted for physical damage and pathological and entomological damage respectively as shown in Table 5.5). Tomato fruit with yellow shoulders were also observed at CLP#2 (Figure 21).

FIGURE 21
Tomatoes with yellow shoulder

SOURCE: PEET, M. WWW.CES.NCSU.EDU/GREENHOUSES_VEG

FIGURE 22
Black mould resulting from skin wound

SOURCE: PEET, M. WWW.CES.NCSU.EDU/GREENHOUSES_VEG

FIGURE 23
Internal cloudy spot from stink bug damage

SOURCE: PEET, M. WWW.CES.NCSU.EDU/GREENHOUSES_VEG

FIGURE 24
Tomato fruit worm

SOURCE: PEET, M. WWW.CES.NCSU.EDU/GREENHOUSES_VEG

FIGURE 25
White fly infection

SOURCE: PEET, M. WWW.CES.NCSU.EDU/GREENHOUSES_VEG

Pathological and entomological damage of tomato amounted to 3 percent at CLP#1 and 3.5 percent at CLP#2. This was because of secondary infections caused by invasion of fungal and bacterial pathogens present in the surrounding environment as a result of physical damage caused by rough and abusive handling (Figure 22). Furthermore, the accumulation of dirt, exudates of spores from decayed fruit from previous harvests, dried senesced leaves and flowers at the bottom and sides of field crates resulted in cross contamination of wholesome fruit. Entomological damage as a result of internal damage from infestations of stink bug (Figure 23), fruit worm (Figure 23) and white fly (Figure 24) were recorded at all three critical loss points for tomato but were more dominant at CLP#1 and CLP#2 than at CLP#3 (Table 5.5).

Mango – Physical damage to mangoes was most visible at CLP#2 (Figure 26). At CLP#2, post-harvest losses were 4.5 percent and this was 1.5 percent and 4 percent more than CLP#1 and CLP#3 respectively (Table 5.5). Physical damage such as bruising, punctures and abrasions were caused by shaking branches, beating fruit clusters with bamboo rods without a pouch attachment and allowing fruit to fall on the hard ground surface. This practice was consistent in Trinidad and Tobago and Guyana. Stem end damage was prominent at CLP#2. Dark coloured scars from fruit-to-fruit rubbing caused by high wind also became more apparent. Latex stains were more obvious at CLP#2 and CLP#3 than CLP#1.

Physiological disorders such as heat stress induced desiccation, internal breakdown, flesh translucency, irregular ripening and lenticel spots were observed but these were related to the cultivar and soil and environmental conditions. For example cv. Long was more susceptible to lenticel spotting than cv. Julie, but the opposite trend was noted for heat stress and internal breakdown. Total losses caused by physiological disorders amounted to 8 percent with the highest losses occurring at CLP#2. At CLP#3 the lowest physiological losses were recorded. Retailers at the municipal market sold mangoes in heaps of 3 or 4 or in polyethylene bags. Consumer purchases allowed for heap or bag selection and not for individual fruit selection across heaps or bags (Figure 27).

Pathological and entomological damage was 4.5 percent at CLP#2, 2 percent at CLP#1 and 0.5 percent at CLP#3 (Table 5.5). The main fungal infection was Anthracnose (Figure 28) but over-ripe fruit and those with physical injuries often had multiple infections dominated by bacterial soft rot. As in Guyana, Saint Lucia mangoes were

FIGURE 26
cv. Julie with irregular ripening, compression damage, shrivelling and bruises

SOURCE: PEET, M. WWW.CES.NCSU.EDU/GREENHOUSES_VEG

FIGURE 27
Mangoes graded and sold in heaps at Castries municipal market

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FIGURE 28
cv. Julie mature and ripe with Anthracnose infection

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not affected by the seed weevil, which is rampant in Trinidad and Tobago. However all three countries had a problem with fruit fly.

TRACING LOSSES ASSOCIATED WITH CASSAVA FARINE PRODUCTION

Cassava production in Saint Lucia is used extensively for value-added products such as cassava farine, casareep, cassava flour and baked products (Figure 29). The process for cassava farine was traced to determine the extent of food losses. The process flow for cassava farine is illustrated in Figure 30. The major losses in farine production were at the beginning where the fresh cassava roots were washed to remove dirt and peel. From an initial quantity of 60 kg of fresh cassava roots processors encountered a 10 to 12 percent loss in weight because of dirt and peel and external fibres. As much as 25 kg of farine is produced plus 5 litres of casareep. Similar findings were obtained in Guyana. The 10 to 12 percent waste from dirt and peel are, in some cases, used for making compost as well as biogas.

FOOD LOSS REDUCTION STRATEGIES

Tomato, cassava and mango are highly susceptible to physical damage at virtually every part of the post-harvest value chain, and reduction of physical injury is essential to reduce losses in quality and post-harvest life.

Wholesaling to agricultural cooperatives (CLP#1)

Tomato – agricultural cooperatives in Saint Lucia should train their members, who are certified tomato growers, and cater to lucrative markets in the hotel industry and supermarket chain stores to minimize physical damage by wearing gloves to protect fruit from fingernail damage, and to carefully place fruit in harvesting aprons before emptying into plastic crates. Reducing physical damage such as punctures, abrasions, bruising, scuffing and compression would result in flavour retention and development of 'tomato-like' aroma volatiles, which would stimulate repeated purchases and raise the bar of the quality profile. Management protocols to limit physical damage would also reduce secondary infections caused by pathogens entering open wounds.

FIGURE 29
Value-added products of cassava manufactured in Saint Lucia

Cassava flour

Cassava casareep

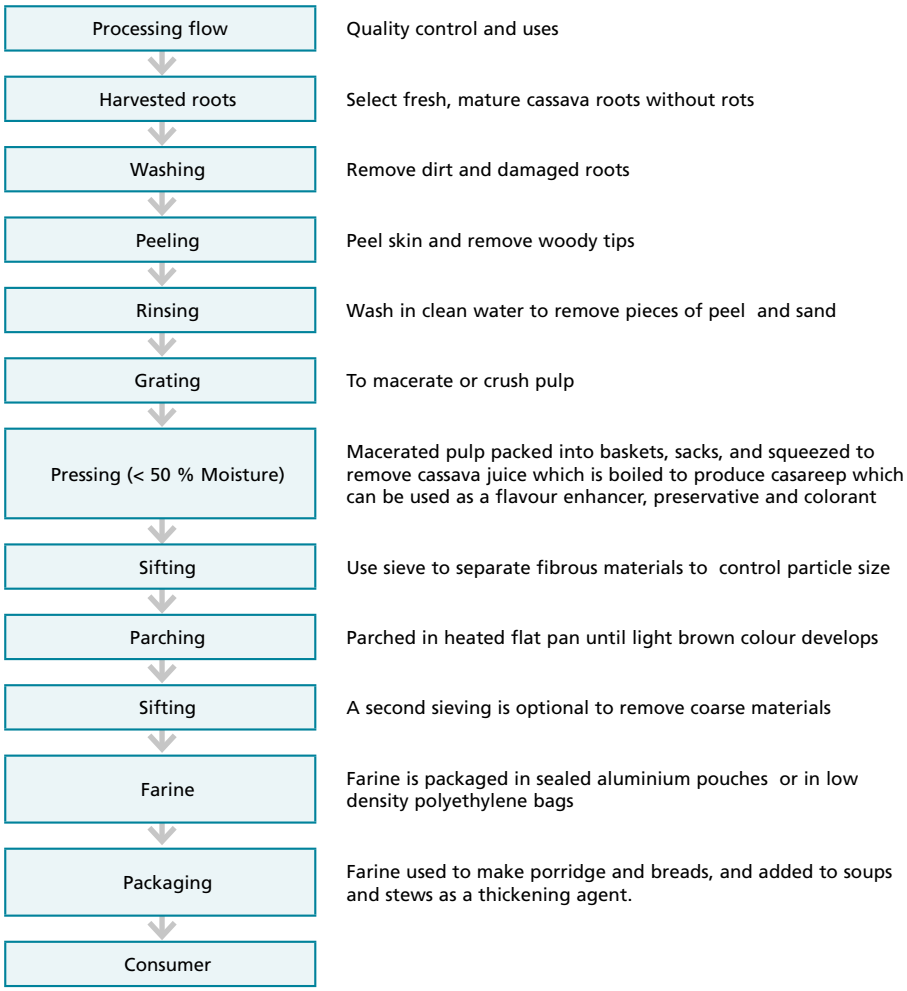
Production of cassava flour

Cassava bread (a baked product)

Cassava farine

Equipment to make cassava farine

FIGURE 30
Tracing CASSAVA FARINE production in Saint Lucia



It is recommended that the time between harvesting and transport to the packinghouses be reduced to minimize field heat accumulation. Keeping fruit covered with broad leaves or under shade would also remove field heat. This is critical since exposing harvested tomatoes to temperatures above 30 °C enhances respiration and inhibits development of lycopene (red colour) and the tomato will eventually turn yellow.

Agricultural cooperatives should select tomato genotypes that are suitable for local production and market demand and sell the seeds to their certified members. Such cultivars should be characterized by good flavour, that is, high sugar and acid content, cultivars with a potential for development of volatiles associated with desirable taste and aroma, fruit that maintains firmness when fully ripe, which would permit harvesting at the breaker to pink stages of maturity, and cultivars containing high beta carotene and ascorbic acid.

Managers of agricultural cooperatives should establish tomato quality standards by discouraging harvesting of immature tomatoes. Tomato maturity guides to show external and internal colour, locule development with jelly mass, thick pericarp should be displayed at the packinghouse and even given to certified growers. This would help in the monitoring and sorting and grading parameters and promote market communications and pricing strategies. Training and demonstrations are recommended of how certified members practically and dependably eliminate immature fruit from those harvested before the breaker stage of maturity. This would involve testing the commercial feasibility of using ethylene treat-

FIGURE 31
Harvesting mango with a picking pole and pouch attachment

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ment to initiate ripening of green tomatoes and discard fruit that do not reach breaker or the ripe stage after 5 days at 20 °C. This would also eliminate immature fruit that have a poor flavour when ripe.

While it is highly commendable to observe the widespread use of plastic crates among Saint Lucia growers, cooperatives should acquire stackable crates for tomatoes that are no deeper than 30 to 35 cm and with a 15 to 18 kg capacity when filled. These crates must have handles and be light coloured to reflect the heat. Plastic crates should be washed and sanitized after each harvest and journey to the packinghouse.

Mango – The following recommendations are specific to mango at CLP#1. Cooperative certified growers should harvest mangoes by either hand picking of fruit borne on the lower tree branches or using a secateur or clipper. Harvesters should be trained to recognize maturity indices and understand that when mangoes are fully mature and ready for harvesting, the stem should snap readily with a slight pull. If a strong pull is to be applied, then the fruit is physiologically immature and should not be harvested because poor flavour and taste will develop. Low borne fruit can also be harvested with the help of clippers. A long-poled picking bag, which can hold up to four mangoes, is recommended for fruit borne in the higher branches (Figure 31).

Precaution is required by harvesters to ensure the fruit is held in the pouch and between the divider and cutting blade as the device is pulled; otherwise the blade may cut the stalk. Clipped fruit could be conveyed through a nylon chute attached from the pouch into padded collecting plastic crates at the base. This saves time and protects the fruit from physical impact damage. This procedure also protects the harvester's hand from the sap, which oozes from the point of detachment. The use of the rod with pouch, blade and descending chute could allow a harvester to pick about 800–1 000 mangoes per hour, depending on fruiting density, tree density and the skill of the worker, who could be trained during a demonstration. At the time of harvest, care must be taken to leave a 3.5 to 4 cm stem to avoid the spurt of milky-resinous sap that exudes if the stem is cut too close. Mangoes harvested in this way are less prone to latex stains and to stem-end rot and other storage diseases.

Recommended practices to avoid latex stain damage include:

- **de-sapping** in a 1 percent solution of calcium hydroxide;
- **washing fruit** in 1 percent aluminium potassium sulphate;
- **applying a surface coating** to fruit prior to de-sapping;
- **trimming and de-sapping** at the cooperative packinghouse; followed by
- **inversion** on a stationary rack or a roller-conveyer running below water or water and detergent sprays for 20 minutes and a method called soil bleeding, that is, inversion in soil in the shade for 30 minutes immediately after harvesting.

Certified mango growers should be told that harvested mangoes should be placed in plastic crates having a capacity of no more than 22 to 25 kg for

transport to the packinghouse. The container filled with fruit should be kept in the shade, or preferably in a ripening room where the temperature is 18-20 °C with 85-90 percent relative humidity for 3-4 days until firm ripe.

Specific recommendations must be applied at the cooperative packinghouse for fresh mangoes:

- fruit should be packed within no more than 3 to 4 hours upon arrival at the packinghouse and it is preferable that the 3.5 to 4 cm stem or peduncle be re-cut at this point to leave about 0.5 cm;
- fruit should be evaluated for overall quality according to market requirements and also for the presence of insects;
- fruit should be sanitized by washing in water containing up to 200 ppm chlorine and air dried:
- fruit should be sorted and graded by size, shape, colour and absence of defects and be packed in clean plastic crates to satisfy supermarket and hotel quality requirements;
- training should be conducted in harvesting procedures, loading and unloading, packinghouse design and functions, transportation and storage;
- exposure to the cost/returns associated with the adoption of these techniques is also recommended.

Saint Lucia Marketing Board retail outlet CLP#2

Tomato – The Saint Lucia Marketing Board retail outlet (Castries) hereby designated as CLP#2 had 3 to 4 tomatoes at different stages of ripening stretch-wrapped in Styrofoam trays and displayed at 30 °C and 45-50 percent relative humidity. Each tray had fruit that had been presorted and graded by skin colour with at least one fruit at the breaker stage, one at the pink stage and the other at red ripe stage. This is commendable and recommended because it allows the consumer to utilize fruit over time until the next purchase. The following additional recommendations are necessary to optimize quality:

- the retail outlet should be air conditioned and fruit and vegetables, including tomatoes, be displayed on refrigerated shelves where temperatures of 15-16 °C and 85-90 percent relative humidity are maintained;
- time and temperature recorders should be installed;
- stacking of fruit trays too high should be avoided to reduce toppling during consumer selection and to reduce compression of fruit trays on the bottom layers;
- frequent inspections should be made to remove soft, damaged or decaying fruit;
- training should be given in post-harvest handling and marketing strategies.

Mango – Maintaining a temperature (18-20 °C) and relative humidity control (85-90 percent) when the mangoes are displayed for sale by retailers has a positive effect on the shelf-life of mangoes, minimizing shrinkage, mechanical injuries, and water loss so that the Marketing Board retail store could realize maximum sales. It is desirable to display mangoes that are ready to eat so as to cause a positive visual impact and showcase the best organoleptic characteristics.

Mangoes should be displayed in an open area in the retail store. This allows the fruit aroma to develop and attract shoppers. Mangoes should not be displayed as a large mountain or pyramid of fruit because ripe mangoes become susceptible to compression bruising that can occur with even the weight of one mango on top of another.

Other notable recommendations to avoid common stocking and display preparation and rotation problems at the marketing board include:

- place mangoes on display as soon as they are delivered to the retail store; order more frequently to avoid storing mangoes at the store;
- display mangoes according to size, ripeness stage and variety;
- avoid building a large pile of ripe fruit so as to prevent compression damage;
- consider having two different displays for mangoes. Locate fruit that is less ripe and will be ready to eat in a day or two on one side and riper fruit that is ready to eat right away on the other;
- inspect the mango display several times each day and immediately remove overripe, shrivelled, leaking, injured and damaged or decayed fruit;
- maintain a good cleaning and sanitation programme for mango displays so that the best quality mangoes are shown to customers;
- training should be given through workshops, field days and guidelines provided on quality and sanitation.

Municipal market CLP#3

Tomato – Pre-sorted and graded tomatoes should be transported to the municipal market in separate clean plastic crates that are no deeper than 36 cm

FIGURE 32
cv. Long, table ripe with bright internal colour

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and have a carrying capacity of 15 to 18 kg. Fruit should be displayed on top of clean tables in shaded areas. Multiple handling, including consumer squeezing, should be minimized. Fruit should be selected, weighed and placed in ventilated low-density polyethylene bags at the point of sale. The benefits of modified atmosphere packaging can only be achieved if supplemented by low temperature storage above the threshold chilling temperature. Proper sanitation protocols and personal hygienic procedures should be adhered to at all times during retail marketing. Training marketers about ripening, fruit defects, grading, display techniques, packaging and sanitation procedures should be undertaken.

Mango – The above recommendations for tomatoes displayed at municipal markets are also applicable for mangoes. Another notable recommendation for retailers is to create an image of selling high quality fruit and to stimulate repeated purchases and consumer confidence including:

- only mature mangoes should be displayed for sale to ensure good flavour quality when fully ripe. To fulfil this expectation, a mango must have begun to ripen internally at the time of harvest (Figure 32). An immature-harvested mango will not ripen properly and will never develop acceptable flavour and aroma.
- retailers should use separators within packages to prevent scuffing, vibration damage, punctures and bruising when transporting, loading and unloading fruit at market outlets.

INVESTMENT PROGRAMME TO REDUCE FOOD LOSSES

Tomato

Post-harvest losses of tomato in Saint Lucia were 20 percent. At CLP#1 post-harvest losses averaged 7 percent. Post-harvest losses measured from samples at CLP#2 were 8 percent. At CLP#3 tomato fruit post-harvest losses were 5 percent.

Based on the 2012 annual production of 288 tonnes of tomatoes/year at USD 2 892/tonne, annual production is valued at USD 832 896 (Table 5.6). The percentage loss at each CLP level is then used to estimate the economic loss. Table 5.7 also shows that at CLP #1 the loss was about USD 58 300. At CLP#2 the loss was an estimated USD 66 600 and at CLP#3 the loss was around USD 41 700; hence the total economic loss for tomatoes in Saint Lucia was calculated at about USD 166 600. It is important to note that these are only estimates based on the results of the percentage losses from the areas where the post-harvest loss assessment studies were carried out. The project did not cover the whole country.

Table 5.7 shows that at CLP#1, the equipment recommended such as picking aprons, plastic crates

TABLE 5.6
Tomatoes – Economic loss associated with respective critical loss

Critical loss point	Percentage of losses	Value of annual production (USD)	Economic loss (USD)
Agricultural Cooperative CLP#1	7		58 303
Marketing Board Retail Outlet CLP#2	8	832 896	66 632
Municipal market CLP#3	5		41 645
Total	20		166 579

Note: Based on 288 tonnes/year (2012) @ XCD 7 808/ tonne (USD 2 892/tonne)
USD 1.00 = XCD 2.70

TABLE 5.7
Summary table of tomato losses, causes and solutions – Saint Lucia

Critical Loss Point	Percentage of losses	Economic loss (USD)	Cause of loss	Intervention to reduce losses	Loss reduction	Cost of intervention	Risks
Agricultural Co-operative CLP#1	7	58 303	Wounds, secondary decay	Harvesting tools, avoid heat exposure, fungicidal treatment. Credit facilities.; Subsidies for tools	Commercial, economic	Cost of equipment = USD 350; supplies = USD 450 and training = USD 6 000	No perceivable risks
Marketing Board Retail Outlet CLP#2	8	66 632	Same	Modified Atmosphere Training	Same	Cost of supplies = USD 300 and training = USD 4 000	
Municipal market CLP#3	5	41 645	Same	Same	Same		
Total	**20**	**166 579**					

and clippers will cost about USD 350, supplies such as fungicides and bactericides will cost USD 450 and training through workshops, demonstrations for a group of about 20 producers and marketers is an estimated USD 6 000. At CLP#2 and CLP#3 supplies (ripening hormone, ethrel) plus training total USD 4 300. There are no perceivable risks associated with the interventions proposed.

Mango

Post-harvest losses of mango in Saint Lucia were 23 percent. At CLP#1 post-harvest losses averaged 8.0 percent. Mango post-harvest losses measured from samples at CLP#2 were 13 percent. At CLP#3 post-harvest losses were 2 percent.

Based on the 2012 annual production of 556 tonnes of mangoes/year at USD 645/tonne, annual production is valued at USD 358 620 (Table 5.8). The percentage loss at each CLP level is then used to estimate the economic loss. Table 5.8 also shows that at CLP#1 the loss is about USD 28 700 and at CLP#2 and CLP#3 the loss is estimated at USD 46 600 and USD 7 200 respectively. Total economic loss is therefore estimated at USD 82 500. As mentioned above, these are estimates only based on the results of the percentage losses from the areas where the post-harvest loss assessment studies were carried out. The project did not cover the entire country.

In the case of mango, Table 5.9 shows that at CLP#1, the recommended equipment (harvesting rod with pouch attached) will cost about USD 400, supplies such as post-harvest fungicides will cost USD 450 and training through workshops, demonstrations for a group of about 20 producers and marketers is estimated at USD 6 000. At CLP#2 and CLP#3 ethylene antagonists supplies such as purafil plus training total USD 4 300 as for tomatoes. There are no perceivable risks associated with the interventions proposed.

TABLE 5.8
MANGO – Economic loss associated with respective critical loss points

Critical loss point	Percentage of losses	Value of annual production (USD)	Economic loss (USD)
Agricultural Cooperative CLP#1	8	358 620	28 690
Marketing Board Retail Outlet CLP#2	13		46 621
Municipal market CLP#3	2		7 172
Total	23		82 483

Note: Based on 556 tonnes/year (2012) @ XCD 1 741/tonne (USD 645/tonne)
USD 1.00 = XCD 2.70

TABLE 5.9
MANGO – Summary table of losses, causes and solutions

Critical loss point	Percentage of losses	Economic loss (USD)	Cause of loss	Intervention to reduce losses	Loss reduction	Cost of intervention	Risks
Agricultural Co-operative CLP#1	8	28 690	Wounds, secondary decay	Tools, avoid heat, fungicidal treatment. Credit facility; Subsidies for tools	Commercial, economic	Cost of equipment = USD 400; supplies = USD 450 and training = USD 6 000	No perceivable risks
Marketing Board Retail Outlet CLP#2	13	46 621	Same	Modified atmosphere, training in waxing	Same	Cost of supplies (wax) = USD 300 and training = USD 4 000	
Municipal market CLP#3	2	7 172	Same	Same	Same		
Total	**23**	**82 483**					

Cassava farine

For cassava farine production the initial post-harvest losses, comprising cassava peel and dirt removal, amounted to 10 to 12 percent. After this stage, there is no significant loss as the solid cassava starch is used for farine or cassava production and the liquid by-product (juice) is boiled to make cassava casareep.

COST BENEFIT ANALYSIS OF THE PROPOSED SOLUTIONS

A mango picking rod is recommended for use in Saint Lucia. The assumptions in Saint Lucia include the following: 10 trees/acre; 2 500 fruits tree; 25 000 fruits/acre; 3 mangoes/lb; 25 000 mangoes = 8 333lbs = 3.78 tonnes/acre; a selling price of USD 1 563/tonne; anticipated loss reduction of 60 percent; cost of picking rod of USD 300 and 5 years depreciation (Table 5.10). Based on the assumptions, profitability in Saint Lucia on 5 acres is estimated at USD 2 205.67

Use of field crates in tomato production is recommended. The assumptions include the following: average production of 6 500 lb per acre, 5 acres per farmer making a total of 32 500 lb harvested using the crates, a selling price of USD 1.31/lb; anticipated loss reduction of 65 percent; cost of field crates of USD 150 and 5 years depreciation (Table 5.11). Based on these assumptions, profitability of using crates in Saint Lucia is estimated at USD 1 757.16.

TABLE 5.10
Profitability of using a MANGO PICKING ROD on 5 acres of mangoes

	Item	Unit	Calculation formula	Value
a	Product quantity	tonnes/year		18.9
b	Product value	USD/tonne		2 892
c	Loss rate	%		0.07
d	Anticipated loss reduction	%		0.6
e	Cost of intervention (picking rod)	USD		350
f	Depreciation	years		5
g	Yearly costs of investment	USD/year	e / f	70
h	Yearly costs of operation	USD/year		20
i	Total yearly costs of solution	USD/year	g + h	90
j	Client costs per tonne product	USD/tonne	i / a	4.76
k	Food loss	tonnes/year	c x a	1.32
l	Economic loss	USD/year	c x b	3 826.12
m	Loss reduction	tonnes/year	k x d	0.79
n	Loss reduction savings	USD/year	m x b	2 295.67
o	Total Client costs	USD/year	i = a x j	90
p	Profitability of solution	USD/year	n - o	2 205.67

TABLE 5.11
Profitability of using a FIELD CRATES on 5 acres of mango production

SLU	Item	Unit	Calculation formula	Value
a	Product quantity	lbs/year		32 500
b	Product value	USD/lb		1.31
c	Loss rate	%		0.07
d	Anticipated loss reduction	%		0.65
e	Cost of intervention (crates)	USD		150
f	Depreciation	years		5
g	Yearly costs of investment	USD/year	e / f	30
h	Yearly costs of operation	USD/year		150
i	Total yearly costs of solution	USD/year	g + h	180
j	Client costs per lb of product	USD/lb	i / a	0.01
k	Food loss	tonnes/year	c ´ a	2275
l	Economic loss	USD/year	k ´ b	2 980.25
m	Loss reduction	tonnes/year	k ´ d	1 478.75
n	Loss reduction savings	USD/year	m ´ b	1 937.163
o	Total Client costs	USD/year	i = a ´ j	180
p	Profitability of solution	USD/year	n - o	1 757.16

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