jpht

Research Article

Journal of Postharvest Technology
04 (01): 016-025, Jan' 2016
www.jpht.info

Characterization of Postharvest Practices and Losses of Fresh Produce along the Caribbean Supply Chain: Guyana and St. Kitts-Nevis

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Received : 08 May 2015
Revised : 28 Dec 2015
Accepted : 16 Jan 2016

Abstract

Inefficient handling and high postharvest losses describe the Caribbean supply chain of fresh fruits and vegetables. In this study, two different approaches to characterize the postharvest practices and losses of key agricultural commodities (tomato, string beans, eggplant, okra and cucumber) were developed for Guyana and St. Kitts-Nevis: (1) producer household surveys (PHS) and (2) modified count and weight (MCW). Results from the PHS baseline surveys revealed that Caribbean farmers sell most of their harvested crops to local markets, keeping the remaining crops for household consumption. In Guyana, the majority of farmers (97%) reported selling their crops at harvest, while in St. Kitts-Nevis, 61% of farmers stored their produces before selling. One plausible explanation for this practice is that farmers delay selling to obtain higher prices based on market demands. While farmers in St. Kitts-Nevis reported 30% postharvest losses of crops due to spoilage, those in Guyana reported considerably less. Results from modified count and weight method revealed that small producers experienced greater postharvest loss compared to large ones due to spoilage and lack of market access. A reasonable explanation to this is the degree of knowledge in high-value crop production between the two types of farmers. As the produce travelled throughout the supply chain, it started to lose significantly ($P < 0.05$) its freshness and its marketable value as well. At the marketing level, small and large retailers in both countries experienced substantial postharvest quantitative and qualitative losses. These losses were due to inappropriate handling and exposure to undesirable environmental conditions.

Keywords

Caribbean
Fresh produce
Postharvest loss
Supply chain
Postharvest handling

INTRODUCTION

Fruits and vegetables play an important role in improving diets. World Health Organization estimated that low fruit and vegetable intake contributed to 1.7 million deaths worldwide annually (WHO, 2012). According to FAO statistics (FAOSTAT, 2013), almost 640 million tons of fruit and more than 1 billion tons of vegetables were harvested worldwide in 2011. Most fruits and vegetables are known to be highly perishable plant produce, they are alive and persist to be active metabolically even after harvesting (Kader and Rolle, 2004). However, their metabolism is different from that of the mother plant growing in its original environment since the harvested produce undergoes varying degrees of stress (Watkins, 2003). Fruits and vegetables must be transported from the field to the table, to arrive in a good condition at the consumer level. The fresh produce supply chain system is a complex web of production, transportation, storage and retailing that moves agricultural products from farm-to-fork through series of activities (Memedovic and Shepherd, 2009, Siddiqui, 2015). The ability to provide high-quality horticultural crop depends on the commitment of all actors in the supply chain. It requires cooperation from the producer to the retailer (Humphrey and Memedovic, 2006).

Recent studies commissioned by the United Nations (FAO, 2013) revealed that postharvest losses (PHL) of fresh crops are of considerable interest due to their extremely high values reaching 50% in developed countries where most losses occur at consumption stages and 55% in developing countries where losses happen at production and marketing stages (Gustavsson et al. 2011; Kummu et al. 2012).

These losses are defined as any change in the quality (sensory attributes) and quantity (weight and volume)

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ISSN 2348-4330

of a produce after harvest that prevents its future use or reduces its marketable value (Kader, 2002).

Crop production in Caribbean countries is considered a vital source of income for many smallholder farmers (Ford, 1992; Kendall and Petracco, 2009). The Caribbean region is characterized by its tropical climate with year-round sunshine, separated into dry and wet seasons (CARICOM Secretariat, 2011). The environmental conditions under which fresh horticultural commodities are produced, transported and displayed have a significant effect on the keeping quality of the foods and the amount that is lost (Florkowski et al. 2014; Lana et al. 2005). The major environmental influences on quality of harvested crops are temperature, humidity and sunlight (Luning and Marcelis, 2009). In tropical countries, precooling technologies are limited and below the required capacity (Trotman et al. 2009). In most of those countries, postharvest infrastructures (cold storage facilities, refrigerated transport, packinghouses, etc.) are either scarce or not functioning properly (Reardon et al. 2009).

Careful handling of produce after harvest is important to maintain crop quality (Hodges et al. 2011). Factors that increase postharvest losses in developing countries vary fromlack of knowledge and skills to technologies used in harvesting, storage, transportation and marketing (Van Dijk and Trienekens, 2012). The majority of food producers and handlers in the Caribbean, lack adequate knowledge and expertise in the application of modern agricultural practices, food hygiene, and good handling practices (Kendall and Petracco, 2009). In most cases, general lack of education on efficient postharvest activities and technologies of fresh produce, lead to rough handling, mechanical damage and food quality loss (FAO, 2007). Moreover, inappropriate packages, which provide little or no protection during handling, transport and storage can also contribute to major postharvest losses of fresh fruits and vegetables (Sivakumar et al. 2011). Produce is often packed in containers with no possible vents access, or usually by using bags, which block the cold air circulation, and thus prevents adequate cooling (Kader, 2005).

The amount of loss differs between crops, location, growing conditions, and along the different segments in the supply chain. Most of the available postharvest loss data are based on estimated numbers and few actual measured data (Buzby et al. 2009). Many existing methods in literature to estimate PHL are based on measuring only weight ratios (Kader, 2003; Kitinoja and Kader, 2012). Conventional count and weight approaches known as "gravimetric methods" have been used to estimate postharvest losses specifically in grain (Compton and Sherington, 1998; Kitinoja and Kader, 2012). This is basically a method that takes a sample, separates it into undamaged and damaged portions, counts and weighs each and calculates the percentage weight loss (Aulakh and Regmi, 2013). Subjective measurements have also been developed and implemented by many researchers. In these methods, visual scales or scale ratings were used to assess those losses known as "visloss" (Aulakh and Regmi, 2013).

On a similar note, Gustavsson et al. (2011) reported that postharvest losses of fruits and vegetables in Latin America and the Caribbean (LAC) were estimated at 20% at the production level and up to 30% at the marketing level (including storage, distribution and retailing). Commonly existing methods to assess PHL in the Caribbean are mainly based on household surveys. A recent document was prepared by the Inter-American Institute for Cooperation on Agriculture (IICA) on the challenges and opportunities of postharvest losses in LAC (IICA Secretariat, 2013). IICA conducted a large survey to estimate these losses. In the Caribbean region, greatest postharvest losses occurred in fresh fruits and vegetables among other horticultural commodities (35% for tomato and 52% for peppers). Results also revealed that there was no scientific and consistent information on PHL in the region and the main factors contributing to these losses were inappropriate handling and exposure to undesirable environmental conditions of harvested crops.

The present study was undertaken in the Caribbean to characterize postharvest practices and losses during production and marketing of locally grown fruits and vegetables. This work included two major objectives:

(1) To assess postharvest handling practices and losses of fresh horticultural commodities on-farm using producer household surveys

(2) To determine, identify and measure postharvest losses of fresh produce along the supply chain segments using a modified count and weight method.

MATERIALS AND METHODS

Study sites

This study was conducted in the Caribbean Community (CARICOM) countries, of Guyana and St. Kitts-Nevis. Guyana is bordered by Suriname to the east, Brazil to the south and southwest, Venezuela to the west, and by the Atlantic Ocean to the north. The Federation of St. Kitts and Nevis is a two-island country located in the Leeward Islands. Two different study sites in each country were selected. Local communities from the geographical regions of Parika/Black Bush Polder and Mansion/Stapleton were involved from Guyana and St. Kitts-Nevis, respectively. The selection of participants, field activities, collection of samples and evaluation of postharvest losses were conducted in collaboration with the research partners: (1) National Agricultural Research and Extension Institute (NAREI) in Guyana and (2) Ministry of Agriculture and Marine Resources (MAMR) in St. Kitts-Nevis.

Experimental design

Producer household survey method (PHS)

The postharvest handling practices and loss data were obtained from a baseline survey designed by Thompson-Colón and Laszlo, (2013). The survey instrument was composed of a 10-module questionnaire and targeted farmers operating small holding farms in selected project countries. Due to the small populations of these countries, as well as logistical and budgetary concerns, local communities were selected with the assistance of local agents. Interviewers were drawn from master lists of smallholder farmers who had registered with local government institutions and organizations. The PHS data collection procedures were similar across both project countries and consisted of in-person, paper-and-pencil interviews (PAPI) conducted with the farmers at their homes or farms (United Nations, 2005). A total of 395 questionnaires were successfully completed among the study sites. Surveys were administered based on farmers' consent to participate securing an ethical engagement with local communities. Interviewers were asked to read a short script included in the questionnaire before the start of the interview; the script explained the confidentiality agreement and the participant's right to refuse at any time.

Interviews with household members were divided into three main sections: (1) the first section focused on assessing activities associated with their farming experience on a yearly basis; this section allowed to identify the types and the density of crops produced and harvested during the last 12 months period, (2) the second part of the survey consisted of collecting information on the percentage of crops freshly harvested and sold in local markets, as well as postharvest quality changes of these crops due to spoilage and storage conditions on-farm, and (3) the last section of the survey was useful to assess the handling practices performed by the farmers' prior to selling their produce in the markets; these practices include grading and types of containers used to carry the produce. For data analysis, Bar Chart statistics were conducted using JMP version 11 software (SAS Inc., USA).

Modified count and weight method (MCW)

(1) *Protocol design and implementation*: A field-based data collection protocol to measure postharvest quality and quantity losses of five key horticultural crops (tomato, string bean, eggplant, cucumber and okra) was developed. This protocol included information on the participants, sampling size, field study kits and quality attributes. These crops were selected on their degree of perishability and susceptibility to losses, their seasonal availability, and their economic importance for local farmers.

The supply chain of fresh produce in Guyana and St. Kitts-Nevis was grouped into three major segments including production, marketing and consumption. At the production or farm level, farmers were divided into two groups namely small and larger scale farms. A production cycle is usually defined as the period from the beginning of harvest in a given farm to the end of harvest when the crop can no longer produce (Dixon et al. 2001). Three sets of data from the same farmer and for the same produce were collected during the same production cycle. A total of three small farmers and three large farmers in each country were selected randomly and participated in this work. At the marketing or retail level, retailers in St. Kitts-Nevis were also divided into two groups of small and larger scale. The small-scale retailers typically purchased small quantities of produce and did not use any temperature control system, although they used umbrellas to protect their crops from the sunlight, whereas the large-scale retailers normally purchased larger quantities of produce and used cold storage and refrigerated shelves in their operations. In Guyana, the supply chain network of fresh commodities was slightly different. Distributors known also as "wholesalers" were also involved in this chain. They purchased crops from the farmers and sold them back to retailers. At the retail level, sampling was conducted at the point when a retailer purchased the produce and continued every day until all the same produce was sold (typically three consecutive days). A total of three small retailers and three large retailers in both Guyana and St. Kitts-Nevis were selected randomly and participated in this study. At the consumption level, only one kitchen center in St. Kitts-Nevis was investigated in this network. This center prepared lunch for students in schools under a school-feeding program established and managed by the local government. The entire experiment was conducted in three replicates.

(2) *Assessment of postharvest losses and quality attributes*: For every study crop, a unit package (sample size) was chosen based on the size and weight of the produce (Table 1). Immediately after collecting the samples from different segments in the supply chain, they were transported to laboratory facilities belonging to the research partner in each country for further quality evaluation. Qualitative postharvest losses were assessed as follow: Visual quality was evaluated for individual fruit using a nine point hedonic scale for the parameters indicating symptoms of deterioration and limits of marketability. A quality index (QI) summarizing all these parameters was determined (Table 2) and the total score for each parameter was calculated according to the method described in "UC Davis Handbook" by Kader et al.(2010). Color attribute was evaluated using rating scale method as shown in Table 3. Firmness and Brix measurements were conducted for individual fruit using a handheld FT 011 penetrometer (QA Supplies, Virginia, USA) and a Brix/RI digital refractometer (QA Supplies, Virginia, USA), respectively. In addition, quantitative postharvest losses were evaluated based on the percentage of bruised, diseased, dehydrated and rejected fruits of the same unit package.

To evaluate the postharvest losses of the study crops and the effect of handling practices of different segments along the supply chain in both Guyana and St. Kitts-Nevis on produce quality, an analysis of variance (ANOVA) followed by a Tukey-Kramer HSD test for comparison of means was conducted using JMP version 11 software.

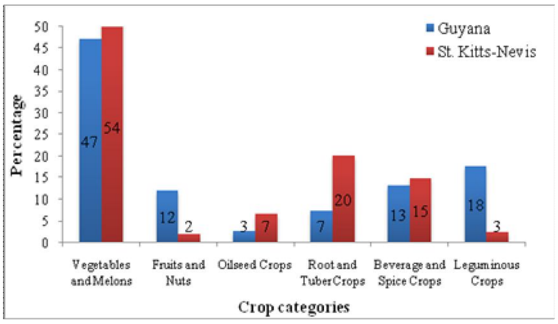

Fig 1: Types of crops harvested during the last 12 months period

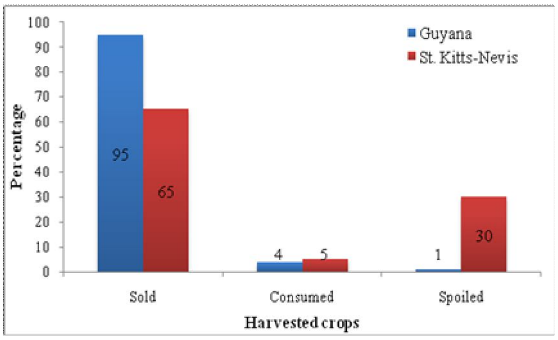

Fig 2: Percentage of crops sold, consumed and spoiled on-farm after harvesting

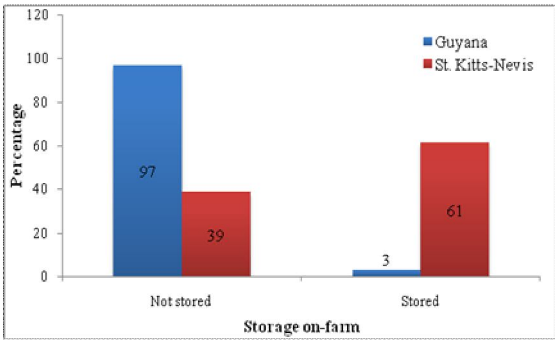

Fig 3: Percentage of harvested crops that were stored by farmers before selling

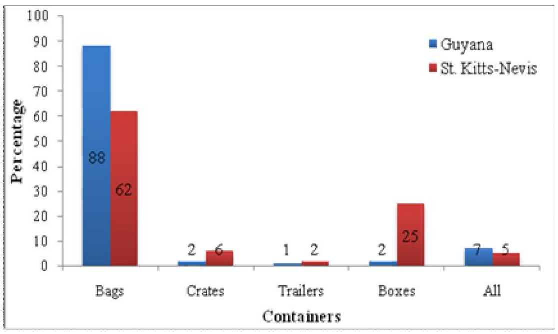

Fig 4: Types of containers used by farmers for harvested crops

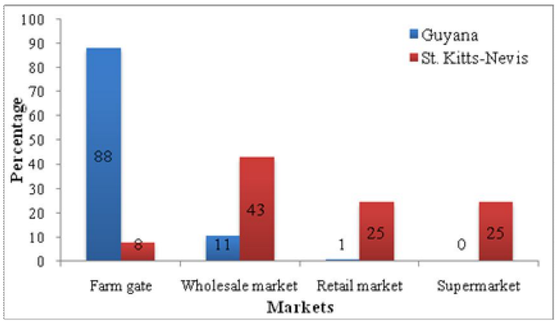

Fig 5: Marketing places used by farmers to sell their harvested crops

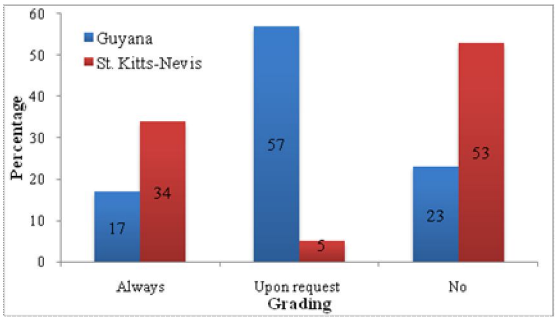

Fig 6: Grading activity of harvested crops on-farm

RESULTS AND DISCUSSION

Producer household survey

Cropping systems

In both countries, the majority of the farmers (more than 50% in Guyana) had plots of land between 2 to 5 acres. A large number of farmers were growing up to 9 crops in St. Kitts-Nevis. However, in Guyana, almost 72% of farmers planted between 3 and 5 different crop varieties. This agricultural strategy was used to ensure enough quantity of diverse crops to supply the market demand. Crop production density is considered a “Good Agronomical Practice” in terms of pest infestation reduction, crop rotation, nutrient cycling and environmental unprecedented changes tolerance (Batt, 2006). The results also showed that crops from six different classification groups (using FAO classification) were grown by farmers with an emphasis on vegetables and melons in both Guyana and St. Kitts-Nevis. As shown in Figure 1, these classifications included vegetables-melons, fruits-nuts, oilseeds, roots-tubers, beverage-spice, and leguminous.

Postharvest crop loss

As shown in Figure 2, up to 95% of the harvested crops were sold to local markets in Guyana, whereas in St. Kitts-Nevis only 65% of the produced commodities were sold. Another remarkable finding was the high percentage of spoilage in St. Kitts-Nevis (30%), where some produce was completely lost on-farm and became unmarketable. On a different note, there was minimal report of storing crops after harvest in Guyana (3%), but in St. Kitts-Nevis over half of the harvested crops (61%) were being stored at the farm level (Figure 3). One plausible explanation for this practice is that farmers in St. Kitts-Nevis delay selling to obtain higher prices based on market demands (Baudron et al. 2012). There is a marked correlation between the spoilage of harvested produce for small farmers and their storage activity on-farm, which compounds the problem of postharvest losses arising from limitations in storage technology under inadequate conditions of temperature, humidity and sunlight. Household members consumed the remaining harvested crops.

Crop	Unit package size (fruit)	Diameter size (mm)	Weight (g)
Tomato	10	72 to 81	93 to 105
Eggplant	10	63 to 76	342 to 412
Okra	15	18 to 23	23 to 29
String Bean	15	5 to 8	5 to 7
Cucumber	10	49 to 63	282 to 342

Table 1: General characteristics of selected crops used for this study

Quality index	Quality	Description
9	Excellent	Essentially no symptoms of deterioration
7	Good	Minor symptoms of deterioration, not objectionable
5	Fair	Deterioration evident, but not serious, limit of marketability
3	Poor	Serious deterioration, limit of usability
1	Extremely Poor	Not usable

Table 2: Full description of quality index scales of study crops (Kader et al., 2010)

Crop	Color
Tomato	1 = Green; 2 = Breaker; 3 = Turning; 4 = Pink; 5 = Light Red; 6 = Red
Eggplant	1 = Bright; 2 =Dull; 3 = Brownish
Okra	1 = Yellow; 2 = Slight Green; 3 = Green; 4 = Bright Green
String Bean	1 = Yellow; 2 = Slight Green; 3 = Green; 4 = Dark Green
Cucumber	1 = Bright; 2 = Dull

Table 3: Rating scales for color attribute of different produce

Preparation activities for fresh market

As indicated in Figure 4, the majority of farmers interviewed reported using large bags as the main field container for their crops, followed by crates and boxes. In Guyana, 88% of selected farmers used only bags to pick up their crops from the field. In contrast, 25% of farmers also used carton boxes in St. Kitts-Nevis. Careful supervision of field packing is needed to avoid harmful physical injuries that sometimes do not appear immediately but it will dramatically reduce the quality of the harvested produce later on (FAO/WHO, 2010).

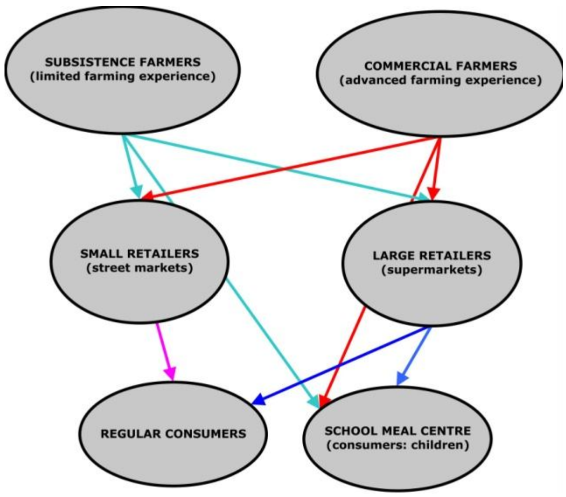

Fig 7: Postharvest supply chain map of fresh crops in St. Kitts-Nevis

Where there are poor storage conditions, selling the crops at the nearest place to the field is highly recommended (Florkowski et al., 2014). The distance between the field and the selling point should be minimized to ensure high quality and reduce postharvest losses of freshly harvested crops (Hodges et al., 2011). Up to 88% of the farmers interviewed in Guyana (Figure 5) were selling their crops at the farm gate, whereas in St. Kitts-Nevis, large quantities of the crops were sold at wholesale, retail and supermarkets. Consequently, this increased the chances of spoilage. These results supported the above discussion related to Figure 2, where the maximum spoilage percentage was revealed to be higher in St. Kitts-Nevis and was reported considerably less in Guyana.

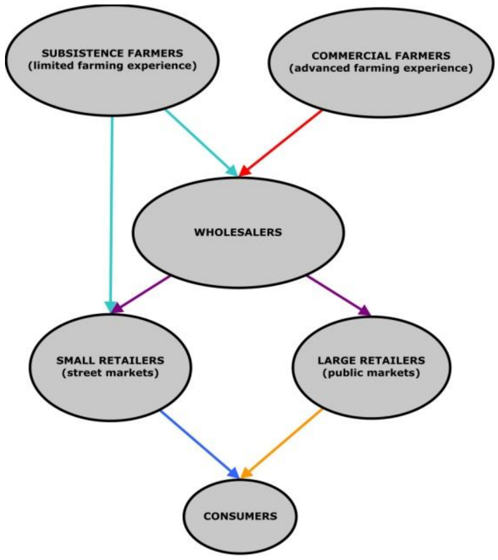

Fig 8: Postharvest supply chain map of fresh crops in Guyana

Another important field activity, which took place during the preparation of harvested produce for fresh market was grading. Hand grading can be used to segregate produce by color, size and grade (Kader, 2002). This activity is subjective and requires a lot of time and effort resulting in high postharvest losses (Florkowski et al., 2014), since over-grading on-farm and in the packinghouse based on strict guidelines that have more to do with appearance (color, size, shape) than nutritional value or eating quality, leads to higher discards of edible produce. As demonstrated in Figure 6, only 17% of the selected farmers in Guyana were grading all the time. In St. Kitts-Nevis, double this number of farmers (34%) conducted grading operations after harvesting, which resulted in higher percentage of losses, similar to what was found previously from Figure 2.

Modified count and weight

Supply chain mapping

Figures 7 and 8 showed the supply chain maps in both Guyana and St. Kitts-Nevis. In both countries, farmers were divided into two main categories: subsistence and commercial farmers. In the first category, farmers have relatively limited farming experience with respect to producing “high-value” crops such as tomato, string beans, cucumber, eggplant and okra. In the second category, farmers have good agronomical experience in growing perishable commodities. They had wide knowledge in the area of crop production in terms of plantation requirements, pesticide and fertilizer usage, harvesting schedule and appropriate postharvest handling practices. On a similar note, small-scale retailers, called also "street markets", bought their crops directly from farmers and sold them in kiosks. These vendors worked in open areas where temperature and humidity were not controlled. The freshly harvested produce was not cleaned before it was displayed under sunlight for most of the day. Any remaining commodities were inappropriately packed and stored in small trucks during the night. Marketing activities for large retailers differed between the two countries. In St. Kitts-Nevis, fresh fruits and vegetables were sold in supermarkets. These vendors were operating in closed areas where environmental conditions were controlled and monitored most of the time. Upon reception, fresh produce was cleaned, graded and packed in different sizes, then displayed on refrigerated shelves. Unsold commodities were adequately handled and stored in cold chambers overnight. In Guyana, large retailers sold their crops in "public markets" under non-refrigerated but shaded conditions with slightly improved handling practices in terms of modes of packaging, cleaning and displaying.

Postharvest qualitative and quantitative loss

Results from the "Modified Count and Weight" method revealed that both countries experienced significant ($P < 0.05$) postharvest qualitative and quantitative losses of selected produce among different segments of the supply chain as well as between various participants within the same segment. Furthermore, under similar handling practices, the extent of postharvest loss varied widely amongst different horticultural crops. This was mainly due to the biological and chemical composition of each produce and its response to the surrounding environment (Watkins, 2003).

As shown in Table 4, significant qualitative postharvest losses ($P < 0.05$) occurred at the small farms compared to large ones for all crops in terms of quality index and firmness. A reasonable explanation to this is the degree of knowledge in high-value crop production between the two types of farmers. As the produce travelled throughout the supply chain, it started to lose significantly ($P < 0.05$) its freshness and its marketable value as well. Tomatoes gained in red color and turned softer in texture same as eggplant and okra became firmer. The results also showed a significant increase ($P < 0.05$) in quality loss at the marketing stage (retailers). Three days after purchasing, the quality index had decreased for almost all crops in both countries. However, the overall quality was better maintained at the supermarkets in St. Kitts-Nevis compared to street and public markets. In this work, the Brix or sugar content remained fairly stable in all crops during postharvest handling activities.

Crop	Color	Quality index	Firmness (N)	Brix (%)
Tomato				
SF	4.60[b*]	8.82[a]	6.02[a]	3.42[a]
LF	4.41[b]	8.61[a]	5.82[ab]	3.47[a]
SR	5.05[ab]	6.45[bc]	2.83[c]	3.48[a]
LR	5.37[ab]	7.37[b]	4.28[bc]	3.67[a]
String beans				
SF	3.00[a*]	8.60[ab]	1.14[b]	na
LF	3.00[a]	8.82[a]	1.17[b]	na
SR	3.00[a]	7.64[b]	1.72[ab]	na
LR	3.00[a]	7.65[b]	1.18[b]	na
Okra				
SF	2.51[a*]	6.98[bc]	1.98[b]	na
LF	2.80[a]	8.04[ab]	2.08[ab]	na
SR	3.40[a]	5.84[c]	2.22[ab]	na
LR	3.76[a]	5.70[c]	2.27[a]	na
Eggplant				
SF	1.00[a*]	7.86[a]	7.38[a]	na
LF	1.00[a]	7.16[ab]	8.14[a]	na
SR	1.28[a]	5.36[b]	6.29[b]	na
LR	1.31[a]	5.41[b]	7.27[a]	na
Cucumber				
SF	1.10[a*]	7.81[ab]	1.86[a]	2.30[a]
LF	1.00[a]	8.36[a]	1.96[a]	2.33[a]
SR	1.42[a]	7.16[b]	1.91[a]	2.42[a]
LR	1.39[a]	7.62[ab]	1.92[a]	2.35[a]

Table 4: Postharvest quality loss of study crops in Guyana and St. Kitts-Nevis.

*Values in the same column with the same letter are not significantly different at $\alpha = 0.05$
SF=small farmer; LF=large farmer; SR=small retailer; LR=large retailer.

Table 5 showed the percentage of quantitative postharvest losses at various segments for each study crop. At the farm level, higher losses ($P > 0.05$) occurred with small farmers, with tomato estimates of

2.07% bruised and 5.28% diseased; string beans estimates of 0.00% loss; okra estimates of 5.00% bruised and 5.73% diseased; eggplant estimates of 1.67% diseased; and cucumber estimates of 3.88% bruised, 2.61% diseased and 1.68% dehydrated. At the retail level, street and public markets experienced greater postharvest losses ($P < 0.05$) for almost all selected crops, with tomato estimates of 32.75% bruised, 16.66% diseased, 30.00% dehydrated and 20.51% rejected or completely lost; string beans estimates of 5.37% diseased, 8.88% dehydrated and 6.45% rejected; okra estimates of 9.69% bruised and 20.46% dehydrated; eggplant estimates of 13.17% bruised, 3.88% diseased and 68.27% dehydrated; and cucumber estimates of 4.44% bruised and 1.21% dehydrated. These losses were mainly due to inappropriate postharvest handling and storage of fresh produce under undesirable environmental conditions.

Crop	Bruised (%)	Diseased (%)	Dehydrated (%)	Rejected (%)
Tomato				
SF	2.07^{c*}	5.28^{b}	0.00^{b}	0.00^{b}
LF	0.67^{c}	5.58^{b}	0.00^{b}	0.00^{b}
SR	32.75^{a}	16.66^{a}	30.00^{a}	20.51^{a}
LR	13.60^{bc}	7.22^{b}	0.00^{b}	6.11^{b}
String beans				
SF	0.00^{a*}	0.00^{b}	0.00^{b}	0.00^{b}
LF	0.00^{a}	0.00^{b}	0.00^{b}	0.00^{b}
SR	0.00^{a}	5.37^{a}	8.88^{a}	6.45^{a}
LR	0.00^{a}	2.96^{ab}	3.79^{b}	2.75^{b}
Okra				
SF	5.00^{ab*}	5.73^{ab}	0.00^{b}	0.00^{a}
LF	1.66^{b}	5.50^{ab}	0.00^{b}	0.00^{a}
SR	9.95^{a}	0.00^{b}	20.41^{a}	0.00^{a}
LR	9.69^{a}	0.00^{b}	20.46^{a}	0.00^{a}
Eggplant				
SF	0.00^{b*}	1.67^{a}	0.00^{b}	0.00^{a}
LF	0.00^{b}	1.68^{a}	0.00^{b}	0.00^{a}
SR	13.17^{a}	0.55^{a}	63.38^{a}	0.00^{a}
LR	10.55^{a}	3.88^{a}	68.27^{a}	0.00^{a}
Cucumber				
SF	3.88^{a*}	2.61^{a}	1.68^{a}	0.00^{a}
LF	1.68^{a}	0.00^{a}	0.00^{a}	0.00^{a}
SR	4.44^{a}	0.00^{a}	1.21^{a}	0.00^{a}
LR	0.00^{a}	0.00^{a}	1.11^{a}	0.00^{a}

Table 5: Percentage of quantity loss of study crops in Guyana and St. Kitts-Nevis

* Values in the same column with the same letter are not significantly different at $\alpha = 0.05$

SF=small farmer; LF=large farmer; SR=small retailer; LR=large retailer.

CONCLUSION

This research study attempted to identify the major postharvest quality management hurdles that different segments in the supply chain are facing in the Caribbean and their effects on postharvest losses. States in the Caribbean region have limited local food availability and diversity and therefore limited intake of fresh fruits and vegetables by local communities. A clear pathway to ensure the availability of food and alleviating poverty is to minimize the postharvest losses (PHL). Therefore, increasing food availability through loss reduction is easier and less costly than through increasing food production. High percentage of the crops harvested in St. Kitts-Nevis and Guyana is lost due to on-farm spoilage, sunlight, high temperatures and inappropriate handling at the retail level. There is also a serious problem with regard to market access for small farmers, which compounds the problem of postharvest losses arising from limitations in postharvest technology.

ACKNOWLEDGMENTS

Funding for this project was provided by The Canadian International Food Security Research Fund (CIFSRF), which is a program of Canada's International Development Research Centre (IDRC) undertaken with the financial support of the Government of Canada provided through Foreign Affairs, Trade and Development Canada (DFATD).

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