Food loss analysis: causes and solutions

Case study on the tomato value chain in the Republic of Trinidad and Tobago
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# Abbreviations and acronyms

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<tr>
<td>ADB</td>
<td>Agricultural Development Bank</td>
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<tr>
<td>ADP</td>
<td>Agricultural Export Diversification Project</td>
</tr>
<tr>
<td>CABA</td>
<td>Caribbean Agribusiness Association</td>
</tr>
<tr>
<td>CARICOM</td>
<td>Caribbean Community</td>
</tr>
<tr>
<td>CARIRI</td>
<td>Caribbean Industrial Research Institute</td>
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<td>CARDI</td>
<td>Caribbean Agricultural Research and Development Institute</td>
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<tr>
<td>CAREC</td>
<td>Caribbean Epidemiology Centre</td>
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<td>CLP</td>
<td>Critical Loss Point</td>
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<td>CRU</td>
<td>Cocoa Research Unit</td>
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<td>FAO</td>
<td>Food and Agricultural Organization</td>
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<td>FSC</td>
<td>Food Supply Chain</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>GYD</td>
<td>Guyanese Dollar</td>
</tr>
<tr>
<td>GORTT</td>
<td>Government of the Republic of Trinidad and Tobago</td>
</tr>
<tr>
<td>IDB</td>
<td>International Development Bank</td>
</tr>
<tr>
<td>IFAD</td>
<td>International Fund for Agricultural Development</td>
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<tr>
<td>IICA</td>
<td>Inter-American Institute for Cooperation on Agriculture</td>
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<tr>
<td>ICTA</td>
<td>Imperial College of Tropical Agriculture</td>
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<tr>
<td>ILO</td>
<td>International Labour Organization</td>
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<tr>
<td>LAC</td>
<td>Latin America and Caribbean</td>
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<td>ISHS</td>
<td>International Society of Horticultural Science</td>
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<tr>
<td>LLPB</td>
<td>Livestock and Livestock Products Board</td>
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<tr>
<td>LRTS</td>
<td>Low Temperature Research Station</td>
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<tr>
<td>MFPLMA</td>
<td>Ministry of Food Production Land and Marine Affairs (Trinidad and Tobago)</td>
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<tr>
<td>NAMDEVCO</td>
<td>National Agricultural Marketing and Development Corporation (Trinidad and Tobago)</td>
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<tr>
<td>NAMISTT</td>
<td>National Agricultural Market Information System (Trinidad and Tobago)</td>
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<tr>
<td>OECS</td>
<td>Organization of Eastern Caribbean States</td>
</tr>
<tr>
<td>PHL</td>
<td>Post-harvest loss</td>
</tr>
<tr>
<td>PRCSSP</td>
<td>Poor Rural Communities Support Services Project (Guyana)</td>
</tr>
<tr>
<td>READ</td>
<td>Rural Enterprise and Agricultural Development Project (Guyana)</td>
</tr>
<tr>
<td>RH</td>
<td>Relative humidity</td>
</tr>
<tr>
<td>SMCL</td>
<td>Sugar Manufacturing Company Limited (Trinidad)</td>
</tr>
<tr>
<td>THA</td>
<td>Tobago House of Assembly</td>
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<tr>
<td>TT</td>
<td>Trinidad and Tobago</td>
</tr>
<tr>
<td>TTABA</td>
<td>Trinidad and Tobago Agribusiness Association</td>
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<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
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<td>UWI</td>
<td>University of the West Indies</td>
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<td>VS</td>
<td>Vascular Streaking</td>
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Executive Summary

Fresh tomatoes from the market are a popular and versatile fruit vegetable, making significant contributions to human nutrition throughout the world for their sugars, acids, vitamins, minerals, lycopene and other carotenoids, among other constituents.

In the Republic of Trinidad and Tobago tomatoes are one of the leading vegetables with an average annual production of 1 680 tonnes in 2008 increasing to 2 150 tonnes in 2012. In addition, 493 tonnes of tomatoes were exported to regional markets in 2012.

The quantity handled annually and the perishable nature of the fruit have led to heightened concerns among producers, wholesalers, retailers and consumers about maintaining quality and marketing losses. Factors relating to causes, types, and magnitude of damage that lead to deterioration in quality and post-harvest losses are significant for the growth and development of the tomato industry in the Caribbean. Accordingly, FAO in collaboration with CARICOM initiated a project entitled ‘Reduction of post-harvest losses along the food chain in the CARICOM sub-region’ and identified tomatoes as one of the three commodities for post-harvest loss measurement.

The main objectives of the investigation included an in-depth analysis of post-harvest handling practices of tomato 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.

An analysis was made of the tomato value chain as items of food consumption, with quality attributes that were to be protected and enhanced in various marketing channels and the significance of losses having both technological and socio-economic origins were examined. The links were examined between growers on the one hand and, on the other hand, the provisions made for transferring relevant research information on identified problems to producers, traders, processors. Improved operations were designed and evaluated so as to improve operations throughout the system and alternative post-harvest handling systems. The study also described the factors affecting logistics performance in the CARICOM region, particular emphasis was placed on logistics affecting produce losses in the supply chain.

Tomato post-harvest losses were measured at three critical loss points (CLPs) after screening the value chains in both countries. The critical loss points were at harvest (CLP#1), packinghouse operations (CLP#2) and at retail markets (CLP#3). Total post-harvest losses for tomatoes were measured at 27 percent for Trinidad and Tobago. Physical damage leading to unmarketable fruit in Trinidad and Tobago at the three CLPs amounted to 5 percent and these were dominated by radial cracks, abrasions and shoulder scars. Physiological losses were 8.5 percent in Trinidad and Tobago related to desiccation, russetting, cuticle cracks, blossom end rot, catface or defaciation and puffiness. Pathological and entomological losses were the highest at each CLP but more so at CLP#3 than CLP#1 and #2 and were recorded as being 13.5 percent for Trinidad and Tobago.

Proposals for reducing post-harvest losses of tomatoes at CLP#1 include: harvesting fruit at the same stage of physiological maturity; using light coloured plastic crates that are not more than 8 to 10 inches deep (20.32 to 25.4 cm), ventilated and with handles for ease in loading, assembling and unloading and packing harvested tomatoes in containers and protecting them from the sun to guard against sunscald. Proposals for reducing post-harvest losses of tomatoes at CLP#2 include: adherence to sanitation, temperature and relative humidity (RH) control of pre-sorted tomatoes with uniform maturity indices should be a prerequisite for quality management in the packinghouse, where tomatoes should be temporarily stored to facilitate fruit ripening. Packing houses should be cleaned to ensure there are no decaying commodities from previous harvests. Proposals to reduce post-harvest losses of tomatoes at CLP#3 include using varieties that are more resistant to harsh treatment during distribution and the prevailing conditions of the wet season. These should be varieties having a thicker pericarp, retention of firmness when ripe also would be desirable. Moreover, retailing should occur under shade in well-ventilated areas in order to minimize heat stress and reduce physiological disorders and decay.
Post-harvest losses of tomatoes measured at the end of the post-harvest handling system in Trinidad and Tobago were 27 percent. At CLP#1 post-harvest losses averaged 7 percent while samples measured at CLP#2 were 8 percent and 12 percent for fruit measured at CLP#3. Losses were highest at CLP#3 where the tomatoes were displayed for sale under ambient conditions at roadside, mobile and municipal markets post-harvest. In Trinidad, the loss at CLP#1 was estimated at USD 493 800, at CLP#2 the loss was estimated at USD 564 300 and at CLP#3 the loss was calculated as USD 846 500; hence the total economic loss was an estimated USD 1.9 million.
Chapter 1
Introduction

Background information
A high incidence of post-harvest losses exacerbates the problems of low agricultural productivity and food security in countries of the Caribbean Community (CARICOM). Post-harvest losses cause the quality and quantity of food to be severely reduced, thereby affecting incomes and impacting on the rural poor in the region. The Food and Agriculture Organization of the United Nations (FAO) in 2012 indicated that post-harvest losses are highest in developing countries. Fonseca and Vergara (2014) reported that 50 percent of the fruits and vegetables and 37 percent of roots and tubers in the Latin America and Caribbean (LAC) region are lost before they reach consumers and further articulated that improving logistics systems and management would be an efficient approach to reducing losses across the supply chain. They found that failure in logistics including product handling, precooling, packaging, storage, transportation, and inappropriate infrastructure, are among the most common reasons for the high quantities of food losses. These estimates do not include losses of 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, inadequate temperature and relative humidity (RH) control, 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 (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.

Efforts to combat this situation in the past have not been very successful partly because countries lack the required and up-to-date information about the scale of the problem, which could help them develop programmes to address the problem. This lack of reliable and up-to-date information and data has continuously prevented governments, the private sector and other key stakeholders from implementing workable solutions to address the problem. While there is increased acknowledgement among governments in the CARICOM region and the international community that reducing post-harvest loss is one of the main elements to ensure increased food security. The use of inappropriate and outdated approaches continues to constrain current interventions. This rapidly changing context, including urbanization and globalization, means that interventions that were once regarded as successful may no longer be so and this is causing governments to inadequately handle the challenges facing the post-harvest sector.

Given the need to better understand the strengths and weaknesses of post-harvest handling systems in the CARICOM and to identify, plan and implement intervention policies and practices, the FAO identified two countries, Guyana and Trinidad and Tobago to conduct detailed value chain analyses pertaining to cassava, tomato and mango.

Study objective
The main objective of this study was to conduct an in-depth analysis of post-harvest handling practices of tomato producers, marketers, processors 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. Furthermore, the assessment aimed to identify the critical loss points (CLPs) and causes of losses at these points by using post-harvest loss (PHL) assessment methodologies and tools. In addition,
desk research was conducted to identify cost effective, environmentally friendly and gender appropriate solutions to reduce post harvest losses, drawing on an inventory of past and current technologies and practices in the region and outside the region.
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 of cassava, mango and tomato. The assessment was also conducted in Saint Lucia, which is a CARICOM Member Country and 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 important subsectors in the CARICOM region were identified during a previous study. The identification of these priority crops followed an in-depth desk study to review the available information on production, post-harvest handling including processing, marketing and export for the major 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 that are important to the agricultural systems in the region were identified, however, cassava, tomato and mango emerged as important food value chains and were, therefore, recommended as the priority crops for the project on the reduction of food loss and waste in the CARICOM region.

Selection of farmers, supermarkets and other stakeholders
The tomato value chain includes a highly diverse and complex number of producers (farmers) and traders, including types of markets such as farmers’ or public municipal, roadside, mobile, supermarkets, processors 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 whole value chain and its operations. In order to reveal 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 required of the study, field observations and interviewing were of paramount importance.

Wholesalers and retailers were randomly selected and the wholesalers interviewed were from the wholesale markets Macoya Debe. Retail markets selected in Trinidad were Tunapuna, Chaguana, Sangre Grande, and Marabella. Roadside and mobile markets were selected at random throughout the villages. At each market outlet, every stage with where there was the potential for reduction of reduced marketable quality and eventual manifestation of post-harvest losses, from the field producer to procurement as for traders at the point of consumer purchase, were selected for an in-depth analysis. This approach referred to as the ‘systems approach’.

Data collection
The methodology used for this study involved a review of the literature; collection and analysis of the documentation and technical information on tomato; selection of the specific supply chains to the study and justification for this choice; identification of 3-4 stages of the food chain where the losses are higher or have the greatest impact and selection of 1-2 for detailed analysis and participation in 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 were included. The implementation strategy for this study embraced the Food Loss Assessments methodology recommended by FAO, which were adapted where necessary to the Caribbean situation.
Study execution approach
The study had five key components:

Literature review – A literature search on previous studies documented by regional institutions such as FAO, CARDI, Inter-American Institute for Cooperation on Agriculture (IICA), 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 and Trinidad and Tobago Agribusiness Association 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 included farmers, processors, retailers, wholesalers, supermarket and association. Selection was based on production and marketing volumes from data obtained from the national marketing institutions in both countries. A processing company, or cottage industry, were also included from each country for development of a main value-added product from each commodity.

Conducting and managing field Interviews – Approximately 2.5 months were spent in the field to conduct interviews and collect data. In an effort to catalogue all the standard operating practices in the value chain, 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 involved: dynamic, face to face interviews revealing an interpersonal process with key decision-makers associated with production, post-production, processing into value-added products, distribution and marketing functions; the consultants establishing 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 mango farmers of the possible nature of post-harvest problems in terms of quality changes and losses for the theme examined; initiating 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. While some interviews were held, with the assistance of the Agricultural Assistants, in the county extension offices of the MFPLMA and NAMDEVCO, others were identified from the list of registered farmers and processors. On several occasions tomato farmers were met during attendance at some of the Agricultural District Meetings. A combination of methods was used with traders. Supermarket retailers were informed by a telephone call to alert them about the survey, potential objectives and uses. Wholesalers, public markets, mobile market and roadside market vendors were interviewed at the actual location, mostly without previous arrangements. Interviews almost always took place in the midst of the activity characteristic of the 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 they occurred.

The great advantage, however, of being able to observe and record manifest behaviour pertinent to systematic processes needed to be tempered by the imperative that the consultants, retained an observational role, and did not introduce themselves into the process to the extent that they became a variable, thereby altering even imperceptibility, the true decision-making environment. The consultants and technicians always attempted to recognize that their presence might have encouraged an atypical response. These effects were believed to be minimized after thoroughly cross-checking responses against 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 – As shown in Figure 1, the following components served as the Critical Loss Points (CLPs) for tomato harvesting (CLP#1), packinghouse operations (CLP #2) and retail display (CLP#3), where qualitative and quantitative losses were measured. Samples were purchased at each CLP and at the exact location
where the activity of that particular stage was observed. Tomatoes are not processed into the traditional value-added products such as tomato ketchup, tomato juice and tomato paste as these are imported. However, at the cottage industry level, tomato is processed into tomato choka and frozen. Tomato choka was selected as the value-added product for traceability studies. Each sampling comprised three replications of 10 to 12 kg of randomly selected tomatoes representative of a market load.

Each tomato sample was examined for marketable quality on a scale of 1 to 9 based on a method outlined by Sherman (1982) with 1 = unusable, 3 = unsalable, 5 = fair (limit to marketability), 7 = good and 9 = excellent. Following this each tomato sample was examined for damage and classified into two broad categories: marketable and unmarketable, based on the severity of the damage. The unmarketable tomato samples 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, tomato samples were further subdivided into three categories according to the nature of the damage apparent at that location, that is, physical, physiological and pathological and entomological. Physical damage included cuts, bruises, punctures, scratches, splits, crushes, abrasions and cracks. Physiological damage included moisture loss (wilting, shrinkage), heat stress, cuticle cracks, puffiness and catfacing and internal breakdown. Pathological and entomological damage included that caused by fungi and bacteria. Insect damage was related to Infestation by thrips, white flies and mites. The weights of each category of damage were recorded and the percentage of post-harvest loss calculated for each category. Total post-harvest losses were obtained by summing the losses recorded at each CLP. Tomato samples were also taken to the University of the West Indies and NAREI post-harvest laboratories to collect data on fruit dimensions, firmness and total soluble solids.

Description of the key activities of the study

The flow of tomatoes 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 fruit to move from one component to the next, including delays as well as measurable characteristics of the environment, i.e. temperature, relative humidity and time of day. In addition, hands-on familiarization with the tomato handling operations provided the framework for examining typical patterns of decision-making and action taken by participants within the mango value chain. This also provided information about the tomato value chain dynamics and allowed for a comprehensive mapping of the tomatoes value chain in both countries (Figure 1). By inserting the stages of the post-harvest handling system for tomato within the value chain also provided the template for tracking and tracing and more importantly identification of Critical Loss Points (CLPs).

The tomato value chain includes a highly diverse and complex number of producers (farmers) and traders (market types: farmer’ or public municipal, roadside, mobile, supermarkets, processors) 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 whole value chain and its operations. Field observations and interviewing were of paramount importance in uncovering the differences in post-harvest operations among the diverse range of producers and marketers as well those linked to cultural methods in different locations required of the study. The techniques employed were based on the four-S approach used by FAO, which has the following elements:

- Preliminary Screening of Food Losses (‘Screening’).
- Survey Food Loss Assessment (‘Survey’).
- Load Tracking and Sampling Assessment (‘Sampling’).
- Monitoring and Solution Finding (‘Synthesis’).

In Trinidad and Tobago wholesalers and retailers were randomly selected. In Trinidad the wholesalers interviewed were from the Macoya and the Debe wholesale markets. Retail markets selected in Trinidad were Tunapuna, Chaguanas, Sangre Grande and Marabella. Roadside and mobile markets were selected at random throughout the villages. Only supermarkets that were in operation over the last three years with refrigerated displays and a minimum output of 5-8 kg of tomato were selected. At each market outlet, every stage where there was the potential for reduction of marketable quality and eventual manifestation of post-harvest losses, from the field in the case of a producer, or
from procurement in the case of a trader to the point of consumer purchase was selected for in-depth analysis. This approach is referred to as the ‘systems approach’.

The flow of tomato 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 fruit to move from one component to the next, including delays as well as measurable characteristics of the environment, i.e. temperature, relative humidity and time of day. In addition, hands-on familiarization with the tomato handling operations provided the framework for examining typical patterns of decision-making and action taken by participants in the tomato value chain. This also provided information of the tomato value chain dynamics and allowed for a comprehensive mapping of the tomato value chain in both countries (Figure 1). By inserting the stages of the post-harvest handling system for tomato within the value chain also provided the template for tracking and tracing and more importantly identification of Critical Loss Points (CLPs).

As shown in Figure 1, the following components served as the CLPs for tomato (CLP#1 harvesting, CLP #2 packinghouse operations, CLP #3 retail display), where qualitative and quantitative losses were measured. Samples were purchased at each CLP and at the exact location where the activity of that particular stage was observed. Each sampling had three replications of 5 to 8 kg of randomly selected tomatoes, representative of a market load. Simulated post-harvest storage trials of tomato samples were conducted in the laboratory at the UWI and evaluated after 1, 2, and 3 days similar to marketing conditions observed and recorded during field and market visits.

Each tomato sample was examined for marketable quality on a scale of 1 to 9 based on the Sherman method (1982) with 1 = unusable, 3 = unsalable, 5 = fair (limit to marketability), 7 = good and 9 = excellent. Following this each tomato sample was examined for damage and classified into two broad categories: (a) marketable and (b) unmarketable, based on the severity of damage. The unmarketable tomato samples 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, tomato samples were further subdivided into three categories according to the nature of the damage apparent at that location, that is,
physical, physiological and pathological and entomological. Physical damage included cuts, bruises, punctures, scratches, splits, crushes, abrasions and cracks. Physiological damage included moisture loss (wilting, shrinkage), chilling injury, heat stress, blossom end rots, cuticle cracking, puffiness, russetting and calcium deficiency. Pathological and entomological damages included damages caused by fungi, bacteria, insects, white fly and spider mite.

The weights in each category of damage were recorded and the percentage of post-harvest loss calculated for each category. Total post-harvest losses were obtained by summing the losses recorded at each CLP (Figure 1). Tomato samples were also taken to the UWI Post-harvest laboratory to collect data on fruit dimensions, firmness and total soluble solids.

Approximately 2.5 months were spent in the field for interviewing and data collection. In an effort to catalogue all standard operating practices in the value chain, a set of themes of inquiry was developed to guide the interviewing process and compiled in a questionnaire. Preliminary interviews were used to identify the themes for questioning. All interviewees cooperated, many enthusiastically, when the interview was conducted in their own work environment in a two-way fashion, that is, employing the ‘mirror image technique’, which has been described under Conducting and managing field interviews.
Chapter 3
Situation analysis

RELEVANT INSTITUTIONS
The Ministry of Food Production Land and Marine Affairs (MFPLMA) in Trinidad, established a Biochemistry Laboratory Unit in 1983 at the Central Experimental Station, Centeno where post-harvest research is conducted on a wide-range of tropical fruits, vegetables and root crops. The findings of this research are fed into other divisions of the Station and to the Extension arm of the MFPLMA. The MFPLMA also hosts a Farmers Training Centre at the station where several post-harvest short courses and workshops are held throughout the year to educate farmers, extension field officers, marketers, exporters on essential post-harvest operations from field harvest to produce display and consumption. Training is also focussed on strategies to optimize quality and reduce post-harvest losses.

The University of the West Indies is another key institute in the region. The Faculty of Agriculture at the University of the West Indies, Saint Augustine Campus has been conducting agricultural research since 1926. Post-harvest studies are currently being pursued at both faculties on innovative methods to reduce losses of tropical commodities and enhancement of value-added products. The UWI has also conducted several workshops throughout the Caribbean. The UWI held the Third International Conference on Post-harvest and Quality Management of Horticultural Products of Interest to the Tropical Region in July 2013 in Trinidad under the auspices of the International Society of Horticultural Science (ISHS). The theme was ‘Post-harvest technological initiatives to improve food security and market access’. A follow-up workshop entitled ‘Post-harvest management strategies to reduce losses of perishable crops’ was held in Trinidad in February 2014 by UWI/CTA/NAMDEVCO to train certified farmers, exporters and field officers.

Trinidad and Tobago Agri-business Association (TTABA) is a ‘For Development Company’ established in May 2006 by private sector agribusiness stakeholders with government support to accelerate national economic and social development through the sustainable expansion of the agri-business sector. As a ‘for development not for profit company’ TTABA is not owned by private shareholders but by its current 33 member associations drawn from every level of the agribusiness sector and cannot disburse dividends or profits to individual members but must reinvest its profits to further its objective of actively leading the development and expansion of the agribusiness sector in Trinidad and Tobago.

National Agricultural Marketing and Development Corporation (NAMDEVCO) is a Statutory body created by Act of Parliament No. 16 of 1991 with a mandate “to create, facilitate and maintain an environment conducive to the efficient marketing of agricultural produce and food products through the provision of marketing services and the stimulation of business investment in the agro-industrial sector of Trinidad and Tobago”. NAMDEVCO in fact replaced the Central Marketing Agency. NAMDEVCO’s Market Information System is now on-line. This process resulted in an improved system of collection, compilation and dissemination of market information and intelligence. In addition, NAMDEVCO monitors the activities of Certified Farms in order to forecast the availability of produce.

In 2003 NAMDEVCO established a Packinghouse Facility at Piarco, which was driven by the need for exporters of fresh agricultural products to access the higher-end markets in the developed countries, particularly the supermarket chains. The Packinghouse offers any exporter or private sector the opportunity to receive, temporarily store, process, package, and ship produce bought from certified farms; thereby ensuring the quality
of products necessary to make exporting fresh agricultural produce a profitable enterprise.

Users of the facility, who wish to fill container loads of produce for ocean-freight, can access a power supply and adequate turn-around space for their articulated vehicles. Its storage capacity includes three chilled compartments, which can accommodate approximately 60 tonnes of products at any time, and a frozen compartment, which holds about 30 tonnes of products. Recently a Blast Freezer with approximately 1,000 kg per 12 hour cycle was installed. The close proximity to the airport, and its good road linkage with the major seaports, makes the location of this facility attractive for exporters in particular.

DESCRIPTION OF SUBSECTOR SUPPLY CHAIN WITH GENDER DISAGGREGATED DATA

In Trinidad and Tobago, the distribution of the population by administrative divisions and gender, the 2000 Population and Housing Census indicates that of 1,262,336 people residing in Trinidad and Tobago in 2000, most (95.7 percent) lived on the island of Trinidad, while 4.3 percent resided in Tobago. In absolute and percentage terms, Tunapuna/Piarco accounts for the largest share (16.2 percent) of the national population, followed by Couva/Tabaquite/Talparo (12.9 percent) and San Juan/Laventile (12.5 percent). The 2000 Trinidad census also indicated that the agricultural sector, comprising commercial and subsistence agriculture workers provided 6.3 percent of total employment in 2000. The important commercial crop was sugarcane, which accounted for 29.2 percent of total employment in the agricultural sector, but engaged only 1.9 percent of the employed labour force in 2000. Other agricultural crops grown in Trinidad and Tobago include, rice, cacao, coconuts, citrus fruits, flowers, vegetables and livestock and poultry, but are on the large-scale produced for domestic consumption.

It should be noted that the Trinidad and Tobago 2000 census observed that the high proportion of women in what would be called non-economic activity (unpaid) is generally misleading as many women who report doing ‘home duties’ are usually involved in some small activity, e.g. making sugar-cakes, mitai, etc. or they tend a garden to supplement the family income or have a small income of their own. Moreover, some other non-economic activities performed by women such as cooking or caring for the family are usually chores that normally have to be paid for in cases where women work and should be valued as a contribution to the household budget.

IDENTIFICATION OF ONGOING WORK

Over the last 25 years, the University of the West Indies, Saint Augustine Campus has been involved
in research, teaching and outreach on production and postproduction investigations, both field and undercover protected systems of several processing, non-processing and dual purpose tomato cultivars. Current investigations under the International Development Research Centre (IDRC) project have focussed on the effects of preharvest growth media on post-harvest quality parameters. Post-harvest studies are being conducted to evaluate the quality profiles of selected cultivars (cvs. DRW, Hybrid 61, Matias, Caraibe, Charleston, Striker, Summer Star) and changes in physical, chemical and organoleptic quality attributes of these cultivars during refrigerated and non-refrigerated storage. Studies are also being undertaken to determine the chilling sensitivity of these cultivars. The MAFPLMA at the Central Experimental Station, Centeno are also conducting cultivar evaluations.

**DESCRIPTION OF THE EXISTING MARKETING SYSTEMS**

Discussions with farmers and agricultural professionals and empirical evidence suggest that the demand for fresh tomatoes is strong year-round. Households purchase tomatoes from among a basket of vegetables at municipal markets or at supermarkets. In addition, hotels, restaurants and other small eateries as a group represent the other major buyer. The domestic market for tomatoes is therefore a segmented market of larger tomatoes (primarily Heatmaster) and smaller tomatoes (primarily F1 Mungal). Very small quantities of cherry tomatoes; sometimes imported have also been observed. There are no value-added tomato products prepared from locally grown tomatoes.

**Other observations of the tomato supply chain were as follows:**

- There is general agreement that the largest buyers are the supermarkets, public markets, roadside markets, hotels and restaurants. As for most other vegetables, they bought fresh produce on a daily basis and possibly because on one producer is able to consistently supply acceptable quantities of produce of the desired quality, these buyers maintain a roster of suppliers on whom they could call as required. There are a few suppliers but the roster provides a built-in insurance to these wholesale buyers.

- The collection or distribution system is in the hands of intermediaries and there is no true storage other than intermediaries holding the tomatoes bought from farmers for an average of two-days.

- As at January 2014, farmers reported farm-gate prices of about GYD 264/kg (GYD 120/lb). This was considered low even though prices were sometimes less than GYD 220/kg (GYD 100/lb). Farmers know they are dealing with a commodity that is prone to
price fluctuations. They did not seem motivated to take any specific steps to change this situation. They seemed resigned to the fact that past efforts had failed and there was no other way.

- Farmers were mostly unorganized when it came to marketing. They were engaged in individual production, made individual sales to intermediaries and therefore had no group bargaining power.
- Tomatoes represent one of the vegetables for which credit is used to purchase inputs for expansion. As a result of the unpredictable weather pattern in recent years, a growing number of farmers are gradually adopting the option of shade house production.
- The main inputs that have been traditionally used to produce tomatoes include: seeds or seedlings, insecticides, fungicides and herbicides, fertilizers and limestone. Investments are ongoing as producers plant relatively small areas amidst fluctuating farmgate prices, with higher prices during the rainy seasons.
- Farm to market packaging continues to improve. There has been an observed shift away from sharp-edged baskets as producers increasingly use plastic tubs or buckets and intermediaries place these on multi-shelved pickups or trucks.

In Trinidad and Tobago tomato is used extensively in various forms. As a fresh fruit when fully ripe it is eaten raw as fresh-cut slices, chunks or quarters and included in sandwiches, salads or as toppings on completed prepared dishes. Fresh ripe fruits are also used for stewing in several dishes such as stewed tomato choka, or used as an adjunct to flavour meat and fish as well as other vegetables during cooking.

Tomatoes are also grilled or roasted then the skin removed, the pulp is macerated and spiced with salt, pepper, garlic and onions to make roasted or grilled tomato choka. This product is then sealed or packaged, preferably vacuum-sealed and frozen for more than 6 to 8 months whereby taste and flavour are maintained upon reheating. Tomato cultivars chosen for this value-added product are mainly processing cultivars that have a thick pericarp, reduced jelly and high total solids content. Such cultivars used in Trinidad and Tobago are cv. Roma, cv. Neema, cv. Dorado, and cv. Advantage. The cultivars chosen for fresh-cut slices for sandwiches include cv. Beefsteak, cv. Heatmaster, cv. Kada, and cv. Calypso. These non-processing cultivars are characterized by their thinner pericarp, more jelly, higher moisture content, and fewer total solids as compared to the processing cultivars.

Producers in Trinidad and Tobago have opted to grow processing cultivars, or in some cases dual-type cultivars, even for the fresh market because there are more fruits per plant, higher yields but more importantly a longer shelf-life and they maintain their firmness even when ripe for a longer marketing period and are more resistant to physical damage along the value chain. The market for tomato juice is limited and this product is normally imported. Tomato paste, peeled canned tomato, tomato puree and salsa are imported products. Fresh tomato pieces are also used with other condiments to marinate meat and fish. Some tomatoes are processed at the household level and stored in jars as shown in Figures 4 to 10.
Chapter 3 – Situation analysis

FIGURE 6
Removal of the skins and tough parts by immersing under ice

FIGURE 7
With skin removed tomatoes are then sliced

FIGURE 8
Tomatoes are then filled in jars with lime juice

FIGURE 9
Tomatoes in sealed jars are placed in the canner and kept covered with at least 1 inch in boiling water

FIGURE 10
Tomatoes in sealed jars
SECONdARY DATA AND KEY-INFORMANT (EXPERT) INTERVIEWS

Literature Review

The tomato subsector in the Caribbean was examined during 2008 in the context of its potential as part of a strategic response to improve regional agriculture. The International Trade Centre (ITC) and the FAO developed a ranking based on a set of indices that reflected the relative performance of products, aggregated at the regional level, in terms of their capacity and production efficiency (Production index); their current export performance (Export index); the regional reliance on imports of the product (Import index); and on identified opportunities for trade based on world market conditions (World Market index). Although tomato was a top twenty choice in terms of the export, import and world market indices, it was in the area of world market index that it was seen to have the most potential (#6 ranking). That sixth place ranking changed to second in the category of fruits and vegetables.2

The Ministry of Food Production Land and Marine Affairs (MFPLMA), the Government of Trinidad and Tobago in their national food production plan (2012–2015), identified tomatoes as one of the key vegetables. With a current tomato consumption of 2 600 tonnes and current production of 2 150 tonnes the MFPLMA intended to increase production to 3 100 tonnes by 2015. The main challenges to achieving this target included inconsistent supply throughout the year, uneven quality, misuse of pesticides, development of technology and infrastructure for post-harvest storage and handling, development and encouragement of the use of protected production systems, improvement of the system of farm certification, and increased production of local, high quality tomato seed. The MFPLMA also intend to boost production so as to increase tomato exports to regional markets from the current rate of 493 tonnes per year.

Post-harvest losses for tomatoes in Trinidad and Tobago are estimated to be 24 to 35 percent in the wet and dry seasons respectively. The losses have been attributed to the cultivar, the market type and the seasonality of production (Mohammed et al., 1996). This study also showed that the people most impacted by post-harvest losses are smallholder, small-scale farmers, consumers, wholesalers, produce managers, supermarkets, roadside vendors, exporters, and mobile vendors; in short, post-harvest loss impacts the small-holders, roadside vendors, supermarkets right down to the final consumer. Generally, as there are labour shortages during harvest periods, produce is sometimes harvested in the latter parts of the day when field temperatures are as high as 30 to 33 °C. In most instances, once harvested these commodities are not protected properly from direct sunlight, which causes the produce to overheat, causing transpiration and evaporation. Mechanical injury during transportation, often invisible, further shortens the shelf-life. There is often a lack of affordable harvesting crates that are suitably designed to minimize damage to harvested produce. Without or no precooling, shelf-life is reduced. It is particularly important to maintain the cold chain for fruits and vegetables that are destined for export markets, but this is often a major challenge because of the lack of cold storage facilities, equipment and unreliable electricity supply.

In many instances some, or all, of the following are factors that contribute to post-harvest losses of tomatoes:

- fruit maturity and the absence of harvesting guidelines associated with maturity indexes;
- rough handling during harvesting, resulting in physical injuries and secondary infections;
- collection of fruit in heaps at row ends and placing fruit directly on soil surfaces;

2 http://www.fao.org/fileadmin/templates/est/AAACP/caribbean/TOS_CARIBBEAN_1_.pdf
over packing of fruit in field containers;  
limited protection of fruit prior to and after harvest operations;  
poor sanitary conditions at the packinghouse;  
no precooling of fruit;  
no application of sanitizing agents on fruit;  
poor stacking methods in packinghouses and retail and wholesale markets;  
limited use of refrigerated storage facilities;  
storage of fruit at low relative humidity and absence of wax application;  
susceptibility to chilling injury particularly for fruit marketed by supermarkets; and  
limited protection of fruit at roadside markets against climatic conditions and environmental pollutants (Mohammed et al., 1996).

Data review
The volume of tomatoes produced in Trinidad and Tobago between 2007 and 2012 increased steadily from 1,800 tonnes in 2007 to 2,150 in 2012 (Table 4.5) and, in 2012, Trinidad exported 493 tonnes of tomatoes. The major production areas were Aranguez, Macoya, Orange Grove, Maloney, Vega de Oropouche, Valencia and Paramin in the North; Mayo, Tortugar, Bonne Venture and Tabaquite in Central; and Barrackpore, New Grant and Moruga in the South.

One of the main crops traded at the Macoya Wholesale Market is tomato. Table 4.6 shows that there are in fact three categories (small, medium and large) of local tomatoes traded along with imported tomatoes. The volume of locally grown tomatoes averaged 1,700 tonnes over the 2006–2012 period and in 2012 more than 80 percent of these tomatoes were medium and large.

Table 4.3 shows that during the 2006–2013 period the wholesale prices for medium tomatoes at the Macoya market ranged from TTD 8.94/kg in 2006 to TTD 20.66/kg in 2013 and from TTD 10.87/kg in 2006 to TTD 24.38/kg for large tomatoes. Wholesale prices in 2013 were

| TABLE 4.1
| Trinidad: Volume of tomatoes in 2007–2012 |
|-----------------|-------|-------|-------|-------|-------|-------|
| Year            | 2007  | 2008  | 2009  | 2010  | 2011  | 2012  |
| Volume of Tomato (Tonnes) | 1,800 | 1,760 | 2,150 | 1,660 | 1,963 | 2,150 |

Source: NAMDEVCO

| TABLE 4.2
| Volume of tomatoes traded at Macoya wholesale market (kg): 2006–2012 |
|-----------------|-------|-------|-------|-------|-------|-------|
|                 | 2006  | 2007  | 2008  | 2009  | 2010  | 2011  |
| Tomato (S)      | 287,488 | 358,503 | 312,645 | 364,187 | 334,333 | 283,779 |
| Tomato (M)      | 589,681 | 943,987 | 759,230 | 980,565 | 720,451 | 604,253 |
| Tomato (L)      | 420,310 | 658,163 | 673,898 | 955,348 | 667,726 | 546,485 |
| Total local tomatoes | 1,297,479 | 1,960,653 | 1,745,773 | 2,300,100 | 1,722,510 | 1,434,517 |
| Tomato (Imported) | 5,913 | 568 | 99,687 | 102,433 | 173,099 | 190,691 |

Source: NAMDEVCO

| TABLE 4.3
| Average annual tomato prices at Norris Deonarine northern wholesale market, 2006–2013 |
|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Crops           | Unit  | 2006  | 2007  | 2008  | 2009  | 2010  | 2011  | 2012  | 2013  |
| Tomato (S)      | kg    | 6.94  | 7.49  | 10.26 | 9.01  | 11.62 | 12.08 | 11.75 | 16.38 |
| Tomato (M)      | kg    | 8.94  | 9.52  | 12.8  | 11.11 | 14.5  | 14.84 | 14.55 | 20.66 |
| Tomato (L)      | kg    | 10.87 | 11.25 | 15.21 | 13.36 | 17.74 | 17.62 | 17.56 | 24.38 |
| Tomato (I)      | kg    | 12.13 | NA    | 17.64 | 16.7  | 19.29 | 17.22 | 17.34 | 22.12 |

USD 1=TTD 6.40
Source: NAMDEVCO
essentially double those in 2006. Observations at this market suggested that men and women were engaged in wholesale but that most retailing was by women. At the Chaguanas municipal market retailing was by both men and women but primarily by women.

On the other hand, during the 2009–2013 period tomato retail prices ranged from TTD 10.72/kg to TTD 14.77/kg for medium local tomatoes; from TTD 13.06/kg to TTD 17.82/kg for large local tomatoes; and from TTD 16.70/kg to TTD 17.87/kg for imported tomatoes (Table 4.8).

**Principle tomato supply chains**

Tomato production is widespread. The three main tomato supply chains are North (Aranguez, Macoya, Orange Grove, Maloney, Vega de Oro-pouche, Valencia, Paramin); Central (Mayo, Tortugar, Bonne Venture, Tabaquite); and South (Mayo, Tortugar, Bonne Venture, Tabaquite. South: Bar-rackpore, New Grant, Moruga) Trinidad.

Tomatoes are primarily sold as fresh ripe, however a small but increasing percentage is processed at the home or small cottage industry level and sold as a range of local tomato products inclusive of tomato choka. Figures for the volume of tomato produced by each supply chain are not available but NAMDEVCO data indicates that there are 55 small to medium tomato producers in North Trinidad, 60 in Central Trinidad and 45 in South Trinidad. Over the years, NAMDECO, UWI, CARDI and MFPLMA have all provided

<table>
<thead>
<tr>
<th>TABLE 4.4</th>
<th>Average annual tomato retail prices (TTD/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markets</td>
<td>2009</td>
</tr>
<tr>
<td>Medium (Local)</td>
<td>10.72</td>
</tr>
<tr>
<td>Large (local)</td>
<td>13.06</td>
</tr>
<tr>
<td>Imported</td>
<td>16.70</td>
</tr>
</tbody>
</table>

USD 1=TTD 6.40
Source: NAMDEVCO

**FIGURE 11**

Map of Trinidad and Tobago showing the administrative regions

<table>
<thead>
<tr>
<th>FSC Stage</th>
<th>Location</th>
<th>Months of the year</th>
<th>Number of actors</th>
<th>Products</th>
<th>Volume (Tonnes)</th>
<th>Facilities/Equipment</th>
<th>Duration/Distance</th>
<th>Inputs and Services</th>
<th>Cost of production (TTD)</th>
<th>Value of products TT$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary production</td>
<td>San Juan</td>
<td>January to December</td>
<td>70</td>
<td>Fresh Tomatoes</td>
<td>70</td>
<td>Seeds or seedlings, seedling trays, spray equipment, water cans, wacker, cutlass</td>
<td>12 months</td>
<td>Weed control, pruning, irrigation system, tillage operations, fertilizer applications</td>
<td>85 000/ha</td>
<td></td>
</tr>
<tr>
<td>Harvest</td>
<td>San Juan</td>
<td>January to December</td>
<td>70</td>
<td>Fresh Tomatoes</td>
<td>70</td>
<td>Harvested manually; harvesting aprons, placed mostly in bags or buckets, crates and transfer into trays of pickups; crates sometimes used from farm to homestead or to market</td>
<td>All year round</td>
<td>Labour to harvest, and load as required</td>
<td>5 000/ha 3.50/kg</td>
<td></td>
</tr>
<tr>
<td>Post-harvest handling</td>
<td>San Juan (farm)</td>
<td>January to December</td>
<td>70</td>
<td>Fresh Tomatoes</td>
<td>56</td>
<td>Field sorting and grading, pre-cooling by placing harvested fruits under shade</td>
<td>15-20 km from farm to homestead to wholesale and retail markets</td>
<td>Labour to sort and load as required</td>
<td>3 500/tonne 6.00/kg</td>
<td></td>
</tr>
<tr>
<td>Other post-harvest handling</td>
<td>From San Juan (farm) to packinghouse then to wholesale market (Macoya to Macoya Mkt)/ retail market (San Juan)</td>
<td>January to December</td>
<td>70</td>
<td>Fresh Tomatoes</td>
<td>50</td>
<td>Ripening room, temperature and relative humidity control, sanitation of ripening facility, sorting and grading, packaging in boxes or crates for markets</td>
<td>15-25km from farm to supermarket, municipal markets; about 1-1.5 hours</td>
<td>Labour to sort, pack and load as required</td>
<td>2 000/tonne 8.00/kg</td>
<td></td>
</tr>
<tr>
<td>Transportation</td>
<td>From San Juan to (Macoya to Macoya Mkt)/ retail market (San Juan)</td>
<td>January to December</td>
<td>70</td>
<td>Fresh Tomatoes</td>
<td>50</td>
<td>vans, trucks, stackable crates</td>
<td>15-25 km from farm to supermarket, municipal markets; about 1-1.5 hours</td>
<td>Driver, labour to load and unload</td>
<td>700/tonne</td>
<td></td>
</tr>
<tr>
<td>Wholesale/ retail market sales</td>
<td>(Macoya to Macoya Mkt)/ retail market (San Juan)</td>
<td>January to December</td>
<td>70</td>
<td>Fresh Tomatoes</td>
<td>47</td>
<td>Covered and open air markets; open spaces at markets; refrigerated displays at supermarkets</td>
<td>15-25km from farm to supermarket, municipal markets; about 1-1.5 hours</td>
<td>Driver, labour to load and unload, produce, sale display, package in polyethylene bags</td>
<td>3 000/ tonne 14.55/kg</td>
<td></td>
</tr>
<tr>
<td>Household processing</td>
<td>Household kitchen</td>
<td>January to December</td>
<td>50</td>
<td>Tomato choka</td>
<td>8</td>
<td>Grill, cutting boards, blender, knives, spices and other ingredient, freezer</td>
<td>12 months/15-25Km from farm to household kitchen</td>
<td>Labour to clean, chop, macerate pack, label, and place in freezer</td>
<td>23.00/kg</td>
<td></td>
</tr>
</tbody>
</table>

USD 1.00= TTD6.40 approximately
Support to tomato production, processing and marketing.

Selection of Food Supply Chains
Table 4.5 shows the respective FSCs by parameters such as location, months of the year available, nature of project support, associated facilities or equipment, duration or distance and inputs and services.

As is the case of Table 4.9, Table 4.10 shows the respective FSCs by parameters such as location, months of the year available, nature of project support, associated facilities or equipment, duration and distance and inputs and services. Table 4.10 also shows that in Trinidad and Tobago, the North Trinidad area (Aranguez, Tunapuna/ Macoya, San Juan, Orange Grove, Maloney, Vega de Oropouche, Valencia, Paramin) is a main producing area that supplies Port of Spain and the environs with tomatoes. In terms of economic importance, tomato production is considered to be of some economic importance in relation to the other major producing areas of Central Trinidad and South Trinidad. Tomato production in North Trinidad provides for some employment generation, as there are other options for gaining an income. However, the contribution of North Trinidad to food security is considered low as a result of other possible options. Trinidad does not export tomatoes but in fact imports to supplement local production.

HISTORY OF GOVERNMENT AND PRIVATE SECTOR INVOLVEMENT IN THE SUBSECTOR
The economy of Trinidad and Tobago (TT) is dominated by the petroleum industry and is therefore very susceptible to external shocks induced by movements in energy prices. This reality has signified the need for economic diversification hence the national economic policy and strategy place great emphasis on growth of the non-oil foreign exchange earnings and relatively labour-intensive sectors of the economy, such as tourism, agriculture, agroprocessing and financial services.

Primary agriculture is an economically small but socially important sector and accounts for 16.7 percent of the area. The contribution of agriculture to GDP is small (1.02 percent in 2004), but a significant employer (5 percent of the employed) and key to the rural socio-economy. Agro-industries such as food, beverage and tobacco are a significant segment of the national GDP (3.1 percent in 2004) and manufacturing GDP (45.2 percent).

The country is a net food importer but a net exporter of beverages and tobacco products.

Other noteworthy characteristics of the agricultural sector are that most holdings are small – nationally 87.1 percent were less than 5 ha with 22.0 percent being less than 0.5 ha; in Tobago 45.8 percent of holdings were under 0.5 ha. 76.5 percent of private farmers listed farming as the only or main occupation and 55.3 percent received in excess of half of their income from farming. 14.7 percent of farmers were female. 3.7 percent of farmers had no formal education while 60.2 percent had primary and 27.9 percent had secondary. The age profile of farmers is skewed towards the elderly – 35.4 percent of farmers were over 55 years with 15.4 percent over age 65. Nationally, 11.3 percent of the agricultural land was under irrigation and 33.6 percent subject to flooding. 82.9 percent of the land area (representing 69.3 percent of parcels) is owned/rented/leased and 8.4 percent (representing 17.2 percent of parcels) is held under squatting. Chronic labour shortages are a feature of agricultural endeavours. This may be partly because the sector provides the lowest returns and wages in the country.

The agriculture sector has been in relative decline for several decades and declined in absolute (real) terms in 2003 and 2004. The decline has been attributed to external factors identified as: economic structural transformation and changes in the global trading environment while domestic constraints have been identified as weak research, extension and marketing systems, inadequate area under irrigation, flooding and praedial larceny.

INVENTORY OF ACTIVITIES AND LESSONS LEARNED FROM PAST AND ONGOING INTERVENTIONS
The Government of Trinidad and Tobago’s goal for the agricultural sector is to create a secure nation and this concept is well articulated in the Ministry of Food Production Land and Marine Affairs (MFPLMA) Action Plan for 2012–2015. Food security is defined by FAO (1996) as existing “when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life”. In Trinidad and Tobago, the MFPLMA Action Plan recognizes that the concept of food security is linked to health, sustainable economic development, environment and trade. To achieve this, it is imperative that a higher level of food production and effective utilization of fisheries resources is needed in a sustainable manner to strengthen the agricultural sector. The
MFPLMA has therefore focussed on the development of six commodity groups namely staples (rice, dasheen, cassava, eddoes, sweet potatoes, breadfruit), vegetables (pumpkin, dasheen bush, okra, tomato, hot pepper, cucumber), fruits (citrus, Sucrier banana, pineapple, mango, dwarf pomme-cythere, papaya, avocado, watermelon, banana/plantain, coconut), pulses (pigeon peas, bodi), livestock (sheep and goats for meat, dairy goats and cattle for milk, rabbits for meat, buffalypso/buffalo for meat and milk), aquaculture (frozen tilapia), strategic commodities (cocoa, honey).

For each commodity group emphasis was placed on increasing production and postproduction capacities with the ultimate aim of attaining a greater degree of self-sufficiency, promotion of food security as well as development of export markets for these commodities. The main elements of the plan of action for each commodity group included development of technology and infrastructure for post-harvest storage and handling to alleviate problems of inconsistent supply and quality. In this context, additional packinghouses (Trinidad 4, Tobago 1) at strategic locations would be constructed. Packinghouses are to be equipped with modern packing line facilities including washing, drying, precooling, sorting, grading, hot water treatments, waxing and other hormonal, fungicidal and bactericidal treatments, packaging, storage and post-storage logistics management so that post-harvest losses could be reduced.

Development and commercialization of a range of value-added products such as bakery items, fries, snacks and breakfast cereals within the scope of postproduction strategies to reduce food waste were noted as well. Regarding the reduction of food losses from animals, a livestock policy guide to encourage product development such as meat fabrication, dairy products, grading, standards and branding is envisaged. More specifically for dairy goats, a key element for food losses prevention would be to encourage and train stakeholders in the production of value-added products such as cheese, yogurt and cosmetic products. For rabbits, introduction, adaptation and monitoring standards for slaughtering and grading would be established.

The MFPLMA agriculture action plan contains strategies for development of the sector by creating an enabling environment framework and include:

- **Policy revision** (Livestock Policy, Fisheries Policy, Implementation of revised agricultural incentive programme; agriculture trade policy; land use policy; Integrated coastal zone management policy; national agricultural health and food safety authority).
- **Legislation** to review archaic legislative acts such as Land Adjudication Act, The Plant Protection Act, Animal Health Act, Fisheries Management Bill, Cocoa and Coffee Industry Board Act, Land Surveyors Act, Praedial Larceny Bill, State Land Bill.
- **Post-harvest technologies** to further develop post-harvest management to improve quality, shelf-life and food safety of fresh crop and livestock products in order to increase returns to farmers, reduce post-harvest losses and ensure safer fresh produce to consumers.
- **Post-harvest logistics management** through an infrastructural development programme for improved agricultural access roads to reduce physical damages during transportation from field to packinghouse facilities and market distribution channels, water management and flood control to reduce production losses, young professional development in post-harvest technology for loss reduction through training, internships, conferences, workshops at farmers training centres, Universities and community institutions, marketing infrastructures, research and development, information and communication technology, development of tech-packs, innovative harvesting, loading devices to reduce physical damages.

**CURRENT POLICY FRAMEWORK FOR SUBSECTOR FOOD LOSSES**

The Government of Trinidad and Tobago is taking steps to redevelop the sector and has proposed interventions within the framework of the National 20/20 Vision Plan. The core implementation strategy advanced emphasizes the need to increase productivity, profitability and competitiveness through adoption of improved technologies, varieties and new commodities; improving efficiency and effectiveness of marketing and agricultural health and food safety systems, and links with agro-industry. The core strategy is complemented by efforts to reduce constraints of infrastructure, land tenure, credit and production risk.

The interventions for addressing the above constraints are contained within the 5-year National Medium Term Investment Plan with overall objectives to increase farm profitability and international competitiveness, expansion of
Chapter 4 – Study findings

the Irrigated Area under cultivation, strengthening the Marketing System and Linkages to Demand Centres, improving effectiveness, efficiency and productivity of the infrastructure and systems for research, extension, training, and agricultural health and food safety, support to Agricultural Planning and for developing alternatives strategies for productive and profitable use of agricultural land including a specific focus on unused sugar land, reducing the risk of praedial larceny and more effective participation of industry and farmer organizations.

The sector can access a range of services to further the process of agricultural and rural development. The Ministry of Food Production, Land and Marine Affairs (MFPLMA) and the Tobago House of Assembly (THA) are both involved in providing research, extension, regulatory and administrative services to the agricultural sector. There are a number of public agencies whose mandates address specific areas of intervention: the National Agricultural Marketing and Development Corporation (NAMDEVCO) and the Marketing Division of the THA – Marketing; the Agricultural Development Bank (ADB) – agricultural finance; the Cocoa and Coffee Industry Board – development of the cocoa and coffee industries; the Sugar Manufacturing Company (SMC) – for manufacture and export of sugar; and the Livestock and Livestock Products Board (LLPB) for effectively managing the development of that subsector. In addition, there are a number of farmer and industry organizations, which include the Agricultural Society (a broad umbrella organization for all farmers) and industry organizations such as the Poultry Association.

Moreover, Trinidad and Tobago hosts a number of regional and international organizations. These include the University of the West Indies (Faculty of Food and Agriculture and Faculty of Engineering); the Caribbean Agricultural Research and Development Institute (CARIDI); the Caribbean Epidemiology Centre (CAREC); the Caribbean Industrial Research Institute (CARIRI); the Centre for Agriculture and Bioscience International (Bioscience) (CABI) that works in the area of biological control of insect pests; and the internationally recognised Cocoa Research Unit (CRU) based at the UWI, St. Augustine Campus. The country has offices of the Inter-American Institute for Cooperation on Agriculture (IICA) and the FAO.

At the regional level, the Jagdeo Initiative, which has been endorsed by the Government of the Republic of Trinidad and Tobago (GORTT) provides a framework and strategy for regional agricultural development. Spearheaded by President Bharrat Jagdeo of Guyana, it encompasses the entire CARICOM agrifood/product system for “the creation of an enabling economic and business environment for competitive and sustainable agricultural and rural development”. Key critical constraints affecting agriculture in the region were identified and strategies developed to overcome these constraints within the context of improved international competitiveness. The strategies identified: creating an enabling environment for business and private sector enterprise, including farmers; improving supply capacity and competitiveness; establishing and strengthening of private sector organizations; and refining the resource management capabilities for business and trade efficiency.

The actions outlined in Trinidad and Tobago’s Medium Term Investment Priority Framework are designed to complement this regional initiative while making the requisite domestic adjustments to treat with the challenges and to exploit the many opportunities.

PRELIMINARY ANALYSIS OF POST-HARVEST LOSSES (SCREENING)

General view of the priority subsectors

A general view of the tomato value chain in Trinidad and Tobago was communicated across a wide crosssection of farmers in the key tomato growing districts of both countries. Accompanied with Agricultural Extension Officers and Field Assistants the authors of this report were able to visit the production sites and obtain an overview of all the cultural practices, varieties grown and also all the preharvest factors that could impact on post-harvest losses. The harvesting technique was always manual and fruits were harvested at the mature green and breaker stages of maturity in Trinidad and Tobago. Several producers opted to field sort during the harvesting process.

Harvested fruit was placed in buckets, and boxes and transported from the field to covered sheds often adjoining the house, which will be referred to as the packinghouse. Fruits were placed on newspaper and or 1 or 2 layers of cardboard on concrete floors and allowed to ripen (Figure 12). On a daily basis farmers would sort and remove decayed and unmarketable fruit. When tomatoes are red ripe they are sorted according to size placed in cardboard cartoons (Figure 13) and either wholesaled to retailers or supermar-
kets or retailed at the roadside, public, mobile or supermarkets. Tomatoes are not processed in Trinidad and Tobago, but fresh ripe tomatoes are processed in the household. Tomatoes are roasted or grilled, the 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 choka is then reheated prior to consumption.

**Identification of ongoing work**

The University of the West Indies (UWI), Saint Augustine Campus has been involved in research, teaching and outreach concerning production and postproduction investigations, both field and protected systems (undercover production systems) of several processing, non-processing and dual purpose tomato cultivars over the last 25 years. Post-harvest losses of tomato cultivars grown and marketed in Trinidad were evaluated at the UWI from 1994 to 1996 by Professor Lawrence Wilson, Professor Richard Brathwaite, Dr Majeed Mohammed and Dr Patrick Gomes.

Current investigations under the IDRC project have focussed on the effects of preharvest growth media on post-harvest quality parameters by Dr Majeed Mohammed, Dr Gaius Eudoxie and Dr Wendy Isaac. Post-harvest studies are being conducted to evaluate quality profiles of selected cultivars (cvs. DRW, Hybrid 61, Matias, Caraibe, Charleston, Striker, Summer Star) and changes in physical, chemical and organoleptic quality attributes of these cultivars during refrigerated and non-refrigerated storage. Studies are also being done to determine the chilling sensitivity of these cultivars. The MAFPLMA at the Central Experimental Station, Centeno are also conducting cultivar evaluations.

**Identifying stages in the supply chain where losses are higher**

The tomato value chain is shown in Figure 1 and the three critical loss points (CLPs), where losses were considered to be highest, were at harvest (CLP#1), the packinghouse (CLP#2) and retail marketing and display (CLP#3).

Field data were collected during a survey of selected producers, wholesalers, household processors using a structured questionnaire based on the methodology described earlier. Measurements and data were taken after purchasing samples of fruits at the three identified CLPs and taking qualitative data: fresh weight (digital scale), firmness (Warner penetrometer), colour (USDA colour chart), pericarp thickness (Vernier caliper), number of locules, total soluble solids (Stanley refractometer).
CRITICAL LOSS POINTS: TYPE AND LEVEL OF FOOD LOSSES

The types of losses associated with tomatoes in Trinidad and Tobago were both quantitative and qualitative with critical loss points occurring during field harvest (CLP#1), at the packinghouse where operations included sorting, grading, ripening, packaging and storage at 28-30 °C and 65 to 70 percent relative humidity and hereby designated as CLP#2. CLP#3 occurred at retail markets. The losses were as follows in Trinidad and Tobago (Tables 5.1a and 5.1b).

SAMPLE ANALYSIS

The average of three replicates with each replicate consisting of 15 fruits per cultivar were analysed for the various parameters listed in Table 5.3 for Trinidad and Tobago. Sensory analysis was conducted on the value-added product tomato choka and is presented in Table 5.4.

CAUSES OF LOSSES

Qualitative losses

Tables 5.1 and 5.2 show the percentage decline in tomato fruit quality at specific stages in the post-harvest handling systems and at the 3 CLPs for

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**TABLE 5.1**

Trinidad and Tobago – Qualitative losses in tomato value chain

<table>
<thead>
<tr>
<th>Food supply chain point</th>
<th>Quality reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm harvest</td>
<td>5</td>
</tr>
<tr>
<td>Ripening and storage</td>
<td>10</td>
</tr>
<tr>
<td>Transportation and unloading</td>
<td>2</td>
</tr>
<tr>
<td>Municipal market</td>
<td>4</td>
</tr>
<tr>
<td>Roadside market</td>
<td>2</td>
</tr>
<tr>
<td>Packinghouse operation</td>
<td>10</td>
</tr>
<tr>
<td>Retail market</td>
<td>5</td>
</tr>
<tr>
<td>Wholesale market</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>43</strong></td>
</tr>
</tbody>
</table>

**TABLE 5.2**

Trinidad and Tobago – Quantitative losses occurring in the tomato value chain

<table>
<thead>
<tr>
<th>Percentage handled</th>
<th>Percentage of losses</th>
<th>Percentage of weighted losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvesting CLP#1</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
<td>Packinghouse operations CLP#2</td>
<td>65</td>
<td>8</td>
</tr>
<tr>
<td>Marketing CLP#3</td>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>27.0</td>
<td>19.4</td>
</tr>
</tbody>
</table>
both countries. However Table 5.3 identifies the specific quality attributes according to cultivars at each CLP for Trinidad and tomato growers and marketers. Tomato growers in Trinidad and Tobago were more inclined to grow and sell processing and dual purposes cultivars such as cv. Hybrid 61 and cv. Mumbai in contrast to their Guyana counterparts who preferred non-processing cultivars such as cv. Heatmaster and cv. Mungal. Reasons given by Trinidad and Tobago growers and marketers for selecting these cultivars were attributed to their thicker pericarp, being firmer, longer shelf-life, more uniform ripening patterns, less susceptibility to physical injuries, larger number of fruits per cluster and more satisfied consumers concerning utilization of valued-added cooked dishes such as tomato choka as shown in Table 5.4.

Regardless of the type of cultivar and country, physical damage from bruising caused by impacts against other surfaces or by vibrations during transit from the field to the packinghouse, more than from the packinghouse to the various retail outlets, created both external and internal damage. Moreover, external symptoms of damage included tissue softening, water soaking or cracked fruit walls. This bruise damage was not detected until the fruits were cut and the internal tissues examined. Internal bruise damage symptoms resulted in a higher decline in fruit quality at all critical control points except at CLP#1 for non-processing versus processing cultivars.

Quantitative losses
Table 5.5 shows quantitative losses for tomatoes at each CLP as a result of physical, physiological, pathological and entomological losses. Physical damage leading to unmarketable tomatoes in Trinidad and Tobago at the 3 CLPs amounted to 5 percent. Bruises initiated at the mature green to breaker stages of maturity of the processing cul-

**TABLE 5.3**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Trinidad and Tobago&lt;sup&gt;x&lt;/sup&gt;</th>
<th>cv. Hybrid 61</th>
<th>cv. Mumbai</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLP#1</td>
<td>CLP#2</td>
<td>CLP#3</td>
<td>CLP#1</td>
</tr>
<tr>
<td>Avg. Fruit Weight (g)</td>
<td>39.4</td>
<td>36.8*</td>
<td>34</td>
</tr>
<tr>
<td>Pericarp Thickness (mm)</td>
<td>0.58</td>
<td>0.6</td>
<td>0.58</td>
</tr>
<tr>
<td>Fruit diameter (mm)</td>
<td>4.50</td>
<td>4.33</td>
<td>4.55</td>
</tr>
<tr>
<td>Locule #</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Firmness&lt;sup&gt;y&lt;/sup&gt; g/force</td>
<td>83.0</td>
<td>84.9</td>
<td>82.1</td>
</tr>
<tr>
<td>Total Soluble Solids (percentage)</td>
<td>4.3</td>
<td>4.2</td>
<td>4.9</td>
</tr>
</tbody>
</table>

<sup>x</sup> Stage of maturity at harvest: mature-green to breaker  
<sup>y</sup> Stage of maturity at harvest: pink  
<sup>z</sup> Higher values represent firmer fruits

**TABLE 5.4**

<table>
<thead>
<tr>
<th>Sensory evaluation</th>
<th>Colour</th>
<th>Appearance</th>
<th>Texture</th>
<th>Taste</th>
<th>Flavour</th>
<th>General Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>UWI Students (n= 44)</td>
<td>2.0</td>
<td>2.5</td>
<td>2.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>General Public (n= 36)</td>
<td>3.0</td>
<td>2.5</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Supermarket Consumers (n= 39)</td>
<td>3.0</td>
<td>3.0</td>
<td>2.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>
tivars from Trinidad and Tobago were less visible at CLP#1 but eventually became more obvious at CLP#3 as latent physical damage. Symptom development of scuffs (cuticle removal) varied with ripeness stage. Scuffed immature green and partially mature green fruits for all cultivars were not always sorted as unmarketable and allowed to move from CLP#1 to the packinghouse and retail outlets at CLP#2 and CLP#3.

Irrespective of cultivar, tomatoes developed a brownish, callus-like blister over the injured area and were not cosmetically appealing and were even displayed for sale with marketable fruit in heaps or in tied polyethylene bags at CLP#3. While tomato growers from both countries disposed of preharvest defects such as blossom end rot in the field, other preharvest defects such as puffiness (Figure 15), cuticle cracks (Figure 16), russetting (Figure 17) and catfaced (Figure 18) fruit were not sorted at CLP#1 and were allowed to ripen at CLP#2 and displayed for sale at CLP#3. Puffy and misshapen fruit with catface were structurally weak and susceptible to bruising at CLP#2 and CLP#3. Consumer purchase of some tomatoes with these defects was accounted for by less retail culling, which resulted in a higher percentage being sold but the potential was observed for influencing lower prices, poor quality image and expectations and reduced inclination to make repeat purchases.

Fruit from all cultivars that were susceptible to scuffs and abrasions caused by rough loading and unloading practices, handling during sorting and grading and overfilled baskets and buckets at
CLP#2 and CLP#3 resulted in increased water loss during ripening and storage at the packinghouse as well as at CLP#3. Fruit with these physical injuries displayed localized areas where shrivelling was magnified around the damaged areas. Also it was noted that as the severity of scuffs and abrasions increased, water stress and shrivelling progressed faster (Figure 19).

Susceptibility to impact bruising, associated with transportation of the tomatoes from the field to the packinghouse and then to retail markets, increased with ripeness stage at harvest or at CLP#1. Non-processing cultivars were harvested at the mature green and breaker stages of maturity for processing cultivars in Trinidad and Tobago, developed more visible severe bruising symptoms such as softening, water-soaked appearance and internal damage when subjected to similar impact during transportation.

Overall bruise symptoms did not disappear on fruits of any cultivar damaged at the ripeness stages beyond the breaker stage of maturity. Impact-bruised tomatoes from both countries had internal tissues that became water-soaked with shrunken, disorganized and discoloured gel. Impact-damaged ripened fruits initiated at CLP#1 were more pronounced at CLP#2 and CLP#3 and this could be related to enhanced respiration and ethylene production rates, which created the conditions for faster ripening leading to eventual decay. It is also known that impact-damaged induced ripening could result in less titratable acidity and a slightly lower total soluble solids content as compared to undamaged fruit, which could also alter nutritive and taste characteristics. Bird induced physical damage was more extensive in both cultivars grown in Guyana than in Trinidad and Tobago.

Although physiological losses were 8.5 percent Trinidad and Tobago, there were specific occurrences cultivar, preharvest factors and degree of visible external symptom manifestations at the time of harvest and preliminary sorting measures undertaken at CLP#1. Physiological abnormalities in tomato fruit morphology, colour or both were related to environmental stress on the plant as well as nutritional and cultural practices, moisture stress, unbalanced soil nutrients, inadequate or excess of certain soil minerals, extremes of soil pH, poor drainage, and environmental and genetic interactions.

Preharvest physiological disorders such as blossom end rot (Figure 20) identified as discoloured, leathery sunken spots at the blossom end of the fruit were caused by low calcium levels in the soil and erratic watering regimes. This accounted for losses averaged between 4-5 percent in both countries with non-processing cultivars being more susceptible. However these losses were visible and culled at the point of harvest at CLP#1 and regarded as preharvest losses.

Incidences of catface, a physiological disorder characterized by gross deformity of both processing and non-processing cultivars were allowed to ripen at CLP#2 and displayed for sale at CLP#3.
Consumers in both countries considered fruit with minor deformation as being marketable. Physiological disorders such as puffiness were more dominant in the cultivars from Trinidad and Tobago.

Puffiness was associated with fruit having open cavities between the outer walls and the locular contents in one or more locules. Symptoms of puffiness were not externally visible and, although tomatoes lacked gel in the locules, they ripened normally with acceptable colour development and were not culled at any stage in the post-harvest handling system. However because of the hollow nature of the locular cavity the pericarp became weakened leading to increased softening, deformation caused by overhead fruit during packaging, which lead to physical injuries such as shoulder damage and the splitting of the cell wall.

Tomatoes displayed for sale in supermarkets were normally stretch-wrapped over polystyrene foam trays (Figure 21) on refrigerated shelves where the temperature was maintained at 17-18 °C. Before stretch-wrapping, ripe tomatoes were previously stored in chill rooms with other commodities at 4-5 °C for 3 to 5 days. Occasionally, some fruit upon transfer to the warmer temperature displayed symptoms of injury caused by chilling such as pitting, water-soaked areas and in extreme cases secondary infections.

Sunscald (Figure 22) caused serious damage to all cultivars in both countries. Symptoms became most visible after fruit ripening with tomatoes having bleached patches often accompanied by desiccation, leading to sunken areas thereby rendering fruit unmarketable. Sunscald accounted for 2.5 percent of fruit having physiological disorders.

Tomatoes with irregular ripening were the dominant physiological disorder among cv. Mum-bai with unmarketable fruits being twice as high as compared to occurrences of sunscald. Irregular ripening occurred in fruit that was infested by silver white fly. Fruit were rendered unmarketable because of the uneven colour development associated with external longitudinal white or yellow streaks. Internal symptoms were characterized by a lack of internal colouring of the fruit.

Fruit cracking was also encountered. Fruit with severe radial cracking (Figure 23) and concentric cracking were visible at CLP#1 and culled during harvest and considered as preharvest losses. However fruit with mild cuticle cracking or russetting ripened normally at CLP#2 were displayed for sale at CLP#3. Fruit with severe russetting were unmarketable and were less than 2 percent of the total percentage of fruit with physiological disorders represented in Table 5.5.
Pathological and entomological losses were the highest at each CLP, but there were more at CLP#3 than CLP#1 and #2 and were recorded as 13.5 percent for Trinidad and Tobago. The main diseases were Anthracnose (Figure 24) caused by the fungus Collectotrichum spp., bacterial speck (Pseudomonas syringae) and bacterial spot (Xanthomonas campestris) (Figure 25). Evidence of multiple infections were also observed on ripe fruit where physical damage were punctures, cuts and bruises occurred at CLP#2 and CLP#3 as latent infections secondary to wounding. Fruits infected with Anthracnose originated in the field at CLP#1 with symptoms appearing in ripe fruit at CLP#2 and CLP#3 as circular sunken lesions that became more enlarged and sunken with small black dots arranged in concentric circles. On some fruit a split was observed on the lesion that was more often engulfed in a watery mass, which was indicative of secondary infections caused by bacterial fruit rot (Figure 26). Both cultivars from Guyana mostly had bacterial speck and bacterial spots that appeared as slightly raised minute grey lesions with a dark green halo. Bird’s eye lesions appeared on ripe fruit particularly on cv. Hybrid 61 caused by bacterial canker.

Entomological losses were associated with infestations of stink bugs (Figure 27), thrips (Figure 28) and spider mites (Figure 29) on tomatoes from both cultivars from Guyana. Fruit from Trinidad and Tobago was also infested with these insects in addition to silver white fly infestations (Figure 30) that dominated cv. Mumbai more than cv. Hybrid 61.
FIGURE 27
Stink bug damage: Damage on ripe fruit causes yellow irregular blotches. Stink bugs inject yeast, causing fruit to become watery cv. Mumbai (Trinidad and Tobago)

SOURCE: M. PEET, WWW.CES.NCSU.EDU/VEG, 2009

FIGURE 28
Tomatoes spotted wilt virus-vectored by thrips cv. Heatmaster (Guyana)

SOURCE: M. PEET, WWW.CES.NCSU.EDU/VEG, 2009

FIGURE 29
Guyana – Tomato with spider mite damage cv. Heatmaster

SOURCE: M. PEET, WWW.CES.NCSU.EDU/VEG, 2009

FIGURE 30
Trinidad and Tobago – Irregular ripening from silverleaf white fly feeding cv. Hybrid 61

SOURCE: M. PEET, WWW.CES.NCSU.EDU/VEG, 2009
TRACING

Tomato value-added such as tomato ketchup, canned tomato paste, dried tomato and tomato juice are not manufactured in Trinidad and Tobago. However these products are imported by food processing companies and wholesaled to supermarkets and grocery outlets. Tomato choka is a product that is widely made and eaten in both countries at the household level, where tomato choka can be frozen and reheated and used as necessary. It is an effective method of reducing tomato losses when there is glut, particularly in the dry season. Tomato choka was chosen as the value-added product for trace investigation.

Ripe tomatoes selected were free from pest and diseases and physical damage, washed and either

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**TABLE 5.5**

Trinidad and Tobago – Nature and causes of post-harvest losses of tomatoes

<table>
<thead>
<tr>
<th>Types of losses</th>
<th>CLP#1</th>
<th>CLP#2</th>
<th>CLP#3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>1.5</td>
<td>1.0</td>
<td>2.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Physiological</td>
<td>2.5</td>
<td>2.0</td>
<td>4.0</td>
<td>8.5</td>
</tr>
<tr>
<td>Pathological and Entomological</td>
<td>3.0</td>
<td>5.0</td>
<td>5.5</td>
<td>13.5</td>
</tr>
<tr>
<td><strong>Total losses (%)</strong></td>
<td>7.0</td>
<td>8.0</td>
<td>12.0</td>
<td>27.0</td>
</tr>
</tbody>
</table>

(Unweighted)

**FIGURE 31**

Production of tomato choka

1. Red ripe tomatoes
2. Wash
3. Roast or slice fruits
4. Remove skin from roasted fruits
5. Macerate pulp with blender
6. Add spices, salt, pepper
7. Cook for 4-5 minutes (low heat)
8. Seal package choka
9. Freeze at -18 °C
10. Thaw and reheat for consumption
roasted or sliced and cooked. Fruit skins were peeled after the tomatoes were roasted and the fruit pulp was either macerated or blended. Spices and salt were added and then cooked on low heat for approximately 4-5 minutes. Losses from the skin were 1 to 1.5 percent. There were no losses from sliced, cooked tomato choka since the skin was not removed. Sensory evaluation of tomato choka was undertaken by a trained panellist and the data presented in Table 5.4. The data showed that while there may be some concern about the dark red colour and mushy texture, overall acceptability among all panellists was good and taste and flavour were also highly rated. Frozen tomato choka proved to be an effective processing option to reduce post-harvest losses of tomatoes. Figure 31 shows the process flow for tomato choka.

**FOOD LOSS REDUCTION STRATEGIES**

**Field harvest CLP#1**

- Harvest fruit at the same stage of physiological maturity. In the field, it is often difficult for inexperienced pickers to judge between immature and mature green tomatoes. A simple way to determine maturity is to slice the tomato with a sharp knife. If seeds are cut, the fruit is too immature for harvest and will not ripen properly. A minimum harvest maturity guideline is determined by internal fruit structure indices. Gel formation is advanced in at least one locule and jelly-like material is formed in other locules. To ensure the best quality vine-ripened tomatoes should be harvested at the breaker stage as in Trinidad and Tobago. Fruit at the breaker stage that have some interlocular gel and a pinkish red colour on the inside, are sure to be mature. If tomatoes are to be vine-ripened, fields should be harvested often and thoroughly to narrow the range of ripeness. Harvesting every day may be desirable during the peak season. Remove all diseased, misshapen, and otherwise cull tomatoes from the vines as soon as they are discovered. Remove discarded tomatoes from the field to avoid the spread and build-up of diseases and insect pests. Tomatoes should be removed from the plants by gently twisting them without tearing or causing undue damage to the fruit or plants as rough handling will result in both visible and latent damage.

- Use light coloured plastic crates that are no more than 8-10 inches (0.2-0.3 m) deep, ventilated and with handles to facilitate easy loading, assembling and unloading. Ideally, picking containers should be wide, shallow, and stackable to avoid excessive weight and bruising of tomatoes at the bottom of the container. For existing rough packaging, such as baskets, internal liners should be used to act as a buffer against physical damages. Containers should be stackable and not weigh more than 30 lbs (13.5 kg).

- Tomatoes should be sorted according to size or different stages of maturity and field packed.

- Harvested tomatoes packed in containers should be protected from the sun to reduce heat stress such as sunscald. This can be done by covering containers with broad leaves, moist clean cloth and by providing temporary storage under a tree or shed or under an umbrella.

- Proper field sanitation practices, that is, removing decayed fruits from field, preventing the fruit from touching the soil, sanitation of all harvesting containers after use, adherence to personal hygiene such as trimming fingernails. Clean hands and sanitary personal habits are required of workers at all times when handling produce items. Growers should provide sanitary facilities and instructions for all workers handling produce. Careful supervision and proper instruction of the harvesting crew are essential for the success of any hand-harvesting operation. Frequent checking of harvesting pails for trash and poor-quality tomatoes is recommended.

- Reduce multiple handling times by limiting unnecessary loading and unloading. Hand-operated carts or wheelbarrows are useful for carrying the tomatoes from the field.

- Harvest during the coolest time of the day, that is, early morning or late afternoon.

- Pest and disease management to reduce damage and post-harvest losses are highly recommended. Adoption of suitable cultural practices such as disease-free seeds, fertile beds, mulching, would promote vigorous growth and limit growth and development of stressed tomato plants. Insecticides such as Permethrin, Cyfluthrin or Bifenthrin would be effective in controlling stink bugs, aphids and fruit worms. Spinsad is a natural product for the control of caterpillars and thrips. Pyrethrin is also a natural product for the control of aphids and caterpillars. Neem oil
extracts and insecticidal soap are less toxic options used to control aphids and whiteflies. Adequate coverage of upper and lower leaf surfaces with these insecticides are recommended for effective pest control. Whiteflies are also controlled with horticultural oil, which effectively smothers all stages in the life cycle of this insect. Lower incidences of white fly infestations could be controlled with yellow sticky traps. Leaf undersides are reached with a bug master that is designed to produce multi-directional spray coverage. Another recommendation to control white fly infestation is to release natural predators such as ladybugs, lacewings or whitefly parasites. For fungal disease, such as Anthracnose, the recommended chemicals include Inspire Super, Revus Top, Switch and Catamaran. For bacterial speck and bacterial spot Actigard is recommended. However field sanitation practices must always be adopted such as deep burying of infested crop debris, crop rotation, selection of resistant varieties.

- Training producers, harvesters and retailers in harvesting techniques, maturity indices, optimal use of harvest containers, loading and unloading practices, precooling methods, stacking, ventilation requirements and significance of post-harvest logistics management.

**Packinghouse operations CLP#2**

- Adherence to sanitation and temperature and relative humidity control of presorted tomatoes with uniform maturity indices must be a prerequisite for quality management in the packinghouse where fruit should be temporarily stored to facilitate ripening. On most tomato grading lines, the fruit is dumped or floated out of bulk bins or hand field crates, which reduces bruising. Passing the fruit along a slow roller conveyer that slowly turns each tomato is the best way to inspect thoroughly for defects. Tomatoes that are misshapen, damaged, decayed, or cracked should be discarded (Plate 28). Firm flesh, shiny skin, and uniform colour are indicators of good quality. Tomatoes should be washed sufficiently to remove dust and foreign material by spraying them with a small amount of chlorinated water as they move over a set of soft brush rolls. The wash water should be several degrees warmer than the pulp temperature of the tomatoes to avoid drawing water and disease organisms into the fruit. The water should be chlorinated at the rate of 125 parts per million (1 US quart (0.94 litres) of 5.25 percent chlorine bleach to 100 gallons (378.5 litres) of water). The chlorine level and pH of the wash water should be checked at least hourly during the day with test papers or a meter. (A neutral pH of 7.0 is desirable.).

- The packinghouse should be clean with no decaying commodities from previous harvest. It should be enclosed and kept cool (air-conditioning temperature 18-21 °C (65-70 °F); 90-95 percent relative humidity (RH) for standard ripening, 14-16 °C (57-61 °F) for slow ripening. Mature-green tomatoes can be stored up to 14 days prior to ripening at 12.5 °C (55 °F) without significant reduction of sensory quality and colour development. Decay is likely to increase following storage beyond two weeks, at this temperature. Typically 8-10 days of shelf-life are attainable within the optimum temperature range after reaching the firm-ripe stage. The optimum ripening temperature to ensure sensory and nutritive quality is 20 °C (68 °F). Colour development is optimal and retention of vitamin C content is highest at this ripening temperature. Tomatoes allowed to ripen off the vine above 25 °C (77 °F) will develop a more yellow and less red colour and will be softer. Unsanitary conditions in the packinghouse are a source of cross contamination and losses because of decay (Figure 33).

- High relative humidity (90-95 percent) is essential to maximize post-harvest quality and prevent water loss (desiccation). Extended periods of higher humidity or condensation may encourage the growth of stem-scar and surface moulds.

- Management of ripening would depend on market forces. At CPL#2 it may be necessary to slow the ripening process. This can be done by removing all decayed and physically damaged fruit from the packinghouse because these can be a source of ethylene that accelerate ripening and senescence. Use of an ethylene absorbent such as purafil pads and adequate ventilation could also be introduced.

- To speed fruit ripening, the use of ethrel could be used.

- Training in post-harvest packinghouse operations including proper design of equipment
with temperature and relative humidity control devices, packinghouse sanitation practices, layout of fruit to manage optimum ripening quality, efficient sorting and grading procedures to suit market requirements, adherence to ripening protocols, ethylene, respiration and transpiration procedures to minimize losses, ventilation requirements, post-harvest treatments such as fungicidal and bactericidal dips and hormonal treatments and stacking arrangements and significance of post-harvest logistics within the packinghouse.

Retail marketing CLP#3

- The high levels of post-harvest losses should stimulate producers and traders to seek tomato varieties that are more resistant to harsh treatment during distribution and the prevailing conditions during the preharvest wet season. Varieties having pests and disease resistance, thicker pericarp and retention of firmness when ripe would be desirable.
- Retail marketing under shade in well-ventilated areas would reduce heat stress; reduce physiological disorders and decay.
- Plastic crates should be used throughout the tomato value chain. Avoid pails, buckets, basins and baskets that are too deep, unclean and without inner buffer linings (Figure 34).
- At all retail markets except supermarkets tomatoes packed in sealed polyethylene bags were not stored in suitable low temperature. This resulted in a build-up of respiratory heat and gases and therefore the package was merely a container convenient for handling, rather than a suitable modified atmosphere to increase shelf-life.
- At supermarkets where tomatoes were stretch wrapped in polystyrofoam trays and displayed under refrigerated conditions condensation often occurred because of temperature fluctuations that promoted pathological problems. Accordingly, the need for proper temperature management must be monitored and maintained.
- Although post-harvest losses were not extensive at wholesale markets, as compared to other retail outlets, price markdowns were independent of the market forces of supply and demand, but based on the deterioration of quality, which resulted in a tremendous economic impact on the overall performance of the system.
Training is required in packaging such as modified atmosphere packaging to minimize physiological disorders, proper rotation of produce, compatibility factors during display with other non-climacteric and climacteric commodities, attractive and innovative display techniques, optimizing conditions of refrigerated storage facilities, stacking procedures, protection from heat injuries and significance of post-harvest logistics in obtaining the best quality fruits for the market display.

**Investment programme to reduce food losses**

**Trinidad and Tobago**

Post-harvest losses of tomatoes measured at the end of the post-harvest handling system in Trinidad and Tobago were 27 percent. At CLP#1 post-harvest losses averaged 7 percent while samples measured at CLP#2 were 8 percent and 12 percent for fruits measured at CLP#3. At CLP#3, where fruits were displayed for sale under ambient conditions at roadside, mobile and municipal markets, post-harvest losses were highest. Degradation of fruit quality accelerated as the tomatoes ripened particularly where superficial damage was not detected at the earlier stages of the value chain and were allowed to move towards the later stages at CLP#3.

Based on the 2012 annual production of 2 150 tonnes of tomatoes/year at USD 3 281/tonne, annual production was valued at USD 7 054 150 (Table 5.6). The percentage loss at each CLP level was then used to calculate the estimate economic loss. Table 5.6 shows that at CLP#1 the loss is about USD 493 791, at CLP#2 the loss is 564 332 and at CLP#3 the loss is calculated at USD 507 898.8; hence the total economic loss is estimated at USD 1 566 021.30. The calculation of the economic loss is based on the results of the percentage losses from the areas where the post-harvest loss assessment studies were carried out and therefore these are estimates and should not be taken as official national statistics.

Table 5.7 shows the corresponding magnitude of loss for each CLP, the cause and type of loss, the suggested interventions to reduce the losses and the cost of interventions. At CLP#1, the Table also shows that the equipment will cost about USD 300; and training workshops and demonstrations for a group of 20 producers and marketers was an estimated USD 6 000. At CLP#2 facilities to induce synchronized tomato fruit ripening conditions by incorporating an air-condition system with relative humidity control of 85-90 percent, together with frequent sorting to remove decayed fruits in a sanitized environment is needed to optimize fruit quality. This initial investment would cost around USD 750. The use of a ripening agent to enhance the ripening process and to achieve uniform ripening patterns would cost about USD 300 and training to manage the packinghouse operations was estimated at USD 4 000.

At CLP#3 where fruit decay is dominant but would have started at CPL#1 or #2 would mean that post-harvest treatments of fungicides and bactericides would have to be applied at CLP#2 to reduce losses resulting from pests and diseases at CLP#3 and this would incur an additional cost of USD 700. There are no perceivable risks associated with the interventions proposed.

In Trinidad and Tobago losses were cumulative and the injuries to fruits at CLP#1 created avenues for further quality degradation as the commodity moved along the value chain to CLP#3.

The calculation of the economic loss is based on the results of the percentage losses from the areas where the PHL assessment studies were carried out and therefore these are estimates and should not be taken as official national statistics.

### Table 5.6

<table>
<thead>
<tr>
<th>Critical loss point</th>
<th>Magnitude of losses percent</th>
<th>Value of annual production (USD)</th>
<th>Economic loss (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field harvest CLP#1</td>
<td>7.0</td>
<td></td>
<td>493 791</td>
</tr>
<tr>
<td>Packinghouse Operations CLP#2</td>
<td>8.0</td>
<td>7 054 150</td>
<td>564 332</td>
</tr>
<tr>
<td>Retail Marketing CLP#3</td>
<td>7.2</td>
<td></td>
<td>507 898.8</td>
</tr>
<tr>
<td>Total</td>
<td>22.2</td>
<td></td>
<td>1 566 021.30</td>
</tr>
</tbody>
</table>

USD 1.00 = TTD 6.40

Note: Based on 2 150 tonnes of tomatoes / year at @ TTD 21.00/kg or TTD 21 000/tonne (USD 3 281/tonne)
TABLE 5.7
Trinidad and Tobago, tomatoes – Summary table of food losses, causes and solutions

<table>
<thead>
<tr>
<th>Critical Loss Point</th>
<th>Percentage of losses</th>
<th>Economic loss (USD)</th>
<th>Cause of loss</th>
<th>Intervention to reduce losses</th>
<th>Loss reduction</th>
<th>Cost of intervention</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLP#1</td>
<td>7</td>
<td>493 791</td>
<td>Cuts, bruises, puncture, abrasions, stem end damage</td>
<td>Correct maturity at harvest, trained harvesters, harvesting aprons, shallow plastic crates</td>
<td>Commercial, economic</td>
<td>Cost of equipment = USD 300; training = USD 6 000</td>
<td>No perceivable risks</td>
</tr>
<tr>
<td>CLP#2</td>
<td>8</td>
<td>564 332</td>
<td>inadequate temperature and relative humidity monitoring, unsanitary storage,</td>
<td>Ripen fruits in single layer, room 20-22°C with RH 85-90 percent. Sorting to remove decaying fruits</td>
<td>same</td>
<td>Air condition room with humidifier = USD 750; Ripening agent = USD 300; training = USD 4 000</td>
<td>No perceivable risks</td>
</tr>
<tr>
<td>CLP#3</td>
<td>12</td>
<td>846 498</td>
<td>Lack of post-harvest treatments to control decay</td>
<td>Post-harvest dip treatments such as fungicides, bactericides, Sanitized ripening room and containers</td>
<td>same</td>
<td>Post-harvest treatments = USD 700</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>1 904 621</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Cost benefit analysis of the proposed solutions for tomatoes
Use of field crates for tomato production – Field crates are recommended for use in Trinidad and Tobago. It is assumed that with an 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 1.49/lb; anticipated loss reduction of 65 percent; cost of field crate USD 150 and 5 years depreciation (Table 5.10). Based on these assumptions, profitability of using crates in Trinidad is estimated at USD 2 023.34.

In the case of Guyana, the average production is estimated at 5 000 lb per acre with a selling price of USD 0.91 per lb. The other assumptions are the same. Based on which, the profitability of using crates in Guyana is estimated at USD 1 446.63.

Use of a ripening room – For the construction and installation of a tomato ripening room in Trinidad, assumptions include the following: annual throughput of 10 000 lbs/month x 12 months = 120 000 lbs; the selling price of USD 1.49/lb of tomatoes; anticipated loss reduction of 70 percent; cost of ripening room of USD 4 200 and 10 years depreciation. Based on these assumptions, profitability of using a ripening room for tomatoes in Trinidad and Tobago is calculated at USD 9 392.8 (Table 5.9).
### TABLE 5.8
Trinidad and Tobago – Profitability of using field crates in tomato production

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Unit</th>
<th>Calculation Formula</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Product quantity</td>
<td>lbs/week</td>
<td></td>
<td>32 500</td>
</tr>
<tr>
<td>b</td>
<td>Product value</td>
<td>USD/lb</td>
<td></td>
<td>1.49</td>
</tr>
<tr>
<td>c</td>
<td>Loss rate</td>
<td>%</td>
<td></td>
<td>0.07</td>
</tr>
<tr>
<td>d</td>
<td>Anticipated loss reduction</td>
<td>%</td>
<td></td>
<td>0.65</td>
</tr>
<tr>
<td>e</td>
<td>Cost of intervention (crates)</td>
<td>USD</td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>f</td>
<td>Depreciation</td>
<td>years</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>g</td>
<td>Yearly costs of investment</td>
<td>USD/year</td>
<td>e / f</td>
<td>30</td>
</tr>
<tr>
<td>h</td>
<td>Yearly costs of operation</td>
<td>USD/year</td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>i</td>
<td>Total yearly costs of solution</td>
<td>USD/year</td>
<td>g + h</td>
<td>180</td>
</tr>
<tr>
<td>j</td>
<td>Client costs per lb product</td>
<td>USD/lb</td>
<td>i / a</td>
<td>0.01</td>
</tr>
<tr>
<td>k</td>
<td>Food loss</td>
<td>tonne/year</td>
<td>c x a</td>
<td>2275</td>
</tr>
<tr>
<td>l</td>
<td>Economic loss</td>
<td>USD/year</td>
<td>k x b</td>
<td>3 389.75</td>
</tr>
<tr>
<td>m</td>
<td>Loss reduction</td>
<td>tonne/year</td>
<td>k x d</td>
<td>1 478.75</td>
</tr>
<tr>
<td>n</td>
<td>Loss reduction savings</td>
<td>USD/year</td>
<td>m x b</td>
<td>2 203.34</td>
</tr>
<tr>
<td>o</td>
<td>Total Client costs</td>
<td>USD/year</td>
<td>i = a x j</td>
<td>180</td>
</tr>
<tr>
<td>p</td>
<td>Profitability of solution</td>
<td>USD/year</td>
<td>n - o</td>
<td>2 023.34</td>
</tr>
</tbody>
</table>

### TABLE 5.9
Trinidad and Tobago – Profitability of using a ripening room for tomato production

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Unit</th>
<th>Calculation Formula</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Product quantity</td>
<td>lbs/week</td>
<td></td>
<td>120 000</td>
</tr>
<tr>
<td>b</td>
<td>Product value</td>
<td>USD/lb</td>
<td></td>
<td>1.49</td>
</tr>
<tr>
<td>c</td>
<td>Loss rate</td>
<td>percent</td>
<td></td>
<td>0.08</td>
</tr>
<tr>
<td>d</td>
<td>Anticipated loss reduction</td>
<td>percent</td>
<td></td>
<td>0.7</td>
</tr>
<tr>
<td>e</td>
<td>Cost of intervention (ripening room)</td>
<td>USD</td>
<td></td>
<td>4 200</td>
</tr>
<tr>
<td>f</td>
<td>Depreciation</td>
<td>years</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>g</td>
<td>Yearly costs of investment</td>
<td>USD/year</td>
<td>e / f</td>
<td>420</td>
</tr>
<tr>
<td>h</td>
<td>Yearly costs of operation</td>
<td>USD/year</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>i</td>
<td>Total yearly costs of solution</td>
<td>USD/year</td>
<td>g + h</td>
<td>620</td>
</tr>
<tr>
<td>j</td>
<td>Client costs per pound product</td>
<td>USD/lb</td>
<td>i / a</td>
<td>0.01</td>
</tr>
<tr>
<td>k</td>
<td>Food loss</td>
<td>lbs/year</td>
<td>c x a</td>
<td>9 600</td>
</tr>
<tr>
<td>l</td>
<td>Economic loss</td>
<td>USD/year</td>
<td>k x b</td>
<td>14 304</td>
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<td>m</td>
<td>Loss reduction</td>
<td>lbs/year</td>
<td>k x d</td>
<td>6720</td>
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<tr>
<td>n</td>
<td>Loss reduction savings</td>
<td>USD/year</td>
<td>m x b</td>
<td>10 012.8</td>
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<td>o</td>
<td>Total Client costs</td>
<td>USD/year</td>
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<td>620</td>
</tr>
<tr>
<td>p</td>
<td>Profitability of solution</td>
<td>USD/year</td>
<td>n - o</td>
<td>9 392.8</td>
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