Analysis of the Postharvest knowledge system

Case Study of Pumpkin

Majeed Mohammed, Department of Food Production, University of the West Indies, Trinidad West Indies

Commissioned by
Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA)

Introduction

In the Caribbean and other developing countries, 40-50% of horticultural crops are lost before they can be consumed, mainly due to high rates of physical damage, water loss and subsequent decay during postharvest handling (Kader, 2005; Kitinoja and Al Hassan, 2012). Determination of the magnitude of postharvest losses in studies conducted in Trinidad and Tobago has been subjective, and not focussed on differentiation between cultivars, seasonality of production and dynamics of particular markets. The most influential losses at critical stages in the postharvest handling system were also not identified so that corrective action could be taken. Nevertheless, food policymakers from the private and public sectors have recognised, and are convinced of, the significance of reducing postharvest losses of fresh commodities in order to sustain agricultural development and to increase food availability.

Pumpkins are an important source of income for many growers in the Caribbean. Produced throughout the year in Trinidad and Tobago, pumpkins are highly perishable and a major export crop and foreign exchange earner for local producers and traders. In 2012, total production amounted to 1,790 tonnes at a market value of US$1.3 million. Local consumption was 485 tonnes, worth US$352,450. An estimated 1,287 tonnes of pumpkins were sea freighted to ethnic markets in North America, valued at US$935,262. Although data exist on production losses (unsold fruits) due to field diseases, flooding, praedial larceny and pre-harvest culls (Table 1), similar data on postharvest losses have not been reported or documented.

The importance of loss assessment to analyse the pumpkin postharvest handling system in Trinidad and Tobago – using a standardised methodology in the identification of areas for loss reduction activity and for monitoring the effectiveness of such activity – cannot be over emphasised. Accordingly, an analysis of the present handling system, showing strengths and weaknesses of each step from harvest to consumption is a starting point and a pre-requisite to setting priorities for changes in any part of the system (Figure 1). Thus, this investigation initiated and funded by CTA to trace, track and identify

postharvest losses of pumpkins was undertaken at all market outlets in the wet and dry seasons in Trinidad and Tobago with the following objectives:

i. documentation of the existing system;

ii. assessment of the status of postharvest knowledge at all stages in the handling system;

iii. comparison of existing practices to current state of the art systems;

iv. identification of centres of excellence;

v. assessment of the human, infrastructural and institutional capacity;

vi. determination of additional data for policy and strategic interventions.

Table 1. Pumpkin production and market value in Trinidad and Tobago (2012)

Pumpkin production/consumption	Quantity/tonne	Market value @US$726.7/tonne
Production	1,790	1,300,793
Local consumption	485	352,449.5
Export	1,287	935,262.9
Unsold	18	13,080.6

Magnitude of postharvest losses in pumpkins

Postharvest losses of pumpkins in Trinidad and Tobago varied according to growing season and type of market outlet. Dry and wet season pumpkin postharvest losses were highest at export markets, 35.9% and 44.4%, and lowest at wholesale markets, 7.8% and 17.3%. Multiple handling, at harvest, storage and transportation as the commodity moved along the marketing chain, influenced the cumulative levels of quality deterioration, and ultimately the magnitude of postharvest losses (Table 2).

Plate 1. Pumpkins losses due to physical injuries and pathological infections.

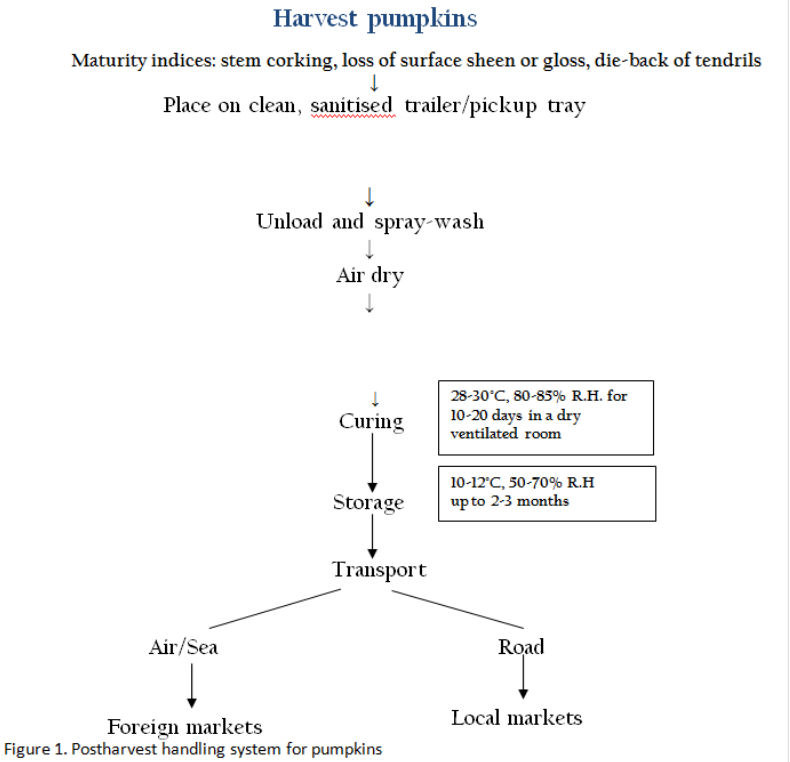

Figure 1. Postharvest handling system for pumpkins

Figure 1. Postharvest handling system for pumpkins

Table 2. Postharvest losses of pumpkin according to type of market and season in Trinidad and Tobago

Market type	Dry season (%)	Wet season (%)
Roadside	18.6	30.8
Farmer's	12.0	18.1
Wholesale	7.8	17.3
Mobile	15.1	27.9
Supermarket	22.3	29.9
Export	35.9	44.4
Average	18.6	28.1

Table 3. Estimation of postharvest losses of pumpkin at various market outlets at critical stages in the handling system during dry and wet seasons in Trinidad and Tobago

Handling system steps	**Roadside**		**Farmer's**		**Wholesale**		**Mobile**		**Supermarket**		**Export**	
	DS	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**
Harvesting	4.4	8.6	2.6	3.6	1.1	3.3	3.3	6.7	4.7	6.8	7.0	9.2
Transportation	2.2	7.2	1.2	2.0	0.5	3.1	2.6	3.9	3.9	4.3	4.9	4.9
Curing	6.0	8.9	4.5	6.6	3.6	6.9	5.6	8.4	7.8	9.9	12.9	16.8
Sorting/grading	2.2	2.5	1.0	1.4	0.3	1.2	1.6	3.3	2.9	4.0	4.6	5.5
Packaging	2.0	2.3	1.3	2.4	1.0	1.3	0.8	2.9	2.5	2.9	3.0	4.7
Storage/display	1.8	1.3	1.4	2.1	1.3	1.5	1.2	2.7	0.5	2.0	3.5	3.3
Total losses (%)	**18.6**	**30.8**	**12.0**	**18.1**	**7.8**	**17.3**	**15.1**	**27.9**	**22.3**	**29.9**	35.9	44.4

DS: dry season; WS: wet season.

Harvesting

Pumpkin farmers were often faced with variations in fruit physiological maturity due to cross pollination by insects. Although seed materials were used from the same cultivar at time of planting, variation among fruits dominated at all farms and markets. Differences in size, shape, skin and flesh colour, some with smooth or rough skin surfaces, with or without striations, were observed. Harvesting operations were manual. Maturity indices used by farmers at harvest included cutting of the corky stems with knives or secateurs when the tendrils were dried. Other maturity indices used by farmers required rotating the pumpkins from the position seated on the soil and examining the skin to detect changes in colour from green or white to a light cream colour, and/or using the knife tip or finger nail to make a slight insertion in the flesh. The degree of exudates flow from this incision as well as the colour of the flesh was used to determine fruit maturity. If the flow of the exudates was minimal or the colour of the flesh was yellow then the fruits were harvested and considered physiologically mature.

Due to differences in fruit size, shape and weight, farmers faced many challenges associated with physical injuries such as compression, cracks, scars, abrasions and punctures during loading of pumpkins into trailers or pick-up vehicles. Postharvest losses estimated at farmers markets amounted to 12% and 18.1 % in the dry and wet seasons respectively. Occurrences of cracks were the highest among physical damage, as seen in Table 4.

Table 4. Nature and causal agents of postharvest losses of pumpkins at farmers' markets during dry and wet seasons in Trinidad and Tobago

Nature of damage at farmer's markets	***Type of damage or causal agent***	***% Pumpkin damage***	
		Dry season	***Wet season***
Physical	**Cracks**	**3.1**	**4.0**
	Scars	**0.0**	**2.0**
	Punctures	**1.0**	**1.0**
	Abrasions	**1.2**	**1.5**
	Compression	**0.0**	**0.0**

Physiological	**Heat stress**	**1.0**	**0.0**
	Chilling injury	**0.0**	**0.0**
	Internal breakdown	**3.9**	**6.3**
	Immature fruits	**0.5**	**1.0**
Pathological andEntomological	**Fungus**	**0.0**	**0.5**
	Bacteria	**0.0**	**0.0**
	Virus	**0.0**	**0.0**
Total losses	**Insect**	**1.3**	**2.8**
		12.0	**18.1**

Plate 2. Variations in size, shape, colour, and skin surface morphology due to insect cross pollination

Transportation

Injuries sustained at harvest were aggravated during transport from the field to the packinghouse, particularly where uneven terrain, slippery road surfaces and limited access roads existed. Physical injuries provided avenues for pathological proliferation. Postharvest losses were related to the time

taken during transport to various market outlets. Pumpkins destined for overseas ethnic markets in Canada, utilising sea transport over 2-3 weeks accounted for the highest levels of losses. Fresh-cut slices of stretched-wrapped pumpkins at local supermarkets were second highest as postharvest losses were 3.9% and 4.3% for dry and wet seasons respectively, despite availability of refrigerated storage (Table 3). Internal breakdown of the inner cavity flesh due to frequent temperature fluctuations and latent infections from untreated slices where sanitary practices were questionable prior to packaging were directly responsible for such losses (Table 4). Where transportation time was significantly lower, such as in wholesale and farmer's markets (1-2 days), postharvest losses were lower compared to supermarkets and export markets (Table 3).

Plate 3. Physical damage due to bruising

Plate 4. Physical damage due to puncture

Pre-cooling and washing

Generally pumpkin farmers did not apply any pre-cooling techniques to remove field heat. However, pre-cooling was done at the National Agricultural and Marketing Corporation (NAMDEVCO) packinghouse facility. Pumpkins were normally washed before distribution and display at market outlets. However at NAMDEVCO's packinghouse proper sanitary protocols were observed whereby fruits were dipped in potable water containing 500 ppm sodium hypochlorite. This was followed with a rinse with clean water and air dried through a warm air tunnel. These fruits were either exported or incorporated into a callalo package and distributed to major supermarket chains. The need to wash fruits is necessary because fruit development takes place on the mound of each plant on the bare soil. Sometimes this promoted soil borne pathogens to bore through the skin which eventually entered the fruit cavity leading to decay. The extensive use of uncured poultry manure enhanced pathological infections.

Plate 5. Washing

Plate 6. Pre-cooling

Plate 7. Final rinse

Plate 8. Air drying prior to storage

Curing

Subjecting pumpkins to a curing treatment at 28-30°C, at 80-85% relative humidity for 10-20 days depending on the cultivar, in well ventilated covered rooms to optimise quality and shelf life, was not carried out by any farmer or market outlet. Curing pumpkins, as shown in Figure 1, is a successful postharvest treatment whereby the skin is hardened, slight physical injuries are healed, ripening is enhanced, a change in flesh colour from yellow to orange is promoted, and sensory quality attributes are improved. Reluctance by pumpkin producers and marketers to implement this essential treatment is not fully understood. Possible reasons for not using the curing treatment could be attributed to the inherited loss in fresh weight and consequent losses in revenue, or perhaps a change in ownership during trading operations during marketing. Curing did not occur at NAMDEVCO either. Failure to include curing treatments resulted in high postharvest losses at all market outlets, but more so for export markets where losses averaged 12.9% and 16.8% respectively (Table 3).

Sorting and grading

Immature pumpkins with major blemishes such as punctures, abrasions, deep cracks and insect damage, are considered unmarketable (Table 4). Grading was based on internal colour. Pumpkins with a bright orange yellow colour flesh had better consumer acceptability and often acquired higher prices. Modified atmosphere packaging techniques were applied to skin-peeled slices that were cubed, pre-weighed and stretched-wrapped over polystyrofoam trays.

Plate 9. Internal flesh colour, one of the parameters used in grading.

Packaging

The majority of pumpkin producers and marketers used polypropylene 'feed' bags. These were readily available, inexpensive and reusable. However the bags also had several disadvantages. They were slippery, not adequately ventilated and allowed for build-up of relative humidity. Accordingly, pumpkins pre-packaged in these bags were more vulnerable to physical damage during loading, unloading and transportation, as well as heat stress in markets where no refrigeration facilities were available.

Plate 10. Polypropylene bags

Storage and display

Internal breakdown of the flesh from the cavity outwards accounted for losses as high as 3.9% and 6.3% in the dry and wet seasons respectively (Table 4). This problem occurs because most producers utilised excessive poultry manure which is normally high in nitrogen. While excessive nitrogen from the application of poultry manure promoted vine and leaf development, it also accelerated fruit softening which resulted in an abbreviated shelf life. Immediately after curing, fruits must be stored at 10-12°C and 50-70% relative humidity to achieve a shelf life of up to 3 months, providing the initial curing treatment is applied (Figure 1). Failure to cure, followed by refrigerated storage, would result in a shelf life of 2 weeks under ambient conditions.

Value added products from pumpkins

A diverse range of value-added products with direct potential to reduce postharvest losses of pumpkins is illustrated in Figure 2.

Fresh-cut pumpkins

Pumpkins were sliced, with or without the skin, and displayed for sale. Or they were cut into chunks and packaged together with other fresh commodities – such as okra, dasheen leaves and hot peppers – sealed in low density polyethylene bags, and stored at 12-15°C on display shelves as a 'callalo package'. This is a ready to cook menu item with a limited shelf life of 2-3 days (Plates 2 and 3).

Plate 11. Fresh-cut pumpkins

Plate 12. Callalo packaging

Dehydrated pumpkin products

Pumpkins were washed, peeled, deseeded and dried to a moisture content of 3-4%, ground into a powder and utilised in making flour mixes, beverages and baked products such as biscuits and bread. The ground product could also be used to make purees for baby food. Recent studies by Harrynanan and Sankat (2013) showed that foam-mat drying technology could be successfully applied for processing and preserving pumpkins to alleviate postharvest losses and to generate revenues for pumpkin producers and marketers. Frozen and thawed pumpkin purees were whipped into stable foams with the aid of a foaming agent such as 5% glycerol monostearate to cause a 3-4 fold increase in volume which became highly porous during drying. According to Harrynanan and Sankat (2013), the pumpkin foam-mats of 0.005 m in thickness were dried at 60°C at a flow rate of 1.5 m/s in a forced oven to a porous, friable, crisp solid which was then converted into a powder. This powder was microbiologically safe up to 3 months with minimal changes in colour and nutritional quality.

Pumpkin ketchup, jams, sauces and pickled products

These products developed by Miss Judith Ann Francis (Caribbean Industrial Research Institute) and Professor George Sammy (Chemical Engineering, University of the West Indies) have been adapted and applied in many cottage industries in Trinidad and Tobago.

Pumpkin beverages and ice cream

Research conducted by De Souza *et al*. (2011) showed that steamed pumpkin cubes blended in water at 120°C into a puree could be added to low fat milk, xanthum gum, cinnamon powder and trehalose as the sweetener to produce pumpkin flavoured low glycemic ice cream and other beverages.

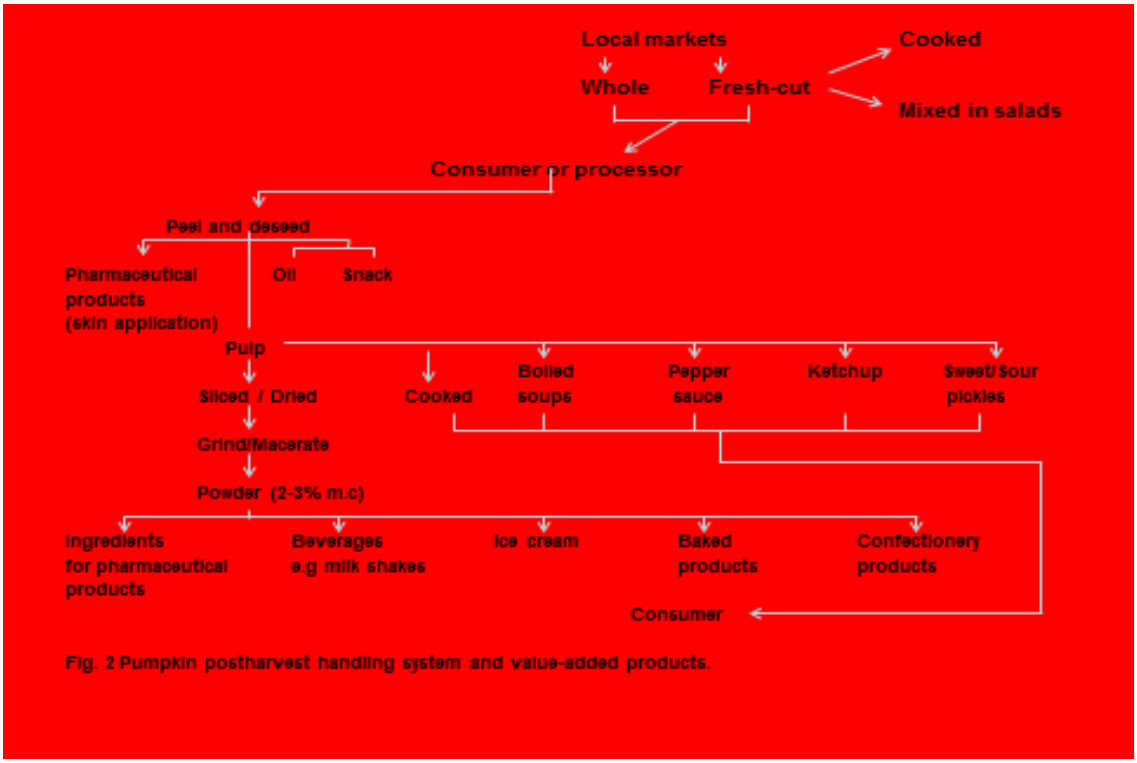

Fig. 2 Pumpkin postharvest handling system and value-added products.

Centres of excellence for research and training

Postharvest research, training and outreach activities have been conducted over the last five and a half decades at the University of the West Indies (UWI), and within the last 3-4 years at the University of Trinidad and Tobago (UTT). Several regional institutions such as the Caribbean Agricultural and Research Institute (CARDI), Caribbean Industrial Research Institute (CARIRI), NAMDEVCO, Inter American Institute for Co-operation in Agriculture (IICA), Trinidad and Tobago Agribusiness Association (TABA) and the Biochemistry Unit, Central Experimental Station (CES) in the Ministry of Food Production are also implementing postharvest and food processing projects on specific groups of tropical commodities. They also conduct short courses at local and regional levels.

At the UWI Department of Food Production there are undergraduate courses in postharvest technology and crop and livestock products technology, advance postgraduate courses in postharvest physiology and biochemistry, and master of science degrees in food quality and commodity utilisation. Research on postharvest physiology of tropical root crops, fruits, vegetables, ornamentals and fresh-cut commodities are conducted for the award of masters and doctoral degrees. The Department of Food Production is also involved in several outreach projects and training courses for produce managers, food handlers, packinghouse operators, food inspectors, marketing boards, school nutrition companies, airline caterers and cruise ship and hotel produce managers, via the outreach Business Development Unit (BDU). The Department of Food Production has linkages with international organisations such as FAO and CTA. International conferences are convened, such as the Third International Conference on Postharvest and Quality Management of Horticultural Products of Tropical Origin held in July 2013 under the aegis of the International Society for Horticultural Science (ISHS). The Department of Mechanical Engineering

conducts research and training in postharvest engineering inputs, the Department of Chemical Engineering conducts research and training in food technology, food microbiology and product development. The Department of Agricultural Engineering focuses on designs and building of mechanical harvesters and other equipment for the food industry. Several short courses and projects are conducted, together with other national and regional institutes mentioned above. Several statutory bodies have laboratory facilities for conducting postharvest and food related activities. There is the Bureau of Standards for quality management systems, Food and Drugs Administration for pesticides residues and food recall, and NAMDEVCO for establishment of grades and standards as well as product development. Table 5 is a summary of the various postharvest and food processing institutes and their functions.

Table 5. Postharvest training, research and outreach institutions in Trinidad and Tobago

Institutions	Functions
1. University of the West Indies	
a. Department of Food Production	Postharvest research on tropical commodities linked to masters and doctoral degrees, short courses, workshops, post-production investigations on value-added food products, food quality and product development profiles, production of fact sheets, conference proceedings and journal articles for outreach.
b. Department of Mechanical Engineering	Controlled and modified atmosphere storage, engineering inputs in postharvest technology, solar and foam drying techniques for value-added food products and refrigeration systems.
c. Department of Agricultural Engineering	Design and layout of packinghouse, hot water treatment facilities, harvesting equipment, and processing equipment.
d. Department of Chemical Engineering	Postgraduate degree in food technology with courses in food quality, food microbiology, and packaging. Food related projects in food processing and preservation techniques.
2.University of Trinidad and Tobago	Research of food quality assurance, food safety and food security, food preservation methods, short courses and international conferences in postproduction technology.
3. IICA, CARDI and CARIRI	Postharvest, food safety and food security projects. Conduct surveys, field and laboratory trials, network with local and regional food policies for postharvest loss reduction, and establish working groups for innovative loss reduction best practices and, food incubators for project expansion and implementation. Implement workshops, seminars, conferences, outreach communication such as conference proceedings,

4. Ministry of Food Production (CES), NAMDEVCO, Bureau of Standards Food and Drugs Laboratory, TABA	bulletins and magazines. Pre-harvest factors impacting on postharvest technology, postharvest field and laboratory trials, establishment of grades and standards, implementation of certified farms for target markets, marketing incentives such as use of packinghouse facilities, accessing raw materials, workshops, monitoring of trial shipments, projects to secure innovative products for local and foreign markets, pesticide and heavy metal analysis, food recall and produce inspection methods.

Access to postharvest information

Despite the resources available for postharvest research and training identified in Table 5, major hindrances affecting the flow of information still exist. Table 6 confirms this since the main source and access to postharvest information were initiated by the producers themselves via trial and error, followed by advice from garden shop owners and from other producers and traders. Extension services within the Ministry of Food Production have been production rather than postproduction oriented. Extension officers have not been trained in postharvest technology diagnostics. Extension services have traditionally focussed on farmers but postharvest technology has a broader scope, including produce managers and inspectors who are required to make decisions on the quality changes of perishable produce that are displayed for sale at all market outlets outlined in this study.

Table 5. Sources and access of postharvest information and innovations among pumpkins producers.

Access to innovations	Respondents (%) in farmer's market*
Extension officer	2.9
Overseas training	1.5
Company training	0.0
Radio/TV media	0.0
Press	3.5
Agricultural associations	5.0
Garden shop	70.5
Trial and error	100.0
Research institutes	16.5
Courses at Farmer's Training Centre	12.7
Fellow producers and traders	66.0

*Percentages sum to more than 100% due to multiple answers given by respondents.

Recommendations to strengthen the postharvest knowledge system in Trinidad and Tobago

The Government of Trinidad and Tobago is committed to reducing postharvest losses, indicated in the National Food Production Plan 2012-2015, as they seek to focus on national food security goals and regional and extra-regional trading practices. In recognition of this they have started to build four

additional packinghouses in key agricultural locations in Trinidad in addition to one at Piarco. A packinghouse is also being built in Tobago. These packinghouses will not only be equipped with automatic packing lines but will also have facilities for development of value-added products. There will also be an expansion of a team of field officers with postharvest training to monitor farms in order to be consistent with Good Agricultural Practices (GAPS) protocols. These farms would be classified as certified farms.

Strategies to improve postharvest knowledge of pumpkin producers and marketers

i. Have regular demonstrations on pumpkin farms to show harvesting at the correct stage of maturity, method of detachment in relation to peduncle length, proper loading procedures to minimise physical injuries, and proper stacking for transport to the packinghouse for curing treatments.

ii. Raise awareness about how to cure pumpkins and the cost benefit ratio in relation to marketable quality as well as eating quality.

iii. Formulate and monitor standards for marketable pumpkins. Empowering farmers about the advantages of selling cured and graded pumpkins.

iv. Demonstrate improved packaging methods of pumpkins to withstand transport, storage and display. Raise awareness of the inherent dangers of using polypropylene feed bags. Design thicker, durable ventilated plastic containers that are stackable for individual pumpkins.

v. Provide training and research to devise value-added food and non-food products from pumpkin (Figure 2).

vi. Assist in marketing of pumpkins to regional and extra regional outlets by engaging in marketing studies and incentives for export marketing.

vii. Provide incentives for graded, clean pumpkins and expand fresh-cut technology to include pumpkin chunks, slices, and grated pumpkin for ready to cook options.

viii. Integrate utilisation of fresh and minimally-processed pumpkin by creating a greater awareness of the medicinal uses and the antioxidant capabilities due to high carotenoid content to caterers in the School Nutrition Programme, restaurants, hotels and hospitals.

ix. Provide information for school children and adults to understand the nutritional benefits of eating fresh and processed pumpkin products.

x. Introduce improved, low cost technology for food processing methods such as foam drying, solar drying and indirect solar drying to make pumpkin flour and other value added products.

xi. Development of market information systems, improving access to market information using low costs systems, formation of farmers and exporters associations.

xii. Develop extension and training strategies for outreach and promotion of appropriate postharvest technologies (holistic approaches, integrated postharvest management systems).

In order to avoid duplication among the various institutions shown in Table 5, a Postharvest Advisory and Management Board, incorporating experts from these institutions, is necessary. Accordingly, to further strengthen the outreach capacity, Ganpat's (2013) postharvest extension model should be adopted (Figure 3).

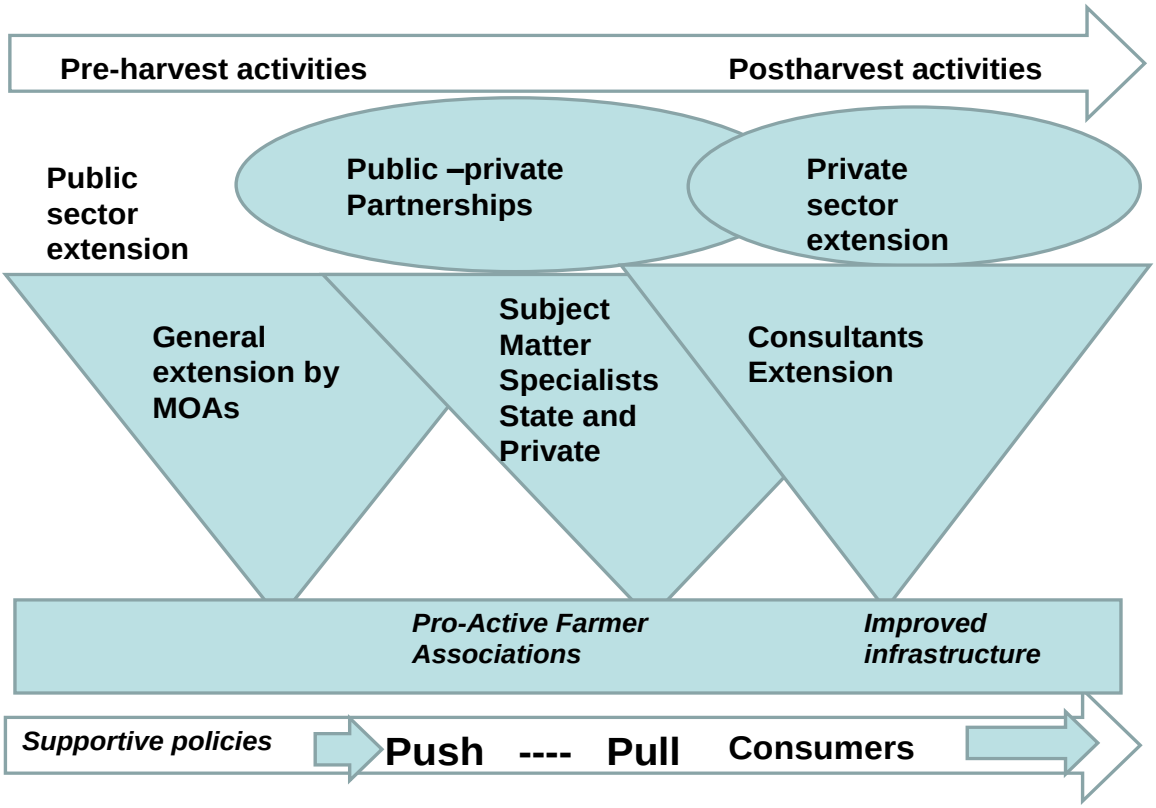

Figure 3. Postharvest extension model (Ganpat, 2013)

The Ganpat (2013) model seeks to promote postharvest extension for categories of clients based on the technical expertise available. A system of mentoring and training to build extension staff capabilities is incorporated in the model for sustainability. The model indicates that teaching activities based on the principles of experimental learning must have a stronger focus; discovery based activities in which learners are involved in action and reflection can bring about higher quality and more sustained learning. Such an approach, along traditional lectures and demonstrations is proposed. For this model of extension to be successful, it must be supported with increased training at all levels; including tertiary level training for the development of postharvest subject matter specialists and diploma level training to provide skilled technicians.

Follow-up action following data from survey:

The following initiatives were conducted based on the findings of this survey:

i. One-day postharvest training workshop for pumpkin farmers and traders certified by NAMDEVCO, highlighting the magnitude of losses and stages in the pumpkin postharvest handling system where corrective actions are required. Samples of value-added products were displayed.

ii. One-day training of trainers workshop, which included extension officers from the Ministry of Food Production and field officers from NAMDEVCO, on postharvest quality management of pumpkins and squash followed by a discussion on the proposed postharvest extension model.

iii. Workshop for pumpkin farmers, research officers and food service officers, and caterers from the School Nutrition Programme to demonstrate how pumpkin muffins, bread, and salads could be utilised for school meals. Sensory evaluations of these products was carried out.

The following areas were identified by participants for further strengthening of the postharvest knowledge system:

i. Ministry of Food Production must formally include postharvest technology in the scope of work for extension, and annual programmes of work should reflect this.

ii. A set of formal in-service training programmes at the national and regional level should be developed and executed to upgrade the technical capacities of extension staff in the area of postharvest activities. This could also promote the development of a cadre of consultants who are well trained and able to operate either individually or as small groups of consultants for hire.

iii. Some specialised courses should also be developed to keep subject matter specialists up to date with the latest technologies. Universities, both regional and national, should take the lead in this training intervention.

iv. Collaboration with the shipping industry to assist exporters with container loading procedures, temperature and humidity control, management of ethylene during transit, sanitation protocols, produce compatibility, selection of appropriate packaging materials and stacking methods.

v. Development of training manuals and practical training workshops to enhance expertise in producing value-added products. Need for farmers to network with bakery and beverage industries as potential new markets.

vi. In the short-term, an inclusive advisory board should be established, comprising of food producers, middlemen, government officials, representatives of farmers' associations and experts to provide extension and education for postharvest technology. A coordinated effort would ensure quality of service and avoid duplication of efforts in a pluralistic extension provision system. The board can also lobby planners for the inclusion of postharvest education

material to be included in the curricula of both primary and secondary schools as a component comparable to that of production. It should also lobby for an increased presence in the curricula of tertiary level institutions.

References

De Souza, G., Wickham, L.D. and Mohammed, M. 2011. Physicochemical and sensory quality attributes of a low glycemic pumpkin ice cream. MSc. Thesis, University of the West Indies.

Ganpat, W. 2013. A model for postharvest extension in the Caribbean. Presented at the 3rd International Conference on Postharvest and Quality Management of Tropical Products of Tropical Origin, July 1-5 2013, Hyatt Hotel, Trinidad.

Harrynanan, L. and Sankat, C. 2013. Product quality attributes of foam-mat dried pumpkin powder. Presented at the 3rd International Conference on Postharvest and Quality Management of Tropical Products of Tropical Origin, July 1-5 2013, Hyatt Hotel, Trinidad.

Kader, A.A. 2005. Increasing food availability by reducing postharvest losses of fresh produce. Proceedings of the 5th International Postharvest Symposium, Acta Horticulturae, 682, 2169-2175.

Kitinoja, L. and Al Hassan, H.Y. 2012. Identification of appropriate postharvest technologies for small scale horticultural farmers and marketers in Sub-Saharan Africa and South Asia-Part 1: Postharvest losses and quality assessments. Acta Horticulturae, 934, 31-40.

Published by CTA, http://knowledge.cta.int/
Edited by J.A. Francis, CTA

Citation: CTA 2014. http://knowledge.cta.int/, "author" accessed on "date."