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LIST OF ABSTRACTS

Addressing Food and Nutrition Security Threats in the Caribbean: Lessons from the Cassava Value Chain in Barbados

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Abstract

Cassava production is one of the most promising industries to deal with the main challenges that Caribbean region is currently facing. Cassava as a strategic locally-produced crop with a vast potential could contribute to addressing the issues of agricultural diversification, economic revitalization, climate change and food import bill. The main objective of this study is to evaluate the main perspectives of the cassava industry development. The paper presents the results of analysis of the profitability of the cassava value chain development in Barbados in terms of economic opportunities for local producers and processors. High production cost of cassava roots and traditional farm management system with low yields are the main constraints of cassava value chain development. Cost-benefit analysis applied to evaluate cassava production models and small-scale plants (mash, flour, chips) shows that returns and generated value can be multiplied many times, when cassava yields are increased up to 28 MT/Ha and higher. Results indicate that growing cassava and transforming it in various value-added products can be a profitable activity if local farmers decrease production costs under proposed management systems and guarantee a constant supply of fresh cassava roots at competitive prices. Policy decisions and incentives are needed to stimulate private sector investments in the development of this industry.

Keywords – Food Security, Value Chain, Markets, Cost Benefit Analysis

Introduction

The Caribbean is often considered as middle income food secure countries. However, given the high food import dependence, increasing incidence of diet related diseases and vulnerability to climate change related shocks, this characterization is highly questionable. The heavy dependence of the Caribbean on a wide range of imported foods has resulted in most countries in the region being designated as ‘net food-importing developing countries (Sankat, 2013; WTO, 2012; FAO, 2011). There is an urgent need to ensure that the region increases its capacity to meet food needs with local production. The development of a viable cassava industry in the Caribbean is a key component of the regional strategy for addressing the high food import bill, food insecurity, rural development and climate change (FAO, 2014a; FAO 2014b).

The Caribbean region has a huge opportunity to substitute imported maize and wheat by developing the cassava industry, which already has a production base in almost all of the countries of the region (FAO 2014b; Henry and Hershey, 2002). Cassava has often been neglected in agricultural development policies as this crop was highly associated by consumers as a product for poor people's consumption. However, cassava has a number of attributes that make this crop attractive for economic, health and environmental reasons.

Cassava lends itself to many high value products which can substitute for wheat, maize and other products. It can be used both for animal feed (cassava chips) and human consumption (cassava flour and mash). (International Institute of Tropical Agriculture, 2013; IFAD/FAO, 2004; Henry et al, 1998). Development of the cassava value chain has important macroeconomic and microeconomic benefits in the region. At macro level, cassava flour and chips can reduce the dependence of Caribbean countries on maize and wheat imports. Moreover, development of the cassava value chain will address several serious challenges related to agricultural development and food and nutrition security in the Caribbean. The cassava industry can contribute to increased consumption of local healthy products; mitigate potential impacts of climate change and save foreign exchange. At micro level, after improved land management cassava farming activity can become the primary source of income, including attracting new farmers in agriculture and generating increased rural employment.

Caribbean countries need to make changes to realize benefits of building cassava industry. Currently, the regional cassava industry is fragmented and disorganized. Public-sector support to cassava industry development has been limited, partly due to resource constraints (human, technological and financial) and inadequate understanding of the role it can play. However, the possibility to partially replace wheat flour in bread-making by cassava mash or cassava flour and the use of cassava for animal feed is vitally important for regional economic development. Recognition of cassava and setting up domestic policies to support the development of value chains will benefit the region by developing rural areas and providing employment opportunities. By developing competitive cassava value-chain, Caribbean countries could reduce not only huge food import of wheat and maize but also improve national food security, increase rural employment and reduce rural poverty (FAO, 2013a; CARICOM, 2010; Hepburn, 2013).

This paper is divided into four parts. First part describes main challenges that Caribbean region is currently facing. Second part describes the data collection procedures and methodology. Third part presents the main benefits of building cassava industry and provides the analysis of cassava chain development in Barbados. Fourth part provides a brief discussion of international policy interventions to support the national cassava industry and value chain development. Last section concludes and summarizes the main results of this paper.

1. MAIN CHALLENGES IN THE CARIBBEAN REGION

1.1 Macroeconomic Challenges of the Caribbean

The Caribbean region is currently facing a number of serious challenges related to agricultural development and food and nutrition security: declining production and loss of markets for traditional exports (sugar and bananas), increased food imports and public debt and general slowdown of economic growth. Displacement of local products by imported food commodities not only has negative fiscal effects, but also social impacts, including loss of employment, decline in the general welfare of rural communities and neglect of rural infrastructure. Agriculture has always been a key driver to enable food and nutrition security and economic development.

Every Caribbean country has seen an increasing dependence on imports and in almost half of them more than 80% of the food consumed is imported (FAO, 2014c). Overall, food imports have increased dramatically in last years, putting additional pressure on national budgets. Table 1 shows that all Caribbean countries have low average economic growth except for Trinidad (which has an energy-oriented economy), low level of agriculture contribution to GDP (except for Guyana), high levels of public debt, especially in case of Jamaica and Barbados and high food import dependence. All these factors decrease countries ability to achieve adequate economic growth.

Table 1: Selected Macroeconomic Indicators in the Caribbean Countries (*GDP Growth, Agriculture value added, Food Import Bill, Public Debt, Food Dependence Ratio*)

CARICOM	GDP growth (Average 2011-2013, %)[1]	Agriculture, value added (% of GDP) (2013)[2]	Food Import Bill (USD, Mn) (2012)[3]	Public Debt (% of GDP) (2014)[4]	Food Dependence Ratio[1] (2012)[5]
Antigua & Barbuda	2.1	2.2	113	89	0.92
Bahamas	2.1	1.8	570	57.6	0.92
Barbados	0.4	1.8	312	101.2	0.87
Belize	3.4	15.3	124	79.6	0.40
Dominica	1.2	17.5	52	70	0.55
Grenada	2.4	6.6	60	110	0.81
Guyana	1.8	18.3	273	58	0.41
Haiti	2.5	n/a	949	20.4	0.44
Jamaica	1.4	6.9	991	132	0.63
Saint Kitts and Nevis	-0.2	1.6	39	83	0.95
Saint Lucia	1.8	2.9	104	77	0.83
Saint Vin. & the Grenadines	1.9	7.7	77	67	0.68
Suriname	2.2	7.0	276	20	0.64
Trinidad & Tobago	4.8	0.6	909	50.6	0.85

Source: [1, 2] from World Bank, [3] from FAOSTAT;[4] from IMF, [5] from FAOSTAT (own estimations)

[1] Food Dependence Ratio=Total Food Imports/Total Consumption, where Total Consumption=(Domestic Production + Imports)

1.2 Social Challenges of the Caribbean

Despite some growth of local economies, Caribbean continues face considerably high levels of unemployment and poverty that affect food security and social development. Table 2 shows that high level of unemployment exists in all countries, especially among youth. Poverty still exists in most Caribbean countries due to decreased employment opportunities, markets challenges and skewed distribution of income. In particular, Haiti and Belize have the highest proportion of the population, living below poverty line. At the same time, many Caribbean countries have not yet met generally accepted measure of eradicating hunger, based on achieving a level of undernourishment of less than 5%. Malnutrition related issues; especially obesity contributes to a high incidence of non-communicable diseases in the region. Prevalence of undernourishment in Haiti is the highest in the region. Moreover, low level of unemployment in Haiti reflects the largest section of Haitian population that is outside the labor market.

Table 2: Selected Social Indicators in the Caribbean Countries *(Unemployment Total, Unemployment Youth, Population poverty line, Prevalence of Undernourishment)*

CARICOM	Unemployment Total (% of total labor force)[1]	Unemployment Youth total (% of total labor force)[2]	Population poverty line (%)[3]	Prevalence of Undernourishment (%)[4]
Antigua & Barbuda	8.4	19.9	18.4	13.9
Bahamas	13.6	28.9	9.3	5.6
Barbados	12.2	27	19.3	<5
Belize	14.6	29.7	41	6.4
Dominica	11	26	29	<5
Grenada	10.2	31.5	38	18.7
Guyana	11.1	23.9	35	10.6
Haiti	7	17.4	58.5	53.4
Jamaica	15	35.5	17.6	8.1
St. Kitts and Nevis	5.1	n/a	21.8	10.2
St. Lucia	20.6	27.5	28.8	12.2
St. Vin. & the Gren.	18.8	33.8	30.2	6.2
Suriname	7.8	22.5	31	8
Trinidad & Tobago	5.8	13.2	17	7.4

Source: [1,2] from World Bank; [3] from World Bank, UNDP, CIA, - last available; [4] The State of Food Insecurity (SOFI) in the World, 2015 (FAO, 2015)

1.3 Environmental and Climate Change Challenges of the Caribbean

Increased numbers of natural disasters during recent years continue and increase the negative impact on economic development and food security in the region. Between 1990 and 2010, Caribbean countries affected by weather hazards had lost, on average, between 1 and 9 percent of their GDP every year (World Bank, 2012). More specifically, natural disasters and climate change negatively affect the production capacity and livelihoods of the rural population. Most of the Caribbean countries have limited capacity to recover readily from shocks. In terms of economic damage the impact of natural disasters on Caribbean countries from hurricanes/storms is much more than in other SIDS; economic losses per disaster often exceed one percent of GDP or more. Climate change is threatening sustainable development in the Caribbean. Table 2 shows the total frequency and intensity of natural disasters and total economic damage for each country. Haiti, Jamaica and the Bahamas have been particularly vulnerable to the adverse impacts of climate change. As result, new climate change adaption strategies are needed which protect agricultural development.

Table 3: Total Economic Damage by Natural Disasters (‘000 US$)

CARICOM	2001-2013	1995-2000	Total
Antigua & Barbuda	$12,600	$450,000	$462,600
Bahamas	$1,935,000	$700,400	$2,635,400
Barbados	$5,200	…	$5,200
Belize	$274,544	$282,460	$557,004
Dominica	$20,000	$195,000	$215,000
Grenada	$889,000	$5,500	$894,500
Guyana	$648,800	$29,000	$677,800
Haiti	$8,356,520	$230,100	$8,586,620
Jamaica	$1,538,757	$51,000	$1,589,757
Saint Kitts and Nevis	…	$828,816	$828,816
Saint Lucia	$41,000	…	$41,000
Saint Vincent & the Grenadines	$41,000	…	$41,000
Suriname	…	…	$0
Trinidad & Tobago	$1,000	$25,127	$26,127

Source: EM-DAT, International Disaster Database, 1995-2013

2. DATA COLLECTION AND METHODOLOGY

2.1 Data collection

Trade and production data used in this study were collected from FAOSTAT[2]. This study used the interviews with the key stakeholders as research instruments for additional data collection. Data on cassava production in Barbados was collected in close collaboration between the FAO and the Ministry of Agriculture of Barbados. Interviews were held with three extension officers from the Ministry of Agriculture, including the field visits (May, 2015). Data on cassava mash and cassava flour production were gathered in Barbados from the interviews with small-scale producers[3] of grated cassava, cassava flour and composite cassava bread (April-June, 2015). Data on prices of cassava products in Barbados were gathered from retail prices of five selected supermarkets[4] in Barbados (June 2015).

2.2. Methodology

Quantitative production modeling is important to identify as well as quantify resource requirements (cassava roots, labour, land etc.) and existing constraints to the achievement of specified levels. This kind of modeling provides a means of ex ante assessment of the expected effects of improved production system aimed at changing selected parameters of the system in order to significantly increase production and productivity.

To determine the feasibility of a certain cassava production model a cost-benefit analysis is used to access the worth of cassava production model. Cost-benefit analysis attempts to measure the value of all costs and benefits that are expected to result from the activity (Boardman et al. 2006). It basically gives an overview of the revenue stream and the cost stream (both investment and operational costs). Moreover, cost-benefit analysis is a technique that is widely used to determine options that provide the best approach for the adoption and practice of cassava production in terms of benefits in labour, time and cost savings (Afreen and Haque 2014; Ebukiba, 2010).

The investment models are measured under two indicators: the Net Present Value (NPV) and the Internal Rate of Return (IRR).

Net Present Value (NPV) is the sum of its discounted cash flows. The following formula is used for calculating NPV:

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_o$$

where: Ct = net cash inflow during the period; Co= initial investment; r = discount rate, and T = number of time periods/

Net Present Value (NPV) is the difference between present value and market value. It is the sum of the discounted cash flows minus the original investment. This method of calculating the net results of a production model is regularly used for agricultural modeling and projects and

[2] The Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), http://faostat3.fao.org/home/E

[3] Seven of Hart, O's and Mrs. Veronica Welcome

[4] Massy Store, Carlton, Emerald City, Trimart and Carmeta's

reflects the difference between the present value of cash inflows and the present value of cash outflows. If the net present value of is greater than its market value, then it will be worth more in the future that the market has presently valued it. As Vernimmen et al. (2005) pointed out the NPV decision rule is to invest in projects when the present value is positive (greater than zero). Models with higher and positive NPV are judged to be more economically feasible.

NPV > 0 Invest
NPV < 0 Do not invest

While net present value is obviously based on the amount and timing of cash flows, it is worth examining how it varies with the discounting rate. The higher the discounting rate, the more future cash flow is depreciated and, therefore, the lower is the present value. This research assumes that economic performance of cassava production is estimated on the basis of net revenues over a period of 10 years, discounted at 10%.

If NPV is inversely proportional to the discounting rate, then there must exist a discounting rate that makes NPV equal to zero. The discounting rate that makes net present value equal to zero is called the Internal Rate of Return (Vernimmen *et al.* 2005). IRR is the rate at which its market value is equal to the present value of the investment's future cash flows. Models with higher IRR are considered to be more profitable (Brealey *et al.* 2008). Assuming all other factors are equal among the various projects, the project with the highest IRR would probably be considered the best and undertaken first as investor can then compare this expected return with his required return rate.

3. CASSAVA VALUE CHAIN DEVELOPMENT

3.1 Importance of Cassava Industry in the Caribbean

Under FAO Global Cassava Development Strategy (2000), cassava has been chosen as a focus crop due to its capacity to become the raw material for an array of processed products that will effectively increase demand for cassava and contribute to agricultural transformation and economic growth in developing countries. Moreover, in recent years cassava (has been recognized by Governmental and other agricultural agencies across CARICOM as a strategic locally-produced crop, with a vast potential to contribute to addressing the issues of agricultural diversification, economic revitalization and reduction of the high food import bill (Ford 2014; Lawrence 2014). Therefore, the development of the cassava industry in the Caribbean can contribute to the resolving of the challenges identified in Chapter 1.

First, in the Caribbean, as in the rest of the world, consumption patterns are increasingly dependent on wheat based products and processed sub-products (bread, cookies, roti, pastries, etc.) as well as corn (Micronutrient Initiative 2007). Cassava has is potential to decrease import dependence on two products: wheat flour in bread and maize in animal feed. Cassava flour can be used as 100% cassava flour for gluten free products, and/or in blends with wheat flour, offering an opportunity to reduce the current food import bill of up to 40% of imported wheat, and wheaten flour (Ford, 2014; Stewart, 2014; Harrynanan, 2013; Mohammed, 2013; Titus, 2014; Titus et al., 2012). Even at only a 10% substitution of cassava for imported maize for animal feed and wheat flour for bakery industry would create significant savings in the food import bill. Cassava has a high potential to generate value-added products in many Caribbean countries such as cassava flour/mash for human consumption and cassava chips for animal feed. (FAO, 2013b; IICA/CARDI, 2013; Plucknett *et al.* 2000). Thus, there is the opportunity to reduce and successfully substitute imported grains, primarily wheat and maize. Table 4 shows that Current imports of wheat amount for 5.98% of total food imports and equal to 311 US$M, while total imports of maize account for 2.84% of total food imports with estimated value at 147 US$M. Even a 10% import substitution of wheat and maize would save more than 45.9 US$M annually for Caribbean countries. For some countries such as St. Vincent and the Grenadines this strategy is especially crucial as total imports of wheat and maize account for more than 20%. In Jamaica, Guyana and Grenada these imports range between 14% and 15%.

Table 4: Selected Agricultural Imports in CARICOM

COUNTRY	Imports Wheat and Flour (US$ mn)	Imports Maize (US$ mn)	Total Agr. Imports (US$ mn)	% of Wheat Imports in Agr. Imports	% of Corn Imports in Agr. Imports	% of Wheat and Maize Imports in Total Agr. Imports
Antigua and Barbuda	3.85	0.08	116	3.31%	0.07%	3.38%
Bahamas	7.24	0.31	539	1.34%	0.06%	1.40%
Barbados	11.50	10.06	327	3.52%	3.08%	6.60%
Belize	9.30	2.53	132	7.05%	1.92%	8.97%
Dominica	0.02	0.01	65	0.03%	0.02%	0.05%
Grenada	7.07	1.02	56	12.53%	1.83%	14.36%
Guyana	27.84	10.14	270	10.30%	3.76%	14.06%
Haiti	93.56	6.02	1234	7.58%	0.49%	8.07%
Jamaica	72.61	82.70	986	7.36%	8.39%	15.75%
St. Kitts and Nevis	1.99	0.08	41	4.90%	0.19%	5.09%
St. Lucia	2.97	0.09	107	2.77%	0.08%	2.85%
St. Vin. & the Grenad.	12.64	2.29	69	18.33%	3.31%	21.64%
Suriname	5.45	1.99	297	1.83%	0.67%	2.50%
Trinidad and Tobago	55.52	30.42	970	5.72%	3.14%	8.86%
CARICOM TOTAL	**311.6**	**147.74**	**5,211**	**5.98%**	**2.84%**	**8.82%**

Source: FAOSTAT (2013)

Second, development of the cassava value chain Caribbean can contribute to addressing important social problems. Cassava value chain development can create employment/job growth and rural development. This would address many issues related to declining incomes from traditional commodities and family farming livelihoods. Increased production of cassava by farmers and involvement of local food processors to produce cassava flour and cassava mash preparation will generate incomes for rural farmers and processers. Moreover, harvesting cassava is a very labour-intensive activity and as a result it could also provide employment to unskilled labor.

Third, climate related disasters can have a devastating effect on agriculture in the Caribbean. A climate resilient crop is needed to cope with future challenges. Cassava is perfectly adapted to a wide range of environments and soil types and can be promoted under almost any climate change adaptation strategy in the Caribbean. Cassava can be grown in difficult environmental conditions characterized by low or extreme rainfall and infertile soils. Even countries that are not endowed with good arable land, could replace more “fragile” crops with cassava (Goldstuck, 2006). Furthermore, cassava can grow in impoverished soils and its roots can be left in the ground (unharvested) for long periods as a food reserve (up to 24 months). It is a naturally drought-tolerant crop that is not easily affected by dry spells (Okogbenin *et al.* 2013; El-Sharkawy , 1993; Essers, 1988). Very few other crops have the same levels of resistance to climate constraints. Therefore, cassava is well adapted to multispecies agricultural systems and to future climatic changes whilst other major food staples could face problems (Jarvis, 2012). These characteristics make cassava a climate change crop that could be promoted more widely in the Caribbean.

3.2 Cassava Value Chain Development in Barbados

This section explains the current situation of the cassava industry in Barbados and shows how improvements in land management systems can increase yields and provide important opportunities for local farmers and processors[5]. Analysis of land requirements shows that with even a moderate increase in land allocated to cassava, a substantial increase in cassava production can be realized to enough supply cassava products for 10% of import substitution. The case study is based on Barbados which has less favorable agro ecological characteristics than other Caribbean countries; therefore the results found could readily be applied to other Caribbean countries where higher yields are easier to realize.

Barbados imports wheat and flour of wheat equivalent to 18,854 MT[6] per year, equal to 11.1 US$M of annual budget expenditures. Imports of maize are estimated at 36,298 MT per year, equal to 12 US$M of annual budget expenditures. Development of the cassava value chain in Barbados could consecutively replace at least 10% of imported wheat flour (1,885 MT) and maize (3,629 MT), saving around 2.2 US$M of national budget, allocated to wheat and maize imports. However, the economic feasibility of promoting cassava chain development depends mainly on the price of local cassava roots and value-added products (flour and chips) in relation to price of wheat and maize imports.

3.2.1 Land requirements

Cassava flour/wheat flour

[5] This section focuses wholly on the economic viability case for building a cassava industry.
[6] Here and after, trade data refers to 2011. Source: FAOSTAT.

Current raw cassava production in Barbados is estimated at 320 MT per year with a yield of 10 MT/Ha. Additionally Barbados imports 105 MT of cassava per year, resulting in a total cassava supply in Barbados estimated at 413 MT. In order to expand domestic production, improved production practices would be needed (improved practices of land preparation, irrigation, fertilizers) in order to increase the yields from current 10 Mt/Ha to 30-35 MT/ Ha, assuming harvest of cassava at 10-12 months. Thus, in order to replace 10% of wheat flour imports the quantity of fresh cassava roots required is 7,070 MT[7]. In order to expand the production of cassava roots, on average around 250 ha are needed per year, but with improved production of only 20 ha per month if yield increase up to 28-30 MT/ Ha. At current yields of 10 MT/ Ha around 700 ha are required. Table 5 shows harvested area required to replace 10 % of wheat imports at various yields.

Table 5: Land Requirements for Import Substitution of 10% of Wheat

Cassava Flour Output (MT)	Cassava Fresh Root Equivalent Input (MT)	Annual Hectares Requirement					
		10[8] MT/Ha	**15 MT/Ha**	**25 MT/Ha**	**28 MT/Ha**	**30 MT/Ha**	**35 MT/Ha**
1,885	7,070	707	471	282	252	235	202
		Monthly Hectares Requirement					
		59	39	23.5	21	19.6	16.8

Source: FAOSTAT, own estimation

Cassava/Maize

According to Table 6, to substitute 10% of maize imports, on average around 350 ha are needed per year or less than 30 ha per month, if yield increases to 28 MT/ Ha. At current yields of 10 MT/ha, 972 ha are required. The land required is higher than the size of holdings for small farmers in the Caribbean which is on average less than 2 ha (Graham, 2012). By forming agricultural cooperatives, small famers can benefit from growing cassava without a need to change the whole structure of agriculture. Table 6 shows the harvested area required at different yields, in order to replace 10 % maize imports that are equal to 9,720 MT of fresh cassava[9].

Table 6: Land Requirements for Import Substitution for 10% of Maize

Cassava Flour Output (MT)	Cassava Fresh Root Equivalent Input (MT)	Annual Hectares Requirement					
		10 MT/Ha	**15 MT/Ha**	**25 MT/Ha**	**28 MT/Ha**	**30 MT/Ha**	**35 MT/Ha**
3,600	9,720	972	648	389	347	324	277
		Monthly Hectares Requirement					
		81	54	32	29	27	23

Source: FAOSTAT, own estimation

[7] Conversion factor: 3.75 MT of fresh cassava roots = 1 MT cassava flour
[8] Current yield is highlighted in grey.
[9] Conversion factor: 2.7 MT of fresh cassava roots = 1 MT cassava chips

The results from Tables 4 and 5 indicate that higher yields of cassava production require lower number of hectares. Currently in Barbados inactive available agriculture land (former cane) which is potentially available for agriculture is estimated at 8768 Ha (Helmer *et al*. 2008). Therefore, land is not a constraint in Barbados for expansion of cassava production.

The main producers of cassava roots in Barbados are small farmers and private and government managed plantations. Current area planted in cassava of small farmers' in Barbados range between 0.5 acres and 2 acres per farmer; government and private plantations range in size and often have 5 acres under cassava cultivation. This is mostly for the fresh market (fresh cassava roots consumption). Cassava roots reach maturity at 9 months and can remain in the soil for up to 18 months, but in Barbados due to local cultural preferences they are harvested at 5-6 months. Fresh roots have limited use; according to Wenham (1995), a major constraint to cassava roots utilization is the rapid microbial degradation after harvest. Fresh cassava roots have a shelf life of only 24–48h after harvest. Thus, one of the best ways to extend the shelf life of cassava is to prepare transform it in other value-added products.

The main value-added product currently consumed is grated cassava for cassava pone preparation. Cassava flour is gluten-free and suitable for persons with celiac disease and gluten intolerance (FAO, 2014b). Cassava flour can be used as 100% cassava flour for gluten free products, and/or in blends with wheat flour or any other commodity flour to be used in the manufacture of pastries, biscuits, pastas and cereals (Avila Rostant and Ramlal-Ousman, 2014; Grauwde, 2014; Harrynanan, 2013; Titus, 2014; Titus et al. 2012). One of the most promising industries for partial replacement of wheat flour is the bakery industry for use in bread making (Stewart 2014; Ospina and Ceballo 2012). However, only a few small-scale processors produce local cassava flour. Most of the demand is supplied by imported cassava flour brands that are available in the supermarkets. Moreover, even local branded products are imported mainly from Brazil and then packaged in Barbados. Current local production of cassava flour is estimated at around of 400-500 lbs. per week with a price range of 5.5-6.5 USD[10]/lbs., while imported cassava flour ranges between 4,5- 6.5 USD/lbs[11]. Moreover, cassava flour imported from Brazil and then packaged in Barbados range between 7 USD/lbs. There is therefore a market for locally produced flour and a gap in the supply. However, imported wheat flour is cheaper; therefore, a challenge to overcome would be to bring down the cost of production in order to make local products more competitive.

3.2.2 Cassava Farmers

This section analyzes cassava cost of production for small farmers and it shows what needs to be done in order to make the cultivation of cassava more profitable. Cassava production in Barbados is primarily organized through small farming and it is characterized by low productive capacity due to rain fed irrigation, reduced harrowing, limited use of fertilizers and low weed /pest control (FAO, 2014). Interviews held with Extension Officers from the Ministry of Agriculture revealed that cassava farm structures range from 0.15 hectare of land to 2 hectares of land but many farmers are landless and lease ex-sugar cane land which means less willingness to put inputs into the land. Moreover, incomes generated from small farming are, in general, low and most farmers earn less than 25% of household expenditure from farming activity. Therefore, main problems of traditional farming in Barbados are associated with the

[10] 1 USD=2 BBD

[11] Average retail prices from selected supermarkets in Barbados (Massy Store, Carlton, Emerald City, Trimart, Carmeta's), June 2015

high cost of labor to hire additional workers, seasonality, lack of available markets and dependence on traditional irrigation (rainfall).

Due to low productivity and traditional land management, cassava famers get low yields at 10-15 MT/ha. Usually, farmers harvest cassava at 5-6 months and rotate it with other vegetables (sweet potatoes, cabbages, sweet peppers or beans). Farmers can even hire additional workers for critical periods (harvest, planting and weeding), but most of them cannot afford to expand their farming activity due to high labor and other production costs. After harvesting raw cassava, roots are usually sold either personally in village and urban open fresh produce markets or through other middlemen (in few cases to the Barbados Agricultural Development and Marketing Corporation (BADMC).

In close collaboration with the Ministry of Agriculture of Barbados, detailed production costs under traditional and improved management systems were estimated. Table 7 shows that cost of production under a traditional management system is estimated at 3,110 BBD$/Ha while improved practice increases this cost up to 6,590 BBD$/Ha. However, introduction of improved land management, planting material, fertilizers, weed and pest control, irrigation and harvesting can increase current yield of 10 MT/Ha up to 35 MT/ha.

Table 7: Cassava Production Cost (BBD$/ha) per 1 MT.

	Traditional Cost (yield -10 MT/Ha)	Improved Cost (yield up to 35 MT/Ha)
Land preparation	690	1,210
Planting Material/Planting	890	970
Fertilizing	585	1,080
Weed Management	300	570
Pest/Disease Management	145	290
Water Management (Irrigation)	n/a	800
Harvesting/Transportation	500	1,670
TOTAL	**BBD$ 3,110**	**BBD$ 6,590**

Source: Ministry of Agriculture of Barbados, own estimations

Under traditional production farmers get yields of 10 MT/ha; however, due to post-harvest losses and high production costs of about 30-50 cents per pound, farmers usually apply a 100-150 % mark-up on fresh cassava roots for wholesale and about 200-250% for retail sale. Current average retail price of fresh cassava roots in Barbados varies from 2.5 to 3 BBD$ for fresh consumption when sold in markets and a wholesale average price of 1 BBD$ when sold to cassava processers. Due to factors of having small producers with low technology adoption, low degree of organization and lack of access to information, there is also high price volatility in the traditional system product markets.

However, under improved production with increasing yields up to 35 MT/Ha due to additional inputs of 3,480 BBD$, the estimated cost per MT could decrease from 695 BBD$ to188 BBD$. Meanwhile, high post-harvest losses (up to 65%), associated with traditional production cost generate average yield at 10 MT/Ha (Table 8).

Table 8: Production Costs Cassava Fresh Roots under two Management Systems and Increasing Yields

YIELD (MT/Ha)	TRADITIONAL SYSTEM COST PER 1 MT	IMPROVED SYSTEM COST PER 1 MT
10[12]	BD$ 311	-
15		-
25		BD$ 264
28		BD$ 235
30		BD$ 220
35		BD$ 188

Source: Ministry of Agriculture of Barbados, own estimations

Estimations presented in Table 9 show that there is an inverse relation between yield and unit cost of cassava roots production. Under traditional system farmers are not able to get more than 10 MT/Ha, while under improved production farmers start to get at least 25 MT/Ha and the estimated cost per pound decreases up to 18 cents per pound. Therefore, if farmers implement improved management techniques, they can improve current yields; decrease their cost of production, increase revenues and competitiveness.

Table 9: Production Costs per pound Cassava Fresh Roots under Improved System and Increasing Yields

YIELD (MT/Ha)	ESTIMATED COST PER LBS. TRADITIONAL SYSTEM	ESTIMATED COST PER LBS. IMPROVED SYSTEM
10	31 cents (BD$)	-
15		-
25		11 cents
28		8 cents
30		7 cents
35		5 cents

Source: Ministry of Agriculture of Barbados, own estimations

[12] Current yield and desired yields are highlighted in grey.

3.2.3 Cost-benefit analysis of cassava roots production in Barbados

For significant cassava production expansion the major constraints are: low yields and high production costs. This section estimates economic gains for farmers in Barbados from implementation of improved management techniques that increase cassava yields and decrease the cost of production. Using cost-benefit analysis, four production models are tested based on the parameters fitting a typical small-scale farmer who operates on 1 Ha=2.47 acres. The main parameters of each model are presented in Table 10 and refer to production cost, cost of land lease, production cycle, productivity, mark-up on farm-gate price, cost of equipment rent and farm productivity. The most important parameter is production cost as it demonstrates how improved yields and farm management system can increase the profitability. Four production costs are used for each model from Table 8. Based on data gathered from Ministry of Agriculture and retail prices of fresh cassava roots, traditional farming model assumes 150% price mark-up, while improved farming models test the assumption of 30% price mark-up and 10% price mark-up.

Table 10: Main Parameters of Cassava Roots Production Models

PARAMETERS	A TRADITIONAL FARMING	B TRADITIONAL FARMING WITH ROTATION	C IMPROVED LAND MANAGEMENT – 30 % mark-up	D IMPROVED LAND MANAGEMENT – 10 % mark-up
Production costs	One yield production cost is used: 311 BBD$ - 10 MT/Ha	Cost is based on yields of two crops: 311 BBD$ - 10 MT/Ha for fresh cassava and 443 BBD$ - 10 MT/Ha for sweet potatoes.	Cost is based on 4 yields: 264 BBD$ - 25 MT/Ha; 235 BBD$ - 28 MT/Ha; 220 BBD$ - 30 MT/Ha; 188 BBD$ 35MT/Ha.	Cost is based on 4 yields: 264 BBD$ - 25 MT/Ha; 235 BBD$ - 28 MT/Ha; 220 BBD$ - 30 MT/Ha; 188 BBD$ -35MT/Ha.
Land lease	1,500 BBD$	1,500 BBD$	1,500 BBD$	1,500 BBD$
Production Cycle	1 cycle (6 months)	2 cycles (11 months)	1 cycle (9-12 months)	1 cycle (9-12 months)
Sale Prices	150 % mark-up on production cost	150 % mark-up on production cost	30 % mark-up on production cost	10 % mark-up on production cost
Equipment Rent	470 BBD$	941 BBD$	470 BBD$	470 BBD$
Post-harvest losses	35% of yield	35% of yield	10% of yield	10% of yield
Farm Productivity	75% of full capacity during the first year and then stabilization	75% of full capacity during the first year and then stabilization	75% of full capacity during the first year and then stabilization	75% of full capacity during the first year and then stabilization

Source: Ministry of Agriculture of Barbados, own estimations

Models A and B assume traditional practice without rotation and with rotation for a yield of 10 MT/Ha. Models B and C assume that farmers start to get at least 25 MT/Ha and the production cost decreases. Results of cost-benefit analysis[13] show that incomes generated from traditional farming cannot attract new farmers in agriculture. Thus, farming is only traditional supplemental part-time activity. Table 11 reports that even rotating cassava with sweet potatoes, there is not significant increase in income due to high post-harvest losses and high production costs. Therefore, only improved farm practices with higher yields can decrease production costs and improve real incomes for small farmers.

Table 11: Results of cost-benefit analysis for farming under traditional system

	A TRADITIONAL FARMING	B TRADITIONAL FARMING WITH ROTATION
IRR	95%	95 %
NPV	13,627 BBD$	17,521 BBD$

The analysis compares model C - for supplying small-scale processors and model D – for large scale processors to show the different profitability under different mark-ups of farm-gate price. Model C uses a mark-up of 30% and Model D - 10% on farm-gate price. Table 12 shows the IRR and NPV under improved systems at different yields related to different production costs. Estimated results show that Model C and D have higher profitability at lower mark-ups instead of traditional 150% mark-up. Even under these low mark-ups the IRR doubles. Models C and D generate an IRR starting from 148% up to 197%, while traditional models A and B generate an IRR of 95%. Generated incomes under new system are much higher than under the traditional system. It means that achieving even 25 MT/Ha yield under improved management will generate enough high returns for farmers.

Furthermore, Model C with 30% mark-up on farm gate prices generates higher values than Model D with 10% mark-up on farm gate prices. However, at 30% mark-up on farm gate prices farmers can become direct suppliers only for small-scale cassava processers (cassava mash and flour). These small-scale operators are not able to pay more than 30% of mark-up on fresh cassava roots in order to be profitable. Meanwhile, at 10% of mark-up, cassava farming activity can be very profitable if cassava farmers become direct suppliers of fresh cassava roots for plants, producing cassava flour/chips. Therefore, their revenues can be improved through the economies of scale as high amount of fresh cassava roots is required constantly. Finally, both models demonstrate a jump in NPV after 30 MT/Ha yields.

[13] Here and after detailed tables of cost benefit analysis available upon request

Table 12: Results of cost-benefit analysis for farming under improved system

FINANCIAL INDICATORS	C IMPROVED LAND MANAGEMENT – 30 % mark-up	D IMPROVED LAND MANAGEMENT – 10 % mark-up
IRR – 25 MT/Ha	189 %	148 %
IRR – 28 MT/Ha	192 %	151 %
IRR – 30 MT/Ha	194 %	153 %
IRR – 35 MT/Ha	197 %	156 %
NPV – 25 MT/Ha	29,706 BBD$	22,649 BBD$
NPV – 28 MT/Ha	29,876 BBD$	22,867 BBD$
NPV – 30 MT/Ha	30,047 BBD$	23,017 BBD$
NPV – 35 MT/Ha	35,442 BBD$	27,856 BBD$

3.2.4. Cassava Mash Producers

This section provides a review of existing cassava mash producers in Barbados and a cost benefit analysis to estimate their profitability in relation to different production costs of fresh cassava roots. In general, use of cassava mash in Barbados is a new solution to introduce the use of cassava for bakery industry. However, the current supply of grated cassava is low. Frozen grated cassava is mainly used for cassava pone preparations by private households. However, main benefits of cassava mash are related to its characteristics and price as it is cheaper than cassava flour. Cassava mash can substitute from 10 to 40% of total weight to produce the composite cassava / wheat bread without affecting the flavor, texture and color of the products (Omaira *et al.* 2015). Moreover, frozen mash after processing of fresh cassava roots can be easily stored for a long time (Uchechukwu-Agua et. al. 2015, Sanchez et. al. 2013)

In Barbados there are few local processors of grated cassava or cassava mash. Average wholesale price of cassava mash is 2.45 per lbs., while retail price is estimated around 4.5 BBD$. The model below examines the investment proposal for local processers to produce grated cassava in order to supply 218 MT of cassava mash per year as a substitute for 1.1% of imported wheat flour for local bakeries. Initial investment includes the cost of setting up a small-scale plant (grinder) with a capacity of 218 MT of cassava mash per year. The total fixed investment is estimated at 40,400 BBD$. The total price includes transportation and installation costs. Main parameters of this model are presented in Table 13.

Table 13: Main Parameters of Cassava Mash Production

PARAMETRES	REQUIREMENTS
Investment Cost	40,400 BBD$
Fresh cassava roots inputs	335 MT of fresh cassava roots per year (35% of losses in peeling). Under improved land management, fresh cassava roots are supplied directly by farmers with. Daily input is 1.39 MT (3077 lbs.) of fresh cassava roots.
Price of Fresh Cassava Roots	30% mark-up on production cost under improved management system. Production cost is based on 4 yields: 343 BBD$ - 25 MT/Ha; 306 BBD$ - 28 MT/Ha; 286 BBD$ - 30 MT/Ha; 244 BBD$ - 35MT/Ha.
Cassava Mash Output	218 MT of cassava mash per year. Daily output is 0.9 MT (2000 lbs.) of cassava mash
Plant Operation Time	Plant operates 20 days per month, 12 months of the year (240 days).
Operation Capacity	First year - 40% of full capacity. Second year - 80% of full capacity. Third year and then - 100% capacity.
Human resource	A total of fifteen (15) workers are required per processing facility at different levels: twelve (12) full-time workers for reception, washing and peeling (300 lbs. per person per day), one (1) full-time worker for running the grinder and quality control at different stages, 2 (two) part-time workers for packaging.
Labor cost	The monthly cost of each full-time worker is 2,000 BBD$, part-time worker - 800 BBD$. Total monthly labor cost is 27,600 BBD$
Utilities (water, electricity)	10,800 BBD$ per year
Building rent	24,000 BBD$ per year
Additional equipment	2,400 BBD$ for 2 fridges
Transportation	Assuming that own van is available, cost of insurance and fuel is 2,400 BBD$ per year.
Targeted price of cassava mash	1.5 BBD$ per lbs., 3306 BBD$ per MT

Source: Interview with cassava mash producers in Barbados, own estimations

Table 14 shows the results of cost benefit analysis at different yields related to different prices of fresh cassava roots which will change the IRR and the NPV. Farmers with improved production capacity over the current yield of 10 MT/Ha decrease their production costs and therefore price of fresh cassava. As result, higher yields generate better revenue for local cassava processors. Under improved management technique even at prices of 25 MT/Ha, cassava mash producers are very profitable. It means that cassava mash producers can start to be financially viable even at production costs with 25 MT/Ha. Therefore, profit can be made even with lower levels of production improvement and little effort would be required from farmers to increase current yield up to 25 MT/Ha. Overall, returns for mash producers depend on farmer's yields, given the fixed price of mash. Once farmers are able to get 25 MT/Ha, returns exceed 90%

Table 14: Results of cost-benefit analysis for cassava mash production under improved system

FINANCIAL INDICATORS	C IMPROVED LAND MANAGEMENT – 30 % mark-up
IRR – 25 MT/Ha	94 %
IRR – 28 MT/Ha	96 %
IRR – 30 MT/Ha	99 %
IRR – 35 MT/Ha	106 %
NPV – 25 MT/Ha	1,058,317 BBD$
NPV – 28 MT/Ha	1,062,910 BBD$
NPV – 30 MT/Ha	1,098,406 BBD$
NPV – 35 MT/Ha	1,174,132 BBD$

3.2.5 Cassava Flour and Cassava Chips Producers

This sections reviews cassava flour and cassava chips production options in Barbados. Currently, in Barbados there are only few local small-scale producers of cassava flour but there is no cassava chips production for animal feed. This paper tests two production models of cassava flour plant and cassava chips plant establishment in Barbados that could replace 2.8% of current wheat imports and 10% of maize imports.

The parameters of two models are presented in Table 15. The models assume cassava farm-gate price with 10% mark-up with improved management techniques. The amount of initial investment for equipment is estimated at 360,000 BBD$. Cassava flour and cassava chips plant has the same characteristics and requires the same initial investment. The models assume the establishment of plants in Barbados with a capacity of 530 MT of cassava flour and 3,600 MT of cassava chips annually.

Table 15: Main Parameters of Cassava Flour and Cassava Chips Models

PARAMETRES	CASSAVA FLOUR PLANT	CASSAVA CHIPS PLANT
Investment Cost	360,000 BBD$	360,000 BBD$
Fresh cassava roots inputs	1,997 MT of fresh cassava roots per year; 166 MT per month; 6.4 MT per day.	9,720 MT of fresh cassava roots per year; 810 MT per month; 31 MT per day.
Price of Fresh Cassava Roots	10% mark-up on farm-gate price under improved management system. Production cost is based on 4 yields: 290 BBD$ - 25 MT/Ha; 258.5 BBD$ - 28 MT/Ha; 242 BBD$ - 30 MT/Ha; 207 BBD$ - 35MT/Ha.	10% mark-up on farm-gate price under improved management system. Production cost is based on 4 yields: 290 BBD$ - 25 MT/Ha; 258.5 BBD$ - 28 MT/Ha; 242 BBD$ - 30 MT/Ha; 207 BBD$ - 35MT/Ha.
Product Output	530 MT[14] of cassava flour per year	3,600[15] MT per year
Plant Operation Time	Plant operates 26 days per month, 12 months of the year (312 days)	Plant operates 26 days per month, 12 months of the year (312 days)
Operation Capacity	First year - 40% of full capacity. Second year 80% of full capacity. Third year and then - 100% capacity.	First year - 40% of full capacity. Second year - 80% of full capacity. Third year and then - 100% capacity.
Human resource	Totally five (5) workers are required per processing facility at different levels: one (1) manager, two (2) workers for reception, washing and chipping, one for (1) for drying and one (1) for storage, milling and refining.	Totally five (5) workers are required per processing facility at different levels: one (1) manager, two (2) workers for reception, washing and chipping, one for (1) for drying and one (1) for storage, milling and refining.
Labor cost	Average monthly cost of per worker is 2,000 BBD$. Total annual labor cost is 120,000 BBD$	Average monthly cost of per worker is 2,000 BBD$. Total annual labor cost is 120,000 BBD$
Utilities (water, electricity)	90,000 BBD$	90,000 BBD$
Other costs	50 BBD$ per 1 MT of output	50 BBD$ per 1 MT of output
Targeted price	7,273 BBD$/MT	1,102 BBD$/MT

Source: Clayuca Corporation (2014), Ministry of Agriculture of Barbados, own estimations

[14] 1 MT cassava flour = 3.75 MT of fresh cassava roots
[15] 1 MT cassava chips = 2.7 MT of fresh cassava roots

The results of cost-benefit analysis for cassava flour and cassava chips plants (Table 16) show how different yields related to wholesale prices of fresh cassava roots will change the IRR and the NPV. Establishment of cassava flour and cassava chips plants are economically feasible investments if farmers can guarantee a constant supply of fresh cassava roots with competitive production prices with yields of 25 MT/Ha or higher. Meanwhile, cassava flour plant investment is profitable even at prices 25 MT/Ha. However, in case of cassava chips plant further increases in yields generates significant improvement of returns. Meanwhile, for the cassava flour model the jump from 25 MT/Ha to 35 MT/Ha does not multiply the returns. Furthermore, cassava flour profits do not increase significantly over a period of 10 years, even if farmers are getting higher than 25 MT/Ha. Overall, cassava flour is more profitable investment but it requires higher operating costs for the buying fresh cassava roots. Cassava chip plant can be more profitable if local cassava farmers increase their yields up to 30-35 MT/Ha. Thus, coordination with farmers to decrease production cost and improve yields is essential.

Table 16: Results of cost-benefit analysis for cassava flour and cassava chips production

FINANCIAL INDICATORS	CASSAVA FLOUR PLANT	CASSAVA CHIPS PLANT
IRR – 25 MT/Ha	391 %	135 %
IRR – 28 MT/Ha	398 %	175 %
IRR – 30 MT/Ha	402 %	194 %
IRR – 35 MT/Ha	410 %	235 %
NPV – 25 MT/Ha	16,042,358 BBD$	4,495,799 BBD$
NPV – 28 MT/Ha	16,388,506 BBD$	6,180,654 BBD$
NPV – 30 MT/Ha	16,567,548 BBD$	7,052,130 BBD$
NPV – 35 MT/Ha	16,949,504 BBD$	8,900,717 BBD$

3.2.6 Main Benefits from Developing the Cassava Industry in Barbados

There are two main elements of the cassava industry development in Barbados: foreign exchange savings and job creation. Table 17 provides the estimations of foreign exchange savings at 10 %, 20%, 30% and 40% of wheat and maize imports reduction. Moreover, each level of food import bill reduction provides different estimations of employment and land requirements for building cassava industry at yield of 28 MT/Ha (from Table 5). Estimation of new jobs from building the cassava industry is based on the assumption that small farmers in Barbados who on average operate on 2.5 acres would require at least 2 workers per farm, while each cassava processing plant (mash, flour and chips) on average requires 15 workers. Overall, results show that even at 10% of wheat and maize import reduction, foreign exchange savings are estimated at 2,3 US$M. Moreover, with the gradual reduction of wheat and maize imports up to 40%, 9,2 USD mn of national budget could be saved. 10% of import reduction can guarantee 1,288 new jobs, where 1,198 are allocated for small farming. Therefore, with import reduction up to 40%, 2,632 new jobs can be created, assuming better specialization of farmers/cassava industry workers and increased operation time of cassava plants. Finally, only

599 Ha are required at 10% and 2,396 Ha at 40% of imports reduction. In Barbados potentially available land for agriculture is estimated at 8,768 Ha (former sugar cane). Therefore, land is not a constraint in Barbados for expansion of cassava production.

Table 17: Benefits of the cassava industry development in Barbados and land requirements

REDUCTION OF WHEAT AND MAIZE IMPORTS	FOREIGN EXCHANGE SAVINGS	NUMBER OF NEW JOBS (including farmers and processors)	AVERAGE LAND REQUIREMENTS (if yield is 28 MT/Ha)
10%	**2,3 USD mn**	1,198 farmers, 30 mash workers, 45 flour workers and 15 chips workers. **Total: 1,288 new jobs**	**599 Ha**
20%	**4,6 USD mn**	1,557 farmers, 39mash workers, 58 flour workers and 19 chips workers. **Total: 1,674 jobs**	**1,198 Ha**
30%	**6,9 USD mn**	2,225 farmers, 51 mash workers, 76 flour workers and 25 chips workers. **Total: 2,271 jobs**	**1,797 Ha**
40%	**9,2 USD mn**	2,632 farmers, 65 mash workers, 100 flour workers and 33 chips workers. **Total: 2,283 jobs**	**2,396 Ha**

Source: FAOSTAT, own estimations

Price competitiveness with imported wheat and corn is a key element of a cassava industry development in Barbados. Local produce with high quality standards can compete with imported commodities and expand domestic agriculture. Table 18 demonstrates current retail and wholesale prices of domestically available and imported commodities, targeted model prices and estimated returns at yield 28 MT/Ha. Overall, results show that under improved management system, farmers can decrease their production costs and sell fresh cassava roots to processers at cheaper prices. Therefore, cassava producers of mash, flour and chips can compete with equivalent imported cassava commodities and contribute to domestic agricultural revitalization. Current price of wheat flour in Barbados is estimated at 3 BBD$/lbs. and livestock feed is 52 cents BBD$/lbs. As results targeted prices of cassava flour (3.3 BBD$) and cassava chips (50 cents) make local produce to be competitive with imported wheat and corn. Finally, targeted prices of local produce can be even modified according to the market conditions, therefore, increasing the returns to cassava farmers and processors.

Table 18: Price analysis of cassava products

PRODUCT	Current Price-retail (BBD$/lbs.)	Current Price-wholesale (BBD$/lbs.)	Imported Price (BBD$/lbs.)	Model Price depends on yields (BBD$/lbs.)	IRR (at yield 28MT/Ha)
Fresh cassava roots	2.5-3	1	n/a	*30 % mark-up:* 11 cents *10 % mark-up:* 9 cents	*30 % mark-up:* 192% *10 % mark-up:* 151%
Cassava mash	4.5	2.45	n/a	1.5	96%
Cassava flour	12	9	8.8	3.3	398%
Cassava chips	n/a	n/a	n/a	50 cents	175%

Source: average retail prices in Barbados, own estimations

4. INTERNATIONAL PUBLIC POLICY MECHANISMS FOR CASSAVA INDUSTRY PROMOTION

This section provides a brief discussion of policy interventions that were implemented in various countries in order to establish and support the national cassava industry and value chain development. Setting up a policy and institutional framework where the critical participants in the value chain are adequately organized to respond to demand, represents one of the essential steps in establishing a successful value chain for cassava industry development. In countries, where cassava value chain development has been successful, public policy interventions were implemented to support local famers and promote new uses for cassava. Main policy interventions used public purchasing programs, consumption promotion, tax rebates, mandatory blending rates for bakery industry, duty for imported wheat, subsidized inputs for cassava farmers and agro-processors.

Table 19 summarizes some of the main international policy support measures that have been introduced to promote cassava use from traditional fresh roots consumption to value-added consumption (bread and beer). These international responses to food security demonstrate public policy support that could be replicated in the Caribbean in order to facilitate cassava value chain development and guarantee the reduction of the food import bill.

Table 19: Examples of International Public Policy Interventions for Promotion of Cassava Industry

COUNTRY	POLICY SUPPORT MEASURE	DESCRIPTION OF POLICY
Brazil	**Legislative Proposals to use 10% cassava flour in bread making**	Cassava consumption is being promoted in Brazil by policies aimed at substituting imported cereals with domestically produced cassava flour. Under the political proposal 5332/2009 - "Brazilian bread" The government has mandated the blending of 10% cassava flour with wheat flour in bread. This initiative is estimated to absorb about half of the country's cassava output. The project is currently under the approval.
Kenya	**Excise tax rebates to beer made from cassava**	In 2013 the government introduced a 50% excise tax rebate on beer made from cassava grown in Kenya.
Mozambique	**Tax break in case of 70 % cassava use in the production of beer.**	Brewer SABMiller uses 70 % cassava in the production of beer and benefits from the tax break
Nigeria	**100% levy on imported wheat**	As an effort to deepen the blending ratio, Nigeria imposed a further levy on imported wheat flour in 2012, bringing the overall duty from 35% to 100%. New import levies form part of a government policy 'compelling cassava flour inclusion in wheat flour' products. Duty-free imports of machinery and equipment required for cassava processing and blending are to be allowed, in order to help people to meet the blending targets.
	Blending rate of 20% in bakery industry	Bakeries are now required to apply blending rates of 20%. As a measure to further support the initiative, the Federal Ministry of Agriculture and Rural Development has instituted a "cassava bread

COUNTRY	POLICY SUPPORT MEASURE	DESCRIPTION OF POLICY
		development fund" worth US$66 million, where funds are obtained from import levies The cassava bread initiative launched in 2011, promotes the inclusion of 40 % high quality cassava flour in bread to reduce cereal imports.
Philippines	**Food Staple Sufficiency Program (FSSP)**	Cassava is a priority commodity under its Food Staple Sufficiency Program (FSSP) that aims to strengthen national resiliency by focusing on food staples that can withstand climate change. The programme provides farmers with subsidized inputs as well as equipment.
Thailand	**Governance assistance under the "pledging scheme"**	Cassava producers in Thailand benefited from significant government assistance in 2012 in the form of price support under the pledging scheme price pledging or insurance scheme. The programme sought to remove some of the distortionary effects of price supports and will encourage quality over quantity. In 2012 some US$1.43 billion set aside for purchasing roots from cassava growers. The purchasing goal was estimated at 10 MT of cassava root, with 9.97 MT of cassava root pledged out of total production of 24 MT.
	Agro-zoning schemes	Direct assistance to producers is limited to an "agro-zoning scheme" that targets productive lands and equips farmers in those lands with better technological knowledge, advice on financing and improved marketing tools.

Source: FAO Food Outlook (2013; 2014).

Countries which were successful in decreasing wheat and barley imports and generating foreign exchange savings, relied on the implementation of these policies. International experience shows that these political measures should include the support to local farmers as well as cooperation with the private sector who are the main importers of food – feed millers, bakeries, supermarkets and hotels. National governments have to stimulate demand for cassava, building up the cassava supply-side to produce value-added products. Policies to promote demand and changes to the consumption patterns could include access to land, purchases for government programs (hospitals, prisons and schools), tax incentives for local producers and compulsory blending rates for bakeries and.

CONCLUSIONS AND RECOMMENDATIONS

Cassava production is one of the most promising industries to deal with the main challenges that Caribbean region is currently facing. Governmental and other agricultural agencies across CARICOM have recognized cassava as a strategic locally-produced crop with a vast potential to contribute to addressing the issues of agricultural diversification, economic revitalization, climate change and reduction of the high food import.

Given the import dependence of the Caribbean on maize and wheat, promotion of cassava flour and cassava chips can reduce current food import bill and stimulate economic growth. With the reference to Barbados, high volumes of fresh cassava are needed to produce both cassava flour and mash. In terms of feed systems, a substantial percentage of maize can similarly be replaced by cassava chips. Therefore, small cassava farmers are the starting point of cassava value chain development. Results show that farming can become a primary source of income and attract new farmers in agriculture, generating employment. At micro level local farmers and cassava processors have an excellent opportunity to increase their incomes if farmers can guarantee a constant supply of fresh cassava roots under improved land management. Moreover, future concerns of agricultural sustainability related to climate change adaptation strategy make the cassava crop a highly recommended climate-resilient crop easily adapted to any Caribbean island.

High production cost of cassava roots and traditional farm management system with low yields are the main constraints of cassava value chain development. Cost-benefit analysis applied to evaluate cassava production models and small-scale plants (mash, flour, chips) shows that returns and generated value can be multiplied many times, when cassava yields are increased up to 28 MT/Ha and higher. Results indicate that growing cassava and transforming it in various value-added products can be a profitable activity if local farmers decrease production costs under proposed management systems and guarantee a constant supply of fresh cassava roots at competitive prices. Moreover, job creation for small-scale cassava farmers and processing plant workers are possible once yields are increased and constant supply of fresh cassava roots is established.

In terms of public policy support, an overview of international public policies for building a cassava industry demonstrates various policy interventions that have successfully promoted cassava use from traditional fresh roots consumption to industrial consumption. The analysis suggests that the success being enjoyed in other countries can be replicated in the Caribbean to ensure the reduction of food import bill, social benefits and contribution of a climate change adaption strategy. Policy decisions and incentives are needed to stimulate private sector investments in the development of this industry. Public policy should be utilized to promote production, processing and consumption of cassava products (public purchases for hospitals, prisons and schools and compulsory blending rates for bakeries). Essentially, the development of a viable cassava industry is a key component of the regional strategy for addressing food insecurity, and promoting economic growth in the Caribbean.

REFERENCES:

Afreen, N., Haque, M. S. (2014). Cost benefit analysis of cassava production in Sherpur district of Bangladesh. Journal of the Bangladesh Agricultural University 12(1), pp. 119–126.

Avila Rostant O, Extavour, V., Lopez, V. (2015). Composite Bread as a Value-added Product for the Development of the Cassava Industry in CARICOM. III International Symposium on Roots, Rhizomes, Tubers, Plantains, Bananas and Papaya, Cuba, October 20-23, 2015.

Avila Rostant O., Ramlal-Ousman, M. (2014). Analyzing the Trinidad cassava bread value chain: Testing the Methodology derived from "the Guide to Analyzing and Strengthening Root and Tuber Value Chains in the Caribbean". Presented at the Regional Workshop on Value Chain Approach; organised by CARDI/CTA; Carlton Savannah Hotel, Port of Spain, Trinidad and Tobago. September 23 and 24, 2014.

Boardman, A., Greenberg, D., Vining, A., & Weimer, D. (2006). Cost benefit analysis: Concepts and practice. (3rd. ed.). Upper Saddle River, NJ: Prentice Hall.

Brealey, R., S. Myers and F. Allen Principles of Corporate Finance. (Boston, Mass., London: McGraw-Hill, 2008) ninth international edition [ISBN 9780071266758].

CARICOM (2010). Regional Policy for Food and Nutrition Security (RPFNS) http://www.caricom.org/jsp/community_organs/regional_food_nutrition_security_policy_oct2010.pdf

Ebukiba, E. (2010). Economic analysis of cassava production (farming) in Akwa Ibom State. Agriculture and Biology Journal of North America. Vol. 1 Issue 4, p. 612.

Essers, S. (1988). Bitter Cassava as a drought resistant crop: A case in Mozambique. ILEIA Newsletter, 4 nº 4.

El-Sharkawy, M. (1993). Drought-Tolerant Cassava for Africa, Asia, and Latin America. BioScience Vol. 43, No. 7, International Agricultural Research, pp. 441-451.

FAO (2013a). CARICOM Food Import Bill, Food Security and Nutrition. Subregional Office for the Caribbean. Issue Brief # 5. Food and Agriculture Organization of the United Nations

FAO (2013b). Save and Grow; Cassava. A Guide to Sustanaible Production Intensification. Food and Agriculture Organization of the United Nations

FAO (2014). Food Outlook (October), Biannual Report on Global Food Markets. ISSN: 0251-1959.

FAO (2000). Global Cassava Development Strategy. Food and Agriculture Organization of the United Nations http://www.fao.org/ag/AGP/AGPC/gcds/en/strategy.html

FAO (2011). Regional Consultation on Policy and Programmatic Actions to Address High Food Prices in the Caribbean. Summary of Proceedings. Port of Spain, Trinidad and Tobago, 13-14 June. Food and Agriculture Organization of the United Nations

FAO (2014a). Regional Conference on Cassava in the Caribbean and Latin America, 10-12 February 2014. Conference Report. Food and Agriculture Organization of the United Nations http://www.fao.org/3/a-i4548e.pdf

FAO (2014b). Contributing to the development of a cassava industry. Issue Brief #11 (October). Subregional Office for the Caribbean. Food and Agriculture Organization of the United Nations

FAO (2014c). Food and Nutrition Security in SIDS. 1 - 4 September 2014, Apia, Samoa. Food and Agriculture Organization of the United Nations

FAO (2015a). State of Food Insecurity in the CARICOM Caribbean. Meeting the 2015 Hunger Targets: Taking stock of Uneven Progress. Subregional Office for the Caribbean. Food and Agriculture Organization of the United Nations http://www.fao.org/publications/card/es/c/f21bbc91-da04-4014-936d-5dd90887c4df/

Ford, D. (2014) Why Cassava Industry Now? Proceedings of the Regional Conference on Cassava in the Caribbean and Latin America, Barbados, February 10-12, 2014. FAO/UWI/CLAYUCA. Pages 5-7. http://www.fao.org/3/a-i4548e.pdf

Jarvis, A., Ramirez-Villegas, J., Herrera Campo, B. V., Navarro-Racines, C. (2012). Is Cassava the Answer to African Climate Change Adaptation? Tropical Plant Biology, March 2012, Volume 5, Issue 1, pp 9-29.

Global cassava market study (2004). Business opportunities for the use of cassava. Proceedings of the Validation Forum on the Global Cassava Development Strategy. International Fund for Agricultural Development Food and Agriculture Organization of the United Nations. http://www.fao.org/docrep/007/y5287e/y5287e00.htm

Goldstuck, A. (2006). Cassava Trade Information Brief. Trade and Industrial Policy Strategies (TIPS). Trade and Industry Monitor Volume 38. www.tips.org.za/node/1301

Graham, B. (2012). Profile of the Small-Scale Farming in the Caribbean. Workshop on Small-Scale Farming in the Caribbean. FAO/ Hunger Free Latin America and the Caribbean Initiative.

Grauwde, H. (2014) Suriname Experiences with Cassava Development, presented at the Regional Conference on Cassava in the Caribbean and Latin America, Barbados, February 10-12. Pages 52- 53.http://www.fao.org/3/a-i4548e.pdf

IFAD/FAO (2004). A Review of Cassava in Latin America and the Caribbean with Country Case Studies on Brazil and Colombia. Proceedings of the Validation Forum on the Global Cassava Development Strategy. International Fund for Agricultural Development and Food and Agriculture Organization Of The United Nations.

IICA/CARDI (2013). Roots and Tubers Processing in the Caribbean: Status and Guidelines. Inter-American Institute for Cooperation on Agriculture/ Caribbean Agricultural Research and Development Institute. http://repiica.iica.int/docs/B3244i/B3244i.pdf

International Institute of Tropical Agriculture, (2013). Potential for Commercial Production and Marketing of Cassava: Experiences from the small-scale cassava processing project in

East and Southern Africa. http://www.iita.org/c/document_library/get_file?uuid=1cce5091-8ccc-4c3f-9629-9d168056ee7f&groupId=25357

Harinanan, L. (2013) Roots and Tubers Processing in the Caribbean: Status and Guidelines; Port of Spain, Trinidad and Tobago. IICA/CARDI http://repiica.iica.int/docs/B3244I/B3244I.PDF

Hepburn, E. (2013). Investigating the Understanding, Interest and Options for Agri-tourism to Promote Food Security in the Bahamas. Proceedings of the 30th West Indies Agricultural Economics Conference.

Helmer, E.H, Kennaway, T.A., Pedreros, D.H., Clark, M.L., Marcano-Vega, H., Tieszen, L.L., Ruzycki, T.R., Schill, S.R., Carrington, C.M.S. (2008), Land Cover and Forest Formation Distributions for St. Kitts, Nevis, St. Eustatius, Grenada and Barbados from Decision Tree Classification of Cloud-Cleared Satellite Imagery, Caribbean Journal of Science, Vol. 44, No. 2, 175-198, 2008.

Henry, G., Hershey, C. (2002). Cassava production in South America and Caribbean. In Cassava: Biology, Production and Utilization (eds. R. J. Hollocks, J. M. Thresh, and A. C. Bellotti).

Henry, G., Westby, A., Collinson, C. (1998). Global Cassava End-Uses and Markets: Current Situation and Recommendations for Further Study. European Group on Root, Tuber and Plantain, France.

Lawrence, J (2014). Status of Cassava in the Caribbean: Multipurpose Crop of the 21st Century; Proceedings of the Regional Conference on Cassava in the Caribbean and Latin America, Barbados, February 10-12, 2014. FAO/UWI/CLAYUCA. Pages 10-15.

Micronutrient Initiative (2007) Latin America and Caribbean Region Food Industry Assessment. Micronutrient Initiative. Pages 19-21. http://siteresources.worldbank.org/EXTLACREGTOPNUT/Resources/LAC_Industry_Assessment_Report_to_ICDDRB_Aug_11.pdf

Mohammed Aziz (2013) Analysis of Production and Trade of Selected Root and Tuber Crops within the CARICOM Region, USA, Canada and the United Kingdom, CARDI, Trinidad and Tobago http://www.cardi.org/cfc-rt/files/downloads/2013/11/Publ-24-Market-Analysis-RT-CARICOM-World-Aziz-M.pdf

Okogbenin, E., Setter, T. L., Ferguson, M., Mutegi, R., Ceballos, H., Olasanmi, B., & Fregene, M. (2013). Phenotypic approaches to drought in cassava: review. Frontiers in Physiology, 4, 93. http://doi.org/10.3389/fphys.2013.00093

Ospina, B. and Ceballos, H. (2012).Cassava in the Third Millennium: Modern Production, Processing, Use and Marketing Systems. CIAT, CLAYUCA and CTA. Cali, Colombia.

Plucknett, D.L., Phillips, T.P. and Kagbo, R.B. (2000). A Global Development Strategy for Cassava: Transforming a Traditional Tropical Root Crop. FAO-IFAD. http://www.hubrural.org/IMG/pdf/global_cassava_development_strategy.pdf

Sanchez, T., Dufoura, D., Morenoa, J.L., Pizarroa, M., Aragona, I.J., Domingueza, M., Ceballos, H. (2013). Changes in extended shelf life of cassava roots during storage in ambient conditions. Postharvest Biology and Technology. Volume 86, December 2013, pp. 520–528.

Sankat, C. K. (2013). Agribusiness Essential for Food Security: Empowering Youth and Enhancing Quality Products. 30th West Indies Agricultural Economics Conference, 30th June – 6th July, 2013, Port of Spain, Trinidad.

Stewart, V. (2014) Cassava Replacing Wheat Flour; Proceedings of the Regional Conference on Cassava in the Caribbean and Latin America, Barbados, February 10-12. 2014. FAO/UWI/CLAYUCA. Pages 45-46.

Titus P (2014) Tobago Experiences with Cassava Development; Proceeding of the Conference on Cassava in the Caribbean and Latin America, Barbados, February 10-12, 2014. FAO/UWI/CLAYUCA. Pages 50- 51.

Titus P, Lawrence J and Reid N. (2013) Strengthening the food basket of the Caribbean region: CARDI's contribution to the development of the cassava industry over the past three decades, rev edn. St Augustine, Trinidad and Tobago: Caribbean Agricultural Research and Development Institute. September 2013 (revised).

http://www.cardi.org/wp-content/uploads/downloads/2014/03/CARDI-contribution-to-development-Cassava-industry-over-past-3-decades.pdf

Uchechukwu-Agua, A. D., Oluwafemi, J. C., Linus Opara, U. (2015). Postharvest Handling and Storage of Fresh Cassava Root and Products: a Review. Food and Bioprocess Technology. Volume 8, Issue 4.

Vernimmen, P., Quiry, P., Dallocchio, M., Le Fur, Y., Salvi, A. (2005). Corporate Finance Theory and Practice. John Wiley & Sons Ltd. ISBN-13 978-0-470-09225-5.

Wenham, J. E. (1995) "Post-harvest deterioration of cassava—a biotechnology perspective," FAO Plant Production and Protection Paper 130. FAO, Rome, Italy, 1995.

World Bank (2012), Agricultural Risk Management in the Caribbean: Lessons and Experiences 2009-2012. http://documents.worldbank.org/curated/en/2012/10/17394045/agricultural-risk-management-caribbean-lessons-experiences-2009-2012

WTO (2012). WTO List of Net Food-Importing Developing Countries for the Purposes Of The Marrakesh Ministerial Decision on Measures Concerning The Possible Negative Effects of the Reform Programme on Least-Developed and Net Food-Importing Developing Countries. https://docs.wto.org/dol2fe/Pages/FE_Search/FE_S_S006.aspx?Query=(@Symbol=%20g/ag/5*%20)&Language=ENGLISH&Context=FomerScriptedSearch&languageUIChanged=true#