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The Root and Tuber Industry of Barbados

Current Status and Suggestions for the Future

Jacklyn Broomes

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The Root and Tuber Industry of Barbados: Current Status and Suggestions for the Future

Lessons for Barbados from the World Congress on Root and Tuber Crops, China, 18–22 January 2016

Jacklyn Broomes

Barbados Agricultural Management Co. Ltd

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About the author

Jacklyn Broomes is an agronomist for non-sugar crops at the Barbados Agricultural Management Company Ltd (BAMC). She received her B.Sc. in General Agriculture and M.Phil. in Crop Science from the University of the West Indies, St. Augustine Campus, Trinidad and Tobago in 2007 and 2014 respectively. Prior to her employment at BAMC, Ms. Broomes was actively involved in research towards the development of new and improved value-added products from fresh tropical commodities. At present, her research is largely geared toward increasing the yields of select root and tuber commodities via improved agronomic practices, to improve the food and nutrition security of Barbados and other small island developing states.

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Please address comments on this Working Paper to Judith A. Francis, Senior Programme Coordinator, Science and Technology Policy at CTA.

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List of acronyms

APP	Intra-ACP Agricultural Policy Programme
BADMC	Barbados Agricultural Development and Marketing Cooperation
BAMC	Barbados Agricultural Management Company Ltd
BAS	Barbados Agricultural Society
BIDC	Barbados Investment and Development Cooperation
BMA	Barbados Manufacturing Association
CABA	Caribbean AgriBusiness Association
CAFAN	Caribbean Farmers Network
CARICOM	Caribbean Community and Common Market
CARDI	Caribbean Agricultural Research and Development Institute
CAVA	Cassava Adding Value for Africa
CBSD	Cassava Brown Streak Disease
CFSC	Caribbean Financial Services Corporation
CIAT	International Center for Tropical Agriculture
CIP	International Potato Centre
CTA	Technical Centre for Agricultural and Rural Cooperation
FAO	Food and Agriculture Organization
IICA	Inter-American Institute for Cooperation on Agriculture
MARD	Ministry of Agriculture and Rural Development
OFSP	Orange-Flesh Sweet Potato
SASHA	Sweet Potato Action for Security and Health in Africa
UWI	University of the West Indies
WCRTC	World Congress on Root and Tuber Crops

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Executive summary

Approximately 432 km^2 in size and with an estimated population of 284,644 (2013), Barbados is one of the small island developing states (SIDS) of the Caribbean. Characteristics of Barbados as a SIDS include a highly open economy and reliance on imports; dominance of the monocrop sugarcane (*Saccharum spp.)*; high costs of production; restricted consumption, technical and financial capacities; vulnerability to natural disasters; limited natural resources and inadequate market size. These factors have had distinct negative effects on the production, utilisation and competitiveness of locally produced agricultural commodities such as root and tuber crops (RTCs) (Rawlins, 2003).

The most highly produced and utilised RTCs in Barbados are sweet potatoes, yams and cassava. These staple crops are mainly consumed fresh and represent a major source of carbohydrates in the Barbadian diet. Locally grown varieties of sweet potato are therefore in high demand. However, except for the period between 1995 and 1997 when there was a sudden increase in sweet potatoes export to the UK, domestic production of RTCs has generally been on the decline. The factors contributing to the declining production, sale and utilisation of RTCs in Barbados will be discussed in this report.

This report also examines the RTC development challenges that are faced by the Barbados Agricultural Management Co. Ltd (BAMC) and Barbados on the whole, in relation to RTC production, sale, marketing, research, post-production and post-harvest technologies. Whilst highlighting the programmes currently in place to address these limitations, suggestions for further work in Barbados are made, based on the observations of the first World Congress on Root and Tuber Crops (WCRTC) held in China.

> *"Essentially, all models are wrong, but some are useful."* (Box and Draper, 1987)

It is against the aforementioned quote that this report has been written. Essentially, this quote dictates that every model[1]* is wrong because it is an over-simplification of reality. However, some models can still be of use as simplifications of reality are helpful in allowing one to better understand, explain and resolve a problem or challenge. As such, any interventions being recommended as solutions to the challenges of the Barbadian RTC industry, based on the experiences of others, must take into consideration the unique challenges of the Barbadian public and private agricultural entities.

1 model - simplified version of a concept, phenomenon, relationship, structure, system, or an aspect of the real world (McCullagh, 2002)

Introduction

Barbados: A brief overview of the agricultural sector

Within the Caribbean, there are many small island developing states (SIDS) that are vulnerable, primarily due to the dominance of single crops and the resulting high level of dependence on the importation of goods (FAO, 2007). In many of these SIDS, the monocrop system is no longer economically viable due to the loss of preferential trade agreements and markets at export.

Barbados, with a land area of approximately 432 km^2, is one such island possessing many of the characteristic properties of SIDSs, including small land area, costly production systems, limited market size and the dominance of the single crop of sugarcane (Rawlins, 2003). However, the agricultural sector of Barbados is still perceived as one of great economic and social importance, with a significant role in ensuring that a satisfactory balance is achieved in relation to food imports and local food production and enhancing foreign exchange earnings. This sector continues to compete for scarce resources such as land, labour (limited availability, aging) and capital in an environment of increasing economic difficulties.

Water is also a very scarce resource in Barbados which, with an estimated 300 m^3 of water per citizen, ranks among the world's 15 most water-scarce countries. The developmental challenges to the food and agriculture systems in Barbados are influenced heavily by domestic and external trade and economic factors (FAO, 2006).

From the early 1990's and onwards in Barbados, there has been a general decline in sugarcane production, reflected in the less than 300, 000 t of sugarcane produced in 2013 (Figure 1).

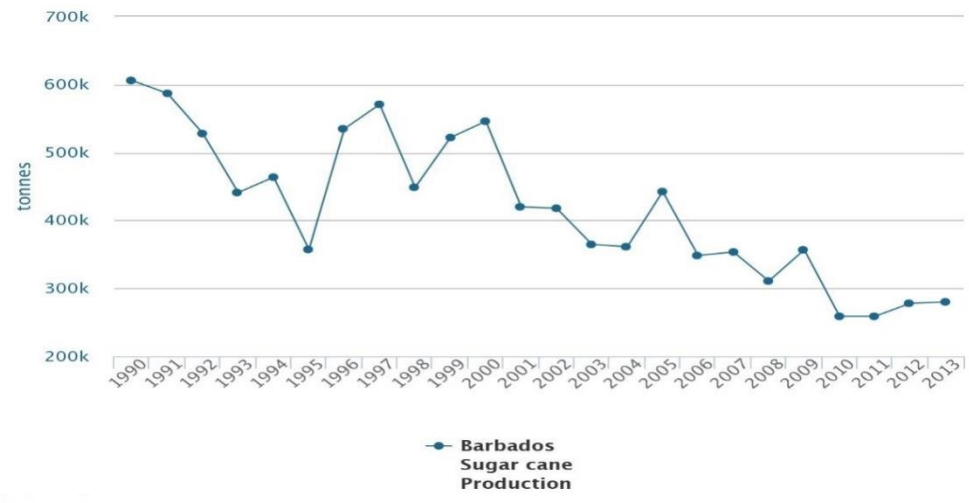

Figure 1: Barbados' sugarcane production for 1990 to 2013 ('000 t)

Source: FAOSTAT (2015)

Decline in sugarcane production has occurred to the extent that the sustainability of this sector is now threatened. Reliance on sugarcane has led to higher levels of food and nutrition insecurity in Barbados which is associated with the decreased agro-production and productivity, declines in agricultural revenues, and increased food import bills (Figure 2). Food related diseases such as obesity, hypertension and vitamin deficiencies are also on the rise due to poor nutrition (FAO, 2007).

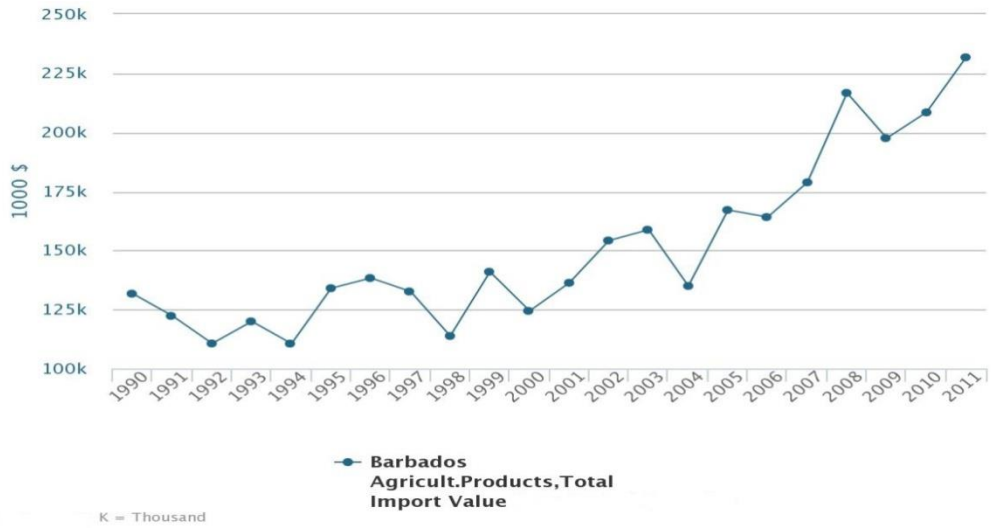

Figure 2: Barbados' food import bill (US$000,000) for 1990 to 2011

Source: FAOSTAT (2015)

It was recognised that diversification of the Barbados agricultural industry was necessary since reliance on sugar cane alone was unfeasible. A Crop Diversification Unit was established by the Barbados Sugar Producers Association in the 1960's, and over 50 crops and livestock production systems were evaluated for their suitability as a substitute for sugarcane. However, it was soon concluded that no particular crop had the characteristics necessary to replace sugar cane both from the point of view of its beneficial effect on the local soils, market or potential revenue (MARD, 1996). It was therefore recognised that in order to improve the food and nutrition security of Barbados, a supplemental crop and/or crops must be identified to support sugarcane production in Barbados. The identified crop(s) should be easily cultivated in tandem with sugarcane and must be versatile in agronomy, post-harvest processing, post-production storage, marketing and most importantly, economically viable (CARDI, 2010). RTCs such as sweet potato and cassava, were identified as ideal crops for development and expansion in Barbados due to their potential to contribute to the local food and nutrition security (CAFAN, 2010).

The importance of RTCs to Barbados' food and nutrition security

The RTCs of sweet potato (*Ipomoea batatas*), cassava (*Manihot esculenta*) and yam (*Discorea alata*) have been identified as crops with high potential to contribute to Barbados' sustained food and nutrition security, mainly through increased production and value-added

development. The functional aspect of the aforementioned crops is their high nutritive and starch content which contributes to a wide range of food use and processing functions. The following points are some of the main arguments for the further development and expansion of the RTC industry in Barbados:

- Staple crop/carbohydrate source: sweet potato, cassava and yam are rich sources of energy to the diet through their carbohydrate content. These crops are efficient in their production of food energy per calorie of labour input.
- Sweet potato is particularly rich in vitamins and minerals; the orange-flesh types carry beta carotenes which can be used in the fight against Vitamin A deficiency.
- Root crops typically have a lower glycaemic index and as such, are described as highly 'satiating' foods, which means that one feels fuller longer and so, would be less likely to over-indulge.
- These commodities are already popular and heavily consumed, especially among older generations (traditional consumer base) and so there is the plus side of familiarity among Barbadians. Local media campaigns and health promotions by different entities have increased awareness among younger citizens and so, demand for these RTCs is on the increase.
- Shelf-life: yam and cured sweet potato have a longer shelf-life which ensures that these commodities remain available over a longer period of time.
- Value-added products: the high starch content of RTCs enables them to be excellent candidates for processing. A vibrant agro-processing industry adds value to local agriculture while simultaneously stimulating production. This can contribute to local job creation at the production, processing and marketing levels of this sector (IICA, 2013).
- Revenue from cash sales: the sale of RTCs locally is an important source of income for small and medium-sized farmers in Barbados. However, income is largely dependent upon market forces with large disparities in income being recorded according to the supply-demand status of the crop at a particular time.
- Export potential/reduction in imports: According to the Food and Agriculture Organization (FAO), alternative flours from cassava and sweet potato have the potential to replace a percentage of wheaten flour in baked goods, animal feeds and other products in Caribbean Community and Common Market (CARICOM) countries including Barbados, thereby contributing to a reduction of the Food Import Bill by approximately 5% (FAO, 2014).

Objectives

a) To review and research the status of RTC development in Barbados, considering the advances that China and other countries have made based on the WCRTC.
b) To identify the gaps and opportunities for value-chain development and improving food and nutrition security.

The current status of RTCs: Production, sales, marketing, research, training, post-production and post-harvest technologies in Barbados

Sweet potato, cassava and yam have become increasingly important in the current agricultural development plans of Barbados with respect to food and nutrition security. However, there are several constraints to production and consumption locally, as seen in Table 1.

Table 1: Current status of factors influencing the RTC industry in Barbados.

Parameter	**Current status**
Production	Poor, inconsistent yields; inconsistent quality of fresh commodity; poor agronomic practices; limited access to clean planting material; slow multiplication techniques; unavailability of new and improved varieties with desired characteristics e.g., drought and pest resistance, high yielding; inability to access water, either through inconsistent supply or lack of irrigation; aging workforce; severe praedial larceny.
Sales	Fluctuating costs according to supply and demand; no set market price; inconsistent supply to local market (Appendix 1); local farmers cannot meet local demand, hence very limited exportation; contract work limited to 'middlemen' such as wholesalers who supply supermarkets, hotels, restaurants, etc.
Marketing	'GEL in Bim' promotion by Ministry of Agriculture and Rural Development (MARD) (grow well, eat well, live well in Barbados) - recently established in 2015 and encourages consumption of local goods; limited marketing otherwise.
Policy	Inadequate legislative framework for addressing rising food imports, praedial larceny and the transfer of land out of agriculture.
Research	Ongoing at MARD, Caribbean Agricultural Research and Development Institute (CARDI), University of the West Indies (UWI), BAMC, Barbados Agricultural Development and Marketing Cooperation (BADMC); focus on sweet potato and cassava - variety and yield assessment, pest and disease management, soil fertility, composite flours.
Training	Ongoing by MARD, Inter-American Institute for Cooperation on Agriculture (IICA), FAO; focus on product development, small business and youth in agriculture.
Post-production	Very limited; crops consumed fresh; high cassava perishability; damage to fresh commodity during transport and storage.
Post-harvest technologies	Limited processing - mainly into chips, flours and breakfast cereals; limitations to the development of the RTC value-chain have been identified as pest management; propagation protocols; changing varietal preferences for the export markets; post harvest management; plant nutrition and the development, presentation and safety of value-added products (IICA, 2013).

In response to these challenges, various local and regional organisations within Barbados have embarked on programmes specifically geared toward increasing the production, processing, marketing and consumption of RTCs (and other agricultural commodities) throughout Barbados. Table 2 summarises the various activities being undertaken in Barbados.

Table 2: Entities contributing to RTC development in Barbados.

Entity	Current programmes	Description
BADMC	Food Promotion Unit	Researches, develops and adds value to sweet potato and cassava through processing (mainly into flour) with the aim to commercialise these products under the 'Carmeta' brand; pancake, cookie and sorbet base mixes have also been developed.
	Land for the Landless Programme	Government initiative where arable land, both private and public, is made available through lease or license arrangements to bonafide farmers who otherwise would not be able to access lands (not limited to RTCs).
BAMC	Non-Sugar Production Units	Largest private farmer in Barbados; oversees sugar industry; charged with the large-scale production of cassava, sweet potato and yam (eddoes to a much lesser extent); primarily used as rotation crop with sugarcane and as a cash crop for revenue in shorter term.
	Non-Sugar Research Programme	Conducts agronomic research aimed at the improvement of the productivity of the afore-mentioned RTCs, mainly varietal assessments, fertiliser trials, multiplication and dissemination of planting material.
Barbados Agricultural Society (BAS)	Local Farmers' Society	An agricultural organisation established in 1845 by an Act of Parliament in Barbados; seeks to represent the interests of the agricultural sector in all relevant forums. The Society is the secretariat for seven commodity groups representing over 500 farmers with women comprising 30% of the total; no commodity group dedicated to RTCs.
	AGROFEST	Large annual agricultural festival; demonstrates the symbiotic relationship between agriculture and the community; demonstrates agricultural career opportunities for young people; allows the information dissemination and sale of RTCs to a large local audience, however they are not the primary focus.

Entity	Current programmes	Description
Barbados Investment and Development Cooperation (BIDC)	Barbados Investment Fund	Close-ended equity fund administered by the Caribbean Financial Services Corporation (CFSC); provides equity financing for small and medium sized businesses operating in Barbados and engaged in agro-industry; can be used toward equipment and real estate.
	Agricultural Development Fund	Provides loan financing to help local farmers become more competitive; also provides incentives, technical assistance and grants to the sector.
Barbados Manufacturing Association (BMA)	Technical Trials in Conjunction with the BADMC	Determining the percentage of cassava flour in composite flour to produce a locally accepted cassava bread, so as to increase the production and utilisation of cassava.
CARDI	APP - Applied Agricultural Production and Processing Research and Technologies	Has engaged consultancies under Component 2 to review the requirements for movement of plant germplasm across the region with an emphasis on RTCs; has expanded its efforts to identify appropriate varieties, both locally and imported as well as to upgrade local germplasm multiplication capacity; agronomic and varietal trials geared toward the identification of climate-adapted varieties of sweet potato and cassava.
FAO	Reduction of Post Harvest losses along Food Chain in CARICOM Sub-region	Using cassava (and other specific crops) as a tool to address food and nutrition insecurity in Barbados and the Caribbean region in order to improve the provision of goods and services from local agriculture, and to encourage more efficient agricultural and food systems; established 'Barbados Cassava Task Force'.
	Processing and Market Development of Cassava; Cassava Working Group	
IICA	APP - Agricultural Enterprise Development through Market Linkages	Training was held specifically for members of the Caribbean Farmers Network (CAFAN) and Caribbean AgriBusiness Association (CABA), under APP Component 3 in order to facilitate improved governance frameworks and organisational capacity of national producer groups and regional producer networks of RTCs; focus on value-chain development.
	I.M.P.A.C.T Project	In collaboration with St. George Farmers' Cooperative under the 'Competency Based Training Fund' – addresses the skills gap in local agriculture in crop farming and agro-processing.
MARD	Barbados Youth Agri-preneurship Programme;	Targets youth between the ages of 16 and 35 who have completed some level of training in agriculture and/or have the intention of developing or expanding a sustainable agri-business.

Entity	Current programmes	Description
	Central Agronomic Research Station	Specific to sweet potato and cassava; there is germplasm maintenance, variety assessment, dissemination of planting material to farmers and the importation and evaluation of new beta carotene varieties; very small eddoes collection; annual survey of sweet potato and cassava production across Barbados.
Private farmers	Large-Scale Root Crop Production	Cultivation of root crops (mainly cassava, sweet potatoes and yam) as income earners; root crops planted in rotation with sugarcane which is the main crop; local supply cannot meet local demand; periods of glut and scarcity.
UWI, Cave Hill Campus	One PhD Candidate – Biology	The effect of organic mulches on the yields of sweet potato.
	One PhD Candidate – Ecology	The characterisation of sweet potato cultivars grown in Barbados.
	One MPhil Candidate – Biology	Assessment of factors affecting the prevalence of Cassava Elongation Disease.

Advances in the RTC industries of China and other countries based on good practice: Lessons learned at the WCRTC

The WCRTC afforded participants a first-hand view of developments around the world relating to RTCs specifically. While the conference mainly focused on cassava and sweet potato, limited work was also presented in yam and Irish potatoes (*Solanum tuberosum*). Table 3 shows the advances in the RTC industries around the world as observed during the oral and poster presentations and field trips of the WCRTC, 2016. This Table is supplemented by evidence in the Appendix 3.

Table 3: Advances in RTC industries of China and other countries based on good practice.

Parameter	Country	Advances observed
Research	China	• 'Integrated Breeding Approach' to cassava genetic improvement: provides plant breeders with modern breeding tools and management techniques to increase agricultural productivity and breeding efficiency • Use of molecular markers to identify genetic variation among sweet potato varieties and those with high beta carotene content • Use of various planting angles to obtain higher cassava root yields • Use of wax and films to coat cassava cuttings to ensure longevity before planting

Parameter	Country	Advances observed
		• Farmer participatory research where research is undertaken on farmer plots so that farmers have a vested interest at every stage.
	Nigeria	• Seed yam production through 'aeroponics'; soil-less medium where tubers can be produced year-round; technology can be used on sweet potato • Development of 'yam cropping systems' in order to improve productivity where effect of spacing, fertilisers and intercropping on yield were investigated • 'Precision Agriculture': input application only where needed.
	Sub-Saharan Africa	• Biofortified Orange-Flesh Sweet Potato (OFSP): identification of improved varieties from the International Potato Centre (CIP); multiplication of clean planting material via shade houses; demo plots; value-chain improvement through development of indigenous products and processes; use of purees as opposed to dried material in product development as more beta carotene is preserved.
	Thailand	• Use of 'Minisett Technology' to improve quality and rate of seed yam production.
	Vietnam	• Assessment of imported cassava varieties from the International Centre for Tropical Agriculture (CIAT) for evaluation under local conditions • 'Cassava Disease Free Seedling System' via tissue culture and disease indexing; '10T for Cassava Production' (Appendix 2); production moved from 8 t/ha in 2000 to 19 t/ha in 2015.
Policy	Bangladesh	• Establishment of 'Commodity Research Teams' so that direct focus is placed on the crop of interest.
	China	• 'Chinese Cassava Agro-Technology Research System' by Ministry of Agriculture: focus on germplasm enhancement for productivity.
	Nigeria	• 'Cassava Transformation Agenda': aimed at producing a new generation of cassava farmers, oriented towards commercial production and farming as a business, and to link farmers to reliable demand from processors or a guaranteed minimum price scheme of the government • Implementation of government policies that incentivise use of cassava for import substitutions and create input markets by working closely with the Ministries of Agriculture, Finance, Commerce and the National Assembly.
	Sub-Saharan Africa	• To ensure consistent supply to processors, guaranteed price of 5–10% above market price to suppliers.
	Vietnam	• Vietnam Cassava Society for commodity centered interventions.

Parameter	Country	Advances observed
Technology	Brazil	• Mechanisation of cassava agronomic operations for yield productivity; applied at planting, weeding, application of inputs, harvesting, transport and storage.
	China	• 'Chinese Technological Systems': which seek to improve industrialisation and technology transfer in cassava industry • Small-scale/semi-mechanisation of cassava agronomic operations; handheld tools; small machinery (Appendix 2) • 'AgriTT programme': facilitates the sharing of successful experiences in agricultural development from China with developing countries in order to improve agricultural productivity and food security; emphasises technology transfer from China to developing country.
	Nigeria	• Machinery imported from Brazil; mechanisation of all agronomic operations for yield productivity • Improved 'Gari' production: improved machinery and techniques; demonstration of good hygiene practices.
	Sub-Saharan Africa	• http://www.sweetpotatoknowledge.org – information portal; useful for information dissemination, technology transfer and public education.
Private sector engagement	China	• Privatisation of starch industry for modern processing; increased starch reclamation through improved technologies; emphasis on costs • New processing lines for cassava flour; equipment scaled to production • Cassava-based ethanol production though large-scale investments in the country's production sector.
	Peru	• '*Papa Andina* Initiative': members of the value-chain (farmers, processors and consumers) were identified and various innovative potato-cooking recipes explored, in order to encourage utilisation among the local population.
Industry–research linkages	China	• Training of Trainers: the cassava industry's contribution to small-holder training • Multilateral cooperation where multiple agencies and countries seek to address the same issue e.g., cassava brown streak disease (CBSD).
	Sub-Saharan Africa	• OFSP: sensitisation programmes aimed at creating awareness of health benefits of OFSP; clinics especially targeted; OFSP marketed as 'superfood' to local consumers • CIP's Sweet Potato Action for Security and Health in Africa (SASHA) Project: development and release of 'Golden Power Biscuit' aimed at addressing Vitamin A deficiency among populace • 'Cassava: Adding Value for Africa (CAVA)': programme aimed at using cassava value-chains for an improvement in the incomes of small-holders in Africa

Parameter	Country	Advances observed
		• 'Climate Smart Cassava Systems': identification of cassava varieties able to withstand changes in climate e.g., drought to ensure production year-round.
	Thailand	• Development of value-chains: cassava chips, pellets and starch from for industry; most exported to China for further processing.

Bridging the gaps: Improving Barbados' RTC industry through the adaptation of new and improved technologies

Barbados cannot afford to be lax in its approach to the advancement of its RTC industry as this sector has much to contribute to the agricultural development and food and nutrition security of Barbados. The upgrading strategies of its RTC programme should be based on the limitations identified in Table 1 and supported by the advances in other countries as seen in Table 3. These suggested strategies are shown in Table 4 below:

Table 4: Suggested upgrading strategies for the advancement of the RTC industry in Barbados.

Parameter	Suggested strategies for Barbados
Research	Environmental * genotype interaction effect on yields to achieve accurate forecasting.
	Germplasm evaluation and characterisation to determine available genetic material.
	The introduction of farmer participatory research where research is established on farmer plots, to encourage the active involvement and contribution of farmers.
Policy	Sustainable and consistent market supply of commodities through contracts for supply of produce; this hinges on guaranteed quantity and price as well as competitive prices.
	Establishment of RTC commodity boards or research teams to ensure commodity-centred interventions are focussed on a needs-basis.
Technology	Improved agronomic practices for yield optimisation.
	Access to new and improved germplasm which may be imported from agencies such as CIP and CIAT.
	Use of biotechnology for the production of clean planting material.
	Increased use of small and large-scale mechanisation to reduce 'labour load', reduce costs, ensure timeliness of operations and improve productivity.

	In a technology savvy country such as Barbados, improved marketing is necessary. Information technology such as websites, Facebook and Instagram should be used for information dissemination. Sensitisation programmes to increase awareness of the benefits and amenability of RTC production, should be circulated to the local population. The transfer of technology from the originator to a secondary user is essential so that new information and technologies relating to RTC development, do not remain stagnant at their origin such as MARD, UWI, etc.
Private sector engagement	Standardised quality of fresh produce and value-added products; improved marketing.
Industry-research linkages	Capacity building through the ongoing training at all levels of the sector, from production to processors and even of trainers so that all persons are kept up-to-date with most recent technologies for the development of RTCs.
	Value-chain development: this is key to identifying and unlocking any process gridlocks in order to achieve maximum process effectiveness; it is also essential for the creation of value that exceeds the cost of providing the product or service and generates a profit.

Summary

RTCs, specifically sweet potato, cassava and yam, are important to the development of Barbadian agriculture as well as to its food and nutrition security. They form an essential part of the local diet as a source of carbohydrates and energy, and contribute to household income through cash/direct sales and sales from food and non-food value-added products, such as feeds and starches.

However, there are several constraints to the development of this industry in Barbados, which include but are not limited to: poor agronomic practices, limited germplasm, poor information dissemination and technology transfer among partners, lack in investment, inconsistent yields, fluctuating costs and under-developed value-chains among other factors. It is therefore concluded that an intervention is necessary to resuscitate this vital industry in Barbados.

Barbados stands to learn from the experiences of others. The 2016 WCRTC aptly demonstrated many successful techniques, technologies, programmes and initiatives that may be adapted in Barbados from around the world, in order to revitalise our precious RTC industry.

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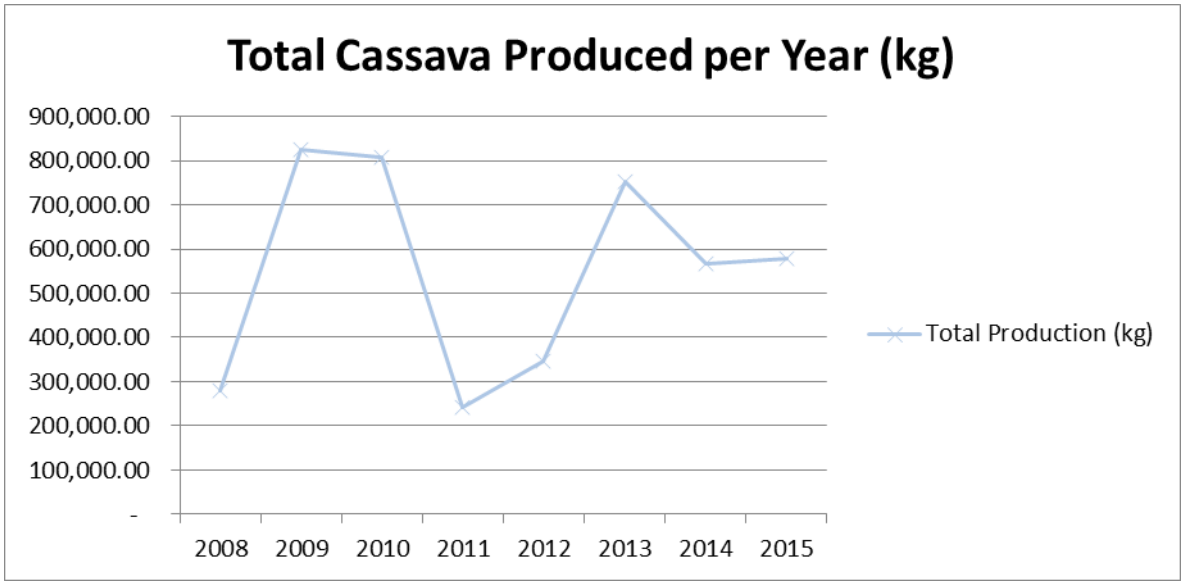
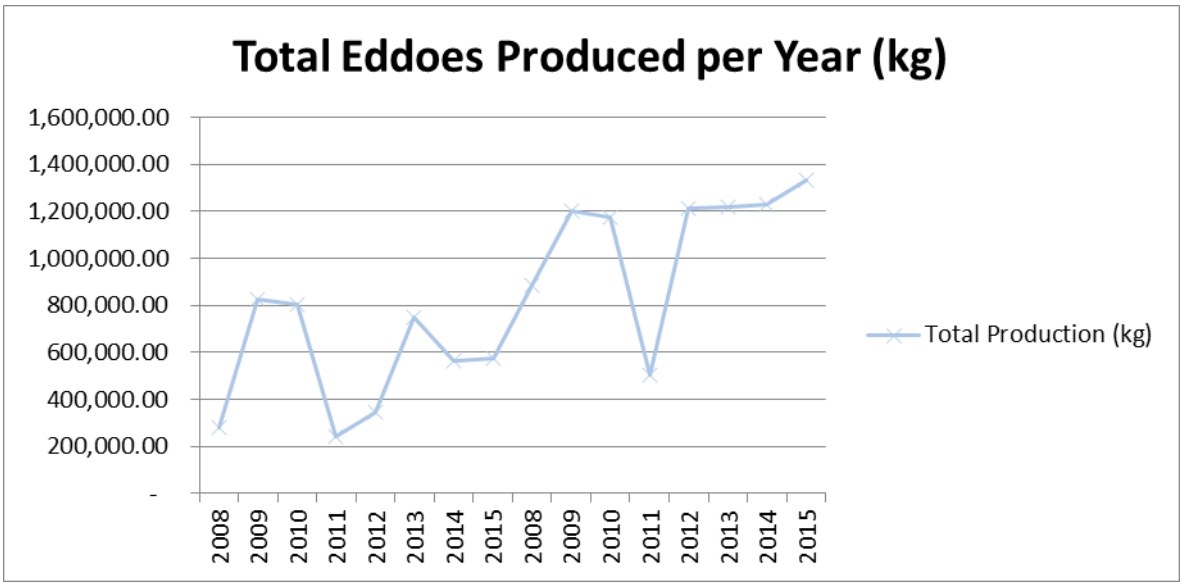
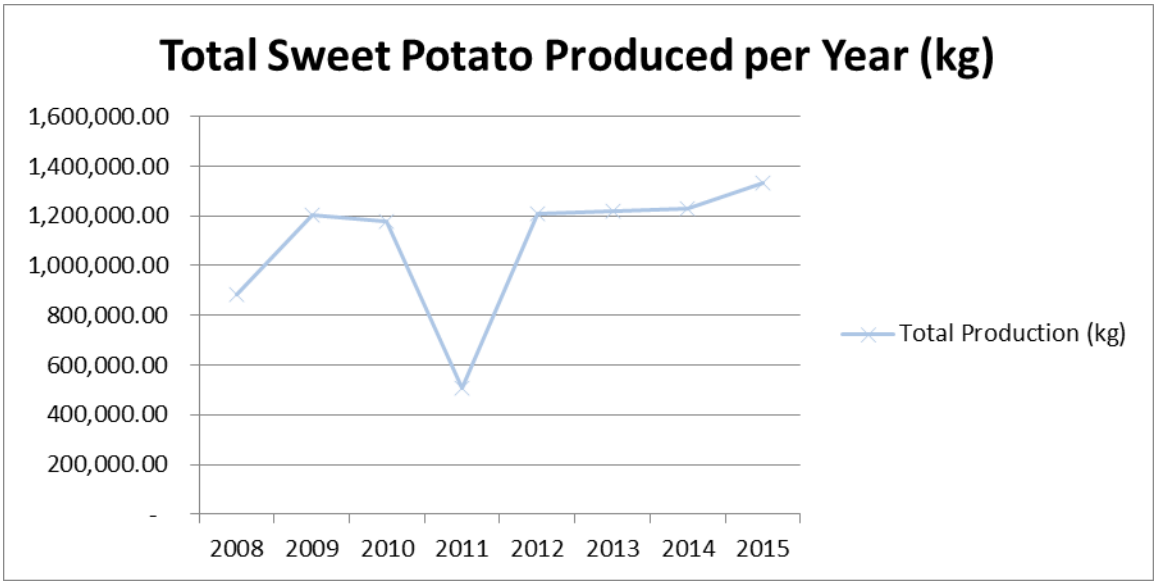
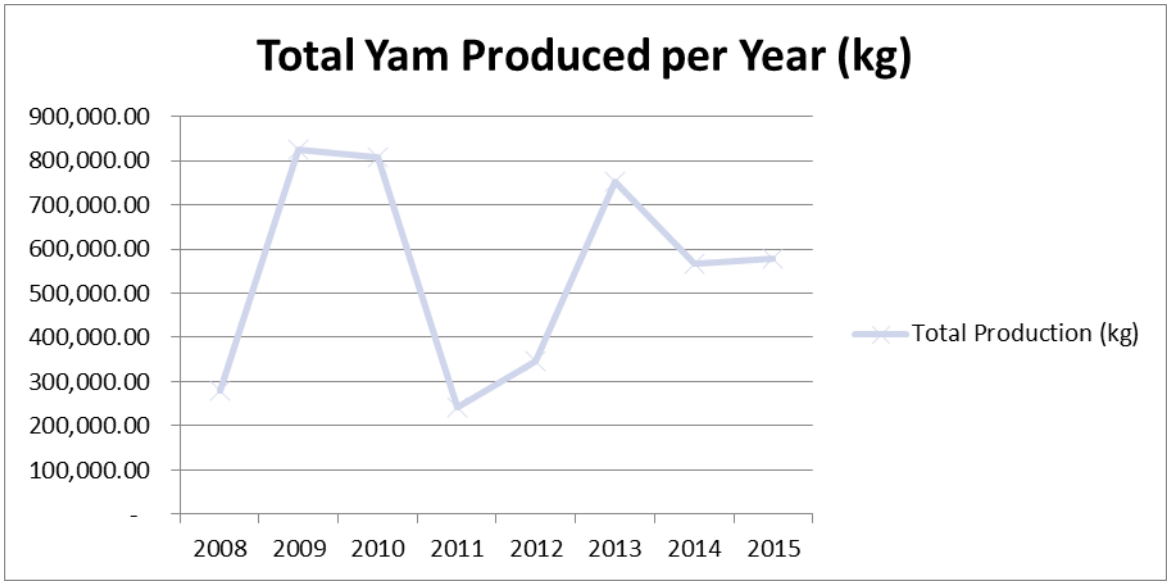
Annex A. Root and tuber crop production in Barbados per year from 2008 to 2015 (kg)






Total Sweet Potato Produced per Year (kg)
1,600,000.00
1,400,000.00
1,200,000.00
1,000,000.00
800,000.00
600,000.00
400,000.00
200,000.00
-
2008
2009
2010
2011
2012
2013
2014
2015
Total Production (kg)


Total Yam Produced per Year (kg)
900,000.00
800,000.00
700,000.00
600,000.00
500,000.00
400,000.00
300,000.00
200,000.00
100,000.00
-
2008
2009
2010
2011
2012
2013
2014
2015
Total Production (kg)

Annex B. 10T (techniques) for intensification of cassava

1) The use of the best planting materials (stakes) of the most appropriate varieties.
2) The optimum time of planting and harvesting, for maximum yield and economic value.
3) The appropriate fertiliser applications of the NPK fertiliser combine animal manure to improve soil fertility and increase yield.
4) The optimum plant spacing suitable for best cassava varieties and various soils.
5) To prevent pest and disease by integrated pest management.
6) The improvement of the agronomic potential for cassava systems: intercropping cassava with groundnut and legumes crops; and crops rotation.
7) The application of herbicides and plastic mulch for weed control.
8) The appropriate method for land preparation and planting, to soil erosion control.
9) The development of water management system for cassava farming.
10) Training Vietnam cassava conservation sustainable development: combines cassava production and utilisation.

Annex C. Photographs of small-scale mechanisation used in cassava production in China

Cassava harvesting implement

Moulding tool

Furrowing body

Plastic mulch implement

The Technical Centre for Agricultural and Rural Cooperation (CTA) is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU). Its mission is to advance food security, resilience and inclusive economic growth in Africa, the Caribbean and the Pacific through innovations in sustainable agriculture.

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