AGROECOLOGY ASSESSMENT OF AGRICULTURE PRODUCTION SYSTEMS JAMAICA

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Acronyms

ABIS	Agriculture Business and Information System
BEEP	Banana Export Expansion Programme
CASE	College of Agriculture Science and Education
CIB	Coffee Industry Board
CLR	Coffee Leaf Rust
EUBSPRDP	European Union Banana Support Programme-Rural Diversification Programme
FAO	Food and Agricultural Organisation of the United Nations
GAP	Good Agricultural Practice
GDP	Gross Domestic Product
GOJ	Government of Jamaica
HACCP	Hazard Analysis and Critical Control Point
IPM	Integrated Pest Management
JAREECH	Jamaica Rural Economy and Ecosystems Adapting to Climate Change
JMD	Jamaica Dollars
JOAM	Jamaica Organic Agriculture Movement
JPS	JAMAICA Public Service
MOAF	Ministry of Agriculture and Fisheries
NEPA	National Environment and Planning Agency
NFAP	National Forestry Action Plan
NGO	Non Governmental Organisation
PA	Protected Agriculture
PIOJ	Planning Institute of Jamaica
PROPEL	Promotion of Regional Opportunities for Produce through Enterprises and Linkages
RADA	Rural Agriculture Development Authority
SIA	Sugar Industry Authority
SHB	Small Hive Beetle
SME	Small And Medium Enterprises
STATIN	Statistical Institute of Jamaica
WMU	Watershed Management Units

BACKGROUND

The Food and Agricultural Organisation of the United Nations (FAO) through its global work has been providing opportunities for dialogue on agroecology including the examination of production systems and sharing of experiences. This has resulted in the identification of a number of commonalities between regions and across different approaches to agroecology. This is to encourage the adoption and improvement of agroecological approaches to farming and the strengthening of the livelihoods of people around the world. The Caribbean region, with its strong history in farming and a need to boost its level of food security in the face of climate change and economic challenges, is being targeted to strengthen its agroecological approach to agriculture.

The FAO is therefore supporting the Caribbean by facilitating initial research and consultations at country and regional levels. Three countries in the region, Trinidad and Tobago, St, Lucia and Jamaica are the initial focus and the resulting findings will be validated at a regional level through consultations. The final outcome will be a methodological approach to agroecology in the Caribbean region towards strengthening local production systems in general and healthy and sustainable lifestyles of the people in particular.

The purpose of this report is to present an overview of the agricultural production and marketing systems in Jamaica and agroecological practices in particular. The information in the report will be used to further identify challenges and ideas through consultations at the national and regional levels to inform the development of the proposed methodology for agroecology in the Caribbean.

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CHAPTER I

1 INTRODUCTION

1.1 WHAT IS AGROECOLOGY?

Throughout the world land use has intensified as a result of the actions of humankind on natural ecosystems, converting them for their own purpose. Over the years, increases in the human population coupled with economic globalization have increased the rate of conversion and degree of intensification of how land is utilized. As a consequence, land use intensification has contributed to loss of productivity, biodiversity declines, and depleted ecological function(McGranahan, 2014).

Today, more than 75 per cent of Earth's terrestrial area has been reshaped into human-dominated biomes (Ellis and Ramankutty, 2008; Klein Goldewijk and Ramankutty, 2004). In meeting the increased demand for agricultural products substantial land-use changes will be required (McGranahan, 2014). This holds true for small island states like Jamaica with fragile ecosystems that must be conserved from degradation hence the complex objective of increasing agricultural production while decreasing the environmental footprint of agriculture. These complex objectives will require more landscapes to provide multiple functions. In other words, ecosystems previously set aside as natural reserves for biodiversity might need to contribute more human-oriented functionality while agricultural areas will need to foster greater ecosystem services and biodiversity (McGranahan, 2014).

We are now at a cross roads in the Caribbean region and must decide whether the protection of a fragile ecosystem and sustainable practices must be at the heart of our future agricultural systems. If so, how then can we integrate sustainable agroecological practices into a diversity of farming systems from plantations to small family farms. Our current food supply system separates most people from their sources of food and from the production environment (Francis *et al.*, 2003),however by integrating agroecological principles we will need to increase the involvement of persons in the production of their own food and also ensure improved availability and sustainable access to highly nutritious foods in adequate quantities.

There is a growing body of evidence that the integration of agroecological principles into agriculture production systems is the path for transformation to sustainable food systems, while making better use of and conserving natural resources and biodiversity, increasing resilience of production and income, enhancing social equality and ensuring nutritional diversity. Agroecology has been defined as "the use of ecological principles for the design of agricultural systems" (Silici, 2014), however it is increasingly recognized that agroecology also takes into account its relationship with economic and social dimensions in the food system. Agroecology offers more than a "design framework for sustainable agroecosystems" (Silici, 2014). The focus should be on applying agroecological principles which are in alignment with the general elements of a sustainable food system that focuses on the uniqueness of each place and are solutions appropriate to its resources and constraints. This approach goes beyond production practices and immediate environmental impacts at the field and farm level (Francis *et al.*, 2003).

Agroecology has three facets (Silici, 2014):

- As a scientific discipline involving the holistic study of agro-ecosystems, including human and environmental elements.

- As a set of principles and practices to enhance the resilience and ecological, socio-economic and cultural sustainability of farming systems and
- As a movement seeking a new focus on agriculture and its relationships with society.

Agroecology has developed as an alternative and a form of resistance to the industrial model of agriculture that focuses on simplification, industrialization, monoculture, and export markets. The agroecological foundations imbedded in traditional knowledge, cultural expression, and long-term farming experiences have created this resistance (Gliessman, 2017).

The recent interest in agroecology is resulting in the development of education, research, and training programmes, as well as public policy to promote agroecology in some countries. Spain, for example, has a long history of development of agroecology with its interdisciplinary roots in both the natural and social sciences, its commitment to social change, and the important role it has played in training many of the agroecologists who have led the agroecological movements in Latin America (Gliessman, 2017).

In the context of climate change and the growing concerns for more healthy food systems, agroecology is gaining momentum as information becomes more available on anecdotal and case study evidence of its multiple benefits, from climate resilience to farm productivity (Silici, 2014). Silici (2014) states that the growing body of evidence does reveal agroecology's multiple advantages over conventional high-external input farming such as:

- Its multi-functional approach to farming (Table 1.1) and capability of meeting environmental, economic and social needs.
- Its greater environmental sustainability and resilience, especially in marginal areas subject to environmental degradation and extreme climatic events, and higher agrobiodiversity.
- Its ability to support farmers' food sovereignty, reducing their dependence on costly and sometimes difficult-to-access chemical inputs.
- Its higher overall productivity of the farm achieved through a diverse range of agricultural products and environmental services, which reduce overall risks of failure in the long term.

Yet its implementation through public agricultural policies, research and extension in the Caribbean region is somewhat limited.

Table 1.1 Examples of agroecological practices (Silici 2014)

- Conservation tillage: no or minimum tillage improves soil structure – including aeration and water infiltration and retention capacity – and organic matter.
- Crop rotation and fallowing: nutrients are conserved from one season to the next, and the life cycles of insect pests, diseases, and weeds are interrupted.
- Mixing crops in a single plot, such as intercropping and poly-cultures: biological complementarities improve nutrient and input efficiency, use of space and pest regulation, thus enhancing crop yield stability.
- Cover crops and mulching: reduce erosion, provide nutrients to the soil and enhance biological control of pests.
- Crop-livestock integration, including aquaculture: allows high biomass output and optimal nutrient recycling, beyond economic diversification.
- Integrated nutrient management, such as use of compost, manure and nitrogen-fixing crops: allows the reduction or elimination of the use of chemical fertilisers.
- Biological management of pests, diseases and weeds, such as integrated pest management, push and pull methods and allelopathy: decrease long-term incidence of pests and reduce environmental and health hazards caused by the use of chemical

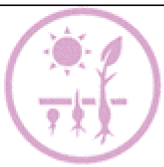
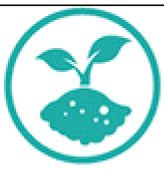
control.

- Efficient water harvesting (especially in dryland areas) such as small-scale irrigation allows to reduce the need for irrigation while increasing its efficiency.
- Manipulation of vegetation structure and plant associations: improves efficiency of water use as well as promoting biodiversity.
- Agro-forestry, especially the use of multifunctional trees: maintains and improves soil fertility through nitrogen fixation, enhances soil structure and modifies the microclimate.
- Use of local resources and renewable energy sources, composting and waste recycling: allows a reduction in the use of external inputs as well diminishing pressure on the natural resource base.
- Holistic landscape management: around field perimeters (windbreaks, shelterbelts, insect strips and living fences), across multiple fields (mosaics of crop types and land-use practices) and at the landscape to-regional scale (river buffers, woodlots, pastures and natural or semi-natural areas).

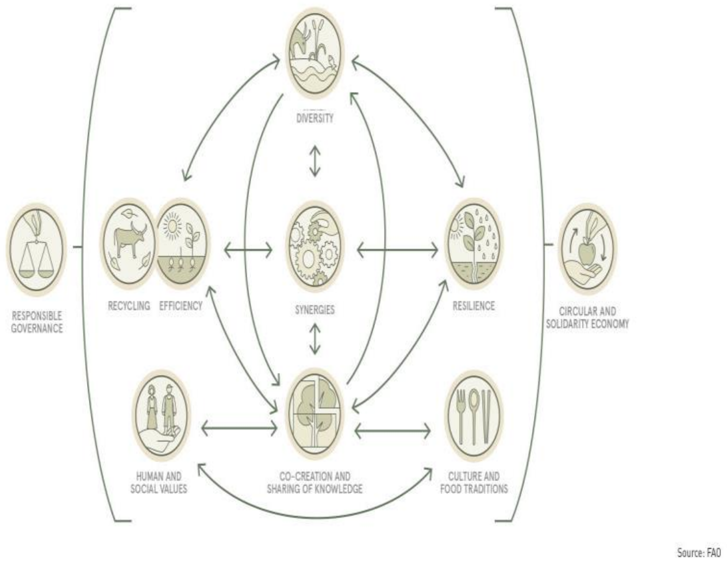
1.2 FAO TENETS OF AGROECOLOGY

The FAO has defined ten key elements from the general principles articulated for agroecology. These elements are characterized by their alignment with principles that should form part of a sustainable food system (FAO, 2017). Table 1.2 presents the ten elements of Agroecology as outlined by FAO and a diagrammatic representation of how they are interlinked and interdependent.

Table 1.2 ***FAO 10 Elements of Agroecology*** *(FAO, 2018)*

 Efficiency	Optimizing the use of natural resources within farming systems. Using inputs more efficiently means that fewer external resources are needed and the negative impacts of their use will be reduced.
 Resilience	Diversified agroecological systems are more resilient – they have a greater capacity to recover from disturbances including extreme weather events such as drought, floods or hurricanes, and to resist pest and disease attack.
 Diversity	Maximising species and genetic resources across time and space within food systems. Diversity in a farming system is a condition of having different elements working in a harmonic way, each providing a specific ecological function.
 Co-creation of Knowledge	Agroecology depends on context-specific knowledge. It does not offer fixed prescriptions – rather, agroecological practices are tailored to fit the environmental, social, economic, cultural and political context. The co-creation and sharing of knowledge plays a central role in the process of developing and implementing agroecological innovations to address challenges across food

	systems including adaptation to climate change.
Recycling	Reutilizing nutrients and biomass existing inside the farming system and increased use of renewable resources promoting a healthy food system. Agroecology is based on the principle that the flow and cycling of nutrients within a farming system should enhance the system through biological means by different components of the system.
Synergies	Designing food systems with an optimal crop/animal assemblage, while promoting ecological functions for self-regulation in foods system. Great strength can be drawn from building on synergies in food systems, including synergies between people and in managing different components of the system.
Human and Social Value	Agroecology places a strong emphasis on human and social values, such as dignity, equity, inclusion and justice all contributing to the improved livelihoods dimension of the SDGs. It puts the aspirations and needs of those who produce, distribute and consume food at the heart of food systems.
Circular Economy	Local solutions and local markets creating virtual cycles. Incomes (monetary and non-monetary) need to be fair and sufficient to sustain livelihoods, ensure food security and well-being and fair price.
Culture and Food Traditions	Agriculture and food are core components of human heritage. Hence, culture and food traditions play a central role in society and in shaping human behaviour.
Responsible governance	Agroecology calls for responsible and effective governance to support the transition to sustainable food and agricultural systems. Transparent, accountable and inclusive governance mechanisms are necessary to create an enabling environment that supports producers to transform their systems following agroecological concepts and practices.

Linkages between the ten elements of agroecology	

1.3 METHODOLOGY

1.3.1 SOURCES OF DATA

Data from a wide variety of sources were used to compile the baseline data for Jamaica. The main data sources were obtained from the Data Bank and Evaluation Division of the Ministry of Agriculture, publications of the Statistical Institute of Jamaica (STATIN), the Planning Institute of Jamaica (PIOJ), Agriculture and Sub Sector Censuses, Competent Authorities and Peer reviewed articles inclusive of online data sources.

1.3.2 AGROECOLOGICAL ASSESSMENT

Case studies were identified which highlighted the application of agroecological principles to show systems in transition or have transitioned to sustainable production systems. The assessment was based on the presence or absence of the following and categorized according to the ten elements of agroecology as defined by FAO:

1. **Efficient use of resources** – Agroecological systems are characterised by cyclical systems, that minimise the use of external inputs by integrating crop and animal systems to make efficient use of natural resources(Laughton, 2017). For example, chemical fertilisers are replaced by composted plant waste or animal manures, and few, if any, pesticides and herbicides are used.

2. **Biodiversity and ecosystem services** – Includes a number of practices common at small scale, agroecological farms that enhance functional biodiversity, which keep agricultural pests and diseases at manageable levels (Science for Environment Policy, 2015; Silici, 2014).

3. **Soil management** – Practices such as zero or minimum tillage, use of permanent beds, mulches or shallow cultivations with machinery, have multiple beneficial impacts on the soil including a reduction in soil erosion, soil compaction, and germination of weed seeds. The combination of livestock with arable and horticultural crops on mixed farms has further

benefits for soil, compared to pure arable farms, adding animal manure to enhance soil health, fertility and carbon sequestration, although use of green manures can have the similar effect (IPES-Food, 2016).

CHAPTER 2

2 ENVIRONMENTAL PROFILE OF JAMAICA

2.1 GEOGRAPHY:

Jamaica as the third largest English-speaking island in the Caribbean has a total landmass of 10,991 square kilometres (CSGM, 2017). The island is surrounded by the warm waters of the Caribbean Sea and is located in the tropics and is centred on latitude 18°15' N and longitude 77°20' W which is about 4.5 degrees south of the Tropic of Cancer or about midway between the southern tip of Florida and the Panama Canal (CSGM, 2017). The island is characterized by a mountainous topography, the range of which runs east-southeast to west-southwest along the centre of the island, surrounded by a flat narrow coastal plain (see Figure 2.1). Three landform regions can be identified: the eastern mountains, the central valleys and plateaus, and the coastal plains. Most of the island is over 300 m with steep slopes giving rise to short, fast-flowing rivers. The topography rises to its highest extent in the eastern section of the island with the highest point in the Blue Mountains at 2 256 m (CSGM, 2017). Jamaica is administratively divided into three counties Cornwall, Middlesex and Surrey with further divisions into a total of 14 parishes (see Figure 2.1).

2.2 CLIMATE:

2.2.1 RAINFALL

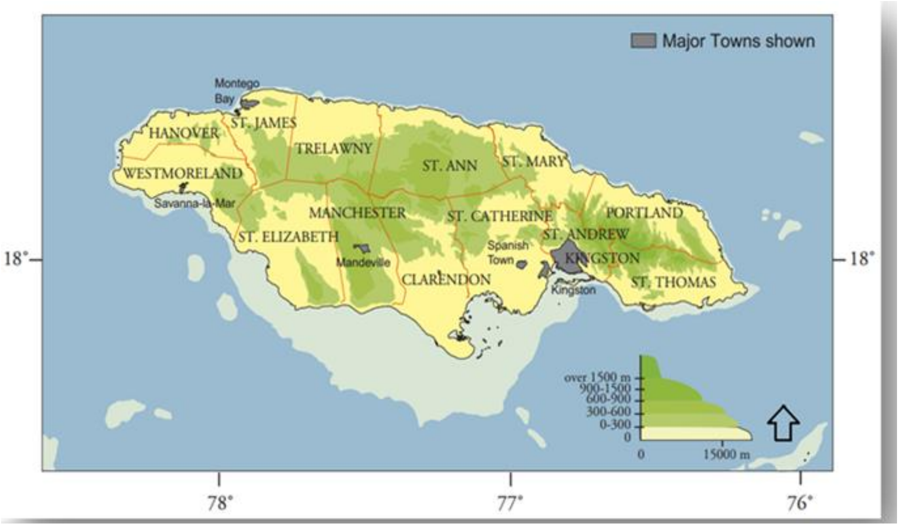
The Blue Mountains and the northeast coast usually receive the highest annual rainfall, based on their location in the direct path of the northeast trade winds. The Northeast coast of Jamaica receives the highest amount of rainfall which is in excess of 330 cm. The southern coast usually receives the least rainfall, due to a rain shadow region on the southern side of the island. There are distinct wet and dry seasons where the latter is represented by periods of rainfall less than 650mm. The two wet seasons are in May to June and September to November and the driest period is usually from December to March (as shown in Table 2.1, Figure 3 and Figure 4). Jamaica's mean annual rainfall been noted to be approximately 200cm. Projected rainfall changes suggest that the mid 2020s will see 0 to 2 percent less rainfall than the annual mean. The 2030s will be up to 4 percent drier, the 2050s up to 10 percent drier, while by the end of the century the country as a whole may be up to 21 percent drier for the most severe Representative Concentration Pathways (RCP) scenario (RCP8.5) (CSGM, 2017).

2.2.2 TEMPERATURE

Temperatures are fairly constant all year round with fluctuations associated with afternoon showers and frontal systems. The warmest months are June to August and the coolest months are November to December. The average annual temperature is 27.40 °C with mean daily temperatures ranging from a seasonal low of 26 °C in February to a high of 30 °C in August. However, the mean annual temperatures for Jamaica is projected to increase by between 0.49° C to 0.57 °C by the 2020s; 0.65 °C to 0.84 °C by the 2030s, 0.85 °C to 1.80 °C by the 2050s and 0.82 °C to 3.09 °C for 2081 to 2100 using a 1986 to 2005 baseline over all four RCPs (CSGM, 2017).

In Jamaica due to the topography of the land there are diurnal and altitudinal variations. On average, the temperature changes by 2 °C with every 300 m change in altitude. These factors contribute to diverse microclimates on the island making it suitable for the growth of a diverse range of crops. For example, average temperatures in the coastal areas range from 22 °C to 30 °C. This contrasts to the average temperatures in the hilly interior of 18 ^{o}C. Similarly, average rainfall in the hilly eastern interior may exceed 5 000 mm compared to the coastal areas of the south that receive less than 1 200 mm (see Figure 2.2). The hilly interior is also characterized by persistent cloud cover that results in mean sunshine averaging less than 6 hrs per day compared to the coastal areas where it is close to 8 hrs with less persistent cloud cover (Eitzinger *et al.*, 2011).

Figure 2.1 Political boundaries, major towns and topographic elevation of Jamaica



Source: http://dipecholactools.org/jamaica/4-national-context/4-1-physical-environment/4-1-2-physiography/

Figure 2.2 Distribution of mean rainfall (1971-2000) (Meteorological Services of Jamaica, 2018)

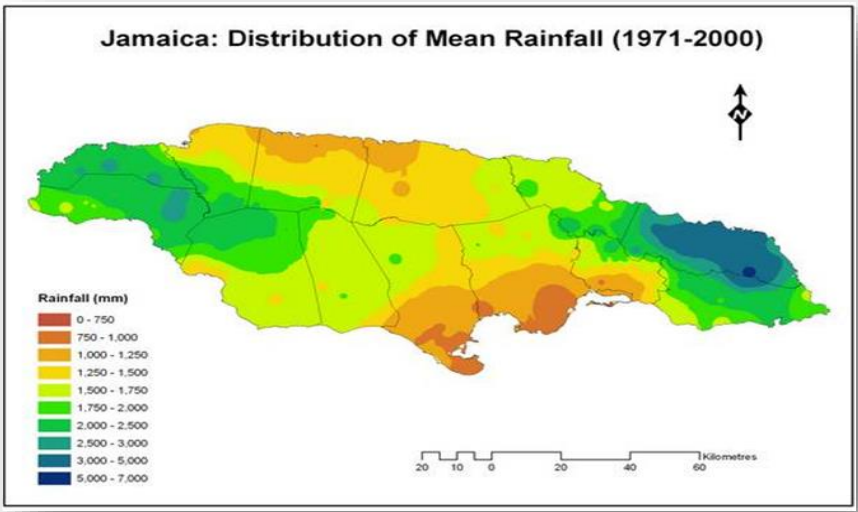


Table 2.1. Baseline 30yr mean monthly rainfall (mm) data by parish 1971 to 2000

Parishes	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Clarendon	45	40	56	68	139	94	57	113	171	209	111	49	1153
Hanover	90	109	104	153	309	283	234	269	292	300	141	90	2378
KSA	70	72	67	93	152	98	65	147	206	241	160	79	1447
Manchester	61	64	91	168	235	115	92	164	203	257	141	58	1649
Portland	346	264	209	263	292	206	170	244	243	361	475	366	3439
St. Ann	103	82	71	93	158	95	67	96	103	169	168	117	1324
St. Catherine	53	55	61	91	156	110	85	129	172	188	115	62	1276
St. Elizabeth	66	78	99	175	262	127	131	205	229	263	124	60	1819
St. James	67	59	60	95	189	161	125	161	222	200	114	96	1549
St. Mary	181	136	108	141	148	117	82	125	141	170	260	209	1818
St. Thomas	94	81	68	92	162	170	120	180	255	287	217	116	1843
Trelawny	92	83	61	89	141	93	76	106	137	160	121	116	1275
Westmoreland	70	80	88	139	274	216	220	274	254	254	136	74	2081
Total	**1338**	**1203**	**1143**	**1660**	**2617**	**1885**	**1524**	**2213**	**2628**	**3059**	**2283**	**1492**	**1773.15**

Source: Meteorological Service, 2018

Figure 2.3 Baseline 30 year mean monthly rainfall by parish 1971-2000

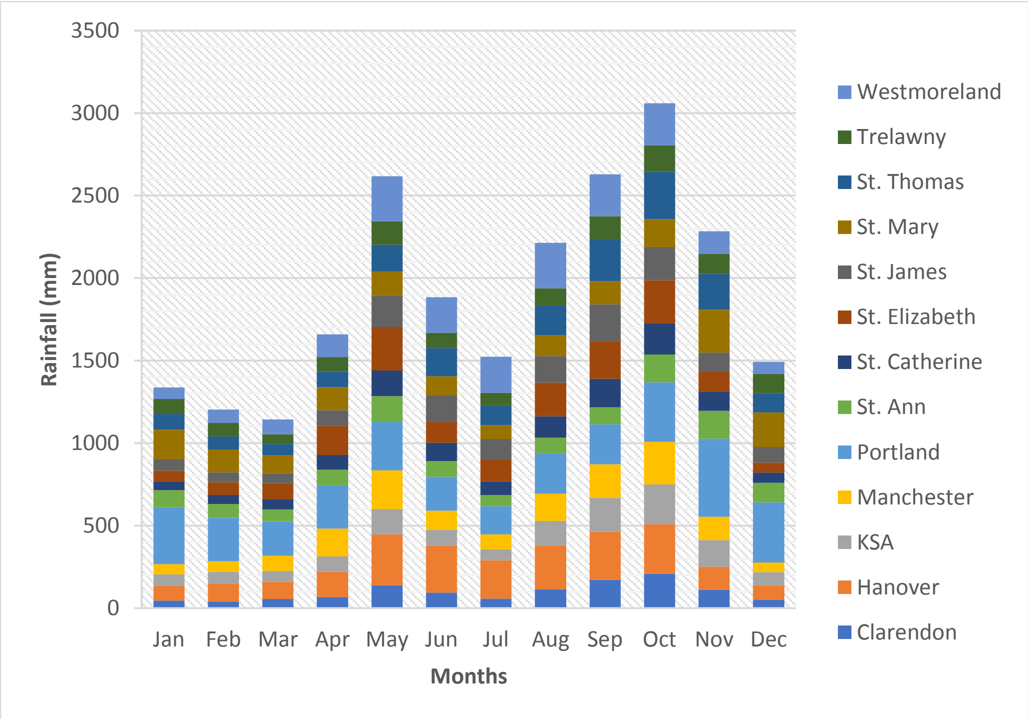


Figure 2.4 Jamaica 20 year mean monthly rainfall 1996-2015

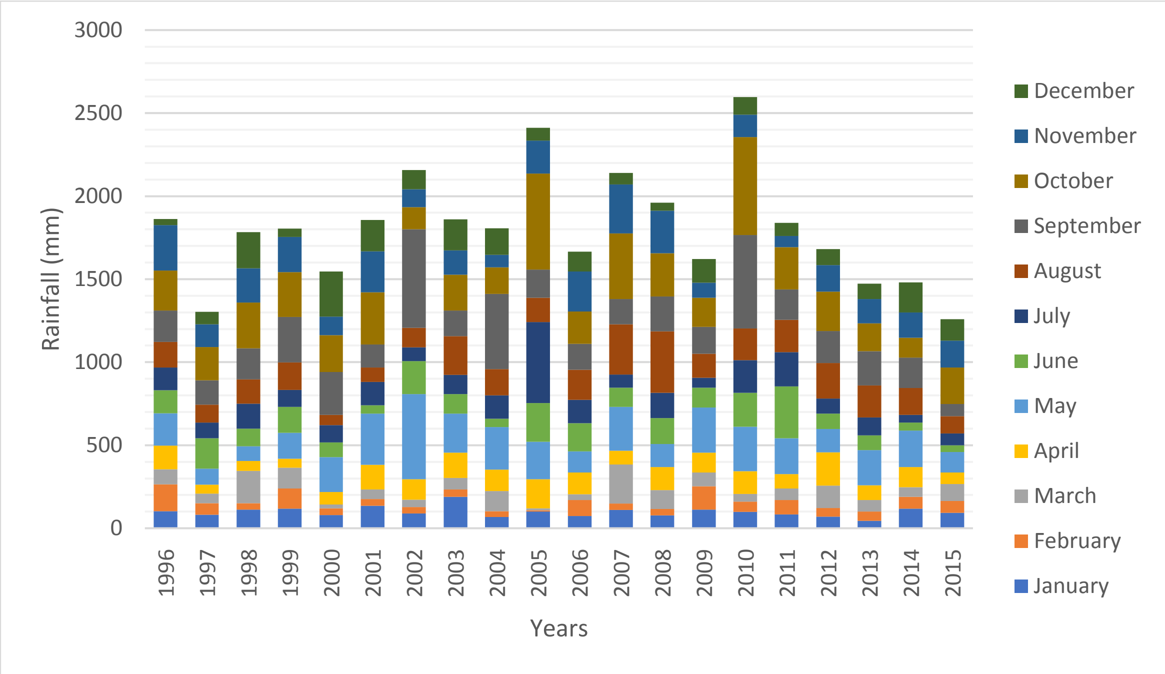
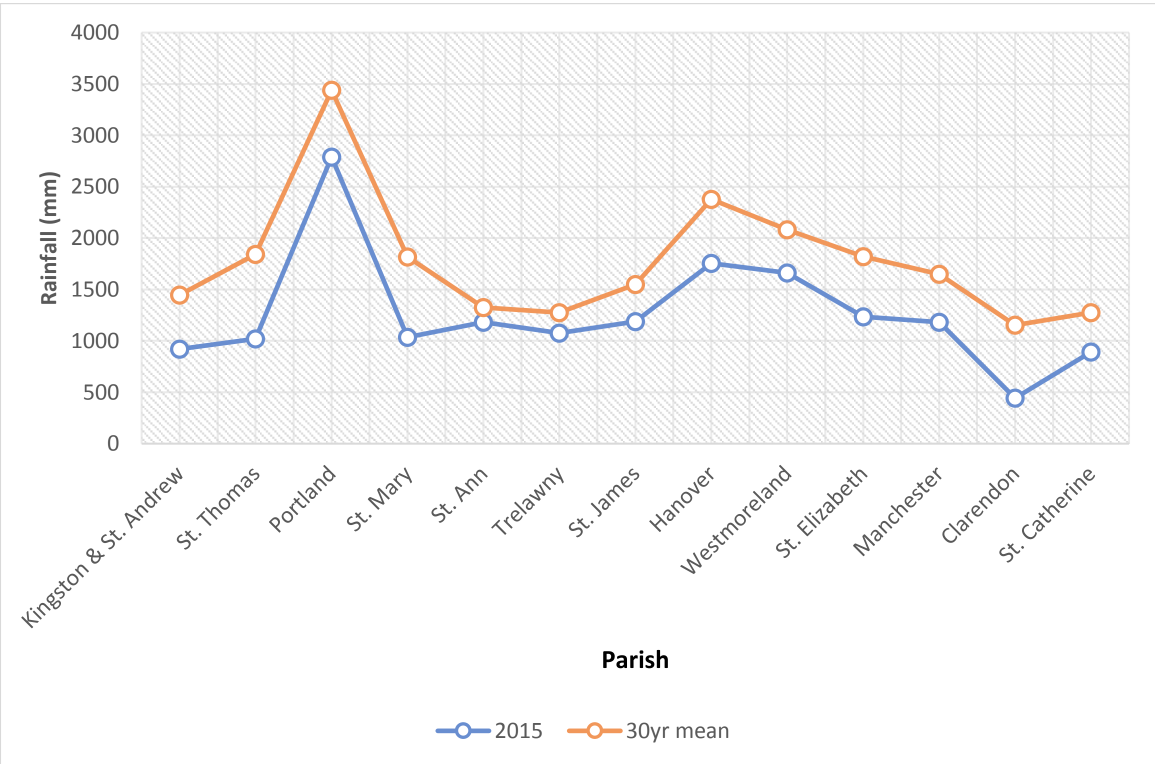


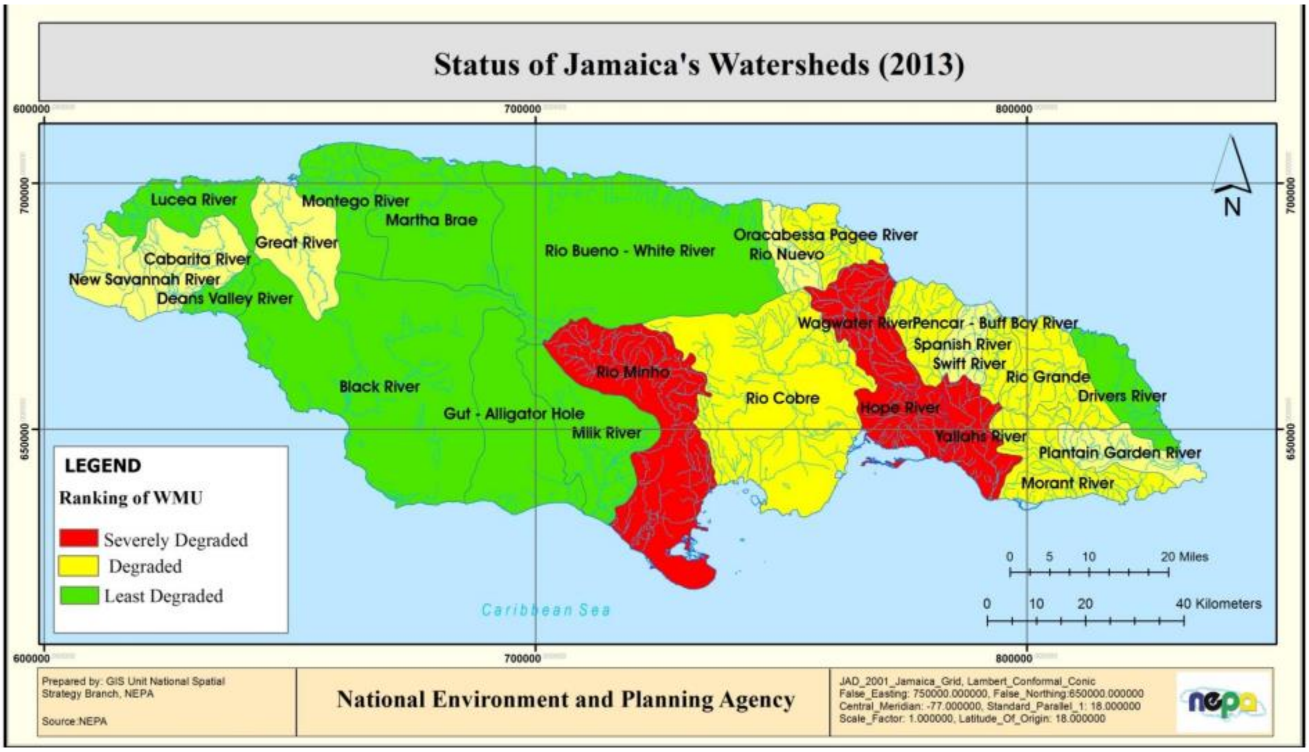
Figure 2.5 Mean annual rainfall 2015 against 30 year mean rainfall 1971-2000 by parish



2.3 WATERSHED RESOURCES

Jamaica is divided into 26 Watershed Management Units (WMUs) containing over 100 streams and rivers. These WMUs are essentially composites of watersheds that fall within 10 hydrological basins or regions (National Environment and Planning Agency (NEPA), 2013). The results of routine monitoring of WMUs conducted by NEPA in 2008 and 2009 classified 10 watershed units as being in critical condition (see Figure 2.6) namely, the Pencar/Buff Bay Rivers, Morant River, Oracabessa/Pagee Rivers, Swift River, the Rio Cobre and the Rio Grande, with the Hope River, Wagwater River, Yallahs River and the Rio Minho as the most severely degraded (NEPA, 2011). The remaining 16 watershed units were listed as either less degraded or least degraded.

Figure 2.6 Jamaica Watershed Resources



Source: NEPA, 2013

2.4 FOREST COVER

The current state of land cover in Jamaica indicates that approximately 40 percent is forest (as shown in Table 2.2 and Figure2.7). Almost 19 percent of the country is classified as having mixed land use (a combination of any of the forest broad classification with that of non-forest) and the remaining 41 percent of the mainland is classified as non-forest inclusive of bamboo (which in 1998 was considered as contributing to forest cover), crop plantations, quarries, water bodies, and infrastructure. (NEPA, 2013), (see Table 2.2). Jamaica's Closed Broadleaf forest has decreased over the last decade, due to human activity. Some forest categories such as the dry forests have declined considerably over the last decade.

Table 2.2 Change in forest cover in Jamaica 1998 to 2013 ('000 hectares)

National Classes of Forest (in 2013)	1998	Land use (%)	2013	Land use (%)	LU Change in 2013	% Loss/Gain
Forest Land Use						
Closed Broadleaf	88.2	8.0	84.6	7.7	- 3.6	- 4.1
Disturbed Broadleaf	174.8	15.9	175.3	16.0	0.5	0.3
Short Open Dry	12.1	1.1	2.6	0.2	- 9.5	- 78.5
Tall Open Dry	42.0	3.8	37.6	3.4	- 4.4	- 10.5
Bamboo*	3.0	0.3	-	-	-	-
Mangrove forest	9.7	0.9	9.8	0.9	-0.1	1.0
Swamp/Riparian forest	2.2	0.2	0.1	0.0	- 2.1	- 95.5
Forest Plantation**	8.2	0.7	8.3	0.8	0.1	1.2
Secondary Forest***	-	-	123.0	11.2	123.0	-
Total (change in forest cover)	**332.0**	**30.3**	**441.3**	**40.2**	**109.3**	**32.9**
Mixed Land Use						
Bamboo and Fields	29.0	2.6	-	-	- 29.0	-
Bamboo & Disturbed Broadleaf	12.7	1.2	36.8	3.4	-24.1	189.8
Bauxite & Disturbed Broadleaf	2.9	0.3	-	-	- 2.9	-
Fields & Disturbed Broadleaf	118.0	10.8	166.4	15.2	48.4	41.0
Fields/Disturbed Broadleaf& Pine plantation	8.2	0.7	-	-	- 8.2	-
Disturbed Broadleaf & Fields	166.0	15.1	-	-	- 166	-

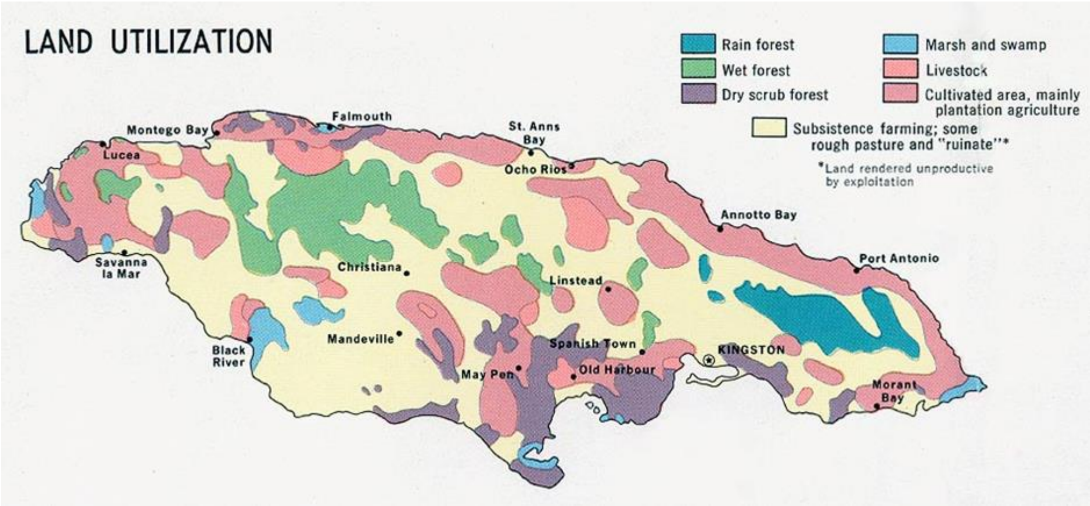
Source: NEPA, 2013

2.5 AGRICULTURE LAND CLASSIFICATION

Land capability classes for Jamaica were derived following the identification of soil types which were characterized and classified and their suitability for cultivation of different crops assessed. Land capability classification was considered the first step towards proper use and conservation of the land. It depends mainly on the extent to which permanent limitations result in safe use limits. Slope of the land for example is a major limiting factor to cultivation in Jamaica. Land capability classes refer mainly to physical properties of the land and are only a part of land use planning and conservation farm planning in which the latter takes into consideration such factors as cropping systems and management (Government of Jamaica (GOJ), 1987).

Lands are classified into two major categories, suitable for cultivation and not suitable for cultivation (GOJ, 1987). A third class, marginal, refers to land which is suitable only for limited cultivation. Although much of Jamaica's land area is suitable for some form of agriculture, productivity limitations are imposed by steep slopes, imperfect drainage and lack of water. Jamaica's land surface consists of plains, plateaus and mountains, a topographical structure with serious constraints for agricultural activities because of steep slopes and resultant soil erosion problems. These constraints have not daunted farmers who farm greater than 50 percent of Jamaica's land surface (see Figure 2.7).

Figure 2.7 Land utilization map of Jamaica



Source: (http://www.gifex.com/jamaica_maps/Jamaica_Land_Utilization_Map.htm)

CHAPTER 3

3 AGRICULTURE SECTOR

Jamaica, can to be characterized by a dual agricultural system, denoted by monoculture large scale plantation style agriculture existing side by side with small scale mixed farming agriculture. The former comprises large plots of relatively flat lands highly suitable for mechanized agricultural production. These farms occupy close to 40 percent of fertile coastal farmland and are often the source of the island's traditional export crops of sugar cane and banana. Coffee, citrus, cocoa and pimento, four other traditional export crops, are grown as monocultures in hilly areas, for the export market.

The small-scale sector, defined as those with farms of approximately 2 hectares or less ,constitute just under 80 percent of the farming community accounts for the greater proportion of farm labour and provides a wide range of crops for the domestic market, including tubers, banana and plantain, legumes and a wide range of tropical fruits and vegetables. The small-scale sector emerged significantly after the slaves were freed and they withdrew from the estates to plant their own plots on the outskirts of the estates (Guido et al., 2018). These marginal farm lands are often located in the rugged interior of the island in ecologically sensitive areas, on steep slopes in cleared forests or on other land that are generally less suitable for farming. Although much of Jamaica's land area is suitable for some form of agriculture, productivity limitations are imposed by steep slopes, imperfect drainage and lack of water.

Traditionally an agroecosystem, particularly one managed intensively is characterized as having a simpler species composition and simpler energy and nutrient flows than "natural" ecosystem. Likewise, agroecosystems are often associated with elevated nutrient input, much of which exits the farm polluting the environment of connected ecosystems not directly engaged in agriculture. Small farmers in Jamaica operate traditional farming systems such as de facto organic farming, intercropping and mixed cropping, and mixed livestock and crops. They also use modern systems such as greenhouse technology. Production practices include sustainable practices such as integrated pest management, rainwater harvesting and micro irrigation. However, many crop farmers are dependent on the use of agro-chemicals, mainly fertilizers and pesticides, while livestock farmers use anti-biotics.

In general water for irrigation when necessary is a major constraint for most small-scale farmers. Rainfed agriculture is the common practice. While the challenges to access available water are most severe for hillside farmers such as those in Jamaica, the majority of small farmers are exposed to the potential risk of crop loss and poor pasture performance due to drought conditions.

Small farmers employ practices to enhance the efficient use of the limited rainwater stored, including the use of rain water harvesting coupled with micro-irrigation systems. Mulching is also quite popular especially on the dry plains in St. Elizabeth where guinea grass is used extensively as mulching material.

Most farmers have been exposed to good soil conservation and land preparation practices either through the Ministry of Agriculture, the Forestry Department or Non-Government Organizations. Most farmers use fertilizers and other agro - chemicals and most have been exposed to capacity building in food safety and fresh produce quality control. However, the extent to which the application of agroecology is practiced is perhaps not well documented except among project reports and studies by the department of geography at the University of the West Indies.

3.1 AGRICULTURE SUBSECTORS:

Jamaica's agricultural sector can be divided into the following sub-sectors:

a) Crop production

    a. Traditional export crops – sugar cane, bananas, coffee, citrus, cocoa, and pimento

    b. Non-traditional export crops – yam, sweet potato, dasheen and pumpkins

    c. Domestic crops – root crops, vegetables, cereals, fruits and pulses

b) Livestock production – poultry (broilers and layers, pigs, cattle and goat (for meat), dairy cows, and bees

c) Fish and Seafood (Marine, Tilapia, Conch)

d) Beekeeping and

e) Forestry

As part of its efforts to reduce the national food import bill and satisfy export demand for fine Jamaican produce, the Government has embarked on the following initiatives (Ministerial Paper, 2017):

- The identification of several strategic areas of growth in the sector, namely herbs and spices (onions, hot pepper, ginger, turmeric), roots and tubers (Irish potatoes and yams), beekeeping (honey), fruits (pineapple and fruit trees), small ruminants (sheep and goat meat) and aquaculture.
- The earmarking of eight (8) agroparks[1] for development. Under this initiative, the Government has leased lands with the requisite infrastructure to farmers/investors, who have the responsibility for working capital and agricultural inputs.

3.2 CONTRIBUTION TO GROSS DOMESTIC PRODUCT (GDP)

The Jamaican agriculture sector, including forestry and fisheries, contributed 7.3 percent to the national GDP in 2016 increasing from 6.6 percent in 2015 (STATIN 2017). Real value added for the agriculture, forestry & fishing industry grew by 13.5 percent in 2016. The higher value added was mainly due to increased output in the sub-industries of other agricultural crops, animal farming and traditional export crops (PIOJ, 2016). The growth in the industry was facilitated by more favourable weather conditions compared to 2015 when island-wide drought conditions negatively impacted production by lowering crop yields and curtailing planting activities. The group, other agricultural crops was weighted at approximately 56.0 percent of the industry followed by traditional export crops at 18.0 percent and livestock farming at 16.0 percent (PIOJ, 2016).

In 2017 agriculture output of Jamaica was affected by adverse weather conditions in the first half of the year due to heavy rains and flooding, with the domestic crop subsector being more severely impacted. The cumulative rainfall during the period January to November 2017 was 121 percent of the 30-year mean. The rains hindered the recovery efforts of crops requiring a longer maturation period, as well as short-term crops for which replanting was impeded (PIOJ, 2018).

[1] Agro-park is an initiative of the GOJ to establish agriculture holdings on under-utilised rural lands by persons interested in agriculture with the aim of facilitating import substitution, enhancing the agriculture supply chain and increasing food security

3.3 AREA UNDER PRODUCTION

The last agriculture census of Jamaica in 2007 had identified about 325 810 hectares of land under production which represented a decline of 81 624 hectares (about 20 percent) since 1996 as shown in Table 3.1. (STATIN, 2007).

Table 3.1 Agriculture Census of Area in Farms by Parish 1996 and 2007

Parish	2007		1996	
	Hectares	Percent of Total	Hectares	Percent of Total
All Jamaica	325,810	100.0	407,434	100.0
St Andrew	8,354	2.6	6,743	1.7
St Thomas	22,257	6.8	25,134	6.2
Portland	16,201	5.0	18,620	4.6
St Mary	20,890	6.4	32,232	7.9
St Ann	37,099	11.4	53,081	13.0
Trelawny	24,803	7.6	33,208	8.2
St James	13,893	4.3	16,166	4.0
Hanover	9,751	3.0	18,582	4.6
Westmoreland	35,241	10.8	40,140	9.9
St Elizabeth	30,022	9.2	38,759	9.5
Manchester	24,521	7.5	23,839	5.9
Clarendon	44,856	13.8	58,275	14.3
St Catherine	37,922	11.6	42,655	10.5

Source: STATIN, 2017

In 2014, 353 800 hectares of land was reported to be under production, a decline from 2007. However, data from the Agriculture Business and Information System (ABIS, 2018) has 472 205 hectares under production. Generally approximately 62 percent of the land in farming may be classified as active farm land; that is, land allocated to crops and pasture (STATIN,2017) (see Table 3.2).

The total number of farms recorded from the last agriculture census in 2007 was about 230 000, with the average farm size being about one hectare (STATIN, 2007). Approximately 85 per cent of the farms identified were less than five hectares. STATIN reported in 2015 that commercial producers, who held only 20 percent of the production units, represented 80 percent of the marketed output (STATIN, 2015).

Although representing a higher proportion of farmland in 2007, lands under crop production declined by over 23 000 hectares between 1996 and 2007. The approximately 154 500 hectares under crops in 2007 represented 47 percent of farmland. However, as of 2014 this had increased to 210 700 hectares (see Table 3.2). In relation to land in pasture, the 48 200 hectares reported in 2007 was just about 50 percent less than the approximately 95 600 hectares reported by STATIN (2017) in 1996. This further declined to 6 500ha in 2014 (see Table 3.2).

Table 3. 2 Area in Farming in Jamaica 2009 to 2014 ('000 hectares)

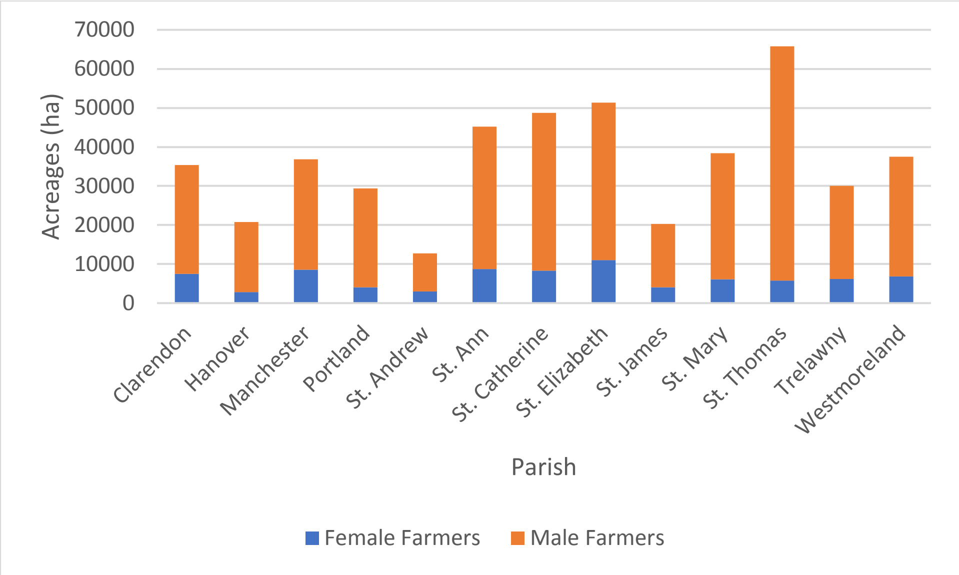
Category	2009	2010	2011	2012	2013	2014
1. Total Agricultural Land	393.1	383.7	374.4	365.3	362.3	353.8
1.1 Arable land	NA[2]	NA	NA	NA	NA	NA
1.2 Land under permanent crops	73.2	72.3	71.5	70.8	69.8	68.9
1.3 Land under permanent meadows and pastures	NA	NA	NA	NA	6.5	6.5
1.4 All other agricultural land, n. e. s.	138.6	138.7	138.7	138.8	138.9	141.8
1.5 Fallow agricultural land	181.3	172.7	164.2	155.7	147.1	136.6
2. Forest and other wooden land (including bamboo)	561.2	564	566.7	569.5	572.3	580.4
3. Built-up and related land	111.4	119	125.3	131.3	131.3	131.4
4. Wet open land	13.9	14.2	14.5	14.7	15	15.3
5. Open land without, or with insignificant, vegetation cover	15.7	14.2	14	13.9	13.5	13.5
Total land area	1 095.30	1 095.10	1 094.90	1 094.70	1 094.50	1 094.50
6. Water	3.8	4	4.2	4.4	4.6	4.6
Total area	1 099.10	1 099.10	1 099.10	1 099.10	1 099.10	1 099.10

Source: STATIN, 2017

In 2017, the parishes with the largest proportion of the total land in farming were in the parishes of St. Thomas, St. Elizabeth, St. Ann, Clarendon, Westmoreland and Manchester (ABIS, 2018). This picture has changed since the last agriculture census in 2007 (see Table 3.2) with St. Thomas being included in the top six with the largest area under production (as shown in Figure 3.1). This could be due to the increased area under dairy production in the parish by Serge Island dairies and agropark investments. The data also showed that in 2017 the majority of registered farmers were from the parishes of St. Elizabeth, Manchester, Clarendon, St. Ann, St. Catherine and St. Thomas. The parishes of St. Elizabeth, Manchester, St. Ann and Clarendon reported the greater proportion of farm lands under production by both men and women.

[2] NA – Not Available

Figure 3.1 Total acreages (ha) in production by parish and gender 2018



Data Source: ABIS, 2018

3.4 FARMER DEMOGRAPHICS:

Jamaica's agrarian landscape is typified by inequalities in land size and quality between small farmers and plantations. Large plantations and pastures dominate the fertile coastal plains while small farmers are confined mainly to the rugged interior on hillsides. Small farmers (those with 2 hectares and less) constitute some 85 percent of the farming community and produce mainly root crops, pulses, vegetables as part of a mixed cropping system and/or as part of an agroforestry system. A Promotion of Regional Opportunities for Produce through Enterprises and Linkages (PROPEL) study in 2015 reported that the local raw material supply base for agro-processing was mainly 200 000 small -scale (under 2 hectares) producers operating in a predominantly mixed cropping and rain-fed farming system. This base supplied approximately 150 active agro-processers operating in Jamaica. Small farmers are also engage in livestock rearing such as cattle, hogs, goats and poultry.

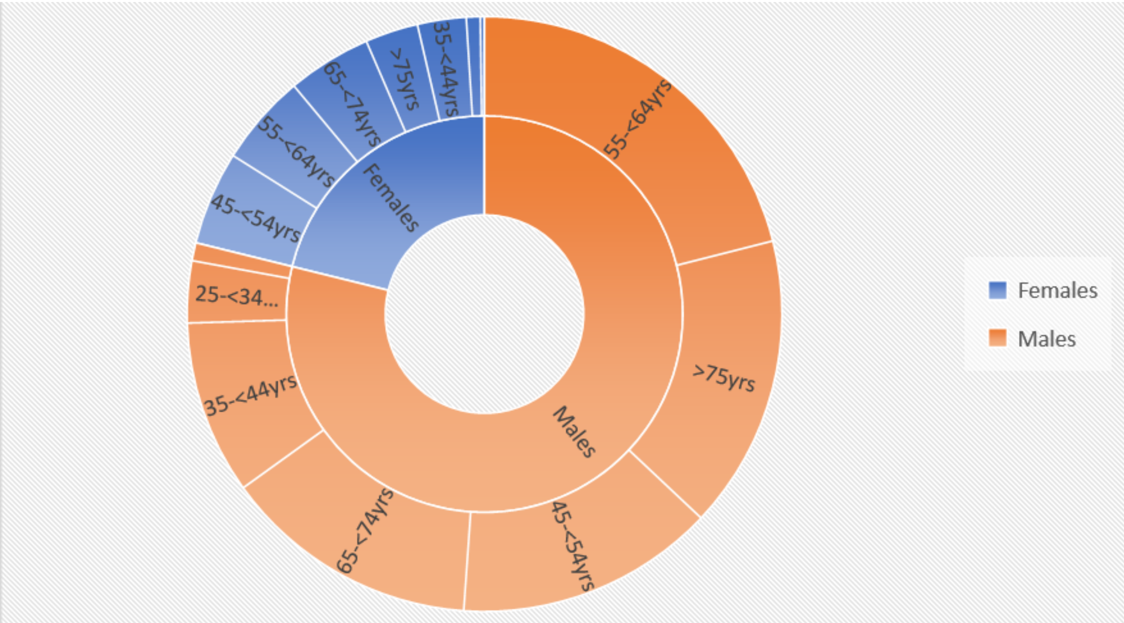
A few Larger farms (over than 25 hectares) specialize in vegetables, fruit crops and condiments and produce very little for the domestic market. Larger farms with 250 hectares of more account for less than one percent of the total number but occupy about 30 percent of farm lands producing primarily for export, sugar, coffee , pimento and to a lesser extent, citrus and cocoa. These farms are also engaged in livestock production of poultry, pigs, dairy and beef cattle.

3.4.1 GENDER AND AGE STATISTICS

The sector employed about 14.7 percent of the country's labour force (198 500 of the total labour force of 1 347 600 people in 2017) (STATIN, 2017). Approximately 146 700 males (74 percent) compared to 51 800 (26 percent) females were employed in the sector in 2017. It is worthy of note that in 2017 the agriculture sector reported the greatest increase in employment for women while being the largest employer of males by industry (PIOJ 2017).

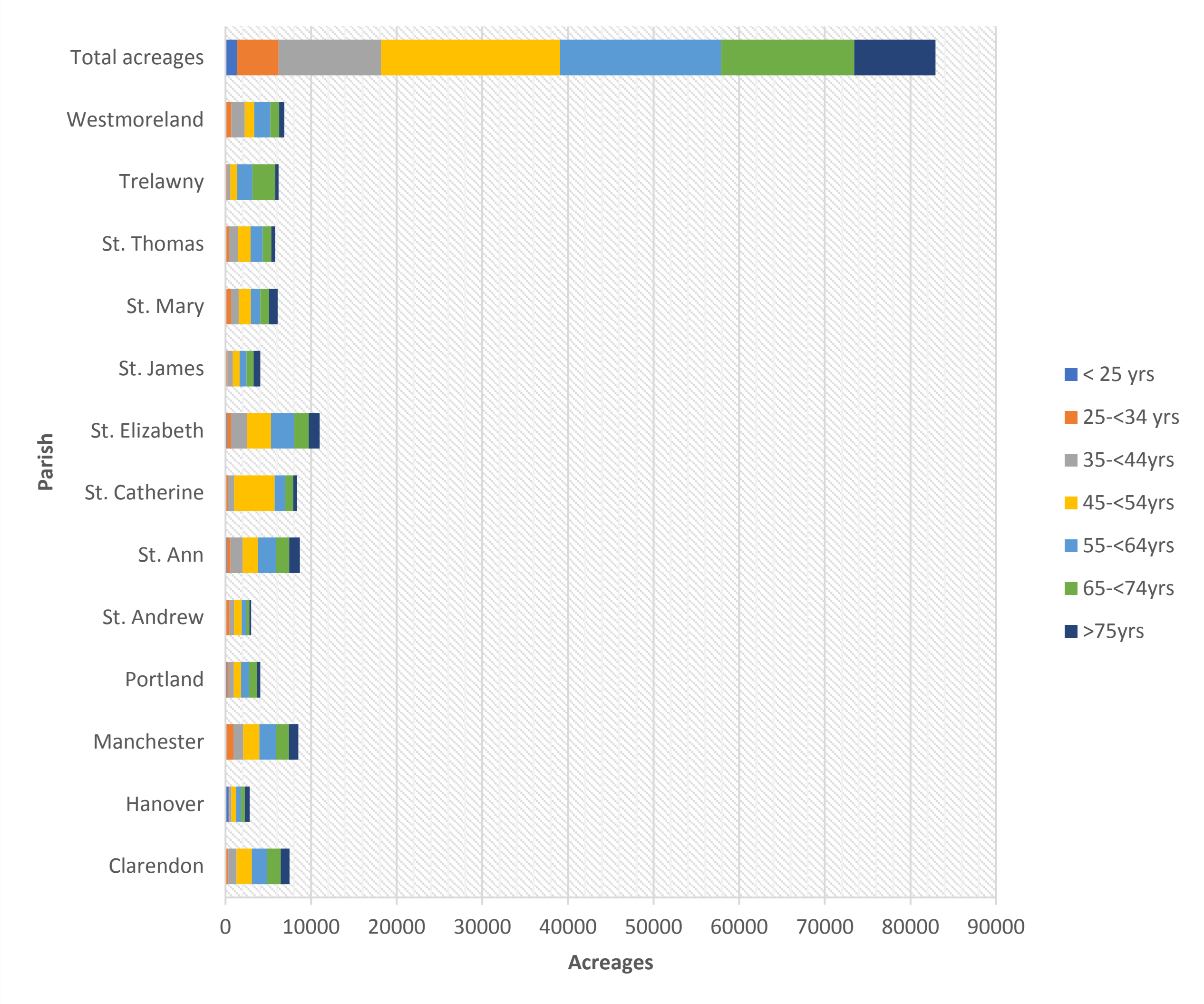
In 2018 the Rural Agriculture Development Authority (RADA) reported that 70 percent of registered farmers were men and 30 percent were women. (see Figure 3.2). The majority of male farmers were in the age group 55 to 64 years while the majority of female farmers were in the age group 45 to 54 years The data indicated that only nine percent of male farmers and four percent of female farmers less than age 44 years have acreages under production and this included youth between the ages of 18 to 25 years. The number of farmers less than 25 years was also in the minority (see Figure 3.3 and Figure 3.4). Women farmers were also involved in multi- functional ways in the production, marketing and processing of fresh foods (Ishemo and Bushell, 2017). It has been reported that women tended to enter the system around age 30 to 35 and that they were primarily involved in areas such as weeding, harvesting and marketing with males being more dominant in the latter (Graham, 2012).

Figure 3.2 Proportion of acreages (ha) under production by farmers by age and gender



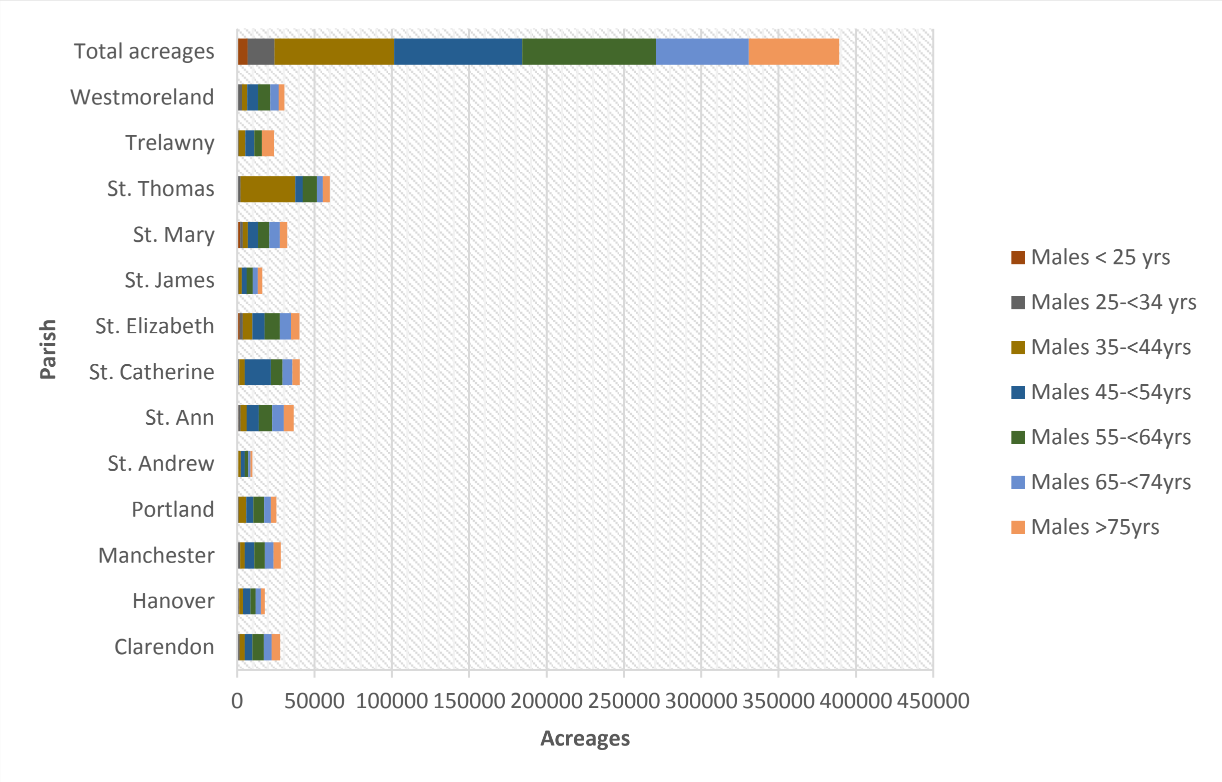
Data Source: ABIS, 2018

Figure 3.3 Acreages under production by registered female farmers by age and parish 2018



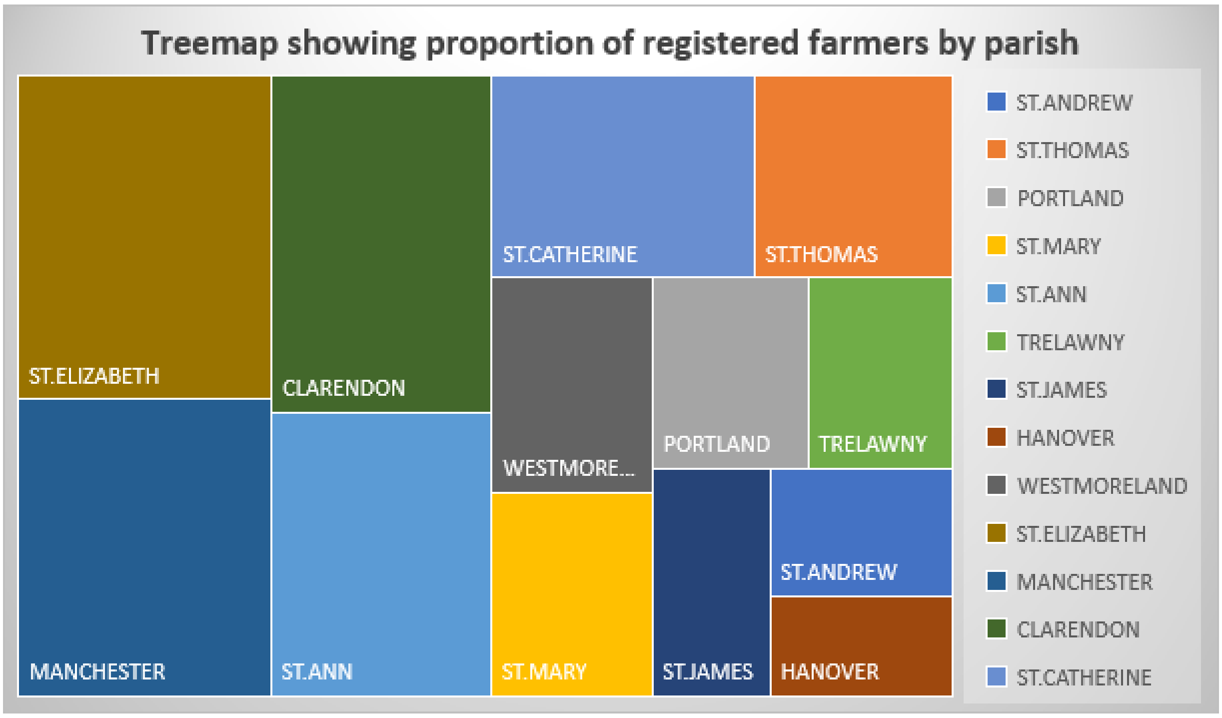
Data Source: ABIS, 2018

Figure 3.4 Acreages (ha) under production by registered male farmers by age per parish Feb 2018 2018



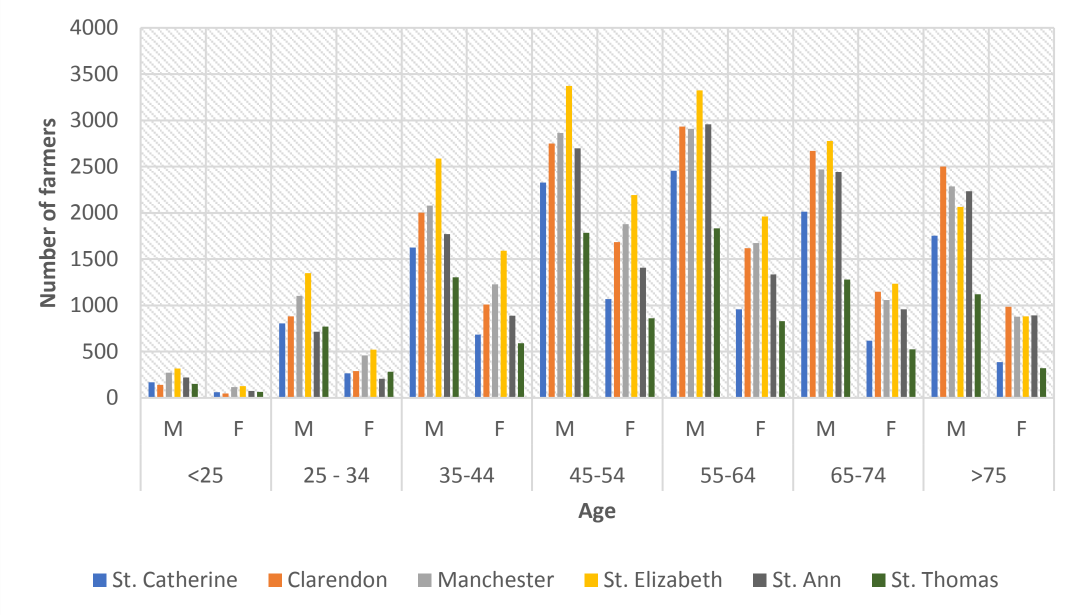
Data Source: ABIS, 2018

Figure 3.5 Tree map showing proportion of registered farmers by parish



Data Source: ABIS, 2018

Figure 3.6 Number of farmers by age and gender in major production regions of Jamaica by parish 2018



Data Source: ABIS, 2018

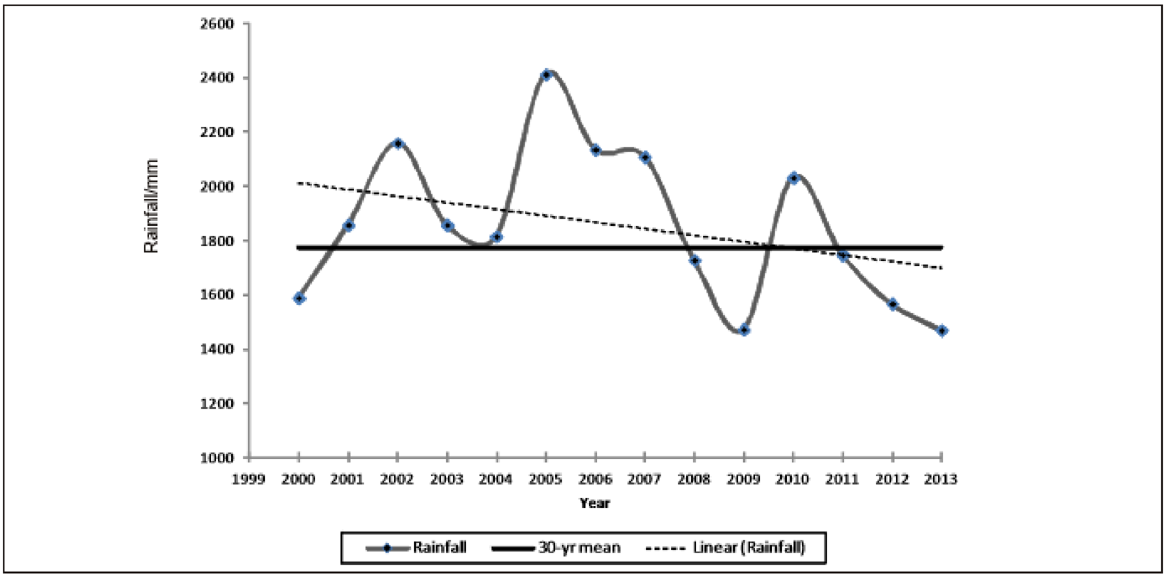
3.4.2 CHALLENGES TO AGROECOSYSTEMS

Agriculture impacts on the Jamaican environment as follows: soil erosion, depletion of forest resources, ground water contamination and reduced stream flows and with the advent of climate change the following realities now face agroecosystems.

Increased intensity of Hurricanes/Rainfall events: Hurricanes are the most prevalent meteorological hazards that occur in the Caribbean. The geographical conditions of the Caribbean region make it prone to such natural events of severe intensity. The Greater Antilles (Cuba, Haiti and Jamaica) have been identified as the most disaster-prone group in the Caribbean being more adversely affected by repeated natural shocks. The last major hurricane to hit Jamaica was Hurricane Sandy in 2012. During the period 2002 and 2007 Jamaica's agricultural sector was affected by seven hurricanes and three extended periods of heavy rains. Total damage incurred to the sector was estimated at USD 285.7 million and the cumulative effects of this increase in extreme events can negatively impact the coping range of a system affecting its ability adapt or recover. (Campbell and Beckford, 2009).

Drought is a real threat to agriculture production areas in Jamaica. A review of the drought indices in 2015 indicated that the average annual rainfall was below the 30 year mean (see Figure 3.7). This was lowest in the May/June period when all but three parishes, Clarendon, St. Mary and St. Thomas, experienced normal drought conditions (that is, average rainfall ranging between 41 and 60 percent of the 30 year mean) (see Table 3.3). Clarendon, St. Mary and St. Thomas were particularly affected, where nine of the 12 periods recorded drought. In terms of extreme to severe drought, this was experienced in some parishes at different times during the year with Clarendon being the most affected (see Table 3.3). In 2015 the April/May period had the highest incidence of extreme and severe drought conditions, with extreme drought being recorded in Clarendon and St. Thomas and severe drought in Portland, St. Mary and Manchester (see Table 3.3).

Figure 3.7 Average Annual Rainfall, 1999-2013 against 30yr mean



Source: STATIN, 2013

Table 3.1 Drought indices by parish 2015

	Jan/ Feb	Feb/ Mar	Mar/ Apr	Apr/ May	May/ June	June/ July	July/ Aug	Aug/ Sep	Sep/ Oct	Oct/ Nov	Nov/ Dec	Dec/ Jan
Kingston & St. Andrew	51	58	45	61	56	24	44	61	79	100	62	47
St. Thomas	55	59	37	20	14	30	19	45	86	132	113	23
Portland	81	114	78	36	41	56	28	48	91	144	118	60
St. Mary	84	113	91	30	18	31	35	50	63	58	53	20
St. Ann	120	133	95	53	53	62	67	120	131	83	63	45
Trelawny	75	80	91	77	59	107	89	117	124	74	102	59
St. James	127	135	77	57	57	59	58	88	100	81	102	47
Hanover	67	80	137	91	59	66	71	87	95	97	85	49
Westmoreland	83	90	116	101	71	87	75	74	87	90	79	63
St. Elizabeth	110	90	59	56	54	76	70	77	90	81	70	43
Manchester	103	121	60	40	43	72	85	90	99	90	69	22
Clarendon	78	58	22	12	12	16	14	32	53	116	138	15
St. Catherine	87	56	72	80	61	37	46	41	67	108	109	64
Jamaica	86	91	75	55	46	56	54	72	90	96	89	43

Note Extreme drought: 0-20%; Severe drought: 21-40%; Normal drought: 41-60%; No drought: 61% and over (of the 30-yr mean)
Source: Meteorological Services

Agriculture Sustainability: Much of the land occupied by small farmers is located on steep slopes in the lands of the upper parts of the WMUs. These lands are characterized by steep slopes in excess of 20^{o} which in addition to being thin or erosive soils make non - limestone derived soils highly susceptible to landslides and slope failures. Most soils in the WMUs are limestone derived soils and the remaining areas are derived from weathered igneous and metamorphic rocks. In these areas over the years inappropriate farming practices have resulted in soil erosion and loss of biodiversity (NEPA, 2013).

The general perception among many informal settlers and subsistence farmers that forested lands are fertile and produce high yields has contributed to the encroachment by farmers and informal settlers into forested areas, especially in the upper watersheds and riparian forests, along river banks (NEPA, 2013). In fact, the opposite is often the case given that the nutrient flux of most forested soils in Jamaica is not sustainable beyond a few years and this forces farmers to move into new forested areas; thus, maintaining the process of degradation of forest resources and their environmental services (NEPA, 2013).

It has been reported that just over 170 000 farmers cultivate more than 245 000 hectares in the watershed areas and have contributed to the most notable degradation of the WMUs by their unsuitable farming practices resulting in massive soil loss, through erosion, siltation of drains and rivers and destructive flooding downstream (NEPA, 2011). Subsistence farmers cultivating in these hilly watershed areas need more access to information and resources to develop sustainable farming practices. Farming cooperatives that have involved groups of mainly smallholders over the years have focused primarily on improving access to farm external inputs (inorganic fertilizer and pesticides) and markets (NEPA, 2013). Over the years the improper management of inputs has contributed to pollution of streams and rivers by runoff.

Large farms and plantations that generally occupy prime agricultural land in the plains dedicated to export crops, or to raising cattle are dependent on high amounts of inputs, chemical fertilizers, pesticides/herbicides, imported feed, water and energy to operate mechanized farming operations. The operation of this type of agricultural system is increasingly vulnerable due to the impacts of increasing costs of inputs and the effects of climate variability and change, in particular prolonged droughts and more intense rainfall patterns (NEPA, 2013).

Hence, the hidden costs to biodiversity, natural resources and ecosystems are also likely to grow, especially when coupled with the effects of climate variability and change, and this is likely to impact negatively on rural livelihoods and economic development and human health.

Small farmer livelihood: Small farmers face challenges in the domestic market due to competition with high food importation and their inability to consistently supply the local market. As a counter measure there has been a trend in small farming towards marketing arrangements and cluster formation in order to consolidate markets. This strategy is popular among the farmer organizations, cooperative networks and Agroparks, but the majority of farmers are still not benefitting from these arrangements. Produce is marketed in many different segments in the domestic market and except for the open markets there seems to be no clearly identified market outlets for small farmers. Middlemen however, are an important part of domestic distribution chains as it eases the burden on farmers to find their own markets. Many of these middle men are linked to fresh produce exporters.

Incomes generated from small farming are in general low and most farm households earn less than 25 percent of household expenditure from farming activities. Risks and uncertainties in the sector make small farmers unattractive to lending institutions. Furthermore, complications associated with land tenure and the unavailability of agriculture risk insurance also militate against access to credit. Many small farmers do not keep records and do not know the financial state of their enterprise. Mostly they blame the low incomes, high costs of production, for example labour, and challenges such as lack of markets, for the disinterest in adopting a business approach to their enterprise.

CHAPTER 4

4 AGRICULTURE PRODUCTION DATA

4.1 CROPS SUBSECTOR - TRADITIONAL EXPORT CROPS

Export earnings from traditional agricultural commodities with the exception of sugar were valued at USD33.2 million in 2016 compared with USD27.6 million in 2015 (PIOJ, 2017). The increase in the value of exports was due mainly to improved earnings from Coffee (up 19.8 percent to USD 27.6 million) (Table 4.1). A comparison of volume of coffee produced with that of other traditional export crops seems miniscule but when the value or earnings were compared, coffee still surpassed the other commodities with the exception of sugar. Earnings from sugar were USD40 million for the 2016 period. Earnings from Pimento, Citrus and Cocoa also increased in 2016 over 2015 (PIOJ 2017).

Table 4.1 Value of Agriculture Exports 2012-2016 (USD '000)

VALUE OF AGRICULTURAL EXPORTS 2012-2016 (US$000)

TRADITIONAL EXPORT CROPS	2012	2013	2014	2015	2016p	% CHANGE 2016/2016
Bananas	120	62	179	259	358	38.1
Citrus(fresh fruits)	1,883	3,322	1,732	1,386	1,806	30.3
Coffee	13,778	16,327	13,479	23,025	27,584	19.8
Cocoa	1,936	504	1,028	544	895	64.6
Pimento	2,303	1,912	2,329	2,369	2,508	5.9
TOTAL	20,020	22,127	18,747	27,582	33,150	20.2

p- preliminary

Source: Statistical Institute of Jamaica

Table 4.2: Production of major traditional export crops, 2012-2016

Crop	2012	2013	2014	2015	2016	Unit
Bananas	47 473	37 211	51 581	54 810	56 607	Tonnes
Citrus	97 072	83 758	71 194	74 336	74 217	Tonnes
Coffee (Total)	6 768	6 874	5 214	5 755	7 580	Tonnes
Blue Mountain Coffee	5 674	5 746	4 355	5 134	6 987	Tonnes
Non-Blue Mountain Coffee	1 094	1 128	859	621	593	Tonnes
Cocoa	1 393	997	1 154	637	726	Tonnes
Sugar	136 645	121 142	149 066	134 223	86 118	Tonnes
Coconut	96.4	97.4	99.2	80.8	99.2	Millions

Source: STATIN, 2017

Figure 4. 1 Production of Selected Traditional Export Crops, 2012-2106

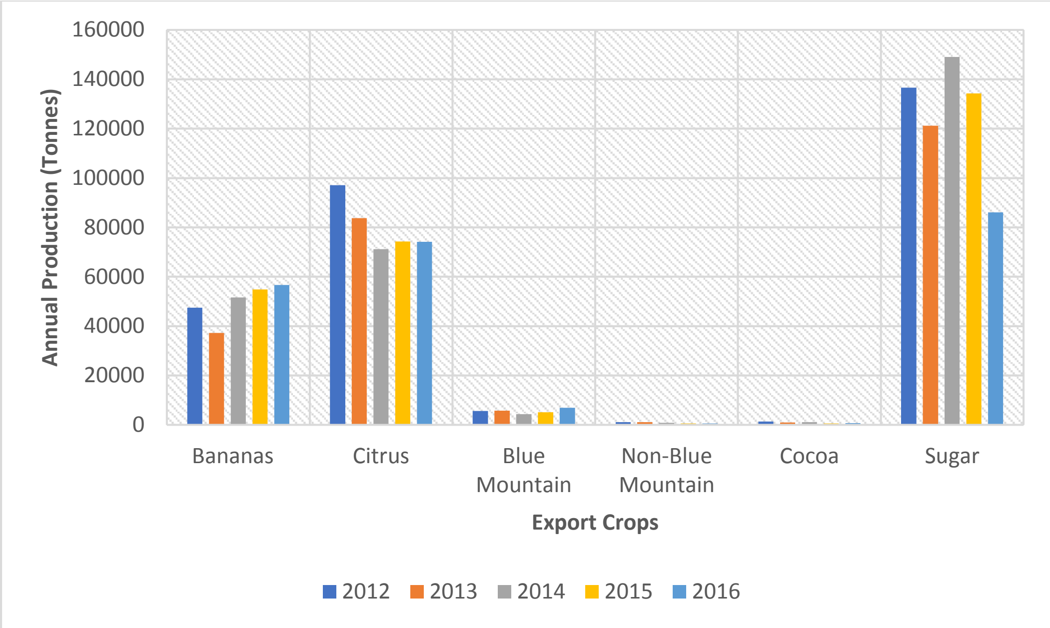
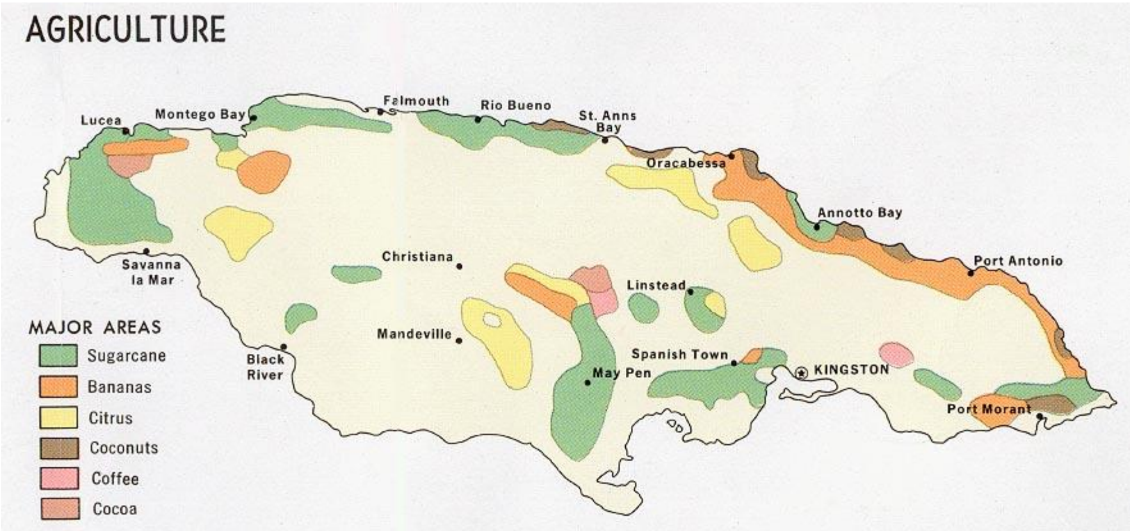


Figure 4.2. Major growing areas of traditional export crops



Source: http://www.gifex.com/jamaica_maps/Jamaica_Agriculture_Map.htm

4.1.1 SUGARCANE:

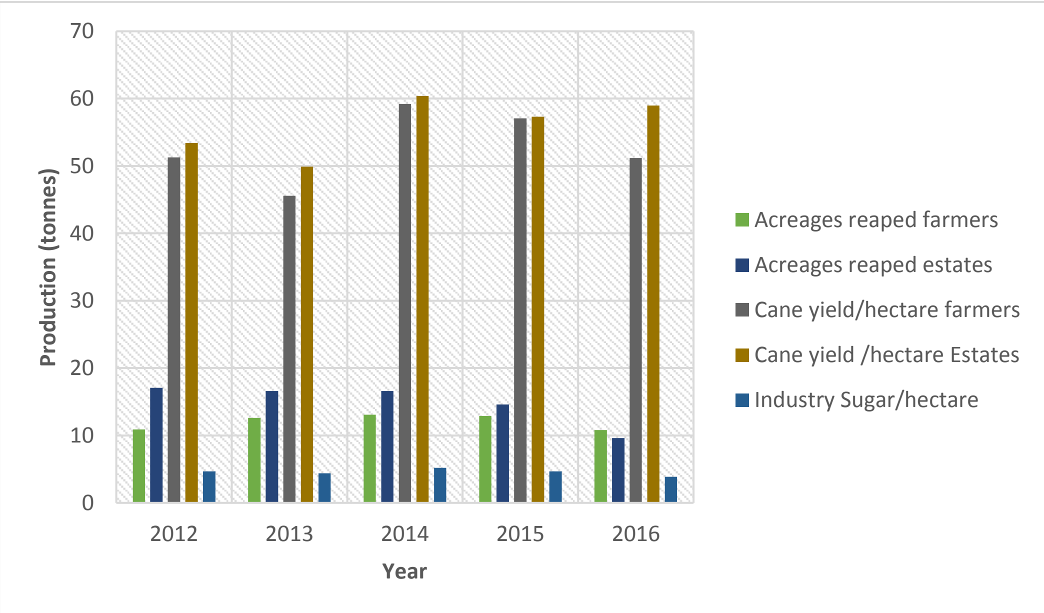
The sugarcane industry contributes approximately one percent to GDP. STATIN (2017) reported for the 2016 crop year that 1 127 000 tonnes of sugarcane was milled producing 79 300 tonnes of sugar (as shown in Table 4.3, Figure 4.3 and Figure 4.4). This was a decline of 28.3 percent and 38.4 percent for sugarcane milled and sugar produced respectively when compared with the previous crop year. This decline was attributed to the fact that less acreages were brought into production for that period. Sugar cane milled is supplied to the factories from two sources, namely, private Farms and the estates operated by the factories (see Table 4.3).

Table 4.3 Production statistics of sugarcane and its derivatives

	2012	2013	2014	2015	2016	Units
Industry Cane milled	**1 475.20**	**1 402.60**	**1 779.30**	**1 572.40**	**1 127.10**	**Tonnes ('000)**
Farmers cane milled	561.6	573.40	775.30	736.10	618.70	Tonnes ('000)
Estates farmers cane milled	913.6	829.2	1,003.90	836.3	508.4	Tonnes ('000)
Sugar production calendar year	130.7	120.4	143.2	128.7	79.3	Tonnes ('000)
Industry Acreages reaped	**28.1**	**29.2**	**29.7**	**27.5**	**20.4**	**ha ('000)**
Acreages reaped farmers	10.9	12.6	13.1	12.9	10.8	ha ('000)
Acreages reaped estates	17.1	16.6	16.6	14.6	9.6	ha ('000)
Industry cane yield/hectare	**52.6**	**48**	**59.9**	**57.2**	**54.9**	**Tonnes**
Cane yield/hectare farmers	51.3	45.6	59.2	57.1	51.2	Tonnes
Cane yield /hectare Estates	53.4	49.9	60.4	57.3	59	Tonnes
Industry Sugar/hectare	4.69	4.39	5.2	4.68	3.86	Tonnes

Source: STATIN 2017

Figure 4.3 Production statistics of sugarcane and its derivatives

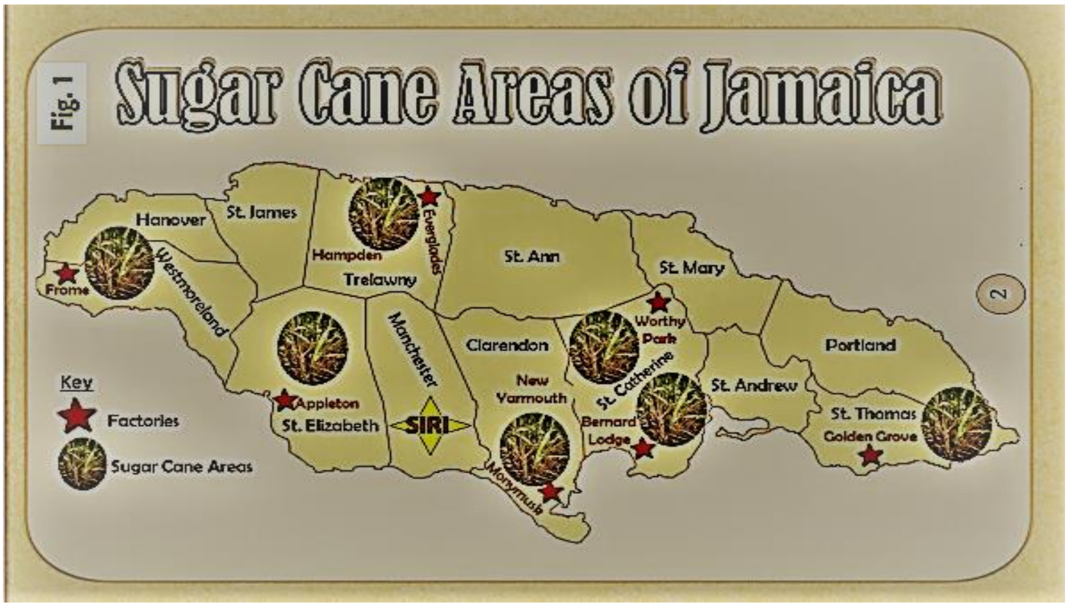


4.1.1.1 PRODUCTION

Sugarcane cultivation in Jamaica occurs in five distinct agro-ecological zones: The Central Uplands, the Dry North Coast, the Irrigated Southern Plains, the Wet East, and the Wet West, (see Figure4.5). The data for 2015 showed 35 164 hectares under cultivation: 19 067 hectares of farms affiliated with six factories and 16 097 ha of farms (owned or leased) operated by 8 841 registered independent producers. This accounted for over 40 000 hectares or 40 percent of the land under permanent agriculture. However, this has drastically reduced to approximately 10 000 hectares accounting for only 10 percent of land under permanent agriculture in 2017.

The industry is currently structured around six estates with operating factories which process the sugar cane into raw sugar and molasses. Four of the six privately owned factories are directly associated with distillation (Appleton, Worthy Park, Golden Grove, and Everglades), the other two factories are Frome and Moneymusk formerly publicly owned but owned and operated by Pan Caribbean Sugar company since 2009.

Figure 4.1 Sugar Cane areas of Jamaica



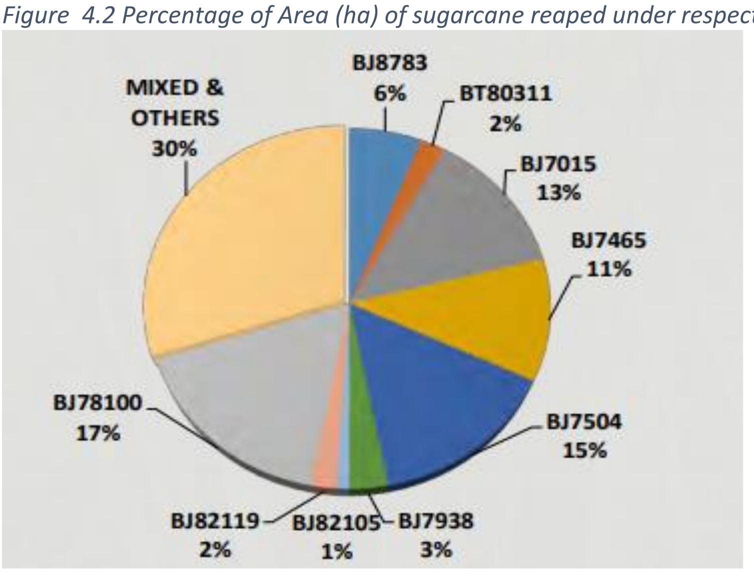
Source: Sugar Industry Authority, 2015

Most of Jamaica's sugarcane production is dependent on rainfall and according to the Sugar Industry Authority (SIA, 2015), only 22 percent of annual sugar production coming from irrigated fields.

4.1.1.2 VARIETIES

Four new varieties - BJ9250, BJ9310, BJ9428 and BJ9764 - with good agronomic characteristics for tillering, germination, stalk erectness, yield and quality were released for cultivation for the 2016 crop (see Figure 4.6).

Figure 4.2 Percentage of Area (ha) of sugarcane reaped under respective varieties in 2014



Source: Sugar Industry Authority Annual Report, 2015

The industry continued to perform below target experiencing further decline in the Tonnes cane per tonne Sugar (TC/TS) ratio (see Table 4.4). The TC/TS ratio has deteriorated from 10.61 in 2009 to 11.89 in 2015. The deterioration in the TC/TS ratio was a result of a combination of factors, mainly the poor weather conditions and a marginal decline in factory efficiency.

Table 4.4 Industry cane and sugar production 2015

Crop Year	Cane Ground for Sugar (t)	96° Sugar Made (t)	tc/ts
2015	1 564 216.91	134 223.00	11.89
Average	1 586 973.17	138 926.67	11.58
Target	3 000 000.00	300 000.00	10.00

Source : SIA 2015

4.1.1.3 DEMOGRAPHICS

The sugarcane industry employs approximately 41 000 persons during the cropping season and an estimated 28 000 persons out of crop (SIA, 2015). It is estimated that approximately 200 000 persons derive their livelihood directly and indirectly from the industry. The industry is vertically integrated and employs a wide range of professionals. These include: accountants, agronomists, chemists, computer programmers and analysts, economists, electricians, engineers, entomologists, machinists, human resource personnel, research scientists, secretaries and technicians. It integrates backward with sectors which supply and/or service farm machinery, tools, fertilizer, weedicides, pesticides, provide transportation (field and factories) and finance. It integrates forward with sectors such as transportation (factories to warehouses and port), rum, finance, shipping, civil aviation and legal services.

The industry plays a central role in Jamaica's rural economy. In the rural areas and around towns such as Frome and Savanna-la-Mar in Westmoreland, Lionel Town in Clarendon, Duckenfield in St Thomas and Clark's Town in Trelawny the growing of sugar cane and its processing into sugar is the major or only economic activity. In the out- of-crop period many people are given credit which is paid up during the cropping season.

Women represent ten percent of unionized workers in the sugar industry (Project, 2004). The overwhelming majority in all areas of the industry are male labourers.

4.1.1.4 MARKETING

The Jamaican sugar industry has primarily concentrated on the production of raw sugar for export to Europe and the United States of America and for domestic consumption. The industry has for some time operated at the basic level of being a raw sugar producer, selling the bulk of its production under "preferential treaty agreements" with guaranteed prices. As the time towards the end of the preferential treaty draws to a close Jamaica is currently focusing exports to the Caribbean and increasing local sales. Value added products include rum (54 450 000 liters produced in 2017) and by products derived includes molasses and bagasse. There have been some flirtations with the production of ethanol, particle board, cane juice, syrup, food fibre and charcoal briquettes.

Whole cane and tops, have been an important traditional dry season feed for ruminants in Jamaica, particularly by farmers operating within or adjacent to cane-growing areas. However large-scale commercial feeding of whole cane or byproducts, except for molasses used in the feed manufacturing industry, has been slow in development. Earlier research work with beef cattle in Jamaica had shown the value of derinded sugarcane ('sugar fith') or chopped whole cane in conjunction with hay or cane tops, supplemented with protein and minerals, as feed for fattening cattle. The sugar industry is uniquely equipped to contribute to the development of the Jamaican livestock industry in that, much of the logistical problems associated with utilizing other indigenous sources of feed are absent. Additionally, a large body of research data on its potential as animal feed is available within the region and awaits commercial application. However recent developments locally re the reutilization of non-productive sugarcane lands for other agricultural enterprises will result in less lands in sugarcane. Hence the utilization of sugarcane and its derivatives for animal feed will continue to be a source for small farmers.

4.1.2 BANANA & PLANTAIN

Banana and plantain continue to be economically important. The major growing banana dependent areas are Clarendon, St. Catherine, St. James, Portland, St, Mary and St. Thomas. In Jamaica, the industry is based around two large plantations and a reduced number of small farmers. Jamaica was the first commercial exporter of bananas in the Western Hemisphere and has produced bananas commercially for over 140 years and was a major exporter up to 2008. Export production in 1996 had peaked at 87 433 tonnes but fell to approximately 37 000 tonnes by 2008. Exports ceased following devastation from a series of hurricanes; Ivan in 2004, Denis and Emily in 2005, Dean in 2007 and tropical storm Gustav in 2008 compounded by the outbreak of Moko disease. Some farmers exited the market and cited high input prices, export quality requirements, and uncertainty about the operations of the government-run exporting board as contributing factors to their exit from the export market. During that 5 year period, only in 2006 was it possible to ship 32 428 tonnes.

With the introduction of the Banana Export Expansion Programme (BEEP) in 2011 banana exports were once again being targeted. The objective of the programme was to expand production with global standards to develop the industry to preserve its competitiveness in both the local and domestic markets.

4.1.2.1 PRODUCTION

In 2015 spatial data collected reflected 1 101 hectares (905 banana farms and 195 plantain farms) across Jamaica but by 2016 the Banana Board reported 3 500 ha under production (JIS, 2017). Although bananas were originally grown by small farmers in the hills, large commercial farms later developed on the plains when the commodity gained importance as an export commodity. However, several natural disasters impacted on farms reducing the areas under production. Production in 2016 was estimated at 56 607 tonnes compared with 54 810 tonnes in 2015 (see Table 4.1) with yields increasing from 15 tonnes /hectare in 2015 to 18 tonnes/hectare in 2016. This showed an increase of just 3 percent. Production has rebounded since the impact of Hurricane Sandy which occurred on 24 October 2012. The hurricane had destroyed approximately 66.0 percent of the banana crop.

4.1.2.2 FARMER DEMOGRAPHICS

In 2017 there were some 2 000 farmers. In 2015 there were some 800 registered commercial growers (Banana Board, 2015) compared to 102 802 growers of banana and 59 262 growers of plantain island-wide reported by STATIN in 2009. There was a 28 percent decline in the number of farmers registered in 2015 when compared to 2014. The moderate decline is hypothesized to be as a consequence of the financial constraints experienced by farmers as a result of lost revenues, due to the impact of the drought on their farms. Farmers in the eastern parishes were most impacted; some experienced declines of up to 60 percent in their annual yields (Banana Board Annual Report, 2015). Approximately 25 percent of banana farmers are women with the majority being male with 93 percent of the latter between the ages of 31 and 60.

4.1.2.3 VARIETIES

There are several varieties of bananas and plantains. The following are the traditional varieties:

- Robusta (highly demanded variety)
- Williams (Ziv)
- Grand Nain
- Lacatan
- Gros Michel
- Silk (Chinese, Apple and Thousand Fingers)

There are also banana varieties developed or endemic to Jamaica and these include:

- RG1 (developed by Ren Gonsalves)
- Tetraploid 1242 (developed by Dr. Ken Shephard)
- Tetraploid 6812 (developed by Dr. Ken Shephard)
- Highgate variety

Plantains grown in Jamaica include:

- Horse plantain
- French plantain
- Saba plantains
- Bluggoe (Frog plantains)
- One Planty (One Hand Bandit)
- Tiger Plantain

Attention is paid to varieties that are resistant or tolerant to black Sigatoka disease and nematode pest infestation with a view to increase cost efficiencies in the Jamaican Banana Industry (AIBGA, 2014). Tolerant banana and plantain varieties developed in Honduras have 30 percent to 50 percent greater yield than traditional varieties. They are being produced for distribution to domestic market producers in Jamaica. The varieties, to be used for the value-added industry are:

- FHIA 17 banana
- FHIA 25 banana
- FHIA 23 plantain

The Banana Board (2015) states that the resilience of Jamaica's banana farms in the face of unfavourable weather conditions can be attributed to the increased distribution of FHIA varieties across the island. These varieties are better able to withstand dry conditions compared with traditional Cavendish cultivars.

4.1.2.4 MARKETING

Jamaica resumed the export of fresh fruit in 2011 consequent to the sector's devastation by Hurricane Gustav in 2008. Under the banana export expansion programme (BEEP), with the demand for high quality fruit on the international market only a small fraction of the industry has been internationally certified to export.

In 2016, 410 tonnes of fruit were exported increasing from a total of 17 235 boxes (318.9 tonnes) (JIS, 2017). In 2015 a total of 337 boxes (6.235 tonnes) of bananas were exported to the U.K.; 6 996 boxes (128.779 tonnes) were exported to Canada, and 9 897 boxes (183.094 tonnes) were exported to Cayman (Banana Board Annual report 2015). All exported bananas were meant for cooking and consumption while green. Exports to the UK were curtailed during 2015 as the effects of the drought which persisted from 2014 into 2015 reduced the projected productivity levels (Banana Board, 2015).

In 2009 there was a total of 27 processors of primary products, 15 ripeners of bananas and plantains and 14 chips manufacturers (two of these processors both the manufactured chips and ripening of fruits) (Banana Board, 2009).

4.1.2.5 PRODUCTION CHALLENGES

Banana farming is quite labour intensive with a high cost for labour and other inputs, as a result, farm owners are constrained to provide increasing amounts of the labour themselves. Small farm sizes mostly on hilly terrain and the exposure to natural disasters have resulted in high production costs in Jamaica.

Banana exports have been faced with increased competition from the Latin American producers and drastic export rule changes which have led to a decline in Jamaican banana production for export, export earnings, and farmers. Secondly, these Latin American producers have the economies of scale to produce banana at a much lower cost than Jamaica and the other Caribbean countries. Jamaica’s cost of production is at least 40 percent higher than that of the Latin American producers; However, the region’s banana producers are currently seeking to tap into new unexploited market segments like organic production as an avenue to stay in the industry.

Another factor that has affected Jamaican banana exporters is the requirement for farms to be certified as having practiced Good Agricultural Practices (GAP), that are standards and practices designed to ensure environmental, economic and social sustainability of farm processes, which in turn, aims to promote safe and quality agricultural products.

All these factors have significantly affected and threatened the survival of the banana industry in the Caribbean, and Jamaica in particular.

However local promotion of the health benefits of banana has been a major campaign from a major supplier of the commodity to target increased consumption of the fruit in the domestic market. Its use in as animal feed by small farmers is practiced in Jamaica but not widespread. Further consideration however must be given to its utilization in livestock feed as a local energy source since in limited supply it cannot adequately meet the maintenance requirement of an animal. Its utilization will be dependent on a number of factors such as the type and class of animal, for example in the case of a monogastric such as pigs whether sows or growing-finishing pigs are being fed or if sows are in gestation or lactation. For a livestock producer to be sustainable and competitive, a compromise must be reached however between minimizing feed costs and maximizing livestock product returns.

4.1.3 COFFEE

Coffee was Jamaica’s third highest foreign exchange earner next to bananas and sugar but has now become the second highest earner (STATIN, 2016). The volume of coffee berries delivered to processing plants during the period August 2015 to July 2016 increased by 31.7 percent to 7 580 tonnes compared with the previous crop year (see Figure 4.7). This should, however, be viewed in light of the unfavourable weather conditions for outbreaks of the Coffee Leaf Rust (CLR) which had significantly reduced yields of bearing trees the prior two years.

Figure 4.3 Coffee production, export and prices for Jamaica 1991 -2018

Data Source: STATIN, 2018

4.1.3.1 PRODUCTION

About 80 percent of Jamaica's commercial coffee is cultivated in the Blue Mountains in an agroforestry ecosystem spanning three parishes, Portland, St. Thomas and St. Andrew. There, arabica coffee grows on steep slopes at elevations between 200 m and 1 600 m. The highest quality coffee is cultivated between 1 100 m and 1 600 m, where cooler temperatures allow berries to mature slowly and produce more desirable flavours. High Mountain coffee requires hilly areas above 300 m outside of the Blue Mountain range. Blue Mountain coffee holds a greater prestige and has the competitive advantage of being benchmarked by its taste, high quality, and appearance of the bean. There are approximately 5 666 hectares of coffee in Jamaica.

Coffee can be grown in most areas of Jamaica once environmental conditions are met such as in the parishes of Westmoreland, St. James, Manchester, St Catherine, and St. Elizabeth. Traditionally, only coffee grown at elevations between 910 m (3 000 ft) and 1700 m (5 500 ft) could be called Jamaica Blue Mountain. Coffee grown at elevations between 460 metres (1 500 ft) and 910 m (3 000 ft) is called Jamaica High Mountain in the Central and Western Regions of Jamaica, and coffee grown below 460 m (1 500 ft) elevation is called Jamaica Supreme or Jamaica Low Mountain. (All land in Jamaica above 1700 m (5 500 ft) is a forest reserve, so no coffee is grown there.)

4.1.3.2 VARIETIES

Coffee varieties: *Coffea Arabica* var *arabica* is the predominant variety grown in Jamaica. It is highly susceptible to CLR. In its effort to manage the disease the industry has introduced hybrids from Turrialba, Costa Rica for evaluation. Coffee grown in Jamaica has low genetic diversity and has not received the same attention, as other agriculture crops such as banana or sugarcane to strengthen its genetic variability. The *Coffea arabica* varieties grown all over the world are derived from either the 'Typica' or 'Bourbon' genetic base, which has resulted in low-genetic diversity among cultivated arabicas. This narrow genetic base has resulted in a crop with not only homogenous agronomic behaviour, but also a high susceptibility to biotic and climatic challenges.

4.1.3.3 FARMER DEMOGRAPHICS

Records from the Coffee Industry Board (CIB) indicate that, on average, 80 percent of the coffee farmers tend plots less than 10 acres but this production accounts for only 20 percent of the total coffee produced annually. Additionally, many of these farmers cultivate even smaller plots that are less than 5 acres. Greater than 90 percent of coffee farmers are men with women playing a major role in the harvesting of the berries.

4.1.3.4 MARKETING

The average Jamaican farmer has between 80 to 175 coffee trees and collects their coffee cherries in boxes (equal to 27 kg) to sell to the processor or mill. A 27 kg box of cherries will yield about 5.4kg of exportable green coffee.

Mavis Bank is the other most recognizable name in Jamaican coffee. Mavis Bank is a privately-owned coffee estate and mill (formerly owned by the government) located about 16 km north of Kingston. It is one of the main employers for the community in the immediate surrounding area of Mavis Bank. Mavis Bank processes coffee from approximately 6 000 farmers, which is the vast majority of the growers in the country. Mavis Bank combined with Wallenford coffee factory are the largest processors of coffee on the island.

Imported foreign coffee beans are blended with Jamaican Blue Mountain coffee for sale locally and overseas. It is done to create a cheaper blended coffee for hotels and some cafes. The value of 100 percent Jamaica blue mountain coffee is twice that of blended coffee and is also produced for the high-end markets.

4.1.3.5 PRODUCTION CHALLENGES

Throughout its history, the Jamaican coffee sector has been affected by market and labour volatility, land degradation, and extreme climate events such as drought or torrential rainfall. Since the late 1990s, coffee across Jamaica has undergone a general decline in production and exports. In recent times coffee growers continue to battle with falling prices for the commodity, pests and diseases such as coffee berry borer (CBB), *Hypothenemus hampeii* and coffee leaf rust disease (CLR).

The International Trade Centre 2010 technical report on the coffee industry stated that, small farmers were by far the most numerous coffee farmers and the most vulnerable to the impact of climate change. This is due to the significant influence that temperature and rainfall conditions have on potential coffee yield and crop development at various growth stages. The balance of these environmental factors is integral in crop productivity and quality. Farmers have experienced two successive years of drought (2013/2014 and 2014/2015) which resulted in underdeveloped coffee beans. Rainfall events in 2017 have resulted in a better crop for the period.

Approximately 3 642 hectares are affected by CLR. With the island's main coffee variety—*Arabica typica*—being more susceptible to pests and diseases and highly sensitive to increased temperatures, farmers are further disadvantaged. To address the issues of pests and disease Integrated Pest Management (IPM) was introduced to the industry in the early 2000's.

Despite the challenges it has been reported that Jamaica's coffee farmers are implementing several adaptive responses to the impacts of climate change. Some farmers are using the *Arabica gesha* (a more disease-tolerant and robust coffee cultivar) to combat the negative effects that the coffee leaf rust and rising temperatures have on the traditional *Arabica typica* variety. The use of chemical fertilizer is on the decline as organic manures such as chicken litter and composted coffee pulp is being used as a substitute. Over 80 percent of coffee pulp is being composted and recycled as manure. Vermicomposting is now widespread among coffee farmers (CIB). Coffee is also increasingly being grown with shade trees, many of which are leguminous which return nitrogen to the soil. Fertilizers and chemical inputs continue to be seen however by conventional coffee farmers as critical to sustaining and improving productivity. The absence of these inputs is seen by the conventional coffee farmer as a contributor to weaker plants with more susceptibility to disease. On the contrary the only certified organic coffee producer in Jamaica, Rowan's Royale located in the Blue Mountains has the experience of sustained levels of productivity in the absence of chemical inputs.

During drought conditions in an attempt to increase moisture retention and efficiently use the limited water available, farmers are also applying a grass mulch to the root of coffee plants and intercropping banana and plantain trees throughout the farm for added shade. Intercropping also allows farmers to generate additional income and contribute to household food security. Some farmers have also explored the decision to abandon their coffee farms for other valuable and exportable commodities such as sugar cane, cocoa, and yams, mainly due to their production throughout the year, inexpensive maintenance, and low initial financial investment.

A study by Guido et al (2018) identified several stressors that have impacted on coffee farmers in the Blue Mountains area. These were primarily socioeconomic forces, coffee pests such as the coffee berry borer and diseases such as the CLR. During the crop year 2012-2013 the infestation of CLR was very severe causing an estimated loss to Jamaica of USD 5 million, 25 percent of total industry earnings, (Gleaner 2017). Another stressor was climate phenomena which have predominantly impacted farmers. It was noted that the impact of hurricanes on coffee crops would continue to affect coffee berry production which coincides with the hurricane season and) during 2013 to 2015 the drought became the major constraint to coffee production affecting the size, weight and quantity of berries, predisposing trees to pests and disease.

Farmers were found to have to manage multiple stressors that overlap in time and whose impacts set the conditions for future impacts. In the face of these multiple stressors the farmers' response has been to modify their expenditure on inputs focusing more attention on cash crops in the system while still growing coffee. Farmers on the extreme side of the spectrum would abandon their coffee fields. This latter strategy by farmers appears to be the popular response when faced with reduced income. Farmers tended to expand into other activities that require fewer inputs in the face of stress (Guido *et al.*, 2018). This decision would impact on the future crop if not addressed.

Farmers who continue to engage in conventional coffee farming continue to be negatively impacted by low market prices in good rainfall years even if coffee berry output is good while prices soar during drought due to scarcity of the commodity. In the case of the former, coffee growers are challenged with insufficient revenue due to low prices to purchase inputs for the next season. These inputs are usually in the form of fertilizers and chemicals which in the case of an organic system would not be a necessary evil as nutrient recycling through the use of composts would mitigate against the need for costly fertilizer inputs especially during periods of drought due to better and improved soil conditioning from organic production practices. This is demonstrated by the only certified organic coffee farmer on the island Rowan's Royale. This organic system integrates vegetables into the system and has compost piles throughout the landscape.

The steep slopes where coffee is grown makes it challenging for the inclusion of livestock, hence the integration of beekeeping would greatly enhance the attractiveness of such a system as this source of income generation could greatly assist in supporting labour costs.

4.1.4 CITRUS

4.1.4.1 PRODUCTION AREAS

The major citrus producing parishes in Jamaica are: St. Catherine, St. Mary, Clarendon, St. James St. Elizabeth and Manchester. Of these six parishes, St. Catherine, Clarendon and St. James produced the majority of the citrus crop in 2013. Citrus is also grown on the plains in monocultures on large privately owned commercial farms that supply fruit for processing, primarily into juices, for both the export and the domestic markets. Citrus fruit is also grown on small farms in the hills that were settled by ex-slaves after Emancipation, primarily for the domestic market.

4.1.4.2 PRODUCTION

The citrus industry is worth approximately USD 34 million and is a major contributor to the economy of Jamaica, providing employment, exports and local production for the fresh and agroprocessing market (PIOJ, 2015). It has been estimated that approximately 96 percent of citrus produced was consumed locally and four percent exported. For the crop year July 2015 to June 2016, citrus production was estimated at 71 247 tonnes, not significantly different from the previous year (see Figure 4.2). The largest citrus grower in Jamaica, is cultivating approximately 1 092 hectares of citrus groves on four farms. The company grows Valencia and Parson Brown oranges, pineapples, ortaniques and limes. The traditional harvesting period is from November through June each year and the yield from mature groves averages 700 boxes per hectare.

The decline in this industry from 2009 to 2013 was due mainly to Huanglongbing, commonly known as citrus greening disease in Jamaica. This disease had caused trees to produce predominantly green fruits which failed to ripen properly and severe fruit drop exacerbated by severe drought during the period. The citrus greening disease in the industry led to a decline of all citrus crops (with the exception of grapefruit) ranging from 13.6 percent for sweet orange to 38.9 percent for Ugli citrus fruit. There are some sections of the island that still produce marketable fruit in spite of the presence of citrus greening especially those that continue on tree removal, a nutritional programme and trees having not yet reached their non-productive phase.

4.1.4.3 MARKETING

According to a Gleaner (2017) article, citrus sellers are now receiving premium price on the fresh fruit market because of shortages created by citrus greening disease. Price paid per box has tripled over five years. Most of the fruit is going into fresh fruit sales. Top farm gate price is being paid by higglers. Additionally, domestic demand has found itself in competition with export markets as some producers are taking advantage of world prices for fresh fruit. The processing of local fresh fruit into beverages continues to decline as the citrus industry struggles to revive from the citrus tristeza virus and greening diseases, which have cut national production by more than half since the year 2000.

At under two million boxes, there is only enough fruit to supply one of the two factories, Trade Winds, which has a captive supply. Farm gate prices ranged during 2017 from JMD 2 000 to JMD 3 000 per box, rising higher after the end of the crop in June. That price compares to a range of JMD 810 to JMD 1 000 per box five years ago. Now that production has fallen significantly, this is an incentive for farmers to supply the factory with fresh fruit. Large farmers of citrus are investing in sustaining their existing groves and planting new ones. Still, not all of the processing companies are citrus-based - as products span a range of fruits as well as vegetables.

This current situation in the industry provides a highly profitable opportunity for higglers because when fruit is sold to the factory, farmers now fetch about JMD 110 per pound. The farmer is therefore being paid between JMD 500 and JMD 700per box at the factory gate, depending on juice quality. Comparatively, it is reported that higglers come right to the farm gate and buy fruit for JMD 2 000 to JMD 3000 JMD a box. Of the three markets for citrus, the most profitable is fresh fruit sold at JMD 200 per dozen. The higgler is therefore grossing JMD 3 000 per box with a box of fruit containing on average, 15 dozen oranges.

4.1.4.4 DEMOGRAPHICS

In 2013 on farm employment was estimated at 5 460 individuals while employment at the industry level (including on-farm operations, processing, packaging plant, wholesale and retail trades) was estimated at 19 500 persons. Over 90 percent of higglers in the marketplace are women, most of whom perform the lead role of income earning in the household. They perform the important trading and negotiation role, buying from farmers for resale. This holds true for the domestic market as well.

4.1.4.5 PRODUCTION CHALLENGES

Several production challenges have been identified as follows:

- Lack of innovativeness in the market support
- High input costs-fungicides, pesticides and other direct costs
- Lack of motivation by key stakeholders to re-invest in the sub-sector.
- The farming framework within this subsector consisted mostly of subsistence farming
- Praedial larceny
- Poor agricultural practices
- No shared research pursued in identifying new varieties with tolerance to the (HLB) greening disease.

4.1.5 COCONUT

4.1.5.1 PRODUCTION AREAS

The traditional and major growing areas for coconut are St. Mary, St. Thomas, Portland, St. Ann and St. Catherine. The Coconut Industry Board has its hybrid seed nursery in Barton Isles St. Elizabeth. Maypan is the predominant variety but Panama Tall, Malayan green and yellow dwarfs are also grown.

4.1.5.2 PRODUCTION DATA

The area under coconut production as at 2015 was approximately 15 500 hectares. As at December 2015 the total population of coconut trees was calculated at 3 520 347. Of this number 3 215 076 were seven years and over and in bearing. Production in 2016 was estimated at 99.2 million coconuts compared with 80.8 million coconuts in 2015 (see Table 4.1). The Coconut Industry Board has made much progress in curtailing the lethal yellowing disease and this achievement is contributing to the increase in production.

4.1.5.3 DEMOGRAPHICS

The majority of coconut farms were less than 10 hectares. Hence coconut continues to be a small holder crop. In 2012 the coconut industry board reported 832 growers registered.

4.1.5.4 MARKETING

Production was disposed of through bottlers of jelly coconut water, the Coconut industry Board, higglers, producers of coconut oil and supermarkets. Seed coconuts are exported to Florida in the USA and the Bahamas

4.1.5.5 PRODUCTION CHALLENGES

Investigations continue into breeding for resistance to the lethal yellowing disease through the importation of germplasm from the Ivory Coast and crosses being conducted with the local Panama tall and Brazilian green dwarf palms. The gall mite (*Eriophyes guerreronis*) continues to affect quality and size of nuts if not adequately controlled.

4.1.6 COCOA

4.1.6.1 MAJOR PRODUCTION AREAS

Cocoa is grown in almost every parish, but the major cocoa producing parishes are Clarendon, St. Mary, St. Catherine, St. Andrew, St. Thomas and Portland.

4.1.6.2 PRODUCTION DATA

Jamaica has some 3 561 hectares of cocoa across the island, with Clarendon being the major producer with St Mary having the most land under cultivation. The crop may produce 20-30 pods per tree per year yielding 30-40 beans. The Cocoa Industry Board reported an increase of over 100 percent in the production of cocoa for the 2011/2012 crop year. This amounted to 476.5 tonnes of cocoa, valued at JMD150.6 million as against the 2010/2011 crop year, which recorded only 216.5 tonnes (JIS 2013). The volume of wet cocoa beans delivered to fermentaries for the crop year October 2015 to September 2016 amounted to 726.0 tonnes compared with 637 tonnes in the prior year, an increase of 14 percent. However, production for the 2017 period fell by 35 percent as the industry was severely impacted by the presence of the frosty pod disease as the disease spread from Clarendon to other cocoa growing areas such as St. Mary primarily due to the movement of workers from field to field.

4.1.6.3 DEMOGRAPHICS

Currently, an estimated 7 000 farmers are engaged in the farming of cocoa but only 4 500 are registered.

4.1.6.4 MARKETING

Wet cocoa is dried through a process known as fermentation and exported to chocolatiers in England, France, the UK and the USA. There is a guaranteed market for 1 500 tonnes annually for Jamaican cocoa.

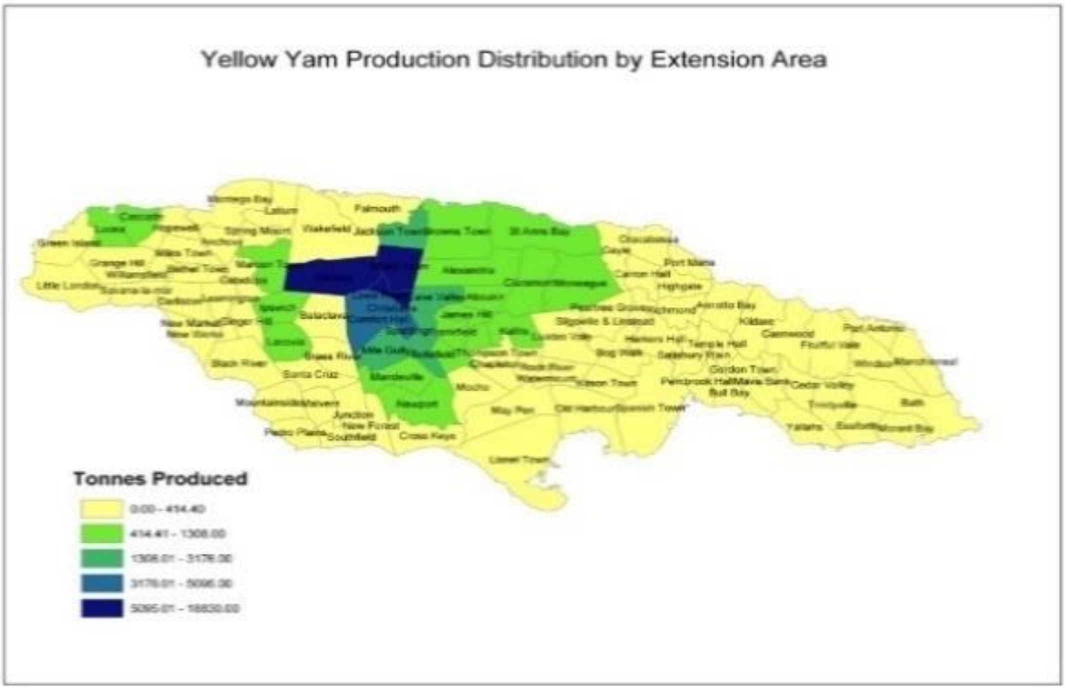
4.1.6.5 PRODUCTION CHALLENGES

Frosty pod disease of cacao is currently the major constraint to cocoa production in Jamaica. The disease was first detected in Clarendon, and if left uncontrolled could result in crop losses of between 70 and 80 percent which would have a devastating effect on the industry. The disease is highly contagious, due to its causal agent the fungus *Moniliophthora roreri*, which invades actively growing cocoa pods damaging them and the seed they produce. The government is currently working with farmers in the containment and management of this disease. The government's National Plant Health Coordinating Committee reported following a delimiting survey that the disease was primarily present in Northern Clarendon, affecting 70 percent of cocoa produced in that area. Northern Clarendon accounts for 70 percent of total cocoa production. Small clusters of farms in St. Mary, St. Catherine and St. Andrew were also found to be affected.

4.2 CROPS SUBSECTOR - DOMESTIC CROP PRODUCTION

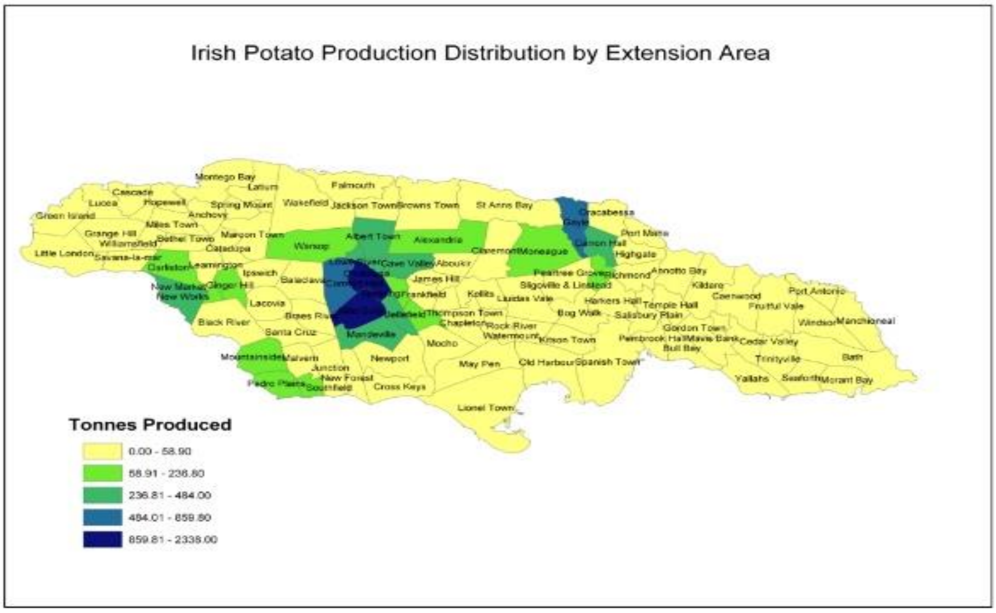
The main domestic crops in Jamaica are vegetables, roots and tubers, fruits, condiments, plantain, and to a lesser extent legumes and cereals (as shown in Table 4.5 and Table 4.6 and Figure 4.8 to Figure 4.26). The commodities that contributed the greatest to domestic crop production for the 2016 to 2017 period were vegetables and yams (see Table 4.5). Important to note, is that yam and potato production increased by 16 percent and 30 percent respectively for the period and accounted for 35 percent and 26 percent respectively of total domestic crop production. Fruit and vegetable production during the period recorded growth of 35 percent and 19 percent respectively.

Figure 4.4 Major growing areas for yellow yam



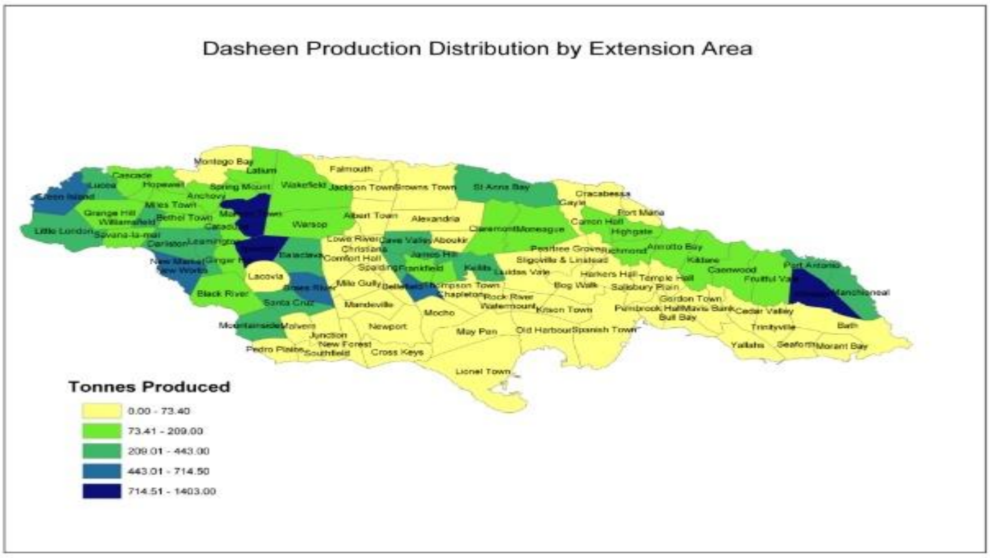
Source: Jamaica Marketing Information System (JAMIS) 2018

Figure 4.5 Major growing areas for Irish potato



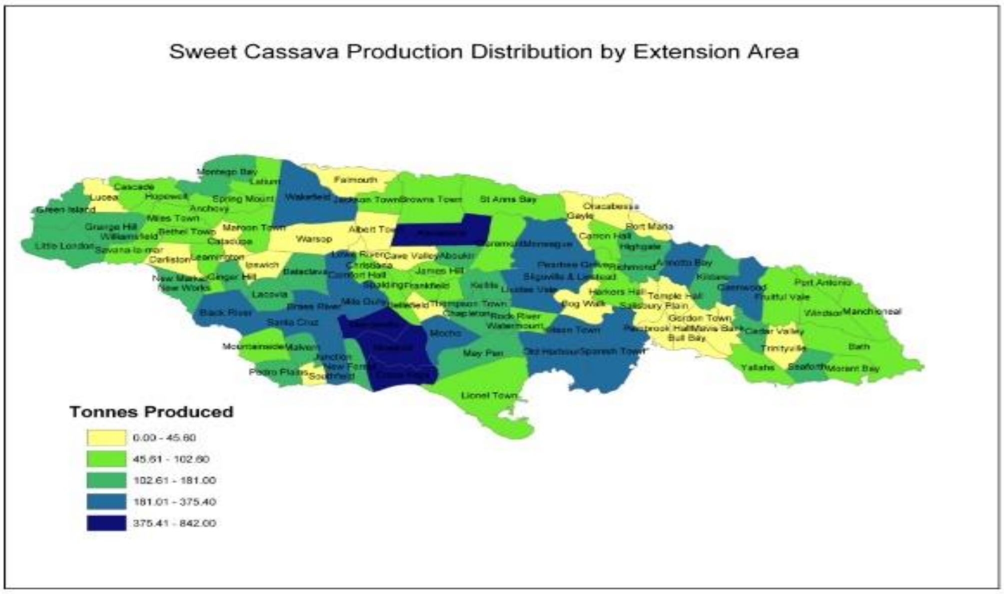
Source: JAMIS (2018)

Figure 4.6 Major growing areas for dasheen



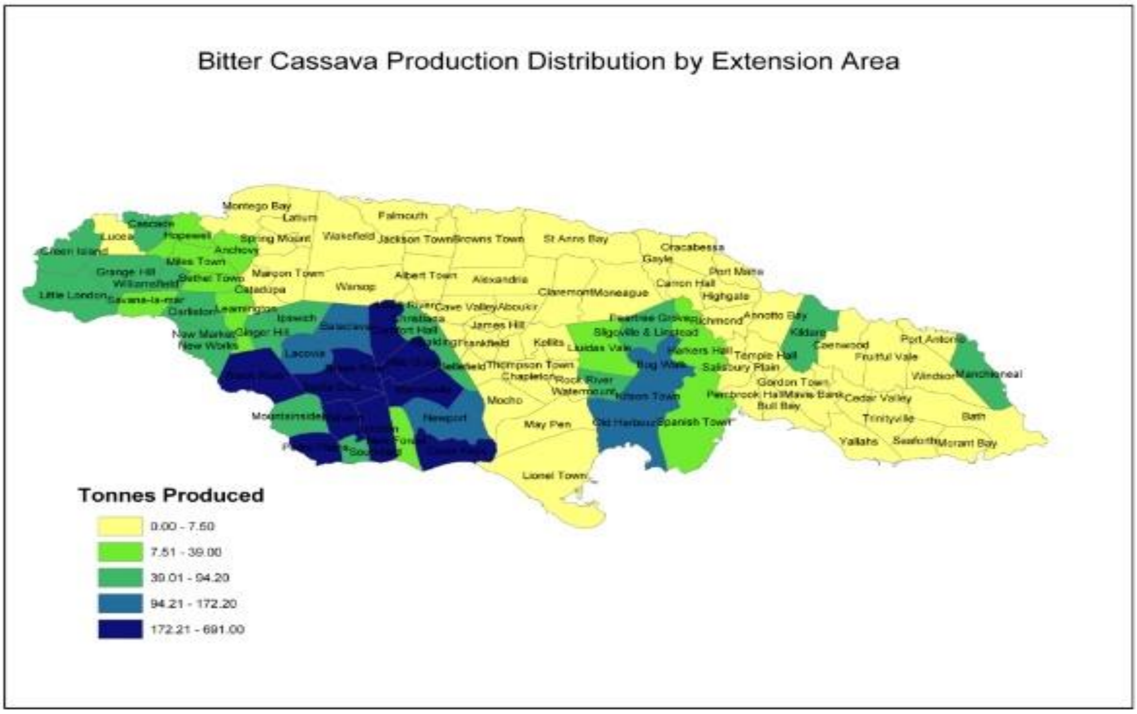
Source: JAMIS (2018)

Figure 4.7 Major growing areas for sweet cassava



Source: JAMIS (2018)

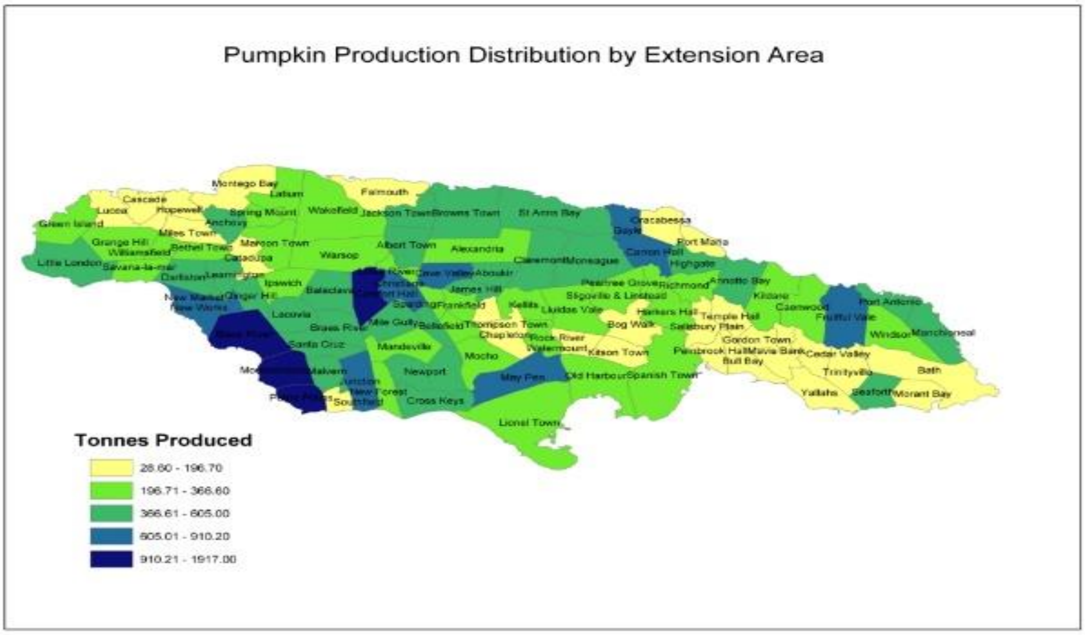
Figure 4.8 Major growing areas for bitter cassava



Source: JAMIS (2018)

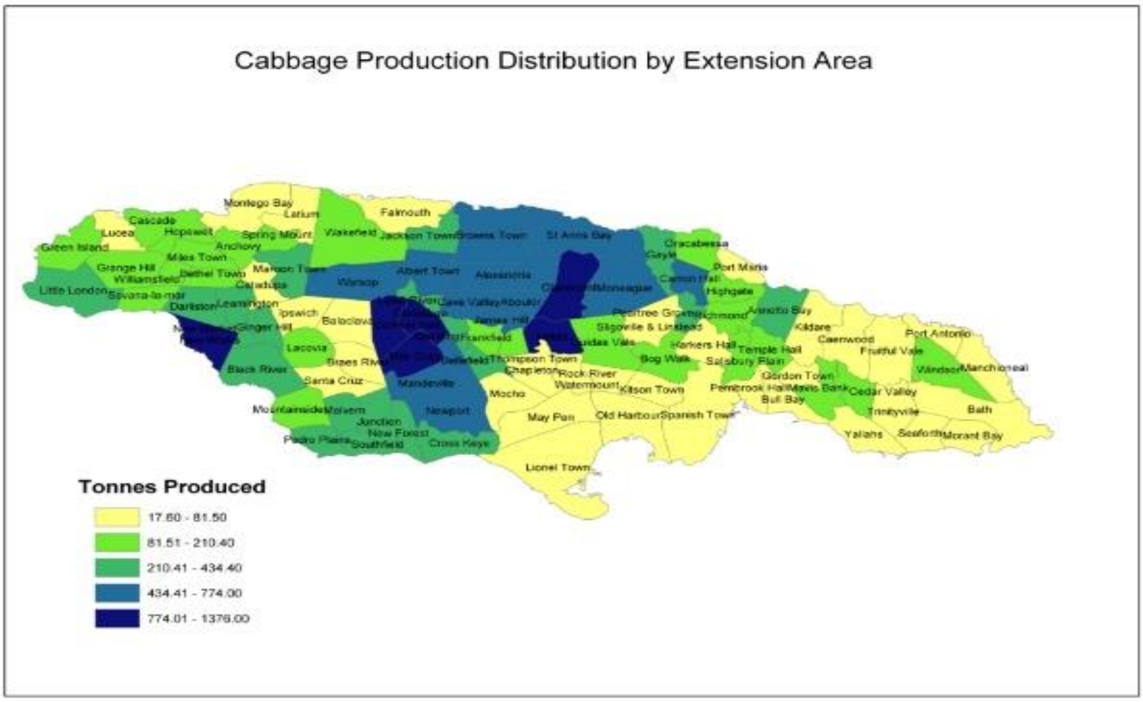
4.2.1.1 GROWING AREAS OF MAJOR VEGETABLE CROPS (SOURCE JAMIS 2018)

Figure 4.9 Major growing areas for pumpkin



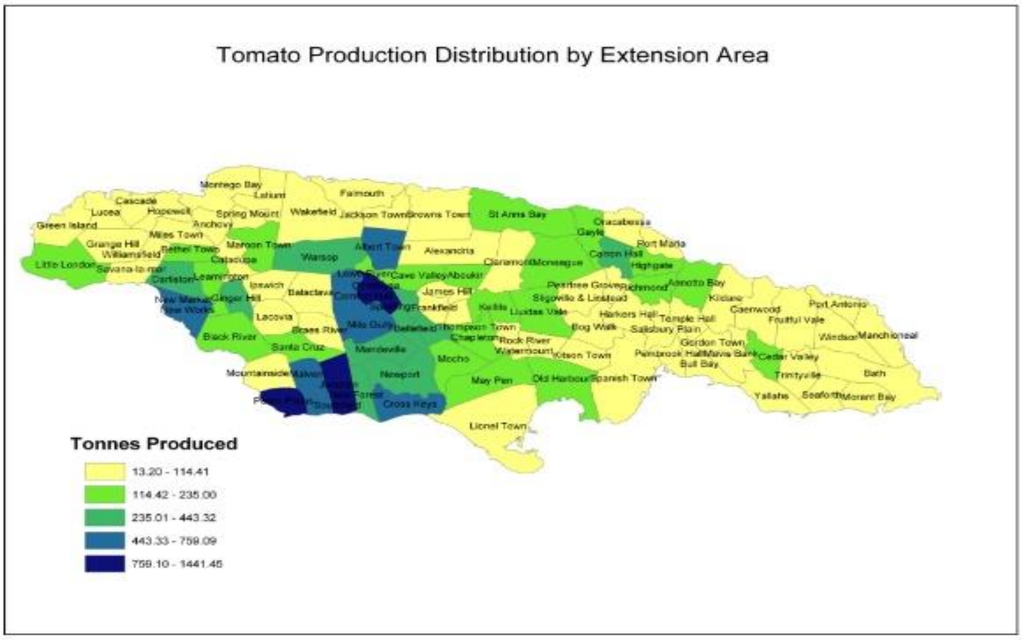
Source: JAMIS (2018)

Figure 4.10 Major growing areas for cabbage



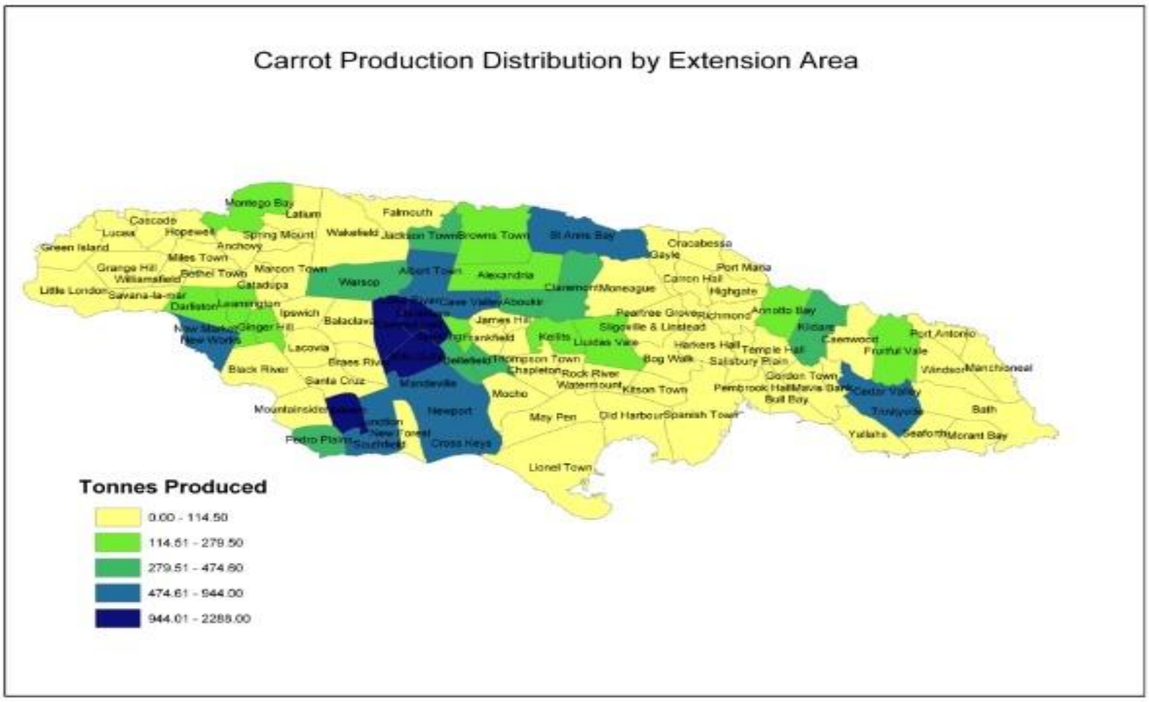
Source: JAMIS (2018)

Figure 4.11 Major growing areas for tomato



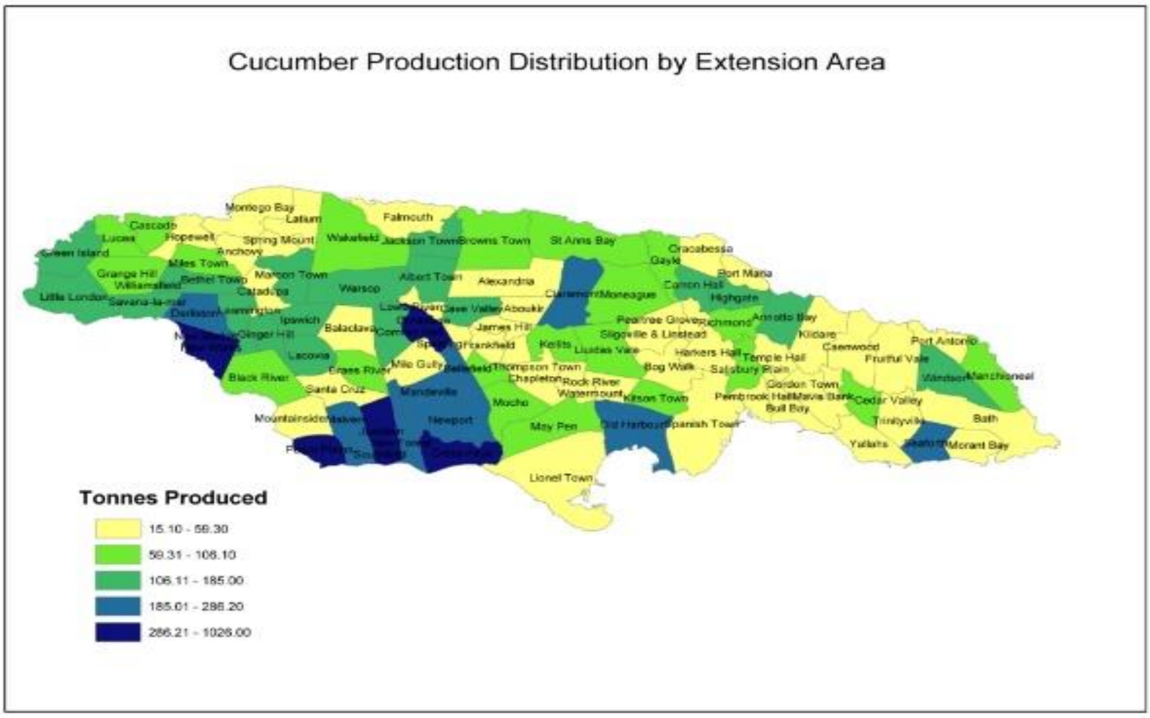
Source: JAMIS (2018)

Figure 4.12 Major growing areas for Carrot production



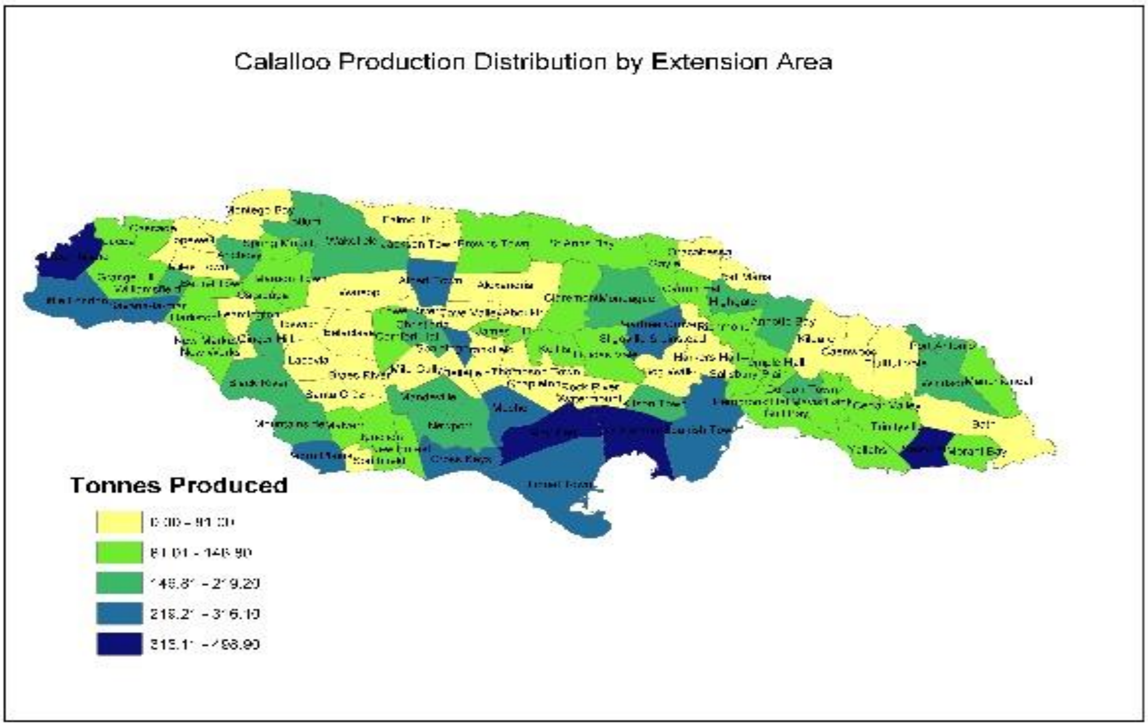
Source: JAMIS (2018)

Figure 4.13 Major growing areas for cucumber production



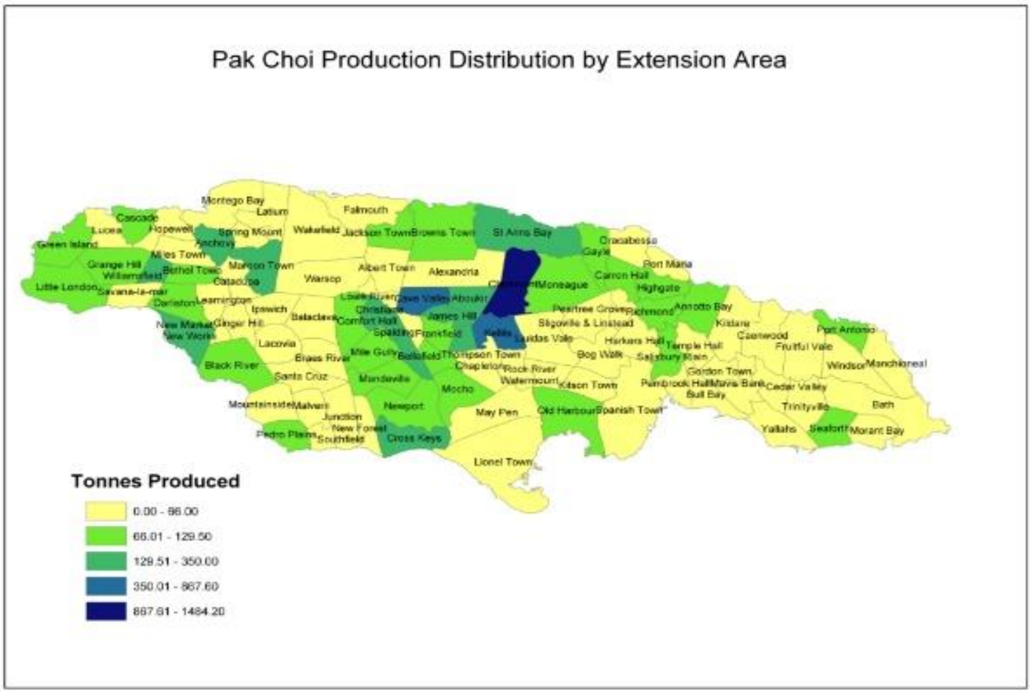
Source: JAMIS (2018)

Figure 4.14 Major growing areas for callaloo production



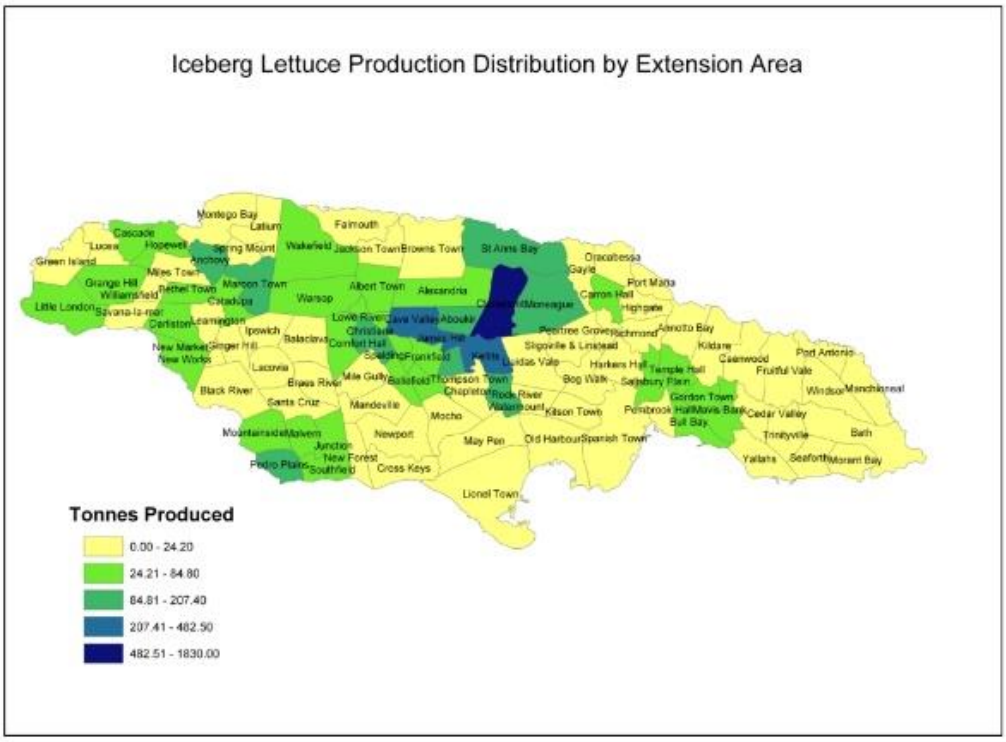
Source: JAMIS (2018)

Figure 4.15 Major growing areas for Pak Choi production



Source: JAMIS (2018)

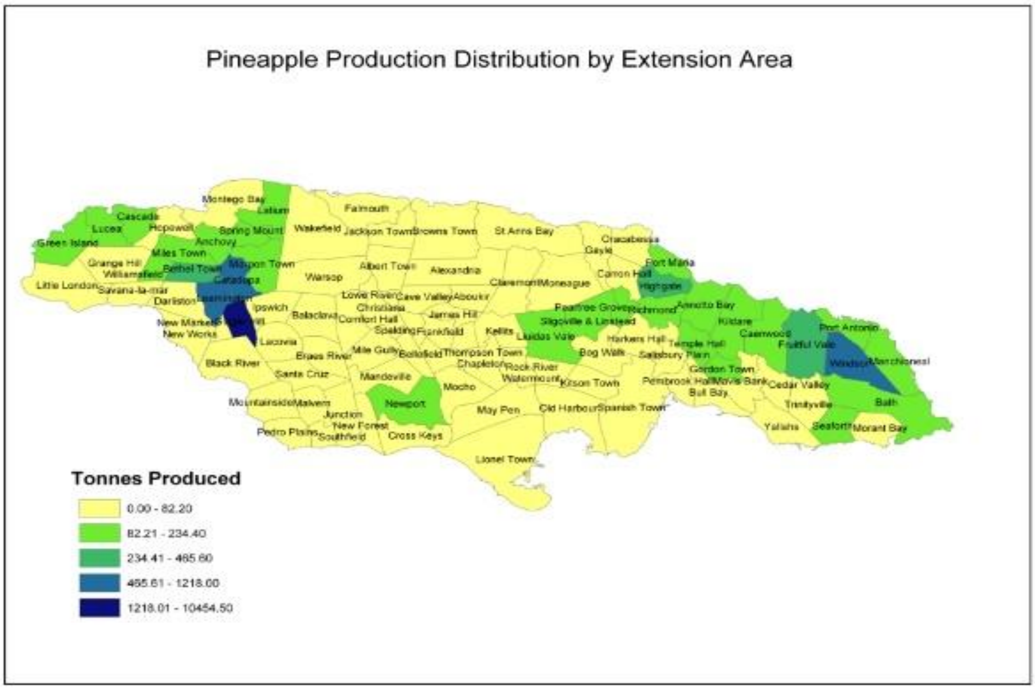
Figure 4.16 Major growing areas for iceberg lettuce production



Source: JAMIS (2018)

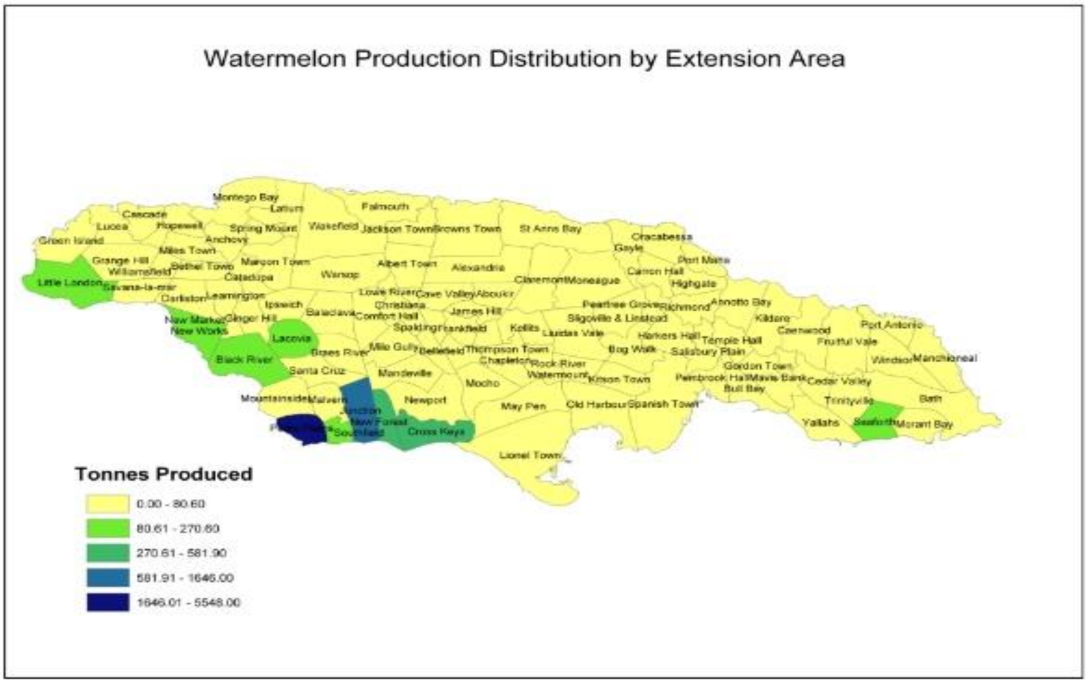
4.2.1.2 GROWING AREAS OF MAJOR FRUIT CROPS (SOURCE JAMIS 2018)

Figure 4.17 Major growing areas for pineapple production



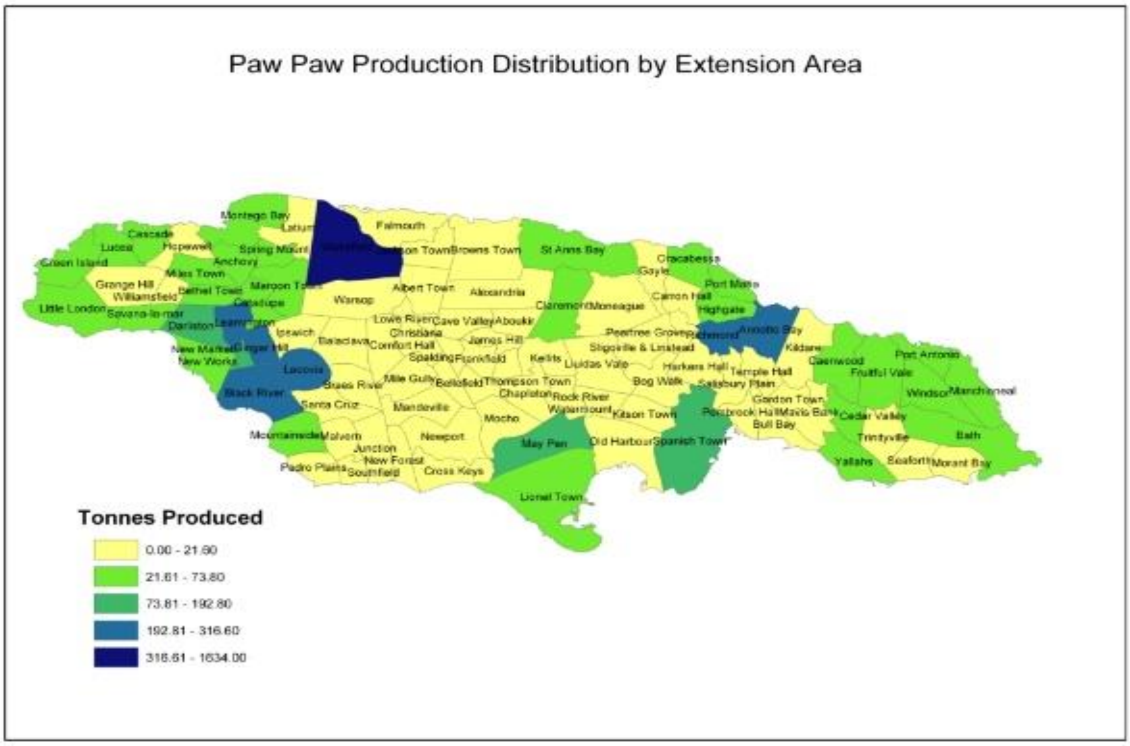
Source: JAMIS (2018)

Figure 4.18 Major growing areas for watermelon production



Source: JAMIS (2018)

Figure 4.19 Major growing areas for paw paw production



Source: JAMIS (2018)

4.2.1.3 MAJOR CONDIMENT GROWING AREAS (JAMIS, 2018)

Figure 4.20 Major growing areas for sweet pepper production

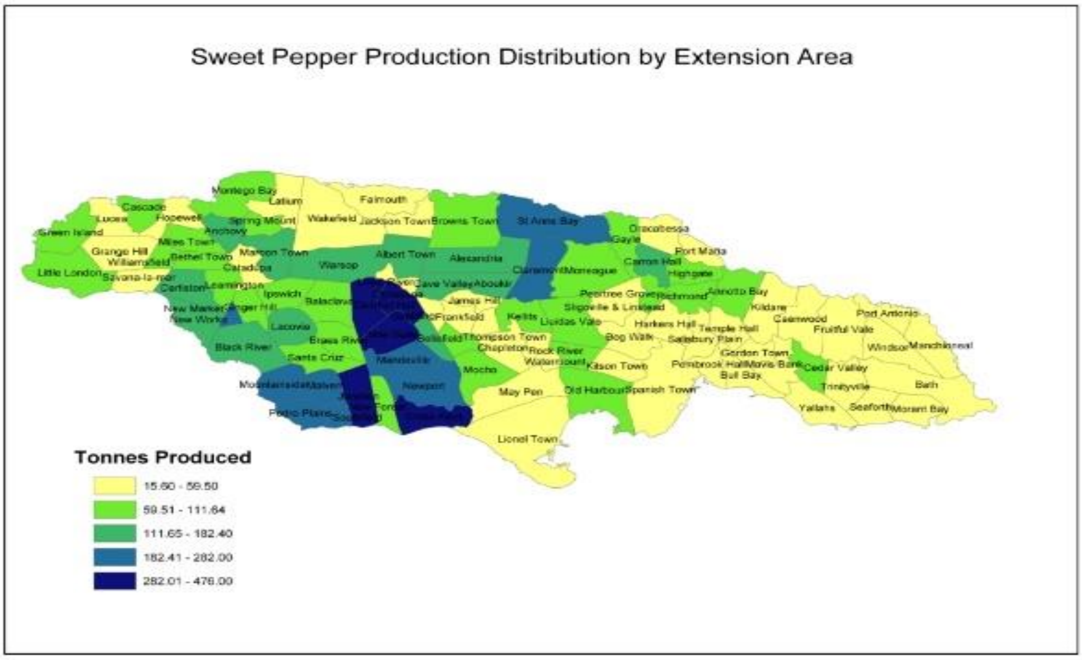


Figure 4.21 Major growing areas for Hot pepper production

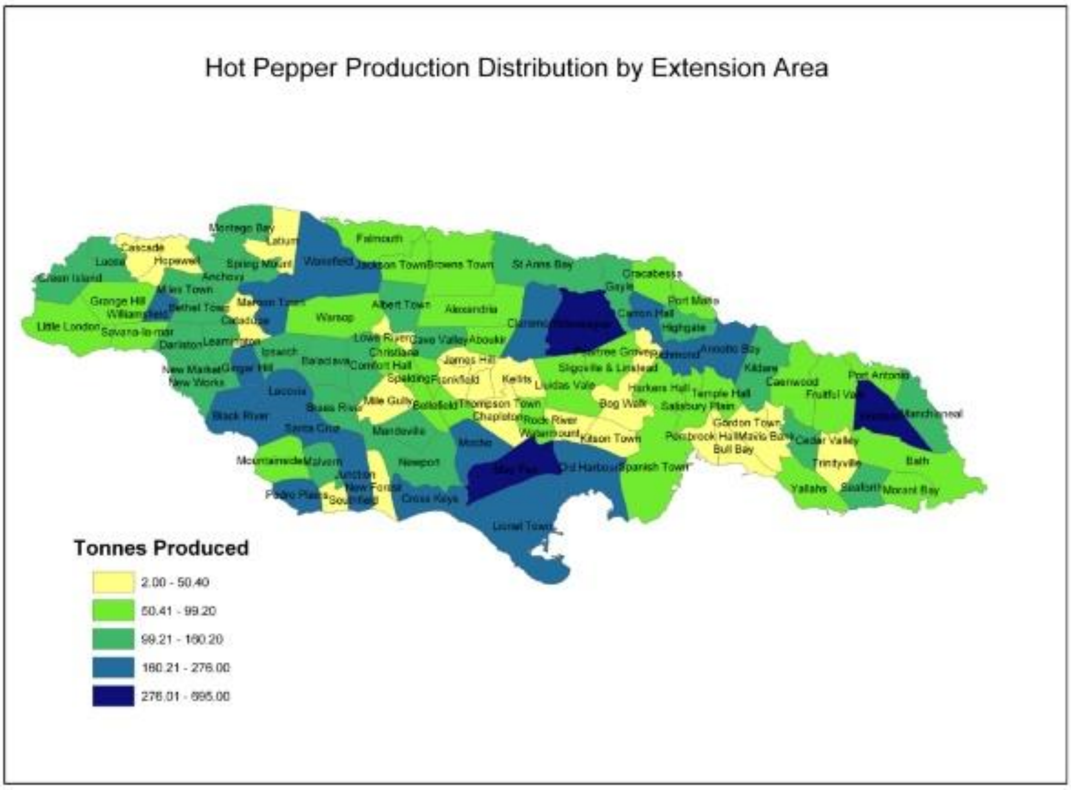


Figure 4.22 Major growing areas for scallion production

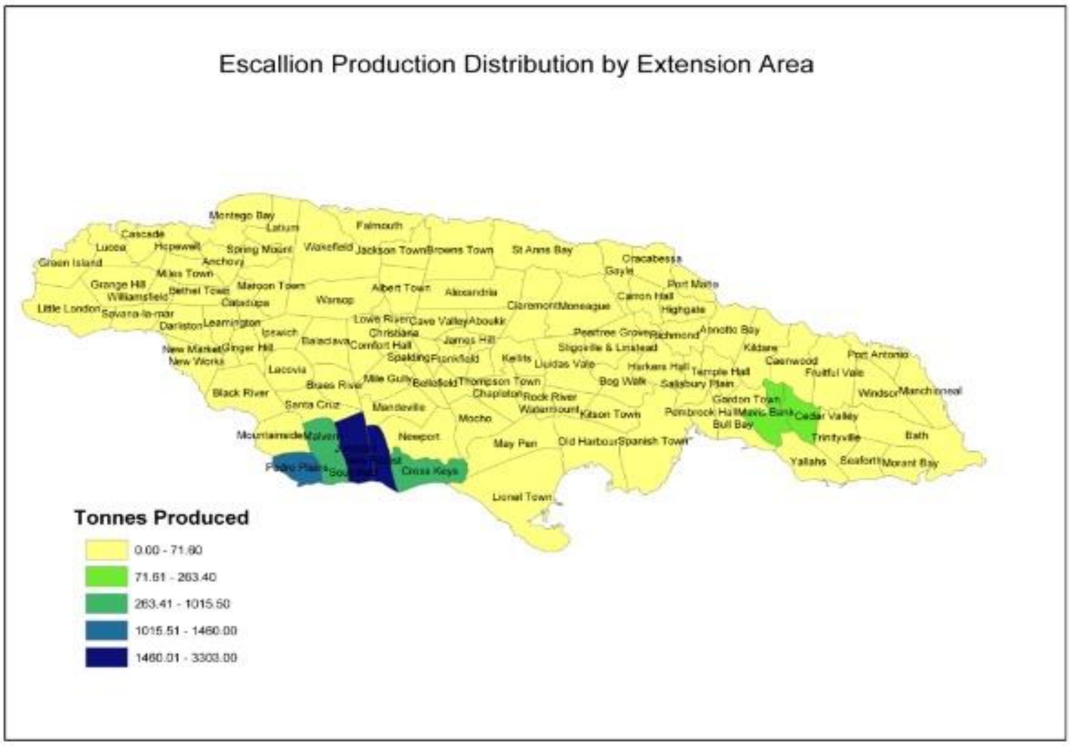


Table 4.5 Annual Domestic Crop Production 2007-2017

Items (Tonnes)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Broad Bean	133	125	171	178	210	224	221	216	217	261	243
Sugar Bean	115	111	125	116	135	146	142	138	138	155	149
Cow Peas	245	222	206	199	232	252	281	259	277	312	330
Gungo Peas	868	668	847	749	965	951	957	913	835	879	752
Red Peas	554	506	768	682	905	987	1,069	919	963	1,039	927
Peanut	3 728	2 825	2 700	2 006	2 643	2 702	2 832	2 464	2 277	2 905	2 878
Beetroot	1 025	1 392	1 650	1 662	1 853	1 541	1 608	1 490	1 254	1 583	1 748
Broccoli	550	475	688	647	817	988	1,157	763	633	858	711
Cabbage	22 110	20 648	25 896	24 515	33 046	32 688	34 584	31 993	32 210	37 689	35 818
Callaloo	12 192	11 184	12 938	12 886	15 693	16 607	15 840	14 473	13 958	16 490	16 338
Carrot	19 365	18 925	25 437	21 026	32 004	29 528	31 829	24 081	23 148	28 371	21 997
Cauliflower	1 490	1 204	1 279	788	1 301	1 063	1 055	1 135	996	1 040	790
Celery	48	95	193	160	174	203	169	215	223	251	323
Cho Cho	2 534	2 596	3 162	3 877	4 691	5 394	4 907	4 525	4 153	5 056	5 453
Cucumber	11 252	11 217	11 428	11 681	16 025	16 617	17 425	15 511	15 810	19 006	18 387
Egg Plant	423	311	404	817	391	362	481	389	415	461	405
Iceberg	5 682	5 364	6 125	6 234	9 607	8 845	9 658	9 316	9 286	11 641	10 791

Items (Tonnes)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Lettuce											
Other Lettuce	619	647	1,200	968	1,578	1,527	1,710	1,984	2,167	2,485	2522
Okra	3 379	3 432	4 377	4 202	5 513	6 345	6 701	5 942	5 728	6 922	6 570
Pak Choi	7 099	6 803	9 101	9 198	12 339	12 454	13 891	13 228	14 747	17 251	17 978
Pumpkin	33 749	32 927	39 785	39 292	49 432	52 171	52 072	46 763	44 653	53 497	50 494
Squash	888	1 192	1 016	1 538	1 631	1 521	1 700	1 670	1 620	1 613	1 880
String Bean	5 596	5 446	6 322	5 621	8 717	8 068	7 843	6 480	6 207	6 766	6 734
Tomato	19 576	19 387	21 190	19 006	26 950	26 526	29 128	25 238	23 891	31 427	27 544
Turnip	1 419	1 311	1 340	1 298	1 713	1 618	1 445	887	744	1 003	1 234
Escallion	10 840	10 190	10 181	11 193	13 908	14 143	16 296	12 436	11 047	14 830	10 714
Ginger	241	298	459	486	444	1 081	1 198	1 274	1 286	1 186	600
Onion	215	455	721	555	1 015	1 089	680	691	1 162	1 092	818
Hot Pepper	6 596	5 338	10 565	11 206	13 293	14 263	15 204	14 101	13 112	16 067	14 520
Sweet Pepper	8 556	7 869	10 804	10 016	14 998	15 154	17 396	15 445	14 939	18 494	18 282
Thyme	2 423	2 131	1 584	1 249	1 053	1 124	1 521	1 446	1 237	729	951
Cantaloupe	2 743	2 520	2 337	2 333	2 624	3 244	3 469	3 352	2 971	4 374	3 052
Paw-Paw	9 119	7 156	10 671	5 314	5 846	6 454	8 382	9 103	9 361	8 583	7 705

Items (Tonnes)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Pineapple	18 102	20 351	21 368	19 749	17 607	19 757	19 185	18 374	18 819	25 296	25 848
Watermelon	9 573	12 230	12 393	10 607	12 666	15 568	15 288	13 618	12 315	16 002	15 289
Cereals											
Hybrid Corn	587	784	1,236	1,343	1,564	1,606	1,784	1,449	1,384	1,420	1631
Ordinary Corn	1 080	1 107	1 114	1 016	1 159	1 192	1 161	1 037	958	916	876
Sweet Corn	7	6	9	2	11	24	20	21	7	5	32
Plantains											
Horse Plantain	14 845	11 345	18 792	23 519	27 509	27 381	23 568	31 005	28 077	32 100	34 671
Other Plantain	4 145	3 690	5 829	6 308	7 826	8 821	7 369	9 481	10 343	11 336	11 422
Roots and Tubers											
Irish Potato	7 477	4 929	8 708	11 222	15 333	15 396	17 421	19 577	18 215	17 007	17 148
Sweet Potato	26 055	25 797	34 229	34 513	42 091	42 165	44 224	39 412	40 535	48 006	41 996
Lucea Yam	10 306	10 542	9 610	10 744	9 138	9 412	10 208	7 826	9 625	12 325	10 851
Negro Yam	11 217	11 075	15 289	15 163	16 311	15 632	15 301	14 010	13 506	13 220	10 926
Renta Yam	8 006	6 662	8 253	9 444	9 892	10 017	9 038	8 450	7 344	8 050	8 207
St. Vincent	2 323	2 026	2 443	2 901	2 801	2 420	2 104	2 203	2 139	2 273	2 057

Items (Tonnes)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Yam											
Sweet Yam	5 186	3 765	4 411	3 907	3 291	2 608	1 805	1 768	1 732	1 867	15 02
Tau Yam	2 588	2 150	2 245	2 442	2 507	2 674	3 207	3 564	3 749	3 359	
Yellow Yam	71 863	64 374	80 531	89 943	88 601	100 326	95 334	95 653	97 216	111 778	105 653
Bitter Cassava	11 487	6 741	5 764	6 426	7 522	6 036	5 750	5 820	6 365	6 367	5 508
Sweet Cassava	7 031	8 250	8 231	12 064	13 011	11 984	11 621	10 739	13 420	15 449	15 255
Coco	6 485	5 464	6 635	7 495	9 432	9 805	9 160	9 540	8 979	9 803	10 430
Dasheen	10 831	11 416	14 305	16 196	18 493	17 888	15 140	14 782	12 402	13 274	15 036
Miscellaneous crops											
Sorrel	749	708	811	1 058	1 212	1 213	1 483	1 214	1 187	1 467	1 253

Source: STATIN & MICAF AMID **Units:** tonnes **Release date:** 10/6/2016 and February 2018

Figure 4.23 Comparative annual estimates of legume production for 2007, 2012, 2016 & 2017

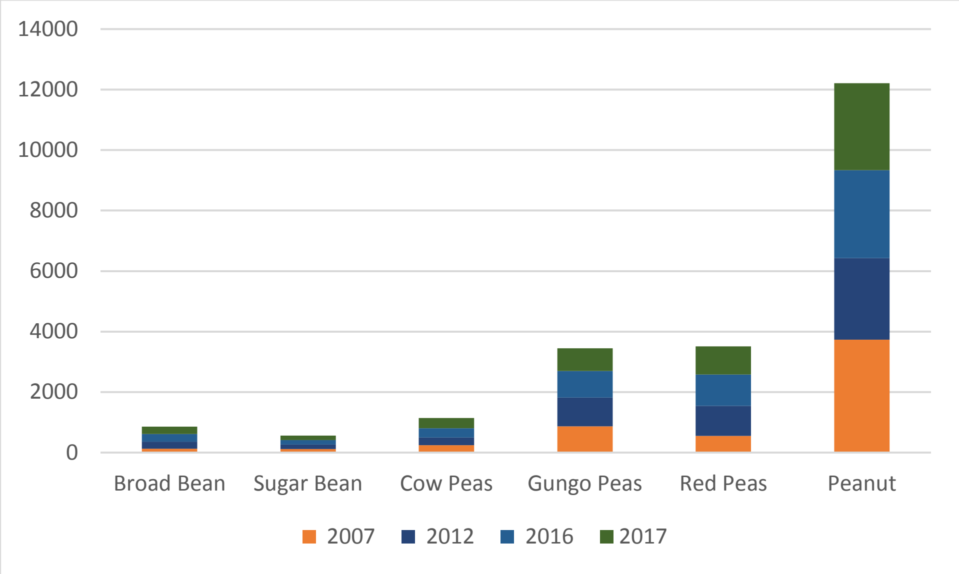


Figure 4.24 Comparative annual estimates of area harvested and yields per hectare for legumes 2016 & 2017

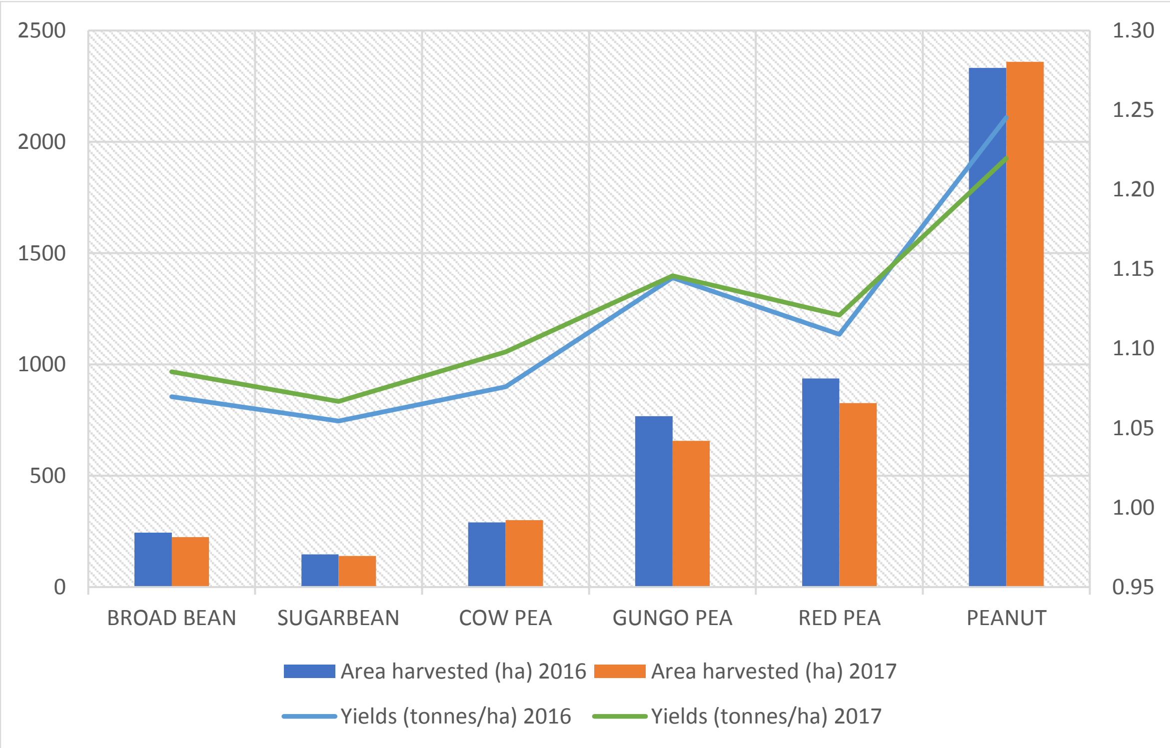


Figure 4.25 Comparative annual estimates of vegetable production for 2007, 2012, 2016 & 2017

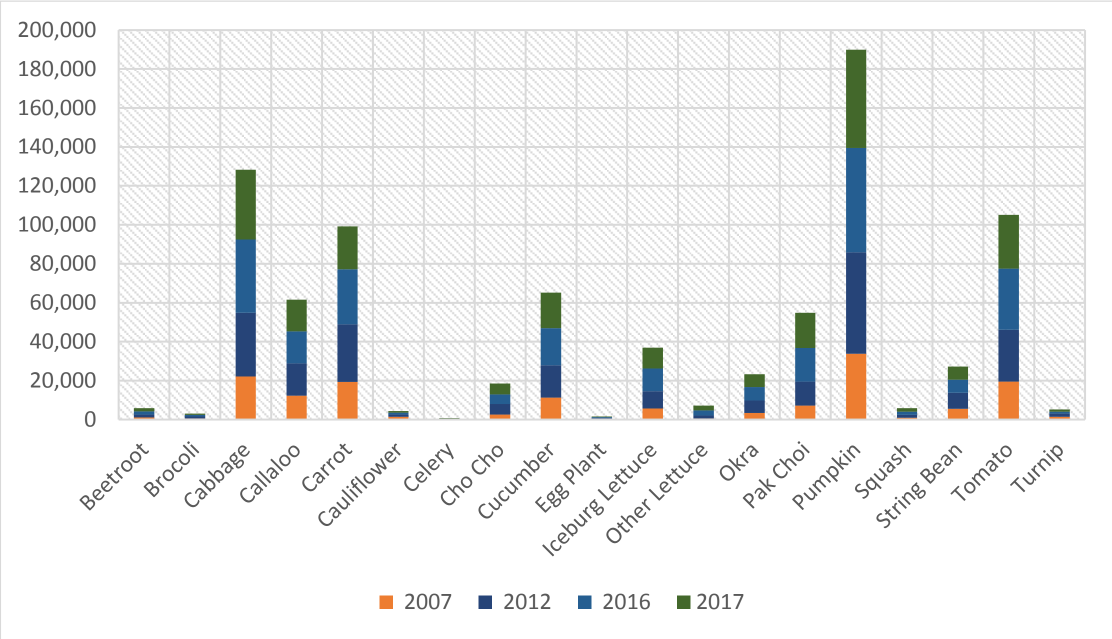


Figure 4.26 Comparative annual estimates of area harvested and yields per hectare for vegetables 2016 & 2017

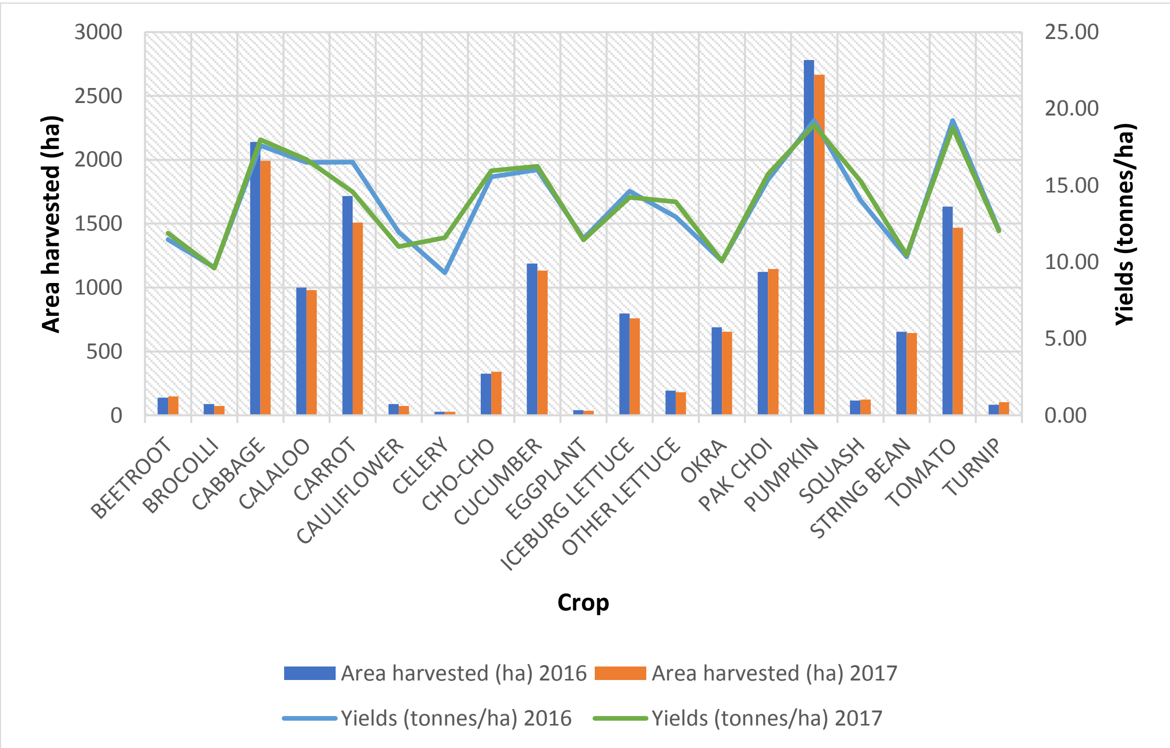


Figure 4.27 Comparative annual estimates for condiment production for 2007, 2012, 2016 and 2017

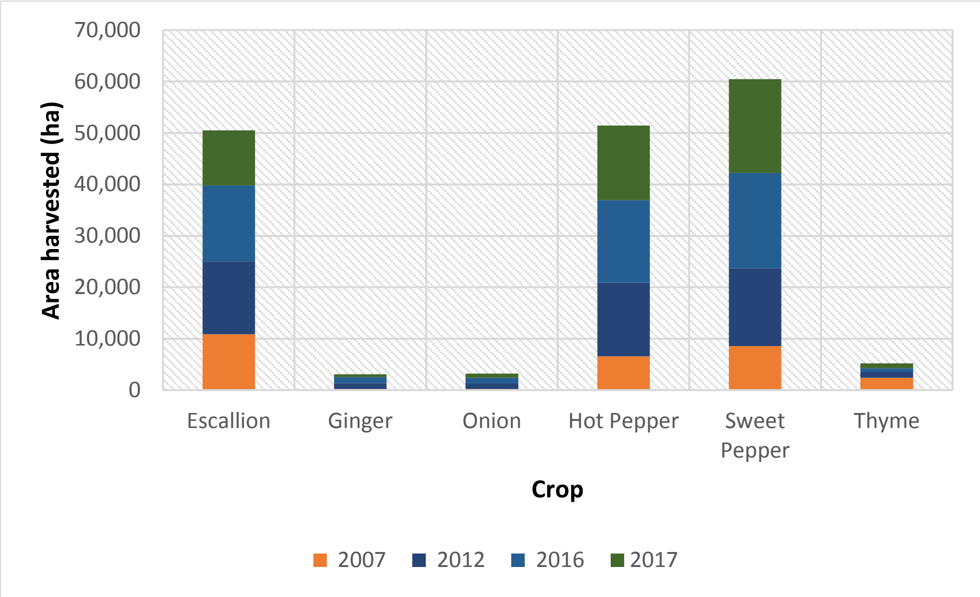


Figure 4.28 Comparative annual estimates of area harvested and yields per hectare for condiments 2016 & 2017

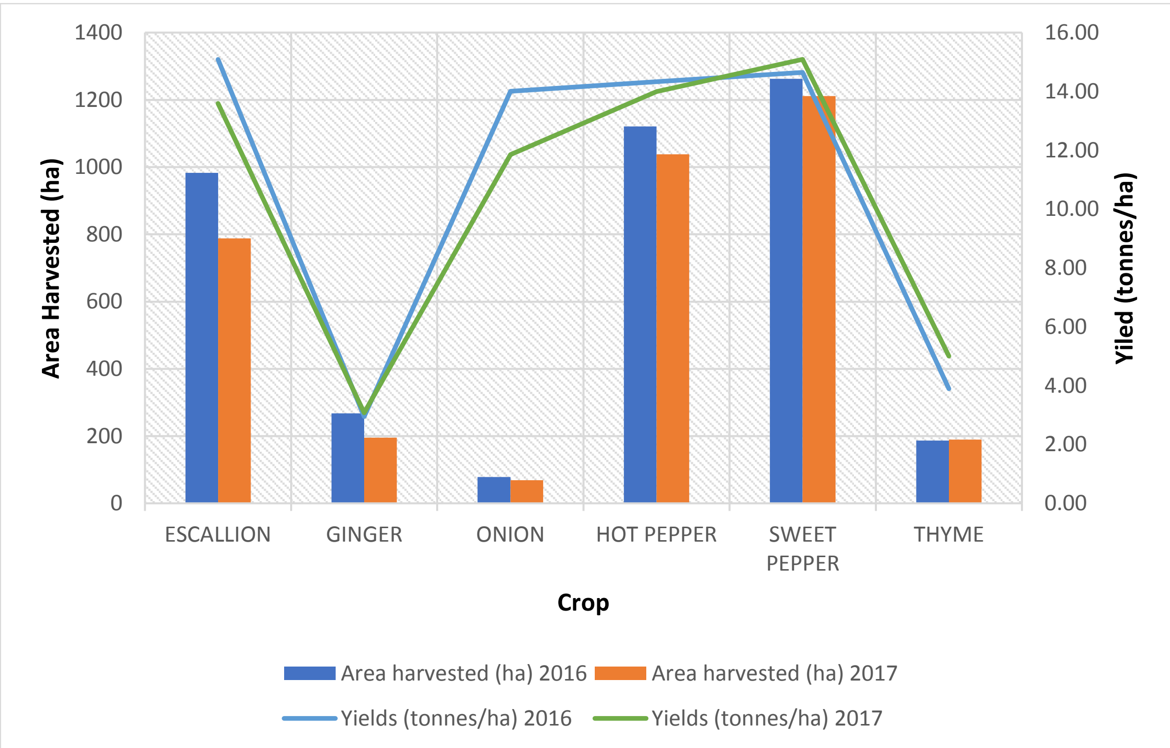


Figure 4.29 Comparative annual estimates for fruit production for 2007, 2012, 2016 & 2017

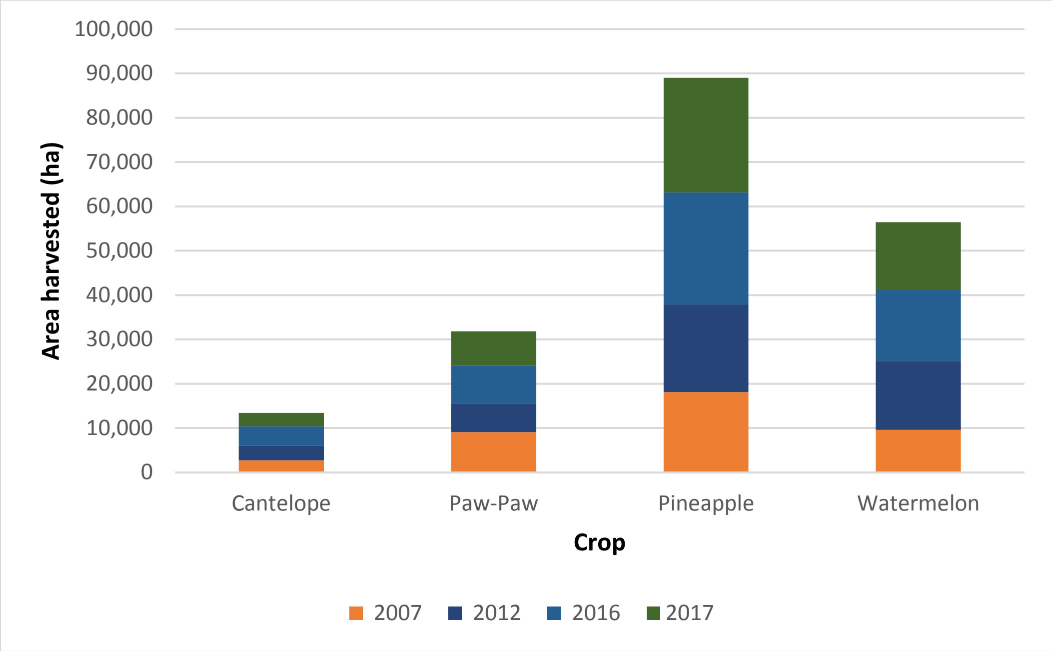


Figure 4.30 Comparative annual estimates of area harvested and yields per hectare for fruits 2016 & 2017

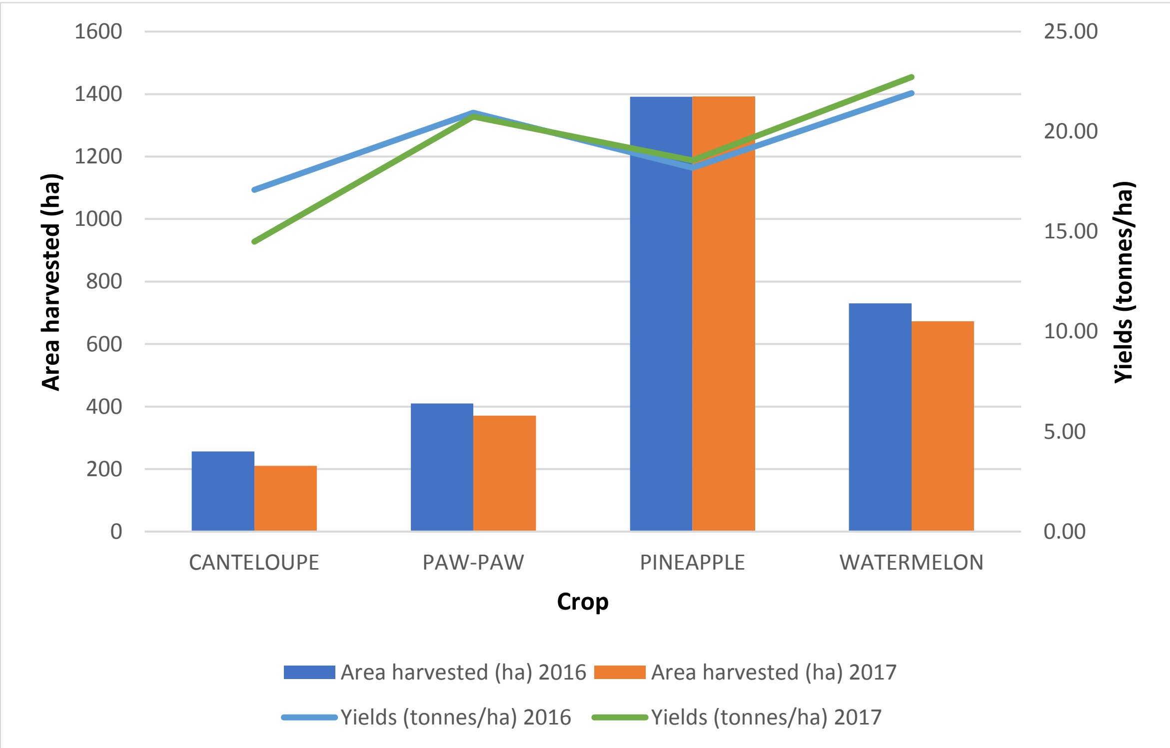


Figure 4.31 Comparative annual estimates of crop production of cereals, roots and tubers for 2007, 2012, 2016 and 2017

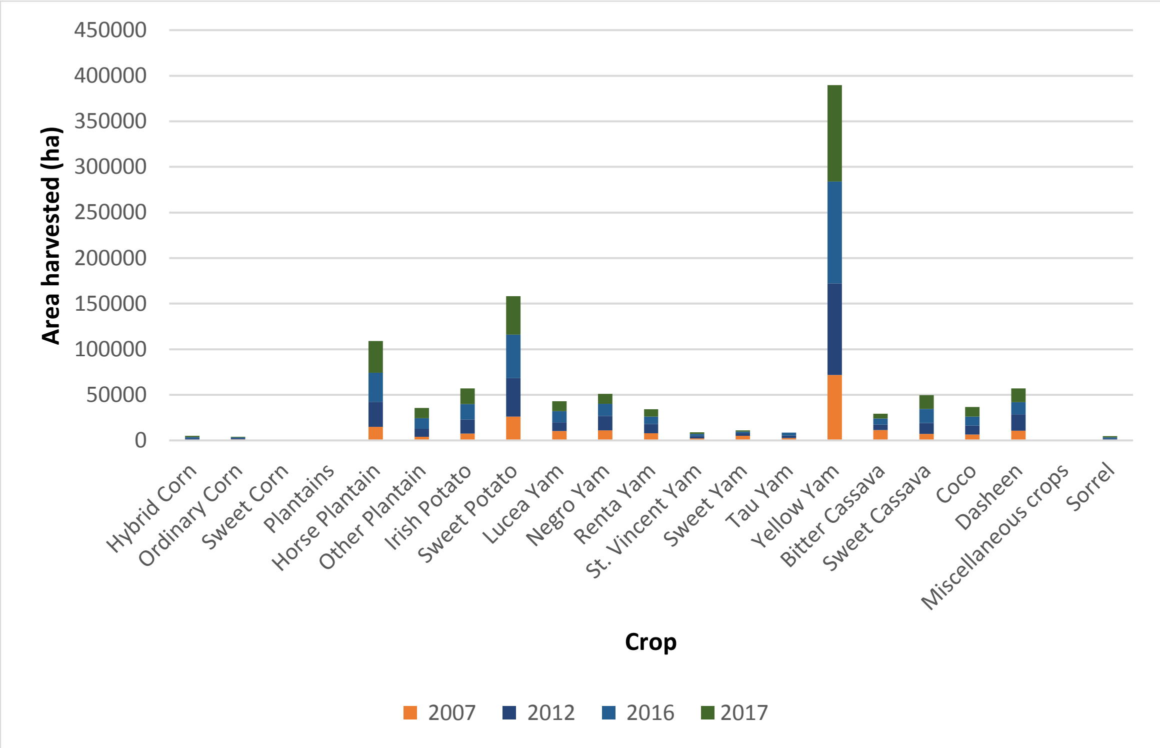


Figure 4.32 Comparative annual estimates of area harvested and yields per hectare for cereals, plantains, roots and tubers 2016 & 2017

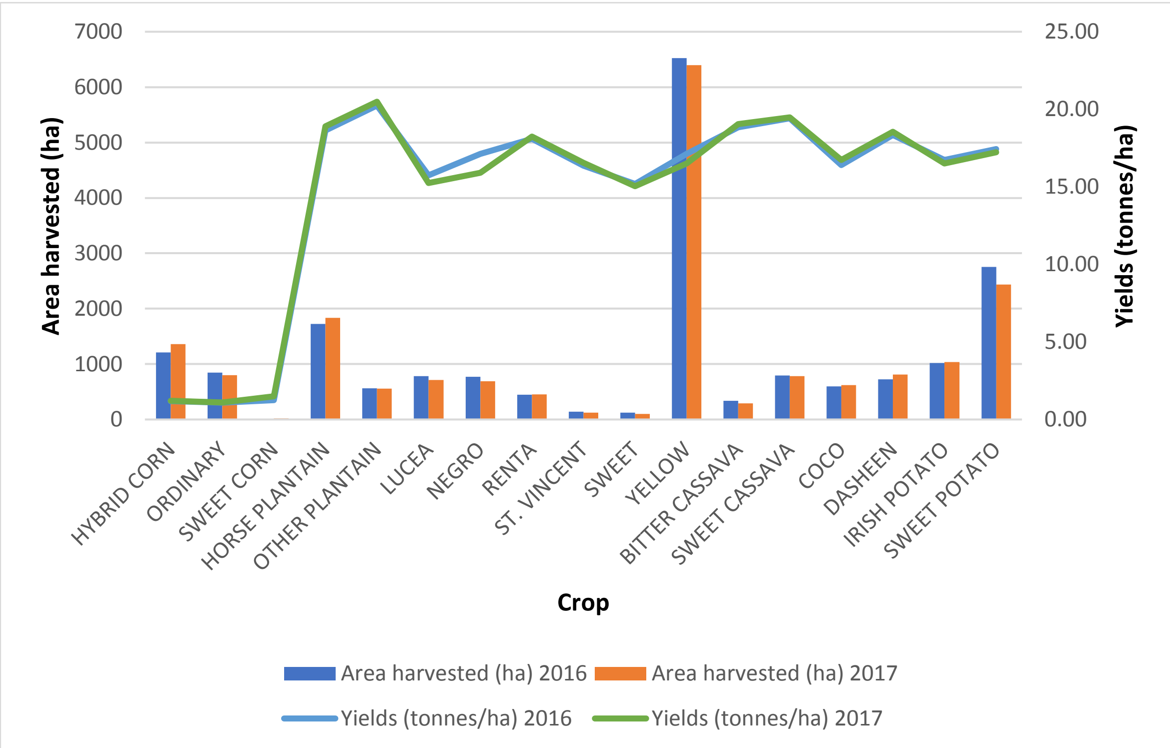


Table 4.6 Domestic crop production and area harvested for 2016 and 2017

	Area harvested (ha)		Production (tonnes)		Yields (tonnes/ha)	
	2016	**2017**	**2016**	**2017**	**2016**	**2017**
Broad bean	244	223.8	261	242.9	1.07	1.09
Sugar bean	147	139.3	155	148.6	1.05	1.07
Cow pea	290	300.3	312	329.7	1.08	1.10
Gungo pea	768	656.2	879	751.8	1.14	1.15
Red pea	937	826.8	1 039	926.8	1.11	1.12
Peanut	2 332	2 359.9	2 904	2 878.2	1.25	1.22
Beetroot	138	147.2	1 583	1 748.1	11.47	11.88
Broccoli	89	74.1	858	711.3	9.64	9.60
Cabbage	2 141	1 992.5	37 689	35 818.1	17.60	17.98
Callaloo	999	979.1	16 490	16 338.1	16.51	16.69
Carrot	1717	1 508.4	28 371	21 996.8	16.52	14.58
Cauliflower	87	71.8	1 040	789.6	11.95	11.00
Celery	27	27.9	251	323.1	9.30	11.58
Cho-cho	325	341.8	5 056	5 452.7	15.56	15.95
Cucumber	1 187	1 132.3	19 006	18 387.1	16.01	16.24
Eggplant	40	35.4	461	405.1	11.53	11.44
Iceberg lettuce	796	759	11 641	10 791.4	14.62	14.22
Other lettuce	192	181.2	2 485	2522	12.94	13.92
Okra	688	653.2	6,922	6570	10.06	10.06
Pak choi	1 122	1 144	17 251	17 978.5	15.38	15.72
Pumpkin	2 782	2 665.7	53 497	50 493.7	19.23	18.94
Squash	115	123	1 613	1 880.1	14.03	15.29
String bean	654	643.1	6,766	6734	10.35	10.47
Tomato	1 635	1 469.5	31 427	27 544.5	19.22	18.74
Turnip	83	102.5	1 003	1 233.7	12.08	12.04
Other vegetables	10	14.9	79	98.2	7.90	6.59
Escallion	983	788.2	14,830	10713.5	15.09	13.59
Ginger	268	194.9	790	599.7	2.95	3.08

	Area harvested (ha)		Production (tonnes)		Yields (tonnes/ha)	
	2016	**2017**	**2016**	**2017**	**2016**	**2017**
Onion	78	69	1,092	817.6	14.00	11.85
Hot pepper	1 121	1 037.9	16 067	14 520.3	14.33	13.99
Sweet pepper	1263	1 211.5	18 494	18 282	14.64	15.09
Thyme	187	189.9	729	950.7	3.90	5.01
Cantaloupe	256	210.6	4 374	3 052.5	17.09	14.49
Paw-paw	410	371.3	8,583	7704.6	20.93	20.75
Pineapple	1391	1392.8	25 296	25 847.9	18.19	18.56
Watermelon	730	672.8	16 002	15 289	21.92	22.72
Hybrid corn	1208	1363	1 420	1 630.8	1.18	1.20
Ordinary	844	799.7	916	875.9	1.09	1.10
Sweet corn	4	21.6	5	32.1	1.25	1.49
Horse plantain	1 722	1 834.5	32 100	34 670.8	18.64	18.90
Other plantain	560	557.5	11 336	11 422.2	20.24	20.49
Lucea	783	712.2	12 325	10 850.9	15.74	15.24
Negro	772	687	13 220	10 926	17.12	15.90
Renta	445	449.9	8 050	8 206.7	18.09	18.24
St. Vincent	139	124.3	2 273	2 057.4	16.35	16.55
Sweet	123	99.9	1 867	1 502.5	15.18	15.04
Tau	195	191.3	3 359	3 280.2	17.23	17.15
Yellow	6524	6397.3	111 778	105 653.4	17.13	16.52
Other	173	99.3	3 233	1842	18.69	18.55
Bitter cassava	338	289.1	6 367	5 508.2	18.84	19.05
Sweet cassava	796	783.2	15 449	15 255.1	19.41	19.48
Coco	598	623.3	9,803	10 429.9	16.39	16.73
Dasheen	724	810.2	13 274	15 035.6	18.33	18.56
Irish potato	1 017	1 038.5	17 007	17 148.3	16.72	16.51
Sweet potato	2752	2437.5	48 006	41 996.1	17.44	17.23
Sorrel	842	740.3	1 408	1 252.9	1.67	1.69

Source MICAF AMID 2018

4.2.1.4 PROTECTED AGRICULTURE (PA) CROPS

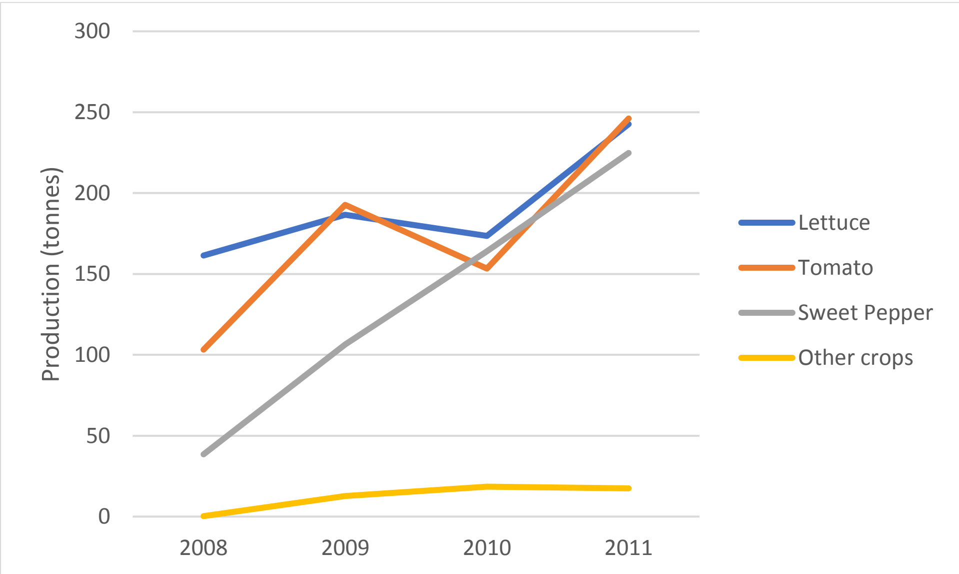
In Jamaica, protected agriculture (PA) was re-introduced to the island for the production of fruits and vegetables in 2004. This primarily involved the use of greenhouses and other protective structures to sustain production levels. This has resulted in an increase in the number of greenhouses from 0.8 hectares in 2005 to over 11 hectares in 2012 (Black *et al*. 2013). General production data for Jamaica for greenhouse-grown vegetables from 2008 to 2011 are shown in Table 4.7. As shown in Figure 4.37 production of PA vegetables has risen steadily over the period 2007 to 2011, with total production growing by 255 percent. The most significant growth was recorded for sweet pepper which had an increase in production of 491 percent. Other PA crops including zucchini, melons and squash account for only eight percent of total PA production (Black *et al*, 2013).

Table 4.7 Greenhouse vegetable production (tonnes) 2008-2011

Produce	2008	2009	2010	2011
Lettuce	161.4	186.5	173.5	242.6
Tomato	103.2	192.7	153.4	246.1
Sweet Pepper	38.5	106.3	164.1	224.8
Other crops	0.3	12.8	18.5	17.4
Total	303.4	498.3	509.5	730.9

Source: Black et al 2013

Figure 4.33 General production data (tonnes) for Jamaica for greenhouse-grown vegetables (2008 – 2011)



Data for PA production of vegetables as a percentage of total national production (open-field and PA) for the period 2007 to 2011 are presented in Table 4.8.

Table 4.8 Protected Agriculture vegetable production as a percentage of national production (open-field and PA).

Crop	2007	2008	2009	2010	2011
Lettuce	1.19	2.01	2.00	1.88	1.84
Tomato	0.35	0.53	0.91	0.81	0.91
Sweet Pepper	0.44	0.49	0.98	1.64	1.50
TOTAL	0.57	0.86	1.21	1.33	1.33

Source: Ministry of Agriculture and Fisheries 2012

4.2.1.5 AGROPARKS

The Agroparks driven by the Ministry of Agriculture and Fisheries are seen as a means to increase land use for agriculture to cultivate inactive farmland and promote agricultural zones (Agro Parks). This is an initiative to support small and medium enterprises (SME) investments in the production of selected crops and livestock directed towards import substitution and replacement, as well as, the provision of raw material for agro-processing and non-traditional exports.

The Agroparks support farming cooperatives and private individuals interested in increasing local production for food processing towards a reduction in the dependency on imported food and the diversification of production away from export crops such as sugar and bananas because of the major reduction in subsidies from the European Union to support the export of such crops (Ministry Paper, 2015).

By the end of 2017, seven of the nine Agropark areas selected commenced agricultural production of a wide range of domestic crops. These were Plantain Garden River, St. Thomas; Yallahs, St. Thomas; Amity Hall, St. Catherine; Hill Run, St. Catherine; Ebony Park, Clarendon; New Forest/Duff House, St. Elizabeth/Manchester. The contribution of the Agroparks to production is not that significant and hence has not been segregated and is included in the domestic crop production estimates.

4.2.2 MARKETING CHANNELS

4.2.2.1 NON-TRADITIONAL EXPORT CROPS

Products of interest: yam, dasheen, pumpkin, sweet potato, hot peppers, turmeric, mangoes, breadfruit, coco, callaloo, thyme, scallion and ginger. The Jamaica Exporters Association database shows that the top ten fresh produce items (excluding cocoa, coffee, papaya, pimento and citrus) that were exported in 2012 had a FOB value of USD 32 141 496, and a volume of 15 653 773 kg These include roots and tubers, vegetables, spices, herbs and condiments.

In 2015 exporters accounted for a small share of available fresh produce supplies (Brac consultants, 2015). For example in 2012, 10 425 tonnes of yams, the largest non-traditional export commodity, only accounted for approximately 8.5 percent of available supplies. In view of the expanding export market opportunities, the potential for increased local production of selected agricultural crops for export is considerable.

These commodities are marketed in the niche markets of the diaspora, with the United States of America, Canada and the United Kingdom being the dominant markets (Brac consultants, 2015). Yam exports were 10.4 million kg in 2012, accounting for 70 percent of export demand of 15 million kg. Over 60 percent of yam is marketed to the United States of America. Sweet potato and dasheen were also major export items, accounting for nine percent and six percent respectively of total demand, while export demand for breadfruit, mangoes and pimento was also significant.

4.2.3 FRESH MARKET

The key focal point for fresh produce trading in Jamaica is the Coronation Market in Downtown Kingston where in 2009 it was estimated that 60 to70 percent of the fresh fruits and vegetables are exchanged and then re-distributed through other municipal wholesale-retail markets in various parishes, for hotels, restaurants, processors and other consumers (Seepersad and Ennis, 2009). Farmers as well as marketing intermediaries (higglers) facilitate this movement of produce from the farms throughout the distribution chain.

The marketing intermediaries (higglers) who are predominantly women in the above 30 age bracket, perform a range of functions in the supply chain, including farmgate purchase, harvest, collection, post - harvest, aggregation, sales, wholesale market purchasing and re-distribution service in the fresh produce marketing system.

In addition to the Coronation Market there are municipal markets strategically located across Jamaica in the major towns of each Parish facilitate wholesale and retail trade (JSIF, 2009). Traders at all municipal markets (including Coronation) include farmers, higglers and buyers. Farmers are most accustomed however to the farm-gate or wholesale markets where payment is received at the time of transaction.

4.2.4 AGRO-PROCESSORS

Processors are engaged in the manufacturing of various products such as beverages, juices, jams, jellies, spices and sauces, and confectioneries for the local and export markets. In some cases, these agro-processors operated under contract for other manufacturers or marketing companies (Brac consultants, 2015).

The estimated value of purchases by agro-processors in 2015 was JMD 10.3 billion (USD 91.7 million). The products of interest by agro-processors included: carrots; scallion; hot (red) peppers and yellow (Scotch Bonnet) peppers; pimento; ginger; cassava; and herbs (peppermint, lemon grass, cerasee, moringa) (Brac consultants, 2015). Agro processors purchased 84 percent of the local supply of hot peppers (5 600 tonnes). For tomatoes, carrots and scallion, they purchased approximately 13 000 tonnes, or 20 to 33 percent of available supplies. A growing segment was the processing of spices, herbs, teas and nutraceuticals.

The main items purchased traditionally by agro-processors are hot peppers, tomatoes, carrots and escallion. According to the 2015 PROPEL market study, the demand for hot peppers is high as the agro-processors purchased approximately 5 600 tonnes (up to 84 percent of available supplies). For tomatoes, carrot and scallion they purchased approximately 13 000 tonnes, or 20 to 33 percent of available supplies.

A growing segment is the processing of spices, herbs, teas and nutraceuticals. Currently, local processors of spices and herbal teas rely heavily on imports for up to 90 percent of their raw materials, as in some cases the required varieties are not available locally, or the level of production may be too low. The leading processors of teas, for example, source raw materials including peppermint, lemon grass, cerasee, and sorrel from Germany, Egypt, the United States of America and Canada. Local manufacturers/processors of seasoning and herbs also import items such as ginger and turmeric.

A Brac consultants study (2015) reported that in 2007 an estimated 6 557 tonnes of tomato, 2 304 tonnes of escallion, 5 620 tonnes of hot pepper, 3 907 tonnes of carrot and 13 tonnes of yams, went into agro-processing

Table 4.9 Volume of Locally Produced Vegetables used by Processors in Jamaica – Tonne/year

	DOMESTIC PRODUCE Tonne/year				
Processors	**Tomato**	**Escallion**	**Hot Pepper**	**Carrot**	**Yam**
True juice	0	0	0	65	0
Gray's pepper	0	0	436	0	0
Musson Jamaica	0	0	0	1 745	0
King pepper	0	436	436	0	0
Spur tree spices Ja ltd	0	22	55	0	0
West best foods	6 546	44	22	35	13
Picka pepper	0	0	3 273	0	0
Busha brown	11	68	45	0	0
Ashman food products	0	9	23	0	0
Central food packers	0	164	68	0	0
Tijule Company Ltd	0	682	545	0	0
Boston jerk seasoning	0	9	11	0	0
Southern fruits & food processors ltd	0	188	24	2 062	0
Walkers wood	0	682	682	0	0
Total	**6 557**	**2 304**	**5 620**	**3 907**	**13**

Source: Seepersad and Ennis 2009

Hot pepper is easily available locally in adequate amounts for six months during the year to facilitate agro processing through the year.

The Walker's Wood processing plant support the "The Walker's Wood Farmers Group", an informal group of farmers which has been in existence for over 7 years and continues to supply the factory with raw material. Crops grown include hot pepper, lettuce, pumpkin, and sweet pepper. The annual demand by Walkers Wood has been estimated at 682 tonnes each of pepper and scallion per year.

4.2.4.1 HOTELS

Products of interest: Lettuce; cabbage; sweet pepper; onion; sweet potato; Irish potato; cucumber; pineapple; squash; red sweet pepper; yellow sweet pepper; tomato carrots, watermelon; cantaloupe; yam; scallion; and hot pepper.

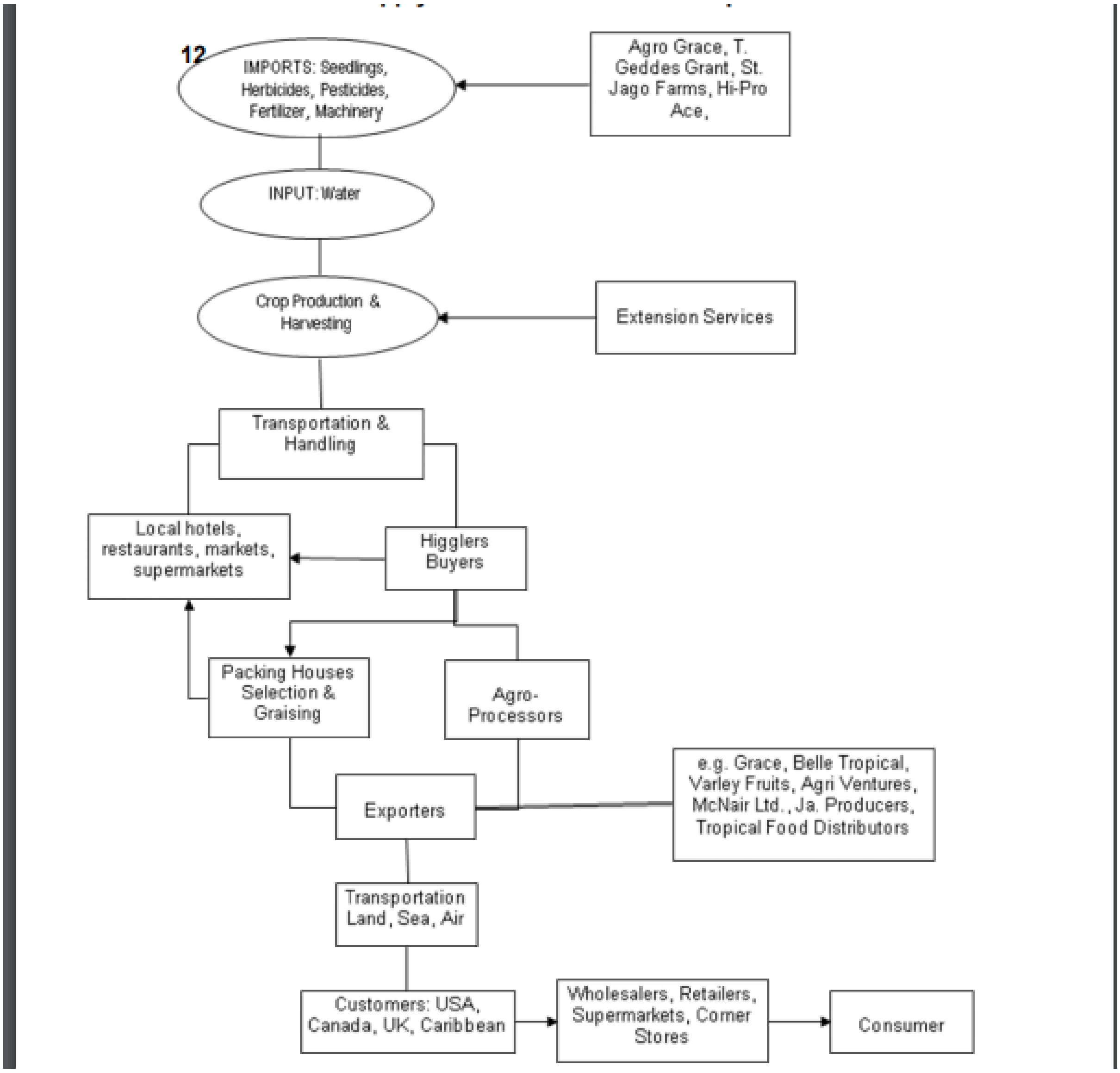
In 2015 hotels purchased about three percent of total domestic food production. Significant gains can be made in local consumption of agricultural produce as hotels often opt for direct and fresh supplies over imported goods. The requirement of the hotel sector for selected fresh agricultural produce was estimated at 34.2 million kg in 2015. The total demand from the hotel sector for the selected fresh produce is projected to reach USD 31.48 million by 2017, from an estimated USD 27.97 million in 2013. Irish potatoes, papayas, cantaloupe and yams would make up the bulk of this demand.

Source of products: Larger hotels usually source from major distributors, while the smaller hotels tend to source directly from farmers or from informal suppliers or parish markets.

Methods of Procurement: Contractual arrangements with suppliers; payment terms are usually on 30-day credit.

Fresh produce from the farms are distributed through a number of channels to the Market place (See Figure 4.38).

Figure 4.34 Supply chain for Jamaica Fresh Produce (Source: JSIF 2009)



4.2.4.2 RESTAURANTS

The main products of interest for the restaurants are: yams, tomato, carrots and hot peppers. Opportunities may also exist for farmers to supply callaloo and pak choi.

Restaurants represented a small yet significant market segment for fresh vegetables in terms of added value to local vegetables. There are four major restaurant chains in Jamaica that utilize a significant amount of fresh agricultural produce: Juicy Patties, Island Grill, Mother's and Tastee. Juicy Patties has 31 restaurants, Mother's has 18, Island Grill 14 and Tastee has one major factory outlet. International chains use negligible volumes of the commodities of interest. The estimated volumes for the commodities of interest for these restaurants are presented in Table 4.10. The annual fresh produce demand by the restaurant sector was estimated at 6 million kg valued at approximately JMD 792 million (USD 7.0 million) in 2009. Large restaurants usually purchase fresh produce on contract from farmers or middlemen. Small establishments usually buy from parish markets.

Table 4.10 Estimated Annual Use of Major Fresh Produce by Selected Major Restaurants, 2008 (Tonnes)

Commodities	Total (Tonne)
CARROTS	57
TOMATOES	124
ESCALLION	49
HOT PEPPERS	57
WATERMELON	0
CANTALOUPE	0
YAMS	74

Data Sources: (Seepersad and Ennis 2009, Juicy Patties, Island Grill, Mother's, Tastee & KFC (2008)

4.2.4.3 SUPERMARKETS

The main products of interest to supermarkets are: carrot, tomato, cauliflower, green and red cabbage, corn, callaloo, celery, pumpkin, bananas, string bean, cho-cho, iceberg lettuce, hot peppers, scallion, fresh fruit, watermelon, cantaloupe, oranges and ground provisions (yams). The main products imported include onions, red kidney beans, and corn. These are usually sourced through major importers

Sales to supermarkets involve credit transactions, small volumes, returns of spoilt and unsold produce and often require refrigerated transport, plastic field crates and a wide range of produce (JSIF, 2009). Supermarkets buy from traditional wholesalers, as well as individual farmers.

The result of a PROPEL market study showed that the aggregated volume of 17 selected items passing through supermarkets stood at 2 773 tonnes at a supplier's value of JMD 421.7 million in 2013 (Brac consultants, 2015).

4.2.4.4 PROTECTED AGRICULTURE MARKETING

There is no central market system for greenhouse output. Produce is bought primarily by middle men, distributors and higglers who supply the supermarkets, hotels and community respectively (Lawrence 2013). Greenhouse growers may also sell directly to the consumer and agroprocessor due to ease of access by consumers to most greenhouse growers facilities.

4.2.5 PRODUCTION CHALLENGES

The following production challenges have been identified for domestic crop production:

- Threat of inappropriate seed varieties being introduced through farm stores and lack of high quality planting materials with resistance or tolerance to local pest and disease agents
- Need to enhance soil fertility, manage pests and diseases with less dependence on agrochemicals
- Plot sizes of the typical suppliers range from 0.1 to 0.2 hectares.
- Periods of glut however some processors expressed willingness to semi-process and store excess during glut periods.
- Inadequate capital to access inputs to sustainably implement GAPs
- Limited available genetic diversity among variety of crops grown

4.3 LIVESTOCK SUBSECTOR

Livestock production systems as defined here refer to all processes involved in animal production, including the type of animals and their management. Research has demonstrated that livestock production has a much higher propensity to generate deep and broad economic impacts (Hamilton, 2013).

According to a Hamilton and Associates (2013) census of the pig industry primary production of livestock, inclusive of pigs, can generate JMD 3.2 value for every dollar worth of activities on farms. This is generated through other activities or providers that are integral to the primary production of livestock namely: breeders, feed suppliers, financial service providers, transportation service providers, abattoirs, butchers, construction service providers, professional service providers, processors, wholesalers, retailers and restaurants, among others. That is to say its multiplier effect is higher than that of other typical economic activities in the agriculture sector such as crops, fruits and vegetables, production, manufacturing and the provision of services.

Despite having benefited from over eight decades of research in tropical livestock production with the potential for contributing to the development of profitable industries the livestock sector has shown a downward spiral with the exception fish production (Table 4.11). Poultry and goat production have shown a stable though not expanding, production base. Small ruminants have gained considerable attention over the last decade and could be a viable option for many small farmers.

Table 4.11 Livestock production, 2009 – 2013

LIVESTOCK SLAUGHTER:	Units	2009	2010	2011	2012	2013	%Change 2013/2012
Cattle	Heads	21,009	20,404	21,218	21,495	20,790	-3.3
Hogs	Heads	121, 954	108,568	108961	142,716	108,936	-23.7
Goats	Heads	43,160	49,085	56,498	54,694	52,682	-3.7
Sheep	Heads	805	400	852	1 296	1 144	-11.7
MEAT, FISH AND DAIRY							

LIVESTOCK SLAUGHTER:	Units	2009	2010	2011	2012	2013	%Change 2013/2012
Beef & Veal	'000kgs	5 426	5 264	5 621	5 800	6 221	7.3
Pork	'000kgs	8 958	7 973	7 110	9 490	8 998	-5.2
Goats Flesh	'000kgs	867	937	1 316	1 094	929	-15.1
Mutton	'000kgs	17	11	23	32	24	-25
Poultry	'000kgs	104 502	100 637	101 526	102 167	101 933	-0.2
Aquaculture (Tilapia, Shrimp)	Tonnes	5 141	4 184	1 150	664	836	29.8
Marine (Fish, Conch, Lobster, Shrimp)	Tonnes	13 205	12 314	14 208	10 494	n/a	n/a
Eggs	Million	128.5	109	137.5	170.2	125	-26.6
Milk	Million litres	14	12.5	12.4	12.9	12.3	-4

Source: STATIN 2014

Four categories of livestock systems have been defined in Jamaica based on access to land and land tenure

- landless systems,
- livestock only/rangeland-based systems (areas with minimal cropping),
- mixed rainfed systems (mostly rainfed cropping combined with livestock) and
- mixed irrigated systems (a significant proportion of cropping using irrigation and is interspersed with livestock)

4.3.1 CATTLE PRODUCTION

The Agricultural Census of 1996, identified 49 663 cattle holdings with a population of 287 000 cattle. St Ann, Clarendon, St Elizabeth, Westmoreland and Manchester had the largest concentration of cattle respectively. The cattle survey of 2014 reported 4 698 responding farmers having 64 504 cattle in all parishes island wide (See Table 4.12). The 2014 survey reported that St. Elizabeth had the largest number of cattle farmers (1 126) having 13 794 animals which represented 21.38 percent of the total population.

4.3.1.1 BREEDS OF CATTLE

Beef breeds: Local (Jamaica Red Poll, Jamaica Brahman, Polled Jamaica Brahman and Jamaica Black)

Dairy Breed: Jamaica Hope and other mixed breeds of graded Holstein and Jersey

Table 4.12 Number of cattle by category by parish 2014

Parish	Total No. of Animals	No. of Farmers	Milking (Dairy)	Nursing (Beef & Dual Purpose)	Pregnant	Dry	Heifer	Young Bulls (up to 3 yrs)	Calves....Female (< 1 yr)	Calves....Male (< 1yr)	Steers (Castrated Male)	Service Bull	Other Mature Bull
Kingston & St. Andrew	561	49	0	25	36	35	46	309	31	39	0	24	16
St. Thomas	8 872	224	2 434	255	2 165	119	1 737	204	1 578	225	0	139	16
Portland	2 564	295	15	536	487	98	430	218	281	303	0	183	13
St. Mary	1 967	143	40	443	293	116	262	126	248	258	0	99	82
St. Ann	7 162	304	717	1 017	793	880	1 104	568	943	785	50	108	197
Trelawny	2 496	231	0	481	228	331	507	198	300	229	6	93	123
St. James	1 576	188	0	312	98	152	331	259	184	151	3	44	42
Hanover	2 448	117	160	237	93	109	412	152	182	99	10	112	882
Westmoreland	7 447	803	1 945	776	444	1 172	823	929	888	15	263	192	
St. Elizabeth	13 794	1 126	470	3 101	2 122	758	1 606	1 617	1 856	1 704	5	431	124
Manchester	7,120	486	611	1 129	873	289	1 161	833	995	944	11	163	11
Clarendon	5 712	515	128	902	658	183	1 354	1 196	604	497	.	87	103
St. Catherine	2 785	217	259	415	235	193	573	348	307	300	18	108	29
Total	*64 504*	*4 698*	*4 834*	*10 798*	*8 857*	*3 707*	*10 695*	*6 851*	*8 438*	*6 422*	*118*	*1 854*	*1 930*

Source: Jamaica Dairy Development Board Cattle Census 2014

Figure 4.35 Cattle population per parish 2014

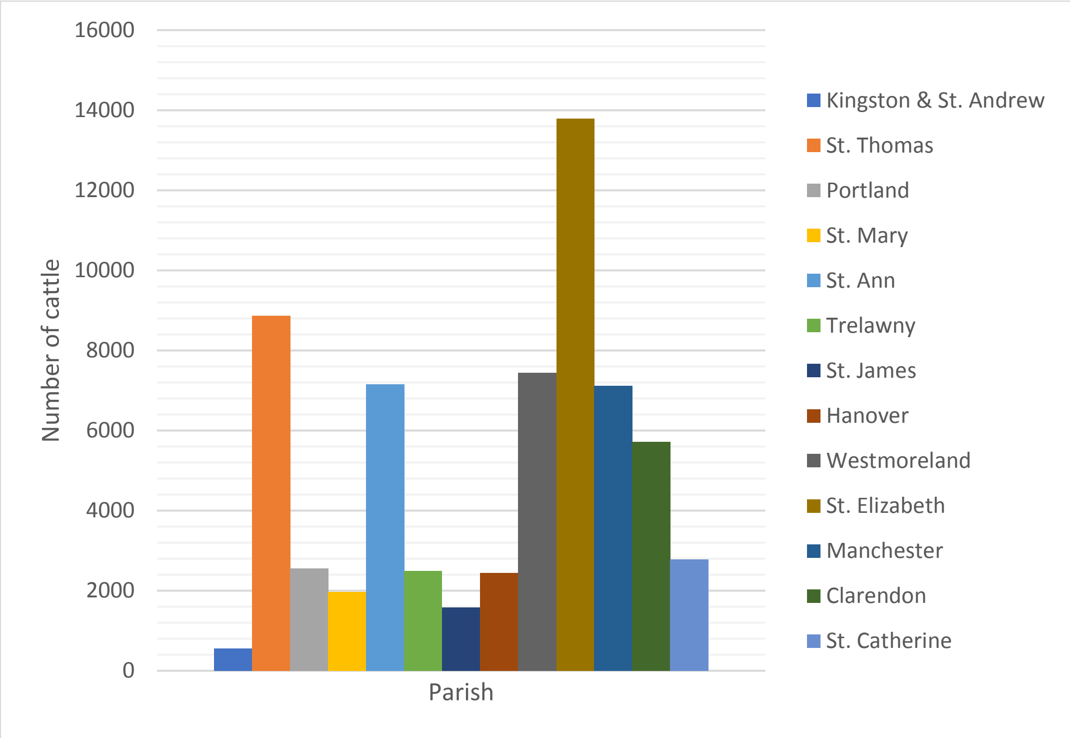


Figure 4.36 Number of cattle farmers per parish 2014

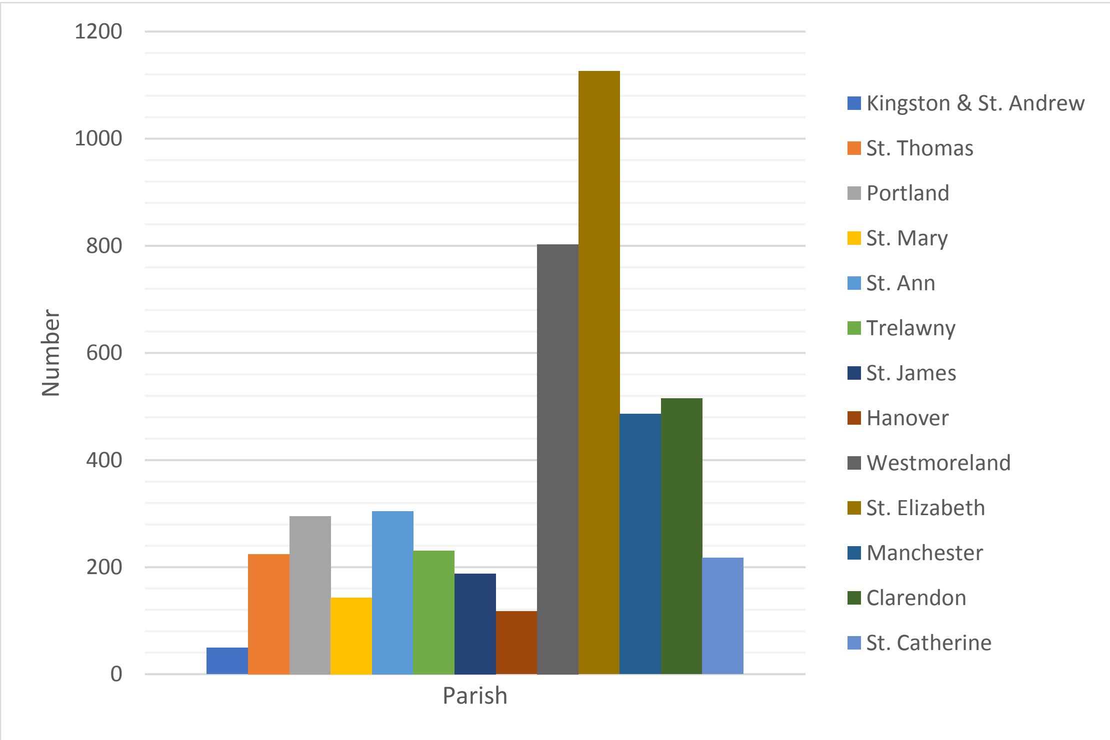


Figure 4.37 Percentage Distribution of Cows by Parish 2014

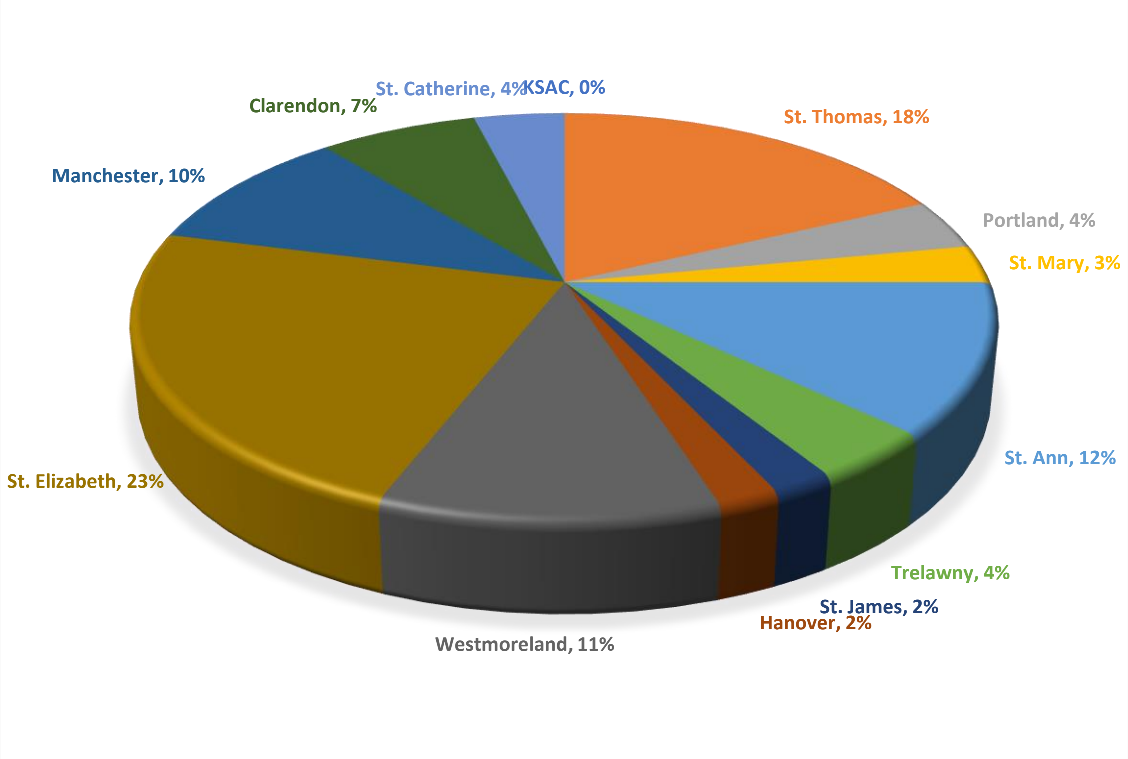
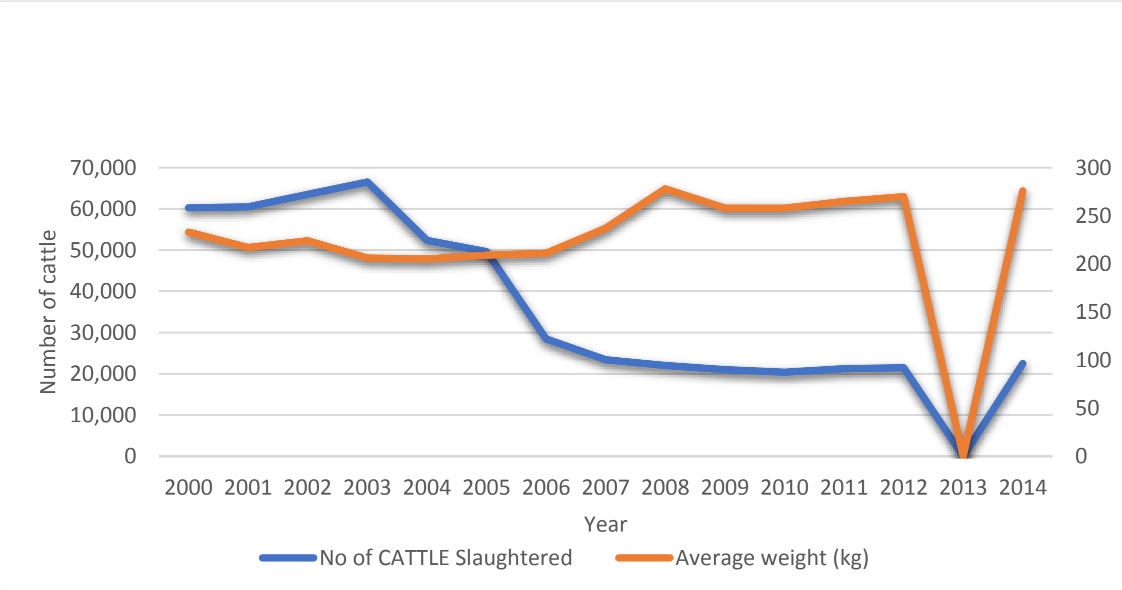


Figure 4.38 Cattle slaughtered against average weight 2000-2014



Data Source : Cattle Census, 2014

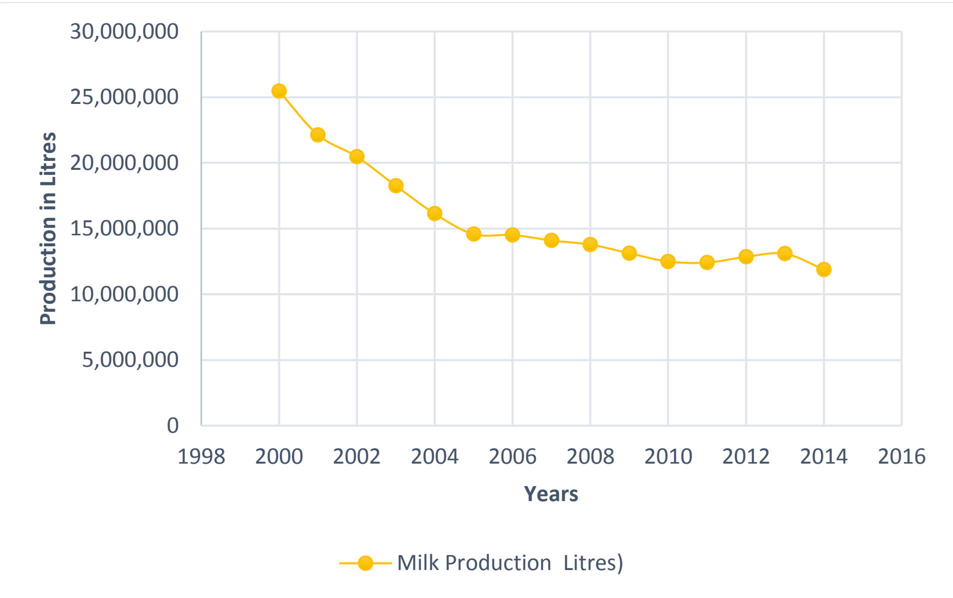
4.3.1.2 DAIRY PRODUCTION

Milk production declined from 23.77 million litres in 1998 to 11.93 million litres in 2014 (Fig 4.43) a reduction of 46.8 percent (Dairy Board, 2014). The quantity of milk produced in 2014 was 3.7 percent lower than 2013. However, in 2017 it was reported that about 13.13 million litres were produced (Gleaner, 2018).

The 2014 cattle census identified 3,674 dairy farmers with a population of 28,196 cows of which 4 834 were milking during the survey period. The largest concentration of milking animals was reported in, St. Thomas, St. Ann, Manchester and St. Elizabeth. These parishes together had 4 232 milking animals which represented 87.5 percent of the total milking herd island wide (Cattle Census, 2014).

The majority of dairy farms had operations with less than 50 cows, however, there were some large-scale entities with herd sizes in the hundreds, the largest of which reportedly had 6 500 animals. Replacement heifers, which is the determinant factor in herd sustenance, amounted to 10 680 animals with a cow: heifer ratios of 2.6:1, with 38 percent of mature females (including heifers) being pregnant at the time of the survey.

Figure 4.39 Dairy Milk production 2000-2014



Data Source: Cattle Census 2014

4.3.1.3 BEEF PRODUCTION

An average of 5 500 tonnes of beef was produced annually for the period 2007 – 2012. However, production in 2013 amounted to 6 690 tonnes while 6 400 tonnes were produced in 2014. In 2000, 60 302 cattle were recorded as slaughtered by the Public Health Inspectors declining by 62.0 percent to 22 889 animals in 2014.

4.3.1.4 CATTLE FARMER DEMOGRAPHICS

The cattle census (2014) revealed that 1 664 non-family males and 98 females were employed, while 1 002 males and 104 female family members were employed by respondent farmers. This implied that there were approximately 5 000 active farmers and 3 000 additional employees directly involved in the cattle sector.

Cattle farming continues to be a viable agricultural activity across Jamaica and can be described as "The farmers' insurance policy" as many farmers stated that it is their only source of livelihood when their crops fail. In fact, it is their insurance to pay school fees whether at high school or university level.

Figure 4.40 Full time non-family members by age and gender employed per parish in cattle operations

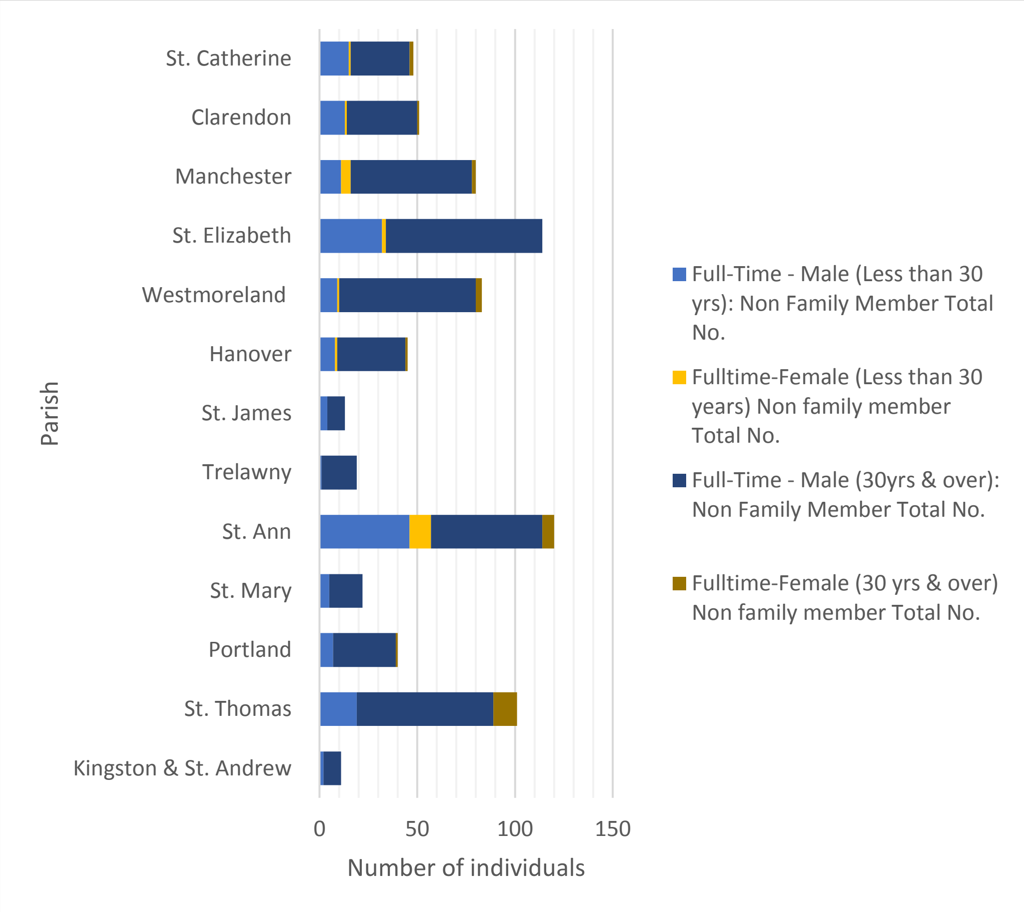
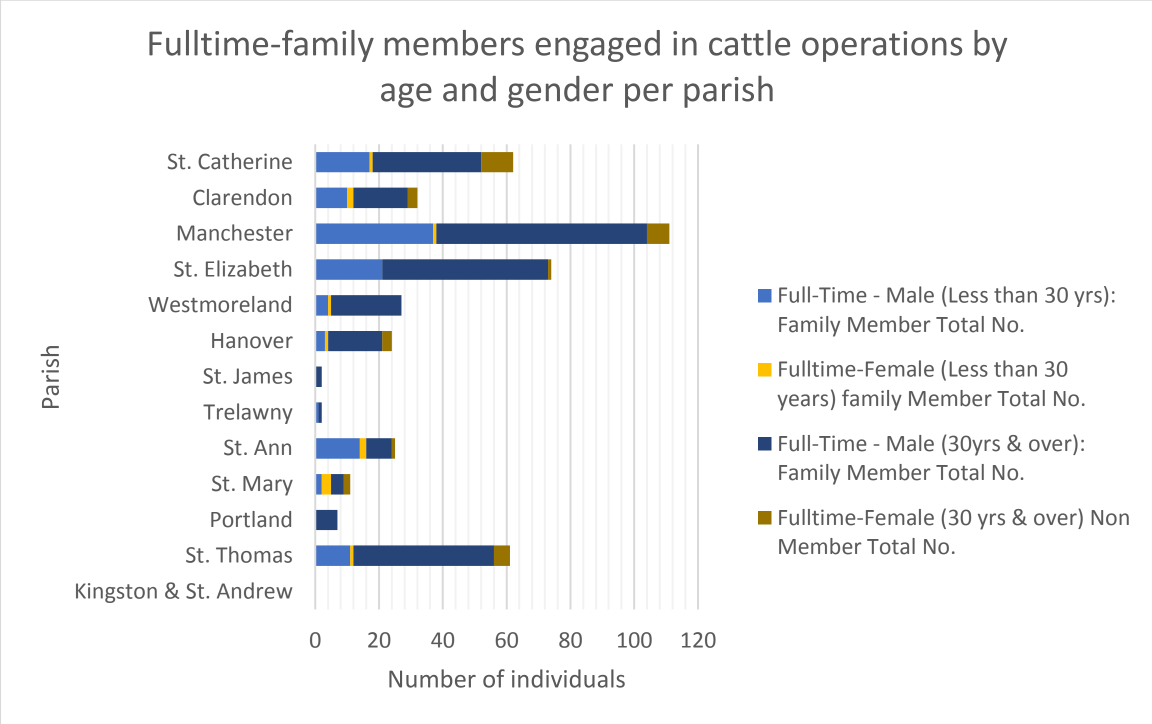


Figure 4.41 Fulltime-family members engaged in cattle operations by age and gender per parish



4.3.1.5 MARKETING

According to the cattle survey report of 2014 beef consumption showed a fluctuating trend from 18 446 tonnes in 2006 to 17 052 tonnes in 2013. However, the 2008 figures showed that 19,290 tonnes of beef were consumed due largely to increased imports in that year. Production, over the same period, was reportedly stable at an average of 5 641 tonnes annually, while import surpassed production by a ratio of 2:1 over the period.

The 2014 cattle survey also showed that per capita milk consumption averaged 9.3 kg over the period 2011-2013, while per capita milk availability averaged 4.71 kg. This represented only 50.6 percent of aggregate demand for milk. The per capita beef consumption averaged 6.23 kg over the same period, while the per capita availability was 2.35 kg. Thus, the influx of imported beef and milk products valued at USD 49.9 million in 2012 and USD 51.98 million in 2013 continued as demand surpassed supply. In 2014, the importation of beef and veal (excluding beef products) exceeded 8 000 tonnes.

Marketing of dairy products has changed significantly since the 1980's. Milk powder from the US and Europe, where governments subsidize their dairy sectors, has been dumped in Jamaica, led to a precipitous decline in the dairy industry. The country now has two large-scale dairy operations along with several satellite farmers who sell milk to these processors.

4.3.1.6 PRODUCTION CHALLENGES

Increasing operational cost coupled with long periods of drought and high levels of praedial larceny have resulted in significant reduction in livestock farming island wide. South- central Clarendon which had one of the largest cluster of dairy farms in the 1970s and early 1980s has now been reduced to a few struggling farmers, battling to survive in an industry so vital to national food security.

4.3.2 SMALL RUMINANTS

4.3.2.1 PRODUCTION

Small ruminants play a vital role for resource poor farmers in terms of livelihood and poverty alleviation (Lallo *et al.*, 2017). In Jamaica the most recent surveys have shown that between 2007 and 2011, the sheep population increased by 17 percent while the goat population saw significant increases of up to 45 percent moving from a total of 482 345 in 2007 to approximately 700 000 in 2011 (Hosein *et al.*, 2013). Despite these positive movements, Jamaica still imported over 4 600 tonnes of sheep and goat meat in 2012. However, by 2013 it was approximately 3 000 tonnes (RADA, 2013). During the period (2005-2013) local production only saw a 20 percent increase in production with a total of 987 056 kg being produced in 2013. In 2009, some 2 591 tonnes of lamb and mutton valued at USD 8.4 million were imported, while production during the same period stood at only 15 tonnes. There was thus a difference of 2 576 tonnes.

In Jamaica, goats are utilised mainly for meat. However, there is tremendous scope for dairy goat production with consequent marketing of fresh milk, various cheeses and other value-added products such as goat milk body lotions and soaps. Major breeds currently being reared include Nubian, Boer, Natives (meat) and Alpine (dairy).

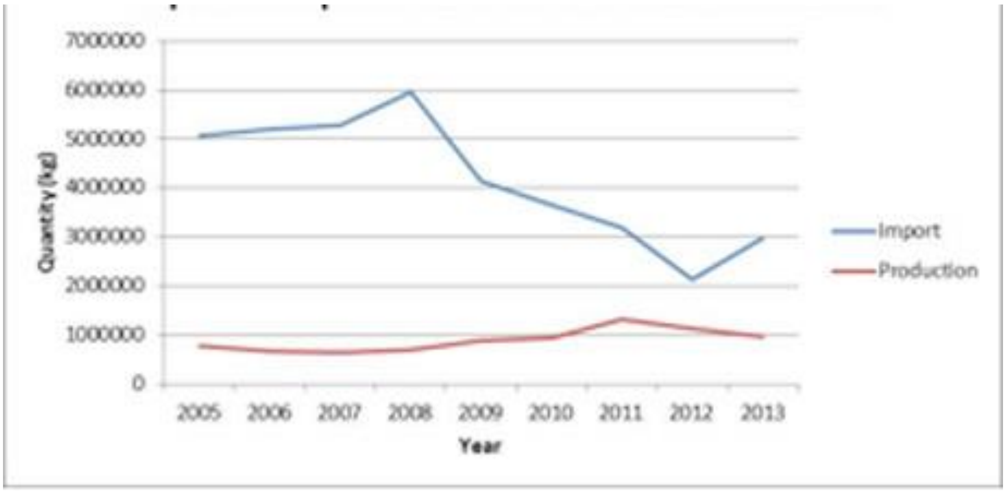
The local sheep flock consists of several breeds including the Dorper, Katahdin, Suffolk, Barbados Blackbelly, the St. Elizabeth and several mixtures of these. The St. Elizabeth is a locally adapted breed, which, although its genesis has not been documented, reports indicate that it is well adapted to local conditions.

Table 4.13 Proportion of Small Ruminant Farm Sizes and Production Systems in Jamaica

Parameters	Proportion
Farm Size	
Landless (%)	0
0-1 acre (%)	10.1
>1-5acres (%)	27.0
>5-15 acres (%)	19.1
>15 acres (%)	43.8
Production Systems Used	
Intensive (%)	13.2
Semi-intensive (%)	82.4
Extensive (%)	4.4
Pasture for Goats (%)	
Communal (%)	14.3
Leased/rented (%)	22.3
Roadside (%)	0
Under crop (%)	1.6
Private (%)	6.4
Pasture for Sheep (%)	
Communal (%)	6.7
Leased/rented (%)	33.2
Roadside (%)	0
Under crop (%) 0	0
Private (%)	0

(Source Lallo et al., 2017)

Figure 4.42 Importation versus local production of chevron 2005-2013



Source: RADA, 2015

	No. Sheep	
Category	2009/2010	2010/2011
Mature Ewes	4 662	5 653
Ewe Lambs	871	1 297
Ram Lambs	809	1 008
Wethers	150	200
Service Rams	96	138
TOTAL	6 588	8 296

Source: Hosein et al., 2013)

Table 4.14 Quantity of mutton and lamb production (Tonnes) (2006 – 2010) - Jamaica.

	2006	**2007**	**2008**	**2009**	**2010**
No. slaughtered	498	541	1 877	805	400
Total weight	8	10	26	17	11
Dress weight	7	8	22	15	9

Source: (Hosein et al., 2013)

Table 4.15 Goat production in Jamaica over the period 2006 – 2010

	2006	2007	2008	2009	2010
Number slaughtered	39 515	40 121	41 369	43 160	49 085
Average Carcass Weight (kg)	14.36	13.39	13.71	16.73	15.90
Dress Weight (kg)	567 411	537 116	567 339	722 180	780 452

4.3.2.2 FARMER DEMOGRAPHICS

The small ruminant industry is still not organized despite the presence of an association and hence any documentary evidence of the players in the industry is lacking especially as it relates to the participation of women and youth. Only anecdotal evidence from observation that this activity has been part of the responsibility of women and young children in rural areas can be noted. The majority of commercial herds are still owned by men. The role of women in small ruminant production has grown over the years with more complex roles being demonstrated by women with higher education.

4.3.2.3 MARKETS

Curried chevron is preferred by local consumers to curried mutton in most restaurant settings (RADA, 2015). However, the price and availability of local goat meat has necessitated the higher importation of mutton to make up for the shortfall in local chevron production. Jamaica is spending JMD 700 million to import goat meat since it has been reported that we need 2.5 million goats to be self-sufficient. The higher importation of mutton is due to its higher availability in external markets and cheaper cost. The predominant species produced on the external market for export is sheep from countries that rear them for wool such as New Zealand and Australia (RADA, 2015).

Local sheep producers however have been encouraged to target the lamb market as that market has proven to be more profitable. Cuts of lamb are primarily sold in high end supermarkets and to the hotel industry (RADA, 2015).

4.3.2.4 PRODUCTION CHALLENGES

- Praedial larceny was identified as the major constraint to goat production.
- Currently farmers are faced with limited feed resources during the dry season.
- In terms of cost of production of small ruminants, feed accounts for over 50 percent and 25 percent of total costs of production on many sheep and goat enterprises, respectively. Labour is the second highest cost of production.
- Anthelminthic resistance of intestinal parasites which can result in heavy worm burden due to dependence on medicines.

4.3.3 PIG PRODUCTION

4.3.3.1 PRODUCTION DATA

Pig breeds reared in Jamaica include the Large White, Land Race and Duroc. The Jamaican pig population in 2012 was 144 917 spanning 6 556 farmers (see Figure 4.47 and Table 4.17). This represented a 70 percent growth in population and 62.5 percent growth in number of farmers between 1998 and 2012 (T. Hamilton & Associates, 2013).

The average annual growth rate for the sector however was 13 percent for the period 1998 to 2003 and only 0.25 percent for the period 2003 to 2012 (T. Hamilton & Associates, 2013). However, like the pig population, most of the growth in the number of farmers took place between 1998 and 2003. The annual average straight-line growth in the number of farmers during this period was 11 percent as against only 0.5 percent in the period 2003-2012 (T. Hamilton & Associates, 2013).

Figure 4.43 The Jamaican pig population 1998 – 2012

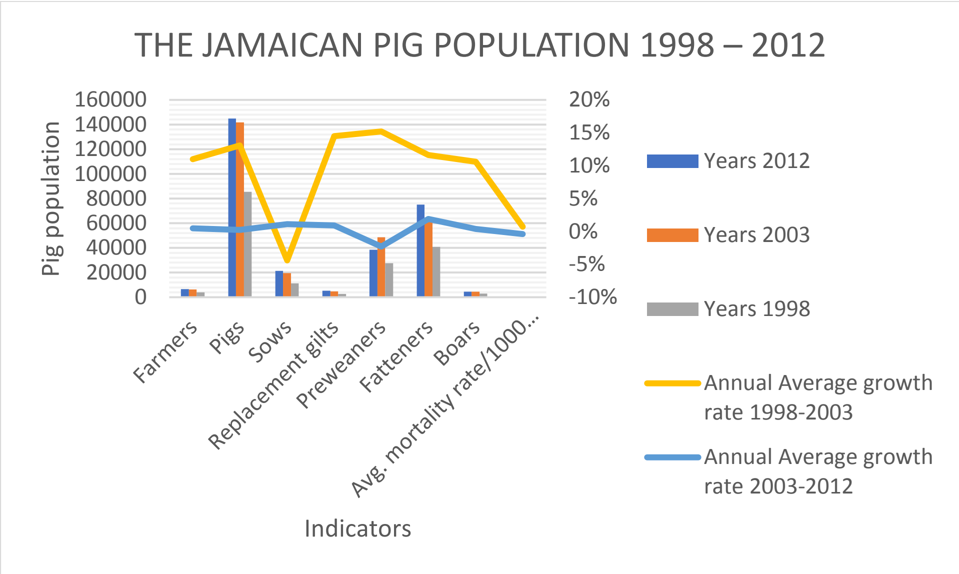
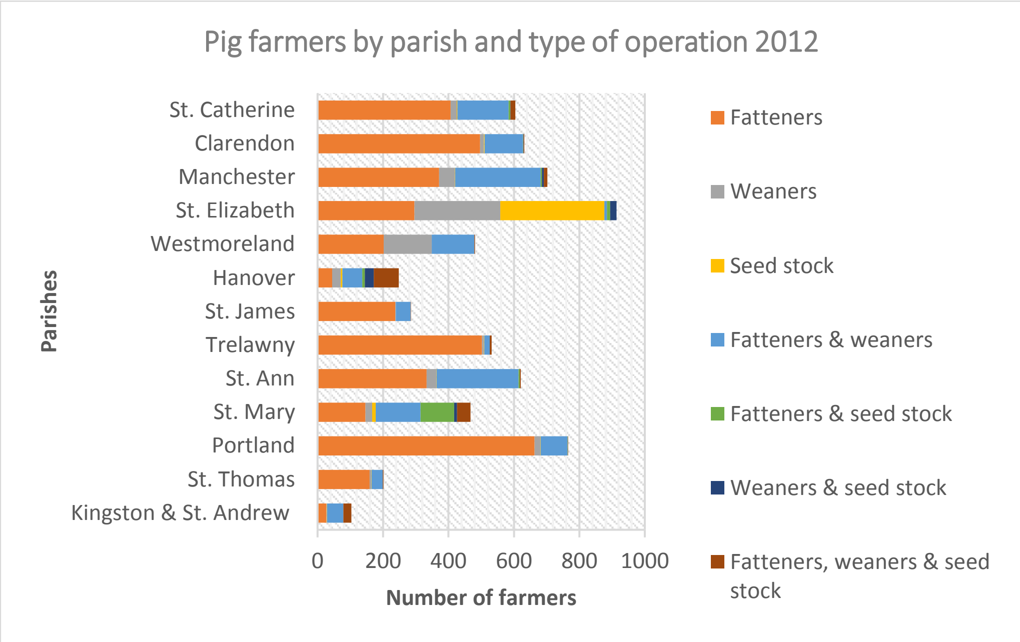


Table 4.16 Number of pig farmers by parish and operations 2012

	Total	Fatteners	Weaners	Seed stock	Fatteners & weaners	Fatteners & seed stock	Weaners & seed stock	Fatteners, weaners & seed stock
Kingston & St. Andrew	103	27	1	1	50	0	0	24
St. Thomas	201	159	5	1	34	0	0	2
Portland	766	663	18	1	82	1	0	1
St. Mary	467	146	21	11	137	102	9	41
St. Ann	621	333	30	1	250	4	0	3
Trelawny	532	503	5	1	17	0	0	6
St. James	285	237	2	0	45	0	0	1
Hanover	248	45	26	5	61	7	28	76
Westmoreland	481	202	147	0	130	0	0	2
St. Elizabeth	914	296	262	318	8	10	20	
Manchester	702	371	48	1	262	4	5	11
Clarendon	632	497	11	2	118	1	1	2
St. Catherine	604	407	18	2	157	5	1	14
Total	**6556**	**3886**	**594**	**344**	**1351**	**134**	**64**	**183**

The pig census of 2012 reported that the average size of pig farms had increased from 21 pigs in 1998 to 27 pigs by 2012 which represented a growth of 29 percent (T. Hamilton & Associates, 2013). Large farmers (50 or more pigs) owned 53.4 percent of the pig population when compared with 44.2 percent in 1998. While, the pig population had grown by only 2 percent (2003 over 2012) the output of pork had grown by 41 percent (from 3.5 Million Kg to 4.95 Million Kg) over the same period with improved genetics and the resultant significant increase in the size of pigs (T. Hamilton & Associates, 2013). The dressed weight of fatteners sold to butchers increased by 21 percent from 54.6 Kg to 66 Kg in 2012 over 2003. Dressed weight to packers/processors increased by 84 percent from 55.9 Kg in 2012 over 2003(T. Hamilton & Associates, 2013).

Figure 4.44 Pig farmers by parish and type of operation 2012



4.3.3.2 FARMER DEMOGRAPHICS

The piggery industry direct employment was about 9 357 in 2012. The 2012 census reported 16 percent of the farmers relying on pig production as their sole source of income (T. Hamilton and Associates, 2013).

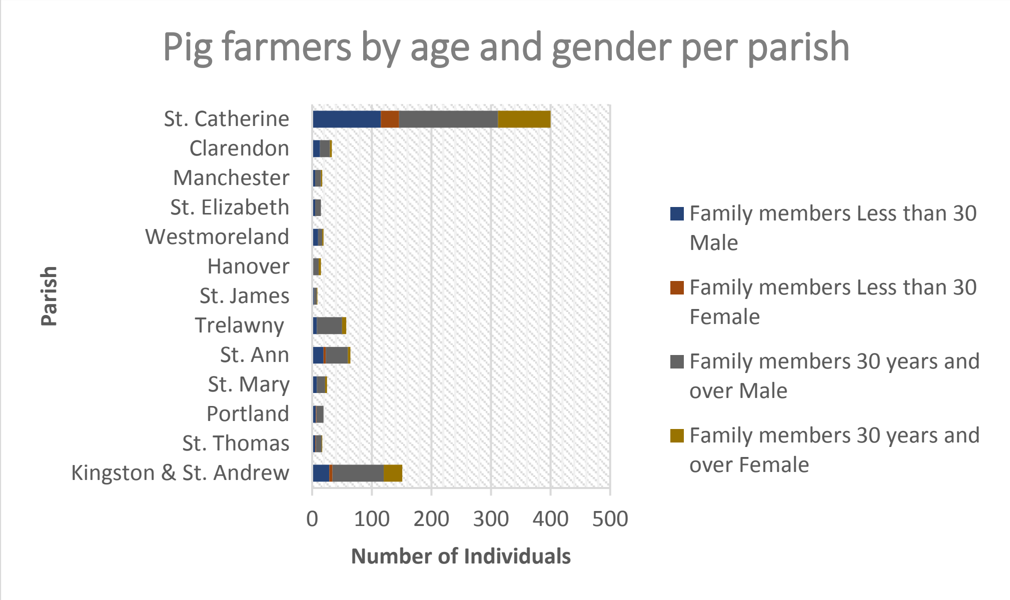
In 2012, only 27 percent of the farmers were less than 40 years old. Women accounted for 16 percent of the work force even though they represented 45 percent of the Jamaican labour force and they were regarded as good animal care givers.

Table 4.17 Family member and non-family member by age and gender engaged in pig rearing

	Total		Non-Family members				Family members			
			Less than 30		30 years and over		Less than 30		30 years and over	
	M	F	M	F	M	F	M	F	M	F
Kingston & St. Andrew	139	42	13	1	11	5	29	5	86	31
St. Thomas	47	4	11	2	21		5	1	10	1
Portland	73	2	28	1	27		6	1	12	
St. Mary	54	5	6	2	26		8		14	3
St. Ann	80	10	10	1	14	1	19	4	37	4
Trelawny	72	8	6		16	1	8		42	7
St. James	22	2	12	1	2		3		5	1
Hanover	82	16	34	9	37	3	2		9	4
Westmoreland	80	7	22	1	41	4	10		7	2

	Total		Non-Family members				Family members			
			Less than 30		30 years and over		Less than 30		30 years and over	
St. Elizabeth	39	3	4		20	3	5		10	
Manchester	70	4	22		33	2	5		10	2
Clarendon	92	4	28	1	34		13		17	3
St. Catherine	364	124	25	3	58	2	115	31	166	88

Figure 4.45 Pig farmers by age and gender



4.3.3.3 MARKETING

Approximately 69 percent of pig meat is sold to the fresh market which is extremely price sensitive. In 2012 farmers estimated that the JMD 307 per kg farm gate price for dressed pork represented 94 percent of their operating costs.

4.3.3.4 PRODUCTION CHALLENGES

Farmers had three major challenges to be addressed by value chain and policy mechanisms to safeguard the viability of their investments (T. Hamilton & Associates, 2013). These were:

- The high mortality rate (20 percent) among pre-weaners requires them to have a much higher than normal sow population.
- Ninety four percent of farmers rank uncompetitive priced feed as their number -one threat for viability.
- The inadequate transformation of their pork into differentiated customer demand driven products in order to give them better market positioning and prices.

The growth rate in the population has significantly decreased in the past nine years mainly because: prices have been declining; the market share for pork has declined; this despite the significant increase in average dress weight of pigs (due to genetic improvements) and reduction in the mortality rate (T. Hamilton & Associates, 2013).

4.3.4 POULTRY PRODUCTION

Two types of poultry production systems are found in Jamaica, layer and broiler production. The Novagen pullet strain is used in commercial layer production because of its suitability to Jamaica's tropical climate. Immediately after hatching at a commercial hatchery the birds are vaccinated against 3 strains of Mareks disease and are grown out on grow out farms to produce 18-week pullets ready for laying. A new backyard layer programme for small farmers was started in 2017, using the breed of layer chicken known as the Barred Rock it is hardy and suited to backyard farming. It is being imported to the island from the Jamaica Broilers Group's operations in the USA. The Barred Rock looks like what was commonly called a Dominic fowl and is excellent at producing eggs. Broiler birds are vaccinated immediately after hatching for Newcastle, Infectious Bronchitis, and Infectious Bursal (Gumboro) Diseases prior to the sale of chicks to farmers.

The poultry sector can be divided into contract farmers and "backyard" chicken farmers. Contract farmers work for one of the large poultry producers such as Jamaican Broilers or Caribbean Broilers. The company supplies the chicks and the farmer buys medicine and food from the company on credit with payment deducted from the final price the farmer receives for the chickens. Although there are few upfront costs with contract chicken farming, the farmer takes all of the risks, the company none. It is difficult to get an accurate measure of the size of the poultry sector *due to the* informal nature of "backyard" farming.

The backyard farmer tends an average of 200 birds for both eggs and meat, often as one of multiple strategies to earn a living. The backyard farmer will provide for a hen house, lights, feed, equipment to deliver water and food to the birds, and buy chicks themselves. The backyard farmer will sell poultry in the local market. Backyard farmers also sell poultry at the cafeterias of local workplaces, as well as to some hotels and restaurants. The backyard farmers feel that they can get a better price working for themselves than contracting with larger companies. There is still a significant element of backyard poultry farming today. Broiler production and egg production have increased in 2017 over 2016 (see Table 4.19 and Figure 4.50)

4.3.4.1 FARMER DEMOGRAPHICS

Poultry production is a predominately female activity and has grown from being the fifth largest category of agricultural work for women in 1993 to being the third largest category of agricultural employment for women in 2001. Women accounted for more than half of all poultry workers in 1993 and 2001 (while they accounted for only between 20 and 24 percent of all agricultural workers). According to Women's Edge Coalition (2004), poultry production has been a growing sector for women with the percentage of women working as poultry farmers nearly tripled between 1993-2001, from 3.6 percent to 9.6 percent. One reason that women may be entering this sector is that there are few start-up costs and women traditionally have more difficulty gaining access to credit or loans to launch a farming venture. With contract or backyard broiler poultry farming, the initial costs are low. Moreover, poultry farming is done in one's backyard so it is something that women can do at home and in combination with their child-care and other household responsibilities. In fact, many women do this to make extra money to support their children or if they don't have other paid employment to support their families.

4.3.4.2 MARKETS

Although poultry farming enables women to combine paid and unpaid work, it is not a particularly lucrative venture. Chicken is less expensive than pork or beef and is considered healthier, particularly white poultry meat. From 1996 to 2000, Jamaican chicken production increased

40 percent and local production was able to satisfy 60 percent of the demand. The remainder, primarily lower-cost chicken necks, backs, and leg quarters were imported from the United States.

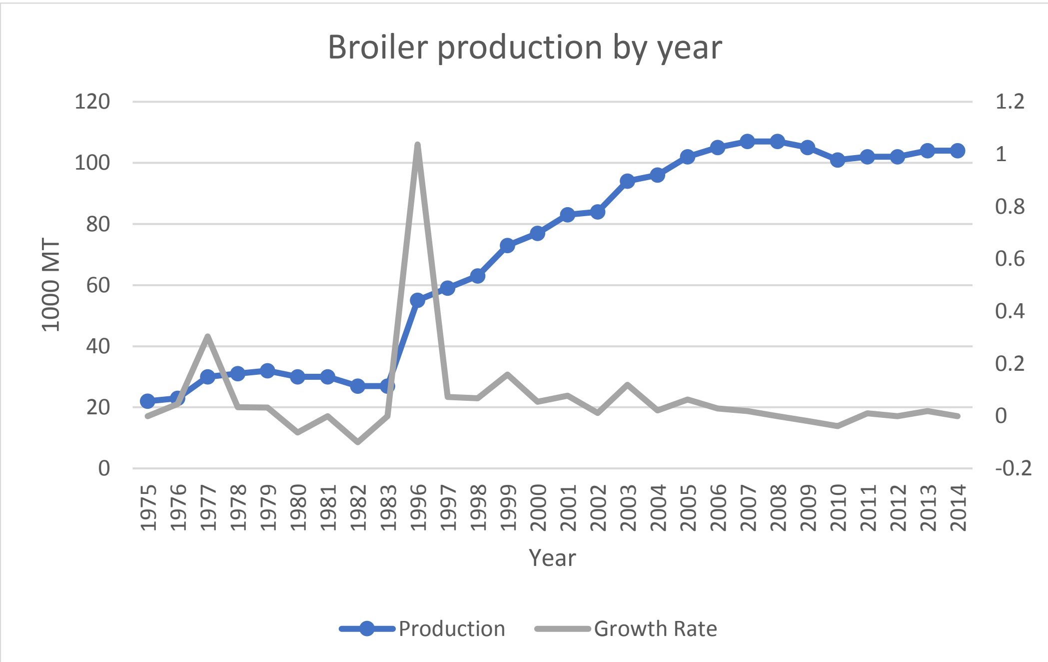
However, Jamaican poultry producers, who must depend on commercial feed formulated from imported inputs and other production inputs, have found it difficult to compete with lower-priced chicken parts. Although data is not available to document how many poultry farmers left the sector, anecdotal evidence suggests that nearly half of the "backyard" farmers may have left the sector. Some analysts have suggested that the backyard farmers moved into other enterprises such as working in the market selling vegetables while others may have moved to tourist areas to find work. Rural women, who are the majority of these "backyard" producers, were most affected by the trade policies. The government has collaborated with the two leading chicken producers to meet local demand for poultry products and boost local production.

Table 4.18 Poultry Production 2013-2017

	2013	2014	2015	2016	2017
POULTRY Broiler Meat Production	112 855 034	109 833 339	101 510 817	125 170 676.32	127 600 000
Stewing Hen Production		479 531	655 683	822 055.50	
Total Poultry Meat		110 312 870	102 166 500	125 992 732	
EGG (each)	149 993 290		170 178 739	174 262 633	183 000 000

Source: MICAF AMID 2017

Figure 4.46 Broiler production and growth rate trends 1975-2014



Source: https://www.indexmundi.com/agriculture/?country=jm&commodity=broiler-meat&graph=production-growth-rate

4.3.5 FISHERIES SUBSECTOR

Fishing has been an economic livelihood in many communities across the island, more so in the southern and eastern coastal parishes. The fisheries sector in Jamaica is comprised of both artisanal and industrial levels and provides employment directly and indirectly to some 40 000 fisher folk, whilst also contributing to the livelihoods of over 200 000 persons (Jones, 2017). Jamaica has one of the highest levels of fish consumption per capita in the Americas (30.6 kg/year), and is highly dependent on imports, which account for about 79 percent of all fishery products consumed domestically. The fisheries sector is typically categorized into (i) inland, freshwater; (ii) marine capture; and (iii) aquaculture sub-sectors. The inland, freshwater fishery in Jamaica is small and limited to subsistence or small-scale commercial fishing (Jones, 2017). However, Jamaica's marine capture and aquaculture subsectors are highly developed and economically significant.

Jamaica's capture fishing resources are primarily reef and reef associated finfishes, resources that have become over-exploited. Several factors including extreme natural events, unsustainable fishing practices (including spear fishing, use of seine nets in nursery areas, and dynamite on reefs), lack of awareness by fishermen about fisheries management, pollution and destruction of critical marine ecosystems have contributed to this outcome (Selvaraju, undated,). These practices can negatively impact the coral reefs resulting in degradation of breeding grounds for juvenile fish (Selvaraju, undated). Climate change is expected to exacerbate these problems. The challenges being experienced in Jamaica's fisheries sector were reflected in the low score (24.8) recorded for the fisheries indicator of the Environmental Performance Index (EPI) 2016 (Jones, 2017).

Jamaica's overfished stock represents not only an ecological concern, but a social and economic one as fishers are forced to work harder, use more fish traps, increase fishing trips, and travel further out to sea to maintain their level of catch (Jones, 2017).

4.3.5.1 AQUACULTURE PRODUCTION DATA

Aquaculture has globally been considered as a key activity to increase fish production. In Jamaica, it has been suggested that the industry is key to the provision of fish. Commercial aquaculture was first introduced to Jamaica in 1976 through a USAID/GOJ funded project (MOAF, 2011). The main food fish produced in Jamaican aquaculture both for local consumption as well as for export is Tilapia. However, the aquaculture industry has expanded to include mangrove oysters and ornamental aquatic flora and fauna species (GOJ, 2014) .

Fisheries Division reported in 2012 that fish was the second most important contributor to animal origin protein intake in Jamaica being second only to poultry meat (Jones, 2017). Local fishery production amounted to an average of some 12 000 tonnes in recent years with wild catches currently accounting for 93.8 percent of landings. The remaining 6.1 percent is accounted for by aquaculture production (Jones, 2017).

Aquaculture activity primarily occurs on the southern plains of Jamaica with the parishes of St. Catherine and Clarendon accounting for the highest concentration and largest size of farms. In 2013, it was estimated that there were approximately 993 hectares of artificial ponds of which 429 hectares or 43.19 percent were in active production. Most of the ponds produce fish weighing 0.2 to 0..34 kg. Starting with 1g juveniles supplied by the Fisheries Division of the Ministry of Industry, Commerce, Agriculture and Fisheries, production may take close to a year, while commencing with 15 g to 40 g juveniles, farming cycles are shortened to 120 to150 days. Farmers are dependent on commercial feed produced locally. The majority of farmers produce fish alone with little integration with crops or livestock systems.

In 2017 there was no significant change (Fisheries Division personal communication, 2018). In 2013, overall aquaculture production stood at 789.5 tonnes. Aquaculture in Jamaica had peaked in 2007 producing up to 7 000 tonnes but has been on a decline falling by 7.4 percent to 646 tonnes by 2015 (Jones, 2017). This fall-off was attributed to among other things, the continued scarcity of red tilapia seed stock which negatively impacted production, as well as the drought conditions during the year which affected pond operations (PIOJ, 2016). Currently average yield from a one-hectare pond is approximately 2 700 kg/ha to 3 800 kg/ha (Jones, 2017).

Figure 4.47 Fish Production trends in Jamaica 1997 to 2010

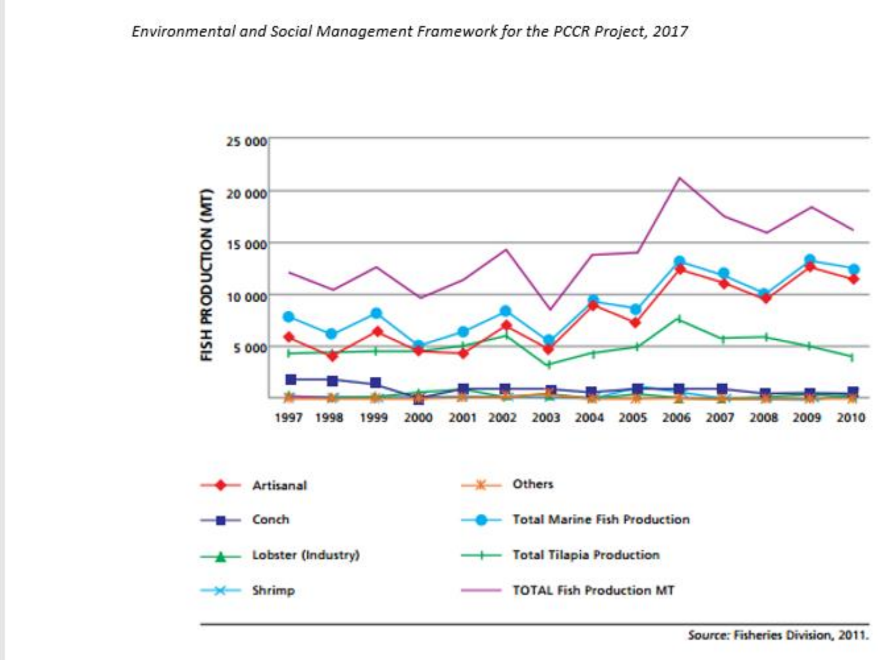
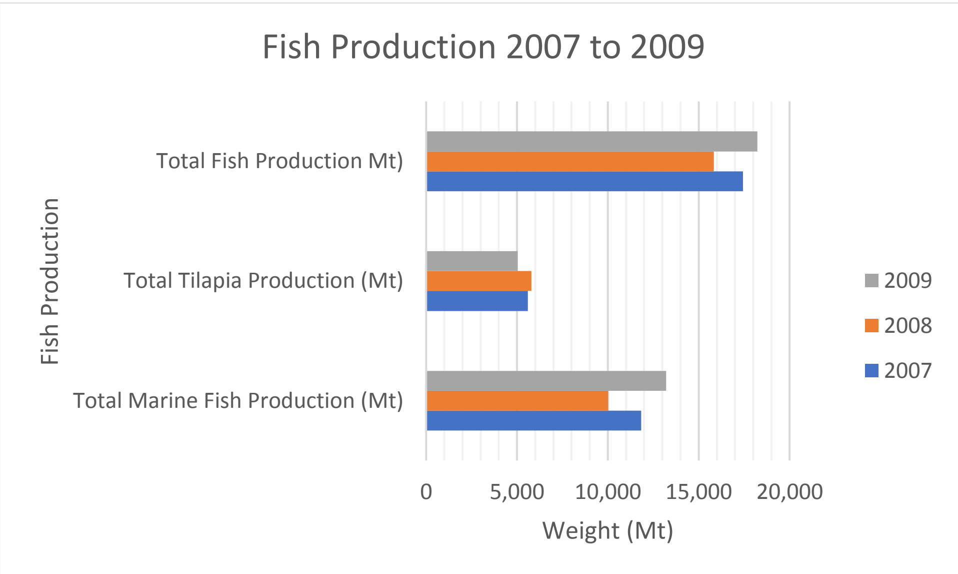


Figure 4.48 Fish Production 2007 to 2009



Source: *http://www.jamaicatradeandinvest.org/sites/default/files/resources/TliapiaProfileApril2014.pdf*

Figure 4.49 Number of aquaculture farms by parish 2011 and 2018

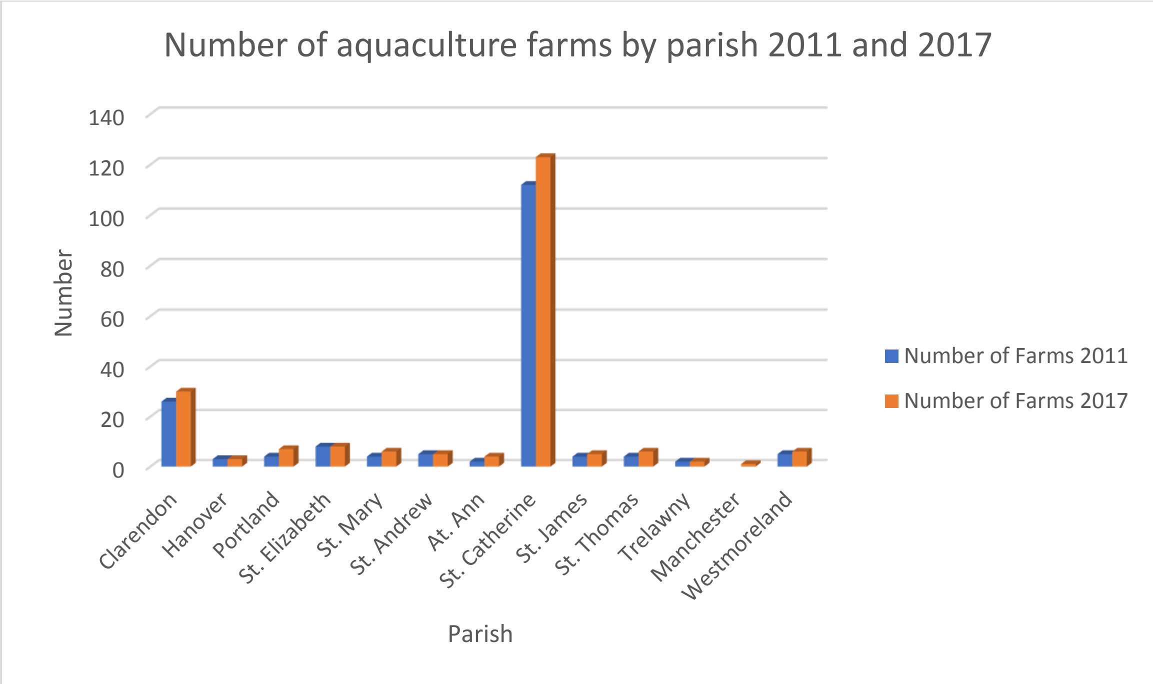


Figure 4.50 Fish pond acreage per parish 2011 and 2017

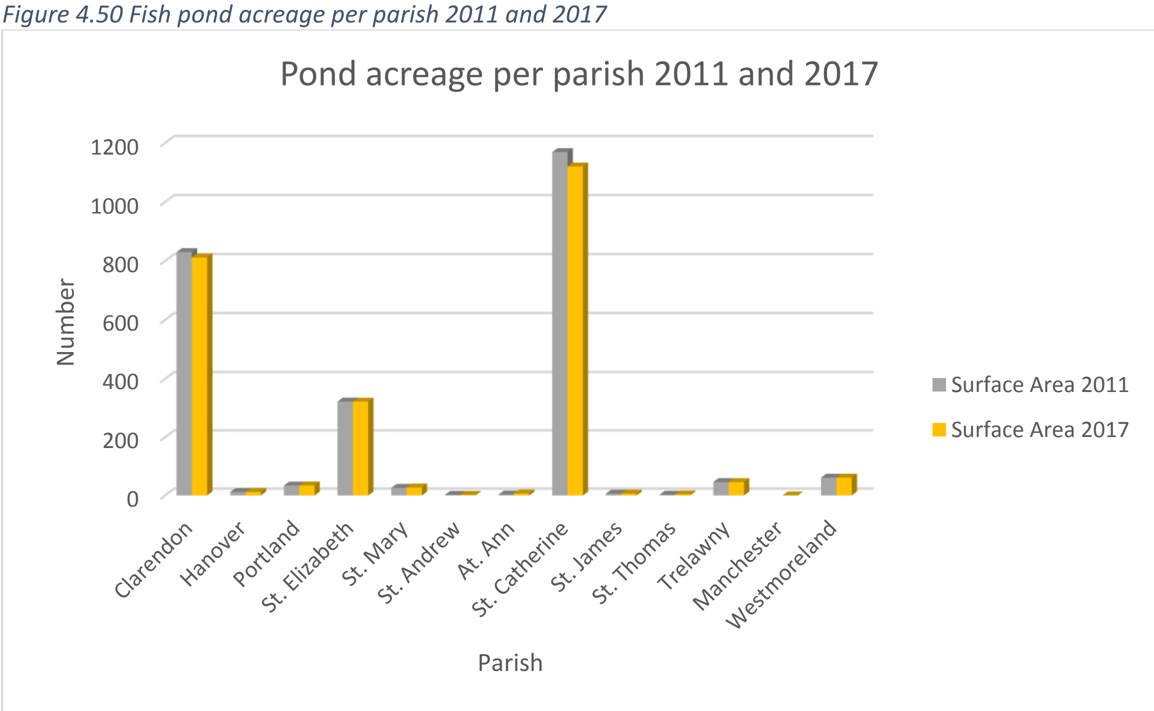


Figure 4.51 Average surface areas per farm per parish 2011 and 2017

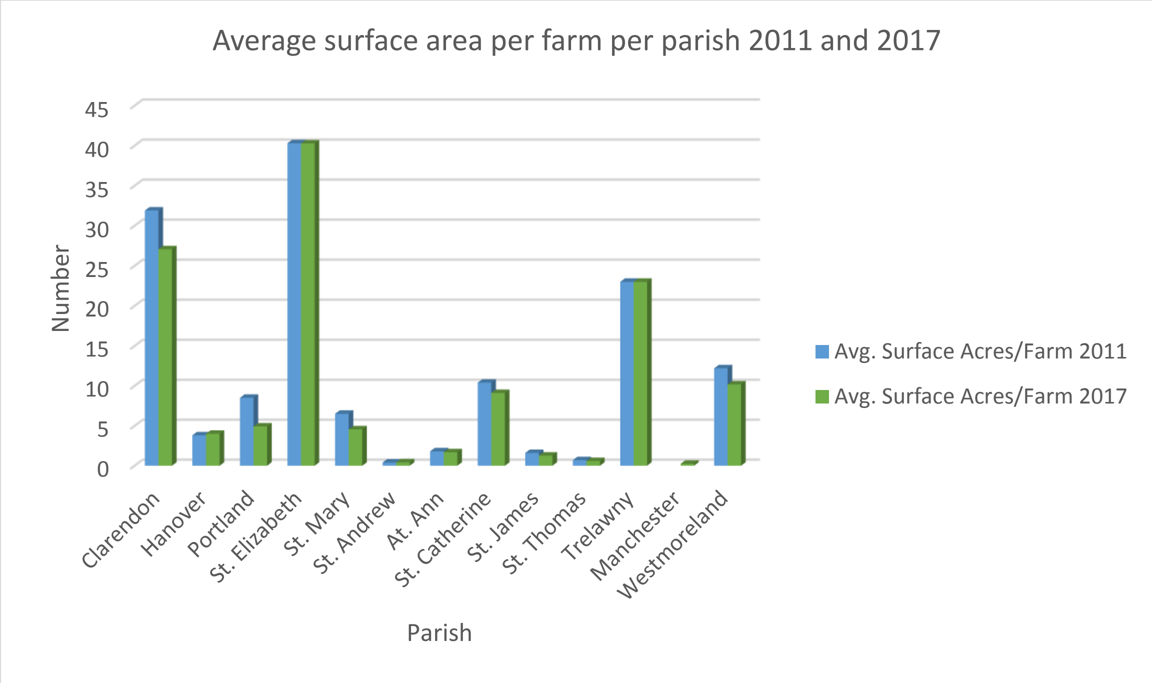


Table 4.19 ***Distribution of Fish Farms by Parish as at December 2017***

Parish	Number of Farms per Parish	Total Pond Acreage per Parish
St. Catherine	**123**	**1120.3**
Clarendon	**30**	**811.79**
St Andrew	**5**	**2.1**
St. Thomas	**6**	**3.569**
Hanover	**3**	**12**
Trelawny	**2**	**46**
St. Ann	**4**	**6.757**
Portland	**7**	**34.37**
St Mary	**6**	**27.3**
Manchester	**1**	**0.25**
Westmoreland	**6**	**61.04**
St. James	**5**	**6.32**
St. Elizabeth	**8**	**322.25**
Total	**206**	**2454.046**

Source: Aquaculture Branch, Fisheries Division, MICAF 2018

Table 4.20 ***Number of fish farms and surface area and as a percentage of the total for 2018***

Parish	Number of Farms	% of total farms	Surface Area	% of Acreage	Avg. Surface Acres/Farm
Clarendon	26	14.5	830	33	31.9
Hanover	3	1.7	11.5	0.5	3.8
Portland	4	2.2	34.1	1.4	8.5
St. Elizabeth	8	4.5	322.5	12.8	40.3
St. Mary	4	2.2	26	1	6.5
St. Andrew	5	2.8	2.1	0.1	0.4
At. Ann	2	1.1	3.5	0.1	1.8
St. Catherine	112	62.6	1 169.2	46.5	10.4
St. James	4	2.2	6.3	0.3	1.6
St. Thomas	4	2.2	2.7	0.1	0.7
Trelawny	2	1.1	46	1.8	23
Westmoreland	5	2.8	61	2.4	12.2
Total	179	100	2 515.3	100	14.1

Source: Aquaculture Branch. Ministry of Agriculture and Fisheries, Jamaica, June 2011

Table 4.21 ***Size distribution of aquaculture farms, including active and inactive farms.***

Type	Size (in acres)	No of Farms	% of Farms	Surface area	% of Acreage	Avg. Surface Acre/Farms
Subsistence	< 1	22	12.3	7.6	0.3	0.3
Small	1-5	93	52	241.8	9.6	2.6
Medium	5.1-20	38	21.2	418.4	16.6	11
Large	>20	26	14.5	1 847.5	73.5	71.1
Total		179	100	2 515.3	100	14.1

Source: Aquaculture Branch. Ministry of Agriculture and Fisheries, Jamaica, June 2011

A survey of aquaculture farmers was conducted as part of the study by Jolly *et al.* (2011) to ascertain their recommendations on how to improve the profitability of aquaculture and to enhance its sustainability(Jolly and Hishamunda, 2011). The major problems and constraints influencing the profitability and sustainability of aquaculture in Jamaica were also solicited from informants. The highest ranked objective by farmers was that of 'environmental sustainability', followed by 'increase in government influence' and 'improved marketing and sales'. 'Technological innovation' was in fourth place, while 'increase in production' was in last place. Participants thought that 'better feed conversion,' was the best means of attaining aquaculture's main goals of profitability and sustainability. In a narrow second place was 'decreased disease problems. The participants' responses in ranking the objective of marketing and sales were unified. Participants revealed that an 'increase in fish price' would enable them to attain their sales and marketing objectives. In second place was 'increase in harvest frequency' and in third place was 'increase in market efficiency'. For meeting the objective of type of government intervention in Jamaican aquaculture 'increase in extension effort' was the number one priority. In second place was 'increase in government assistance' with 'increased research funding' receiving third place (Jolly and Hishamunda, 2011).

4.3.5.2 FARMER DEMOGRAPHICS

At the end of 2013, there were 23 323 fishers and 6 300 registered boats operating from 187 fishing beaches and two cays located at the Pedro Bank. This compared with 21 500 fishers and 6 007 registered boats operating from 187 fishing beaches at the end of 2012. The aquaculture sector in Jamaica directly employed 800 to 1 000 people in 2011. Of this number, the vast majority of the hired workers on fish farms are male. On the other hand, women make up the majority of workers in the processing plants. Only 8 to11 percent of all fish farms are owned and operated by women, this is partly attributed to lack of funding for working capital financing (Clarke, 2014).

Small to medium size farms tend to employ on a full-time basis 1-2 persons and larger farms employ 12–50 persons. Many of the farmers in Jamaica are small-scale with less than one hectare of land but larger aquaculture operations do exist (Jones, 2017). Land tenure poses a big problem for many fishers in the country (Jones, 2017).

4.3.5.3 MARKETS

All tilapia that is produced is absorbed by the local market driven by changes in production to semi-intensive and extensive practices and the exit of the largest tilapia private sector investor. Most fish farmers rely on vendors to buy and distribute their product. The product is usually sold at the farm-gate to the vendor who will take it to markets. The farmer may also sell tilapia to restaurants, hotels, supermarkets and other distributors. The size preferred by local consumers is 227 g to 340 g (Jones, 2017). According to the findings of a study on the Jamaica Tilapia market four major distribution channels of aquaculture products were identified: wholesalers/retailers (62 percent); restaurants (19 percent); supermarkets (22 percent); and hotels (6 percent). In addition, a variety of product forms existed locally, which are: Live fish (most common product form); Fresh whole fish; Fresh scaled and gutted; Frozen scaled and gutted (Jones, 2017).

The demand for tilapia was greatest during the months of March and April, followed by August and finally December. The exact demand during these periods was not quantified at the time but it was estimated that demand increased by approximately 25 percent, 12 percent and 20 percent, respectively, above the baseline (Jones 2017)

Jamaica lost its export market share in 2008. This loss was due to the inability of Jamaica to compete, price wise, with fishery products from Asian countries. However, prior to that fish was exported to the United States of America, the United Kingdom and Belgium. Fish products produced then included a range of fresh and frozen tilapia products including fillets, de-boned and marinated products (Jones, 2017).

Export of aquaculture products to the United States required that the farm and processing facility from which it was produced met Hazard Analysis and Critical Control Point (HACCP) certification standards. This was administered through the Veterinary Services Division of the Ministry of Agriculture and Fisheries. No specific labelling standards exist for aquaculture products, but instead only general labelling is required. The labelling standard is administered through the Jamaica Bureau of Standards (Jones, 2017).

4.3.5.4 PRODUCTION CHALLENGES

The majority of fishers have to supplement their income with other forms of employment such as tourism. It was believed that aquaculture could provide more jobs in the respective communities and relieve some pressure from the marine fishery, provided the environment for its growth was facilitated and some of the key challenges below addressed (Jones, 2017).

Multiple challenges to the aquaculture industry on a whole have been identified especially the production of tilapia in Jamaica. The most pressing for the industry include:

- The availability of appropriate fish feed

- Energy costs
- Marketing
- Inadequate seed stock
- Inadequate and insufficient water supply
- Agricultural theft and
- Competition from imported fish

The challenges highlighted are common to both male and female farmers with agricultural theft continuing to be one of the major factors discouraging farmers from continuing with tilapia production. The impact has been so significant in some instances that it has led to the closure of farms (Jones, 2017).

The high costs involved with production related to feed, energy, etc. all combine to make Tilapia a high cost final product. The market is quite elastic, allowing for various substitutes. Furthermore, the preferential size purchased by the householder is one half pound to three quarter pound, which is not an optimal size for a good return on investment. The high costs of production also make it too costly for local processors to produce fillet or other value-added product (GOJ, 2014).

Good water quality is essential to the growth and survival of fish. Highly productive areas such as Hill Run in St Catherine are impacted by inadequate water supply. This has led to the seasonal production of fish (only in the rainy months) and farmers are only able to produce one crop per year (GOJ, 2014).

The cost of energy has escalated over the years. Farmers have moved from semi-intensive and intensive operations to extensive which requires lower energy usage in a bid to reduce costs. The cost to operate an 18 hectare facility which uses 1 HP paddle wheels and electrical deep well pump is now approximately JMD 800,000.00 per month or US 0.42/KWH. This cost when compared to regional aquaculture producers results in the cost of production being too high.

According to JAMPRO Trade and Invest (2014) since tilapia is a species that responds well to low quality inputs, farmers can experience a reduction in production costs through the intensive use of animal manures and other agro-industrial by-products as sources of fertilizer and feed. It is recommended that improvement in productivity can be realized (JAMPRO, 2014) through adaptive modernization and intensification, as well as the use of alternative (renewable) energy sources.

Jamaican farmers usually produce vegetables, coconuts, and sheep/goats in mixed production systems. In aquaculture production systems some farmers have integrated sheep/goats in their system since they help clean the pond banks and their sale contribute to the payment of labour costs of individuals who must reside on the pond location. A study by Jolly et. al. (2011) tested the assumption that if the farmer acquired 6 acres of land for goat production and the benefits derived from goat production was the sharing of investment capital and labour costs, then goat production could enhance total farm profitability. The additional net benefits from goat production should improve the net present value of investment (NPV) from the total enterprise by 18 percent (Jolly and Hishamunda, 2011). Goat production was found to enhance the profitability of the aquaculture farm business since its production as a separate enterprise was also positive.

4.4 BEEKEEPING SECTOR

4.4.1 HONEY PRODUCTION

The last census conducted of the beekeeping industry was in the year 2009 (MOA&F, 2010). The census revealed that there was significant growth in the industry since 2005 when there was a massive decline in the number of farmers as a result of the ravages of a series of hurricanes as well as the onset of pests and diseases which impacted negatively on the industry and wiped out numerous apiaries. Since 2009 the industry has continued to see a number of new entrants and several existing beekeepers expanding their operations considerably. Every parish now reports a significant increase in beekeeping with the majority still being concentrated in the West - Central parishes. However, it is worthy of note, that the Eastern parishes reported significant levels of increased production and productivity, due strongly to the interventions of the European Union Banana Support Programme-Rural Diversification Programme (EUBSPRDP) in these parishes.

An assessment of the industry (MOA&F, 2010) indicated that beekeeping had become a major commercial activity, becoming the primary income earner for most individuals engaged in it. The data showed a movement from 1 202 farmers in 2009 to 2 500 in 2017 (Apiculture unit MICAF, 2018 unpublished).

The growth of the industry since 2009 indicates an increase in the number of beekeepers inclusive of institutions of 108 percent with numbers exceeding that of 1998 now keeping bees. In addition to this, production and productivity has also increased significantly. The number of hives has moved from 31 416 in 2009 to approximately 49 000 in 2016 and 57 600 in 2017 (Apiculture unit 2018 unpublished). This represented an increase of 83.35 percent. Honey production moved from 630 354.3 litres in 2009 to 934 845 litres in 2016 (Smith, 2016). This represented a 48.3 percent increase in honey production over 2009. This represented more than 200 percent increase in honey production over 2005.

Smith (2016) stated that beekeeping is one of Jamaica's great investment prospects. Since the introduction of European honeybees into Jamaica in the seventeenth century to satisfy the increasing demand for honey and wax, Jamaica's beekeeping technology has improved significantly. The transition from rustic (non-moveable) beehives to the use of standard Langstroth equipment thus reaching over JMD 682 173 975 worth of bees (only) in production as at December 2012.

The parishes of St. Elizabeth, St Catherine and St. James combined accounts for approximately 40 percent of colonies in production. The parishes of Portland and St. Ann remained the lowest beekeeping investment areas. Data indicated that prolonged drought conditions resulting in the death of over 500 colonies in 2014.

Table 4.22 Number of registered Apiaries in Jamaica 2011 to 2017

Parishes	Number of Apiaries on the National Registry for the period January 1, 2011 to December 31, 2017							
	2011	2012	2013	2014	2015	2016	2017	Apiaries	Beekeepers
Kingston and St. Andrew	120	187	147	92	97	167	150	200	160
St. Thomas	19	107	292	83	62	55	81	180	165
Portland	113	84	3	43	34	46	43	150	110
St. Mary	92	7	131	30	43	47	64	260	250
St. Ann	169	103	73	36	45	49	8	120	120
Trelawny	116	3	1	2	0	118	63	150	145
St. James	236	44	0	30	189	67	38	250	240
Hanover	130	38	0	0	3	60	36	165	150
Westmoreland	165	8	17	8	124	113	175	180	170
St. Elizabeth	319	40	0	50	378	306	300	600	400
Manchester	161	53	0	33	12	23	54	180	150
Clarendon	278	0	0	55	40	39	17	250	200
St. Catherine	464	130	43	188	158	125	102	500	480
Total	**2382**	**804**	**707**	**650**	**1185**	**1215**	**1131**	**3,185**	**2,500**

Source: Ministry of Industry Commerce Agriculture and Fisheries Apiculture unit, 2018

Table 4.23 Number of registered bee colonies in Jamaica 2011-2017

	Number of Colonies on the National Registry for the period January 2011 to December 31, 2017							*Estimated Number of colonies (including unregistered colonies)
	2011	2012	2013	2014	2015	2016	2017	Colonies
Kingston and St. Andrew	1785	2823	2793	1382	2023	3476	2462	3,500
St. Thomas	592	1447	4641	1686	1406	1523	592	3,500
Portland	1340	1484	8	593	469	688	817	1,800
St. Mary	2428	68	1921	988	675	714	899	2,400
St. Ann	1484	1507	1101	367	386	543	116	1,400
Trelawny	2726	215	60	50	0	2854	1593	2,000
St. James	4428	747	0	515	3557	750	547	5,500
Hanover	2296	700	0	0	138	1533	496	3,500
Westmoreland	3182	183	57	438	2841	2791	3998	4,500
St. Elizabeth	6008	930	0	1442	11173	8532	7541	13,000
Manchester	3056	1791	123	892	894	427	1111	4,000
Clarendon	4063	0	0	1237	868	501	174	5,000
St. Catherine	6628	2135	548	3581	2825	2782	1753	7,500
Total	40016	14030	11252	13171	27255	27114	22099	57,600

Source :Ministry of Industry Commerce Agriculture and Fisheries Apiculture unit, 2018

Figure 4.52 Number of registered apiaries per parish 2011-2017

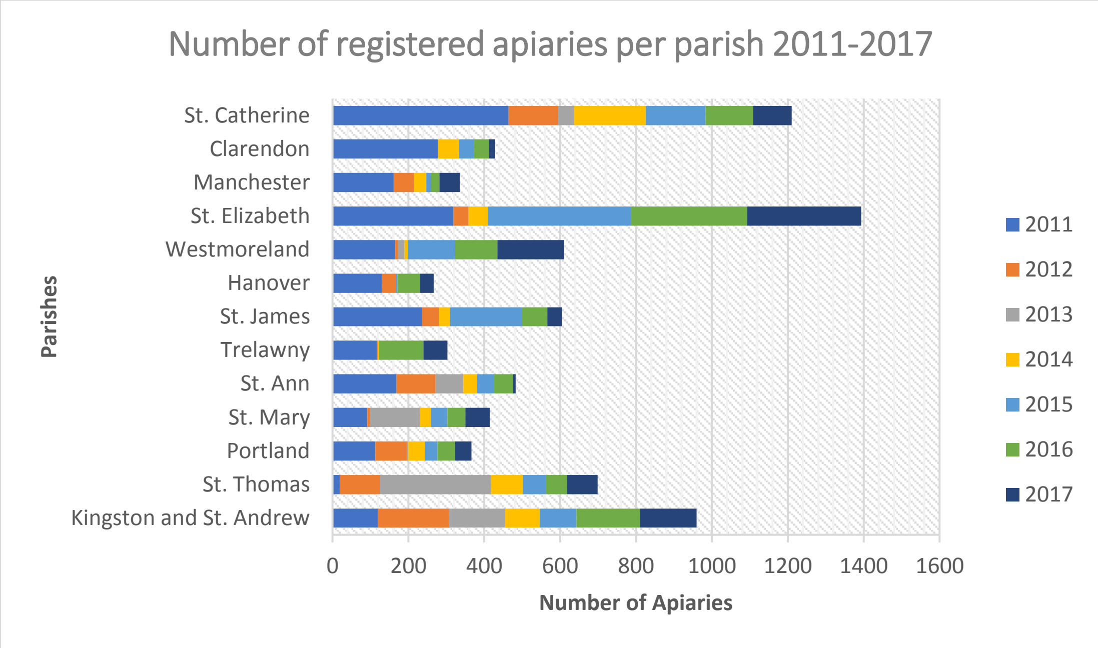
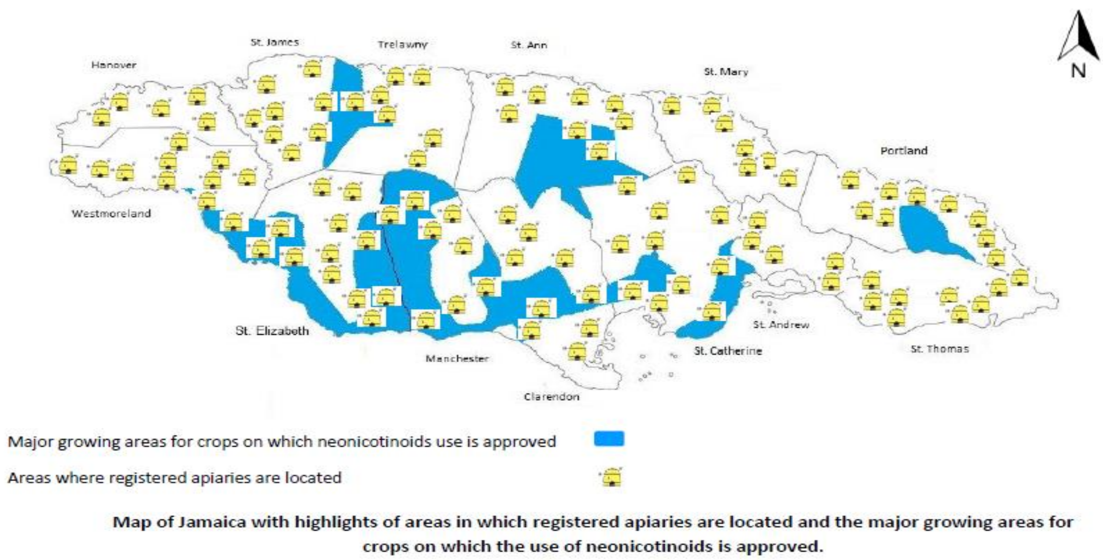


Figure 4.53 Map of Jamaica highlighting registered apiaries in major crop growing areas



Source: Smith 2014

Figure 4.54 Number of registered bee colonies per parish, 2011-2017

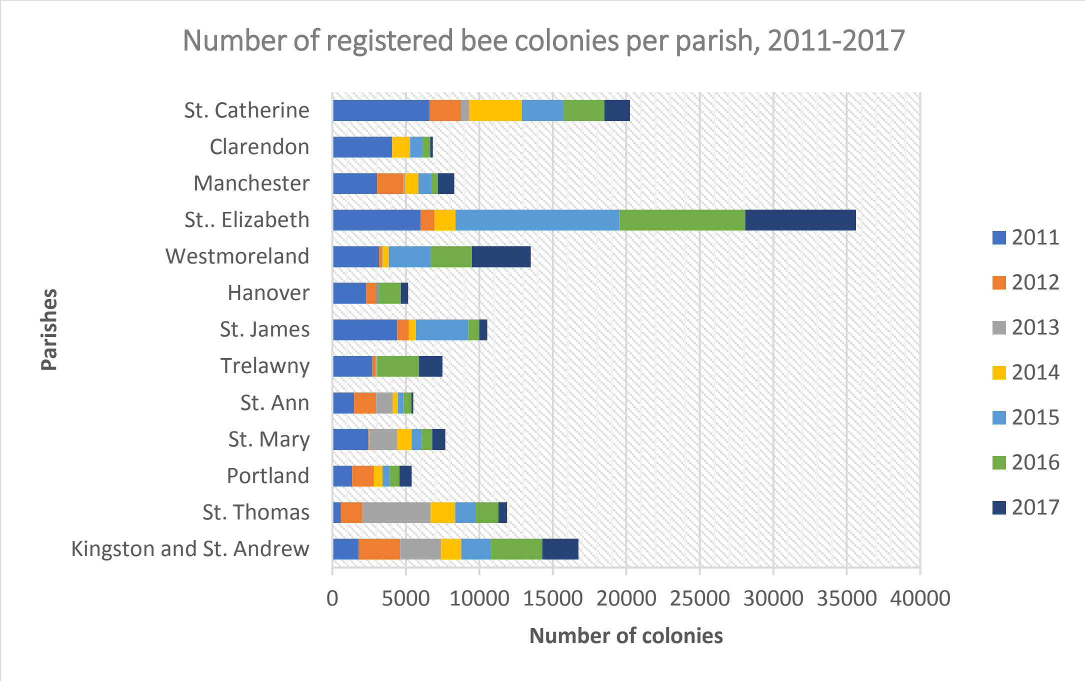
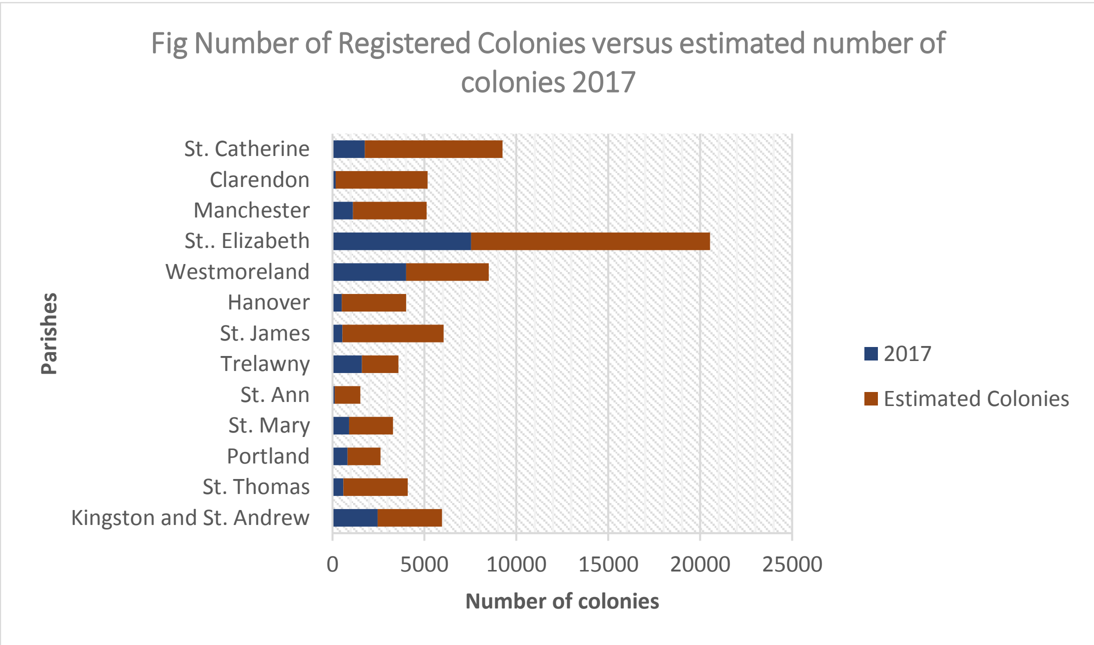


Figure 4.55 Number of Registered Colonies versus estimated number of colonies 2017

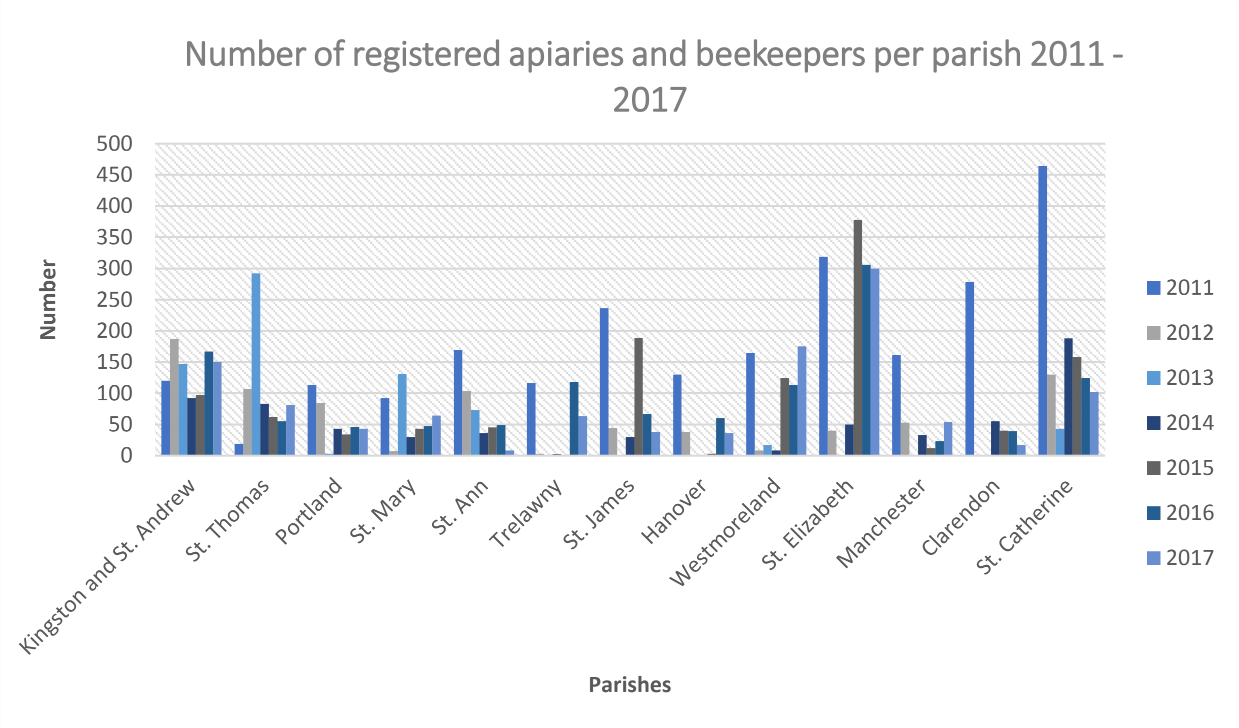


4.4.1.1 BEE GENETIC RESOURCES

Jamaica possesses a honeybee derived from three races of the *Aphis mellifera* spp. These races include the Italian honeybee (*Aphis mellifera* lingustica,) Caucasian honeybee (*Aphis mellifera* caucasica) and the German black bees (*Aphis mellifera* mellifera). Physical features of these genetic lines are evident in any colony of honeybees in Jamaica. It is therefore difficult to find a colony which is pure, that is, of one specific race.

4.4.1.2 BEEKEEPER DEMOGRAPHICS

Figure 4.56 Number of registered apiaries and beekeepers per parish 2011 -2017

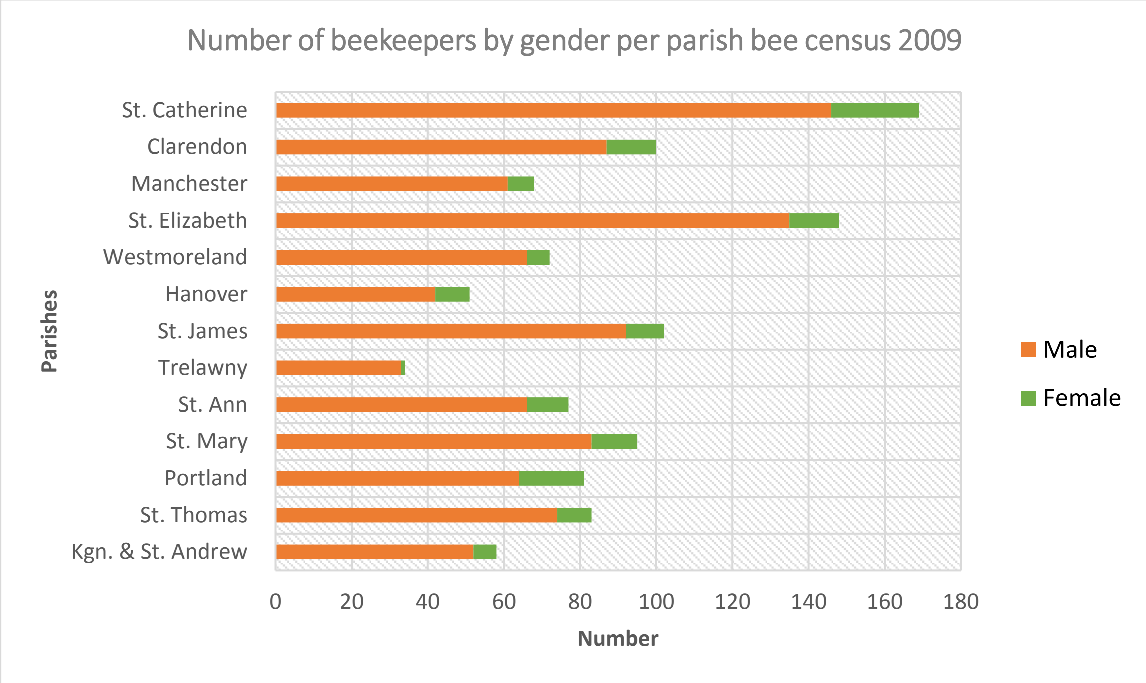


The estimated 3 185 apiaries present in Jamaica are owned by 2 500 beekeepers. However only 1 131 were registered beekeepers as government records showed. This disparity between registered beekeepers and the estimate may be due to farmer perception of the benefits gained in being registered.

Smith (2012) reported 1439 (78.59 percent) males, 260 (14.2 percent) females, 82 (4.48 percent) institutions and 50 (2.73 percent) apiaries where the owners were not identified involved in beekeeping. The parishes of St. Catherine and Kingston & St. Andrew had the highest number of female beekeepers. Institutions that practice beekeeping ranged from schools (primary through to tertiary), Bee Farmers Associations to service clubs such as 4-H (Smith 2012).

The intervention of the EUBSRDP in six parishes since 2005 had contributed to a 300 percent increase in the number of female beekeepers moving from just 45 in 2005 to 137 in 2009 (see Figure 6). As of 2012 this figure stood at 260. Other contributing factors are the initiatives of the Research and Development Division of the Ministry of Agriculture and Fisheries through its Apiculture Improvement Project, specifically the Youth Apprenticeship component. It is also important to note that a number of these new entrants were persons who found themselves made redundant from their jobs in 2007 onwards.

Figure 4.57 Number of beekeepers by gender per parish bee census 2009



4.4.1.3 MARKETING

There is currently a readily available market for honey as less than 5 percent of bee keepers reported that they had a problem marketing their honey (bee census 2009). The industry is set to grow even further as a number of farmers indicated that they intend to increase production in the near future.

The demand for products of the beehive continues to increase (resulting from improved awareness of the values of these products) hence more individuals recognise the need to satisfy this demand. The short term returns on investment is also another attractant to new investments. These returns are rivalled only by a very small number of the investment opportunities in the Agricultural Sector. Beekeeping however has some distinct advantages such as:

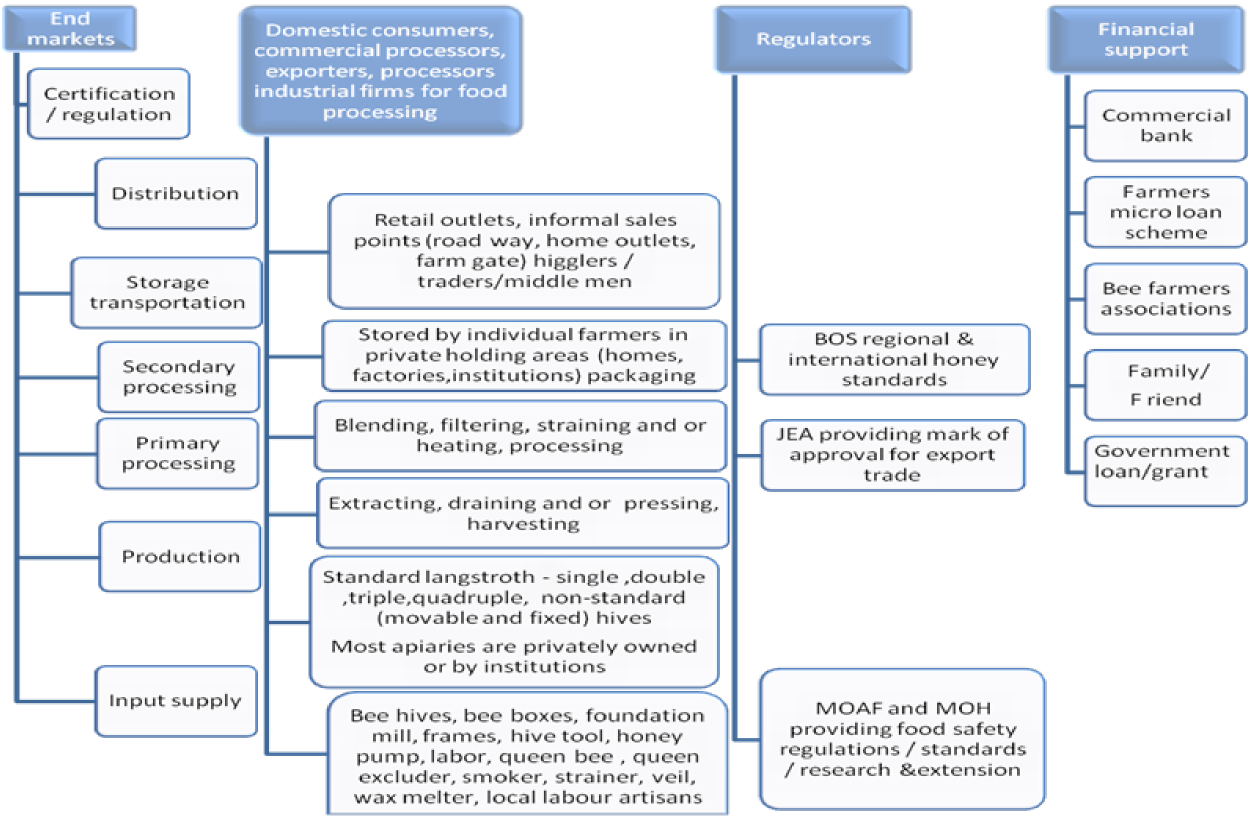
- It does not require large acreages to establish an apiary since hives can be relocated to other areas.
- It is not labour intensive compared to other agriculture production systems.
- Other activities can run concurrently with moderate operations.
- The returns on investment can be significant (though heavily dependent on the level of management).
- Bees do not compete with humans or other animals for food but through pollination increases yield and food availability.

Table 4.24 Bee hive products and their status since 2012

Bee Hive Products	Production of Value Added Products	Status of value added products
Honey	Small production of Beer, wines, sauces, drink, cakes, paste, etc.	Increased since 2012
Bee Wax	Increase in the making of candles, facial creams, scrubs, ointment, etc.	Significant room for development can occur
Royal Jelly	Supplements, candies, pies etc.	Highly under developed
Pollen	Cakes, supplements, wines, etc.	Low collection of pollen and lack of standards
Propolis	Increased production since 2012 Ointments, medication, chewing gums, lip balm etc.	Under developed with rising demand
Venom	Medication, creams	Highly under developed
New Colonies (Bees)	Apiary expansion and setting up new apiaries	Increase use of queens for multiplication
Queens	Export, replace old queens and setting up of new colonies	Significant room for development can occur. Lack export base.

Source: Hugh Smith 2014

Figure 4.58 Honey value chain Jamaica



Source: Smith, 2014

There was more than a 100 percent increase in the price of honey between the 2015 and 2016 honey crop. It takes 2.5 to 3.0 years for investors in beekeeping in Jamaica to get a positive return on their investment. The cost of producing 5.7 kg (1 gal) of honey was approximately JMD1 600 (USD 13.33). About 5.7 kg (1 gal) of honey is sold at the farm gate for an average of JMD 5 000 (USD 41.67) (Smith 2016).

4.4.1.4 PRODUCTION CHALLENGES

Climate change has a direct influence on honey production, bee behaviour and physiology quality of the floral environment for honeybee nutrition and increased or reduce colony harvesting capacity and development such as:

1. **Drought** (due to increased air temperatures and unpredictable rainfall)
2. **Wind Damage** (due to storms)
3. **Flooding /Landslide (**due to Storms**)**

The parishes of Kingston and St Andrew, St Thomas, and St. Elizabeth are more greatly impacted than other parishes by these climatic events (Smith, 2016).

The industry has encountered other problems ranging apart from severe weather/environmental situations such as the onset of pests and diseases. Despite these challenges, the industry has managed to remain productive in terms of not only honey, but overall bee products. The productivity level of the industry has also shown a marked improvement. This was attributed to the initiatives of the Ministry of Agriculture, in terms of pests and disease surveillance, training, and general awareness among bee farmers. The extension service provided, enabled farmers to improve their overall apiary management and increased productivity (Smith, 2016).

Bee pests and diseases: The Jamaican beekeeping industry has grown over the years. This improvement has increased man to beehive interaction, thus contributing to the introduction and spread of two bee pests, namely, Varroa mite and Small Hive Beetle (SHB).

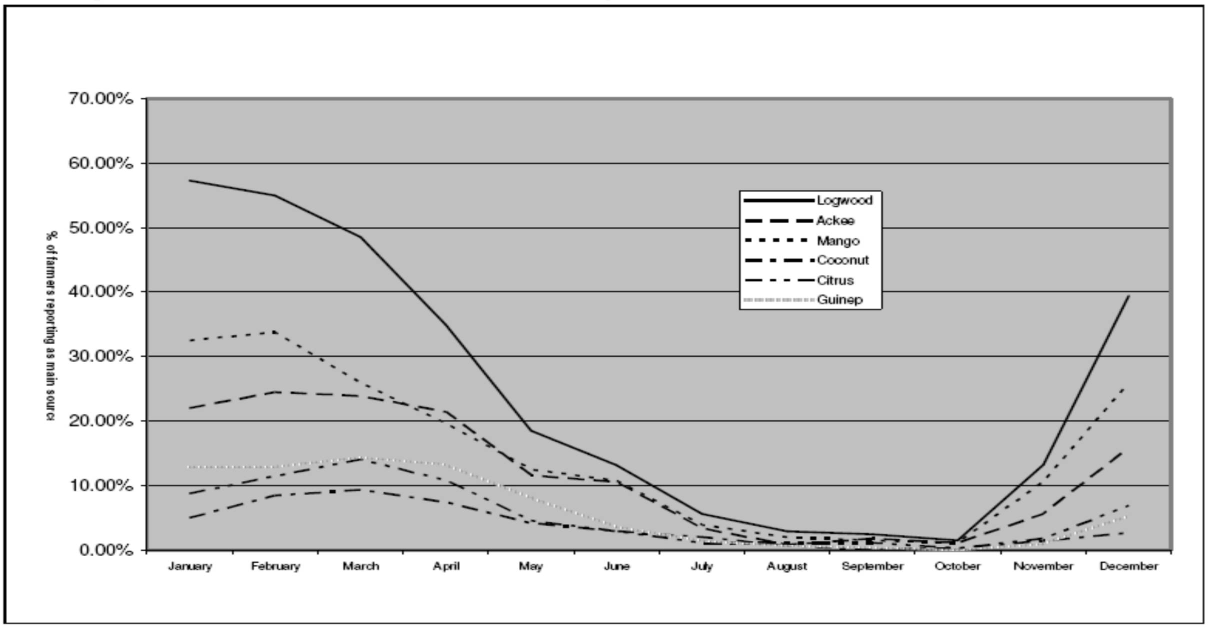
There have been several incidences of Small Hive Beetle and Varroa mite identified across all parishes in Jamaica. This is consistent with international distribution of these bee pest. AFB clinical symptoms are restricted to specific apiaries owned by a few beekeepers.

- Present in all apiaries with **proper hive management** as a control strategy for the effective reduction in the small hive beetle population.
- This has worked resulting in **no dependence or low use of chemicals**.
- The SHB usually causes hive deaths or absconding in apiaries that are not managed properly.

Impact of available nectar sources: The availability of good quality nectar sources is important to honey production. The expansion of housing development negatively impacts on these resources as they are often removed from the environment and replaced by concrete. In Jamaica the top nectar sources include, Logwood, Ackee, Mango, Coconut, Citrus and Guinep. The Annual distribution of the availability of these resources is documented below in Figure 4.63.

Pesticide residues: Pesticide residues in honey is an important barrier to export hence the government's push to monitor and mitigate the development of a culture dependent on pesticide use to manage bee pests and to encourage apiaries in locations where pesticide use is minimal. The industry has faced a longstanding concern with the issue of the use of neonicotinoids in the landscape due to reported negative impacts on beneficial organisms in the system.

Figure 4.59 Annual distribution of the availability of the top six nectar sources



Source: bee_census_2010

CHAPTER 5

5 AGROECOLOGY CASE STUDIES OF JAMAICA

5.1 ORGANIC SYSTEMS

Organic systems in Jamaica are primarily cropping systems which include a wide range of food crops in rotation cropping, intercropping, and agro-forestry. There are a few cases such as Durga's den farm where integrated crop and livestock systems are practiced. An organic system integrating ducks and fruit tree orchards has been reported in the parish of St. Thomas. Some farmers practice some form of organic farming integrating crop and livestock production which often does not satisfy requirements for certification. Other practices include utilization of various forms of mulch and composts both to improve soil fertility and to conserve soil water. Various forms of pesticides may be applied. However, there are cases in Jamaica where elements of agroecology are being practiced:

5.1.1 THE JAMAICA ORGANIC AGRICULTURE MOVEMENT

Although organic agriculture in Jamaica is marginal – in 2013, 0.1 percent of its agricultural land was under certified-organic production, and there were 80 certified-organic producers in the country (Woo, 2015). Most of the organic systems in Jamaica focus on vegetables, herbs and some exotics such as coffee and cocoa. Any form of livestock integration can only be seen in small farmer mixed cropping systems.

The Jamaica Organic Agriculture Movement (JOAM) continues to lead efforts to develop Jamaica's organic agriculture sector. They represent ordinary citizens taking organic agriculture into their own hands to create alternatives to the industrialized food system or to enable sustainable livelihoods based on agriculture, a sector which has become increasingly marginal. There are about three hundred members, ranging from small farmers, a minority of whom are certified organic, to academics, business owners, professionals and small farmers' groups.

The Ujima Farmers Market operated by the Source Farm Foundation is the location where organically grown food is marketed. It is held every two weeks in Kingston and sees about 100 to 150 customers each week it operates with between 10 and 20 farmers participating (Woo 2015). Its mission is to provide farmers in the parishes surrounding Kingston, a venue to provide a variety of fresh naturally grown (pesticide free) produce and related products directly to the consumer. The market encourages direct communication between consumers and growers, fosters social gathering and community building, and promotes nutritious food choices'. The market itself as an institution also serves as an informal assurance of quality since the vast majority of participating farmers are not certified.

According to Woo (2015) one possible threat that organic small farmers could face if the organic sector were to expand in Jamaica is the rising quality expectations and the industrialization of organic practices in the mainstream, certified-organic market which have undermined the profitability of organic exports and marginalized small-scale producers that were traditionally dominant in the Dominican Republic organic sector. Woo (2015) states that while the current risk of the commercial agribusiness sector employing industrial practices in violation of the underlying principles of organic agriculture is low in Jamaica, there is always the potential for that, if the market for certified-organic products were to become lucrative. Woo (2015) states that currently some members of JOAM who he perceived as being more privileged than the traditional Jamaican small farmer despite access to education, funds and diaspora-networks that they are still only just able to break even from their farm operations and also struggle to make ends meet. Like other small farmers need to have other sources of income, usually off-farm jobs, to sustain themselves If this be the case then the recent launch of Jamaica's organic standards will further label products that have been produced in accordance of these set of standards and have been certified by a recognized certified body or authority.

5.1.2 CASE STUDY 1: BALANCE: - INTEGRATED DIVERSIFIED ORGANIC FARMING SYSTEM ROWAN'S ROYALE

Rowan's Royale is a two hectares woman owned and family operated organic farm situated in the Blue Mountains where coffee monoculture is the main source of income for family farmers in the area. The farm itself is located at a height of over 1 219.2 m above Silver Hill Gap in Portland, Jamaica and is situated in the Blue and John Crow Mountains nature reserve. An extensive knowledge of traditional and organic practices is applied on farm. The farm is strategically structured in distinct components that are designed to maximize one another. A nutrient recycling system generates a virtuous closed loop process on the farm, and biodiversity is intensified to multiply key ecological functions and processes within and among the components (e.g. natural pest management and optimal use of biodiversity, rainfall and soil fertility). With the threat of hurricanes and increased occurrence of drought in the region, Rowan's Royale farm faces increased heat from the sun, extreme drought, followed by flooding and heavy winds. As result Rowan's Royale has learned, evaluated and included in their landscape the most resilient plants and practices to reduce their vulnerability (Rowan Campbell, 2017).

The farm was brought under organic production in 1992 using existing coffee plots. Rowan's Royale has been a certified organic farm since 2002. On a day to day basis, the farm management, quality control and inspections rest with the husband and wife team Dorienne and Tony, and they work with their farm team to pick, pulp, dry, store, size, grade, roast and package the coffee.

This has resulted in Rowan's Royale producing quality organic products, including their own compost fertilizers and reducing their dependency significantly on external input providers. The food and nutrition need of the family is still not quite fully met but income generated form the farm would go into procuring other food items not produced by the farm.

5.1.2.1 DESCRIPTION OF AGROECOLOGY SYSTEM

Biodiversity and nutritional diversity is practices with the range of crops grown such as coffee, asparagus, leaf greens, red cabbage, bananas, plantains, mulberries, lemons, mixed greens, peas, beans turmeric, ginger, dasheen coco, and sweet potato. Root crops are the focus in drought periods. On the flatter areas of land there is an increased amount of coco, sweet potato, dasheen, carrots beets etc. Radish is established as a rotation crop in June to August for soil enhancement. The use of vegetables such as Daikon radish as a companion crop for young coffee seedlings in practiced. According to the farmer the radish's bushy leaves provide shade for soil but this variety of radish is also known as the tillage radish providing aeration to the soil and on decomposition nutrients.

The farm has begun experimenting with lentils since 2016. The farm is doing their own on farm trials to identify best drought resistant cover crops.

Nutrient conservation and recycling: Less land is also put into cultivation at any one-time as compost is added and areas left heavily mulched June to August.

Agroforestry: The farm is surrounded by forest with seven organically grown coffee production sections across the farm with several composting piles located in each of the seven coffee production areas. Vegetable farming is done in one to three locations with asparagus being the predominant vegetable crop. Ecosystem services include providing shade for coffee trees and coffee trees in turn act as shade for leafy greens; Acting as windbreaks since the area has experienced an increase in the number of heavy, unseasonable winds which dry out the soil and often cancel out benefits of mist or dew or rain. The strong winds also batter and blow off coffee leaves (other farmers report losing green fruit); mulch off the soil and spread disease spores (coffee leaf rust/American round eye spot). The winds also shorten the period of mist/fog resulting in less available moisture for the crops. Hence trees such as Mulberry and Yacca (*Podocarpus* sp.) are planted, they are known to resist hurricane winds well. It has been observed that forests stand up to heavy winds because they have a mutual support system in the mix of trees and their closeness. The farmer is trying to replicate this in two areas where winds are strong.

Water conservation and recycling: The farm is dependent on rainfall but since the 90s an increase in the area affected by the rain shadow has occurred especially during the summer months thus reducing the amount of rainfall received during that period. The issue of moisture is critical as this impacts on the farm's ability to produce quality coffee. The practice of lining out of berms and swales for the capture of more moisture for the coffee prior to onset of drought is done. Water is harvested by trapping water from farm buildings when it rains. A number 60 gal drums are located throughout the farm so that plants can be easily watered. Heavy mulching of beds, coffee trees to retain soil moisture is also practiced.

During periods of heavy showers excess water that has not percolated through their easily draining soil flows through gullies and watercourses on the land. Hence watercourses are identified and water catchments for storage established. Formal and informal terracing using downed timber and banana trunks (permaculture mulching) are utilized to trap water on terraces to retain soil moisture after rains. Direct sun/heat is avoided by:

Soil conservation: Leaching of nutrients from compost piles by heavy rains are prevented by the use of shredded white paper* which forms a solid 'papier-mache' cap and seals in the compost.

5.1.2.2 OUTCOMES FROM THE PRACTICES

Productivity

- Coffee berries float consistently averages less than3 percent (since 2002) compared to Coffee Industry Board (CIB). In 2015 the CIB after drought had higher than normal float percentage, at the start of the crop which was about 35 to 40 percent. They experienced average losses in yield of 15 to 20 percent.

5.1.2.3 CHALLENGES AND FUTURE CONSIDERATIONS

Challenges faced:

- The topography is rugged and extremely steep, access is difficult and construction costly
- Transportation for farm team, inputs or produce is also extremely expensive
- Alternative energy solutions needed but expensive

Future Considerations

- The farmer intends to introduce beekeeping on their coffee farm
- Identify alternative sources of renewable energy

5.1.2.4 OPPORTUNITIES

It is clearly demonstrated on Rowan's Royal organic farm that it is possible to implement several key agroecological practices in order to satisfy to some degree FAO's agroecological tenets of efficiency, balance, diversity, recycling, synergies, land and natural resources governance. However, no data was shared with regard to overall productive outputs of the system for comparison with conventional systems. But what is worthy of note is the ecosystems services that have benefitted this organic grower to enhance the climate resilience of the farm.

5.1.3 CASE STUDY 2 SYNERGY: AGROECOTOURISM -DURGA'S DEN FARM

Durga's Den Farm is located in the Orange Hill section of Breadnut Hill, St Ann. This five-acre property, overlooks the sea, and is located near to one side of Fern Gully which was once a pasture with a few trees. Organic and permaculture practices are integrally a part of this operation. The eco-lodge was developed applying permaculture principles to be fully self-sufficient. The owners Lise and Michael Alexander have operated this property since 2008.

Based on the application of organic and permaculture principles the farm produces organic food without the use of chemical-based fertilizers or pesticides. Permaculture involves planning and designing a relationship with the natural environment and taking advantage of natural ecosystem services. Trees are a part of the synergistic relationship at Durgas Farm, which produces mainly vegetables and greens.

Nutrient conservation and recycling: Less land is put into cultivation at any one-time as compost is added and areas left heavily mulched June to August. Compost is made of mainly decayed vegetable matter and biofertilizers which are produced on the farm to nourish the soil.

Renewable sources of energy: The energy of the sun is captured and used. As such, Durgas Den Farm is only partially powered by the Jamaica Public Service (JPS). Solar energy is the main source of electricity. Even an oven is heated by natural energy. Their cob oven, made of clay, coir and sand, is fired by wood.

Water conservation and recycling: There is no outside water source, only rainwater is used. The roofs are equipped to catch the rain, which is stored in tanks. The water is distributed around the farm by gravity feed.

Even the used water, at some point, is recycled. There is also no toilet flushing, as such. Alexander doesn't see any reason why much-needed water should be used to flush waste. Therefore, the toilets on the property are composted. Sawdust and other compost are used in the latrines to absorb waste and to keep odours down.

Soil conservation: The soil is enriched by organisms such as worms and their droppings. Black soldier flies are bred to provide larvae for chicken, whose manure, as well as those of rabbits, are used as nutrient-rich natural fertilisers. The rabbits are not raised to be consumed.

Permaculture is practiced as the farm is designed to take full advantage of the existing trees in the environment that help to prevent soil erosion and protect soil surfaces

5.1.3.1 OUTCOMES FROM THE PRACTICES

Practices are integrated into a value chain to support ecotourism

5.1.3.2 FUTURE CONSIDERATIONS

Future Considerations: Scaling up of the technologies used with broader application locally

5.1.3.3 OPPORTUNITIES

It is clearly demonstrated on Durga's farm that it is possible to implement several key agroecological practices in order to satisfy to some degree FAO's agroecological tenets of efficiency, balance, diversity, recycling, synergies, land and natural resources governance. The farm was able to implement conservation climate resilient practices. However, no data was available with regard to overall productive outputs of the system for comparison with conventional systems. But what is worthy of note is the integration of ecosystems services tourism as a form of circular economy. This is indeed a model for youth and women engagement

5.1.4 CASE STUDY 3 CO-CREATION OF KNOWLEDGE - SOURCE FARM FOUNDATION ST. THOMAS

The Source Farm Foundation and ecovillage operates in the community of John's Town in the parish of St. Thomas. It was established in 2005 to facilitate the need of Jamaicans in the diaspora to return home, and to create a place of ecological stewardship and care. The Source Farm is a model community demonstrating; sustainable living, organic and natural farming, and community development initiatives (The Source Farm, 2017).

Diversity: Currently they have over 400 coconut trees and a number of fruit trees that include Avocado, Lime, Banana, Pineapple, Ackee, Mango, June Plum, Guava, Pomegranate and Jamaican Otaheite Apple. Their vegetable crops vary seasonally and include Bok Choy, Broccoli, Tomato, Callaloo, Sweet Potato, Yam, Dasheen, Scallion, Lettuce, Sweet and Hot Peppers, Sorrel, Butternut Squash, Beans, Chards, Lemon Grass and numerous spices.

Co-creation of knowledge: The Foundation runs the 'One One Coco' Natural Farmers School and has recruited from the USA experienced researchers who have provided training to local farmers in rudiments of Permaculture and Organic farming since 2014. Under the project, farmers are exposed to techniques in land preparation, surface water management, erosion control and drought resistant agricultural methods.

Human and Social Value: Farmers are taught hands-on farm management and decision-making techniques as well as necessary farming practices, business skills and knowledge. Over 40 farmers have benefited from their activities. The foundation has an organic market called Ujima which means collective work and responsibility, so farmers, young and old, from across the island who are trained in organic and natural practices, are provided with the space for them to be able to sell their produce to consumers directly

5.1.4.1 CHALLENGES AND FUTURE CONSIDERATIONS

Challenges faced: Continued funding support and recognition be government of the value of this intervention

Future Considerations: Scaling up of permaculture and organic production technologies to be used with broader application locally

5.1.4.2 OPPORTUNITIES

It is clearly demonstrated by the Source Farm Foundation that farmers are interested in learning more about agroecological principles and practices. This model can be a vehicle through which the transition to agroecologically based agriculture can be realized

5.1.5 CASE STUDY 4 CIRCULAR ECONOMY: - JEFFEREY TOWN FARMERS ASSOCIATION

Jeffrey Town located in the western part of St. Mary Parish in north eastern Jamaica is a rural community composed primarily of farmers. At an elevation of 1 700 feet, Jeffrey Town is considered 'deep rural'. The topography of the area varies from gently to rapidly sloped terrain. The high altitude creates a climate that makes the growth of a variety of crops and fruit trees possible. The area is part of watersheds of the two main rivers, the Rio Nuevo and White River, with the landscape being characterized by springs and tributaries. The soil is primarily composed of clay.

The Jefferey Town Farmers Association was the 2014 United Nations Development Programme Equator Prize Winner and second place winners of the Scotiabank Eco Awards in 2011. They have been voted the best sustainable agriculture community and the best youth leader in agriculture in 2012. It was founded in 1991. The Association in 2003 formulated their mission to use agriculture as a platform to sustainably develop the human and physical resources of Jeffrey Town in order to create opportunities and to achieve social and economic stability for all residents, particularly women and youth.

As a poor rural community Jefferey Town had no means of telecommunication for years. However, as a closely-knit community it made the decision that they had to become more self-reliant. The Jefferey Town farmers association was the vehicle through which this was realized. Since its inception the Jefferey Town farmers association has focused on community development work. This includes the community's engagement in communal organic farming. The Jeffrey Town Farmers Association has employed diverse approaches to inform and educate other farming communities in the region on alternative energy options, sustainable agriculture techniques, and disaster risk reduction. Some of these services are offered through the local radio station and multimedia centre owned and operated by the Farmers' Association. The local radio station engages youth while informing the community about important issues. The Farmers' Association has incorporated both solar and wind energy as alternate sources of energy to run the facilities. Solar streetlights have also been introduced in four communities, and a new health facility to meet local medical needs.

The community of Jefferey Town Farmers' Association has embarked upon a number of initiatives to address issues such as land degradation, natural disasters, and irregular water supply in their community. The association focuses on land restoration, water harvesting, and organic farming. Fruit-bearing trees are prioritized in land restoration efforts to ensure food security. In conjunction with the use of climate resilient infrastructure, pineapple plants have been used to stabilize hillsides previously susceptible to landslides, which caused environmental and economic damage to local communities (Gordon, 2014).

5.1.6 DESCRIPTION OF THE AGROECOLOGY SYSTEM

Biodiversity: The region boasts an abundance of biodiversity, including a range of birds, butterflies, turtles, lizards, frogs, toads, fish, shrimp, and crayfish. Farmers in the community cultivate a wide variety of crops, including the local otaheite apple variety, bananas, breadfruit, coconuts, tangerines, lettuce, peppers, sweet potatoes, and Irish potatoes. The increasingly unpredictable change in climate, including both rain-intense tropical cyclones and droughts, creates a difficult environment for optimizing crop selection. However, by increasing agrobiodiversity, Jeffrey Town Farmers Association has worked to foster a production system that is increasingly resilient to changing weather patterns. The group has also introduced beekeeping in an effort to diversify livelihoods

Efficiency: Rainwater harvesting is practiced by reducing the amount of water and debris flowing downhill during intense storms. Tree cover and vegetative barriers work in a complementary fashion to terracing and gabion walls, enhancing soil integrity through their root systems and further protecting against landslides. Trees further serve to soften the impact of raindrops on the ground, thereby reducing soil erosion, and vegetative barriers such as pineapple, sugar cane, and cuscus grass reduce debris flows down the slopes during intense periods of rain. Rainwater flowing off the roof is captured in tanks, with pits built to capture excess water if the tanks overflow. This provides sources of water for both domestic and irrigation purposes at the household level, offering a measure of security in an increasingly variable climate plagued by both heavy storms and drought.

A community outpost is maintained to produce compost for use in the demonstration plot; it also serves as an organic greenhouse where community members grow strawberries.

Human and Social Value

The population was recorded as 2 982 from a 2011 census. Of these, 47 percent are women. The same census data showed unemployment numbers at a staggering 33 percent for those of working age, and 40 percent for youth. Of those that are gainfully employed, 42.2 percent were engaged in agriculture. There was also a high incidence of single-parent families, meaning economic pressure is high for those providing single-handedly for their children. Job opportunities for young people are limited in St. Mary parish, creating cycles of outmigration, crime, and a general lack of youth productivity. As such, Jeffrey Town Farmers targets young people in its programming and activities, working with them to introduce alternative livelihood strategies and training them in organic farming techniques. Currently, more than 30 percent of Jeffrey Town Farmers Association's members are youths. Radio programming has proven to be particularly effective as a mechanism for engaging youth. More than 50 young people have been trained to carry out the majority of work needed to operate the community radio station. Importantly, youth also help create and curate radio programming, which covers topics as diverse as organic agriculture, climate change, and other relevant social issues. The Commonwealth of Learning and the Caribbean Institute of Media and Communication have been important partners in this work. Training courses focus on content, technical skills, and developing an appreciation for the power of the medium. As part of its emphasis on youth, the group employs a participatory approach, where members of the community are invited to become involved in radio programming and content development. The intention behind this initiative, and ultimately what has been created, is a true voice of, and for, local people.

Co-creation of knowledge: Jeffrey Town Farmers Association has met an important need in the community by providing a 'home base' where farmers and young people can meet to discuss common challenges and opportunities, to collectively process value-added products, and to operate the community radio station.

Circular Economy: Among their first joint actions as an association, the group agreed to market their goods collectively to help obtain fair market prices; they also worked to lobby the government to support sustainable small-scale agriculture. The Farmers' association has worked is to diversify and stabilize the incomes of local women. One such project has mobilized community members, most of whom are women, to start chicken farms and has provided funds to maintain, repair, and reinforce chicken coops. The community centre likewise provides space for the women to refrigerate and store chicken products, enabling processing and preparation for the market. All services are offered at a minimal cost, so the program is financially viable even for local women with limited resources. The chicken litter can also be used by participating members to enhance soil quality on their farms with no monetary investment.

Land and Natural Resource governance: Families are close-knit, with most living on family-owned lands that have been passed down through generations of farmers. These lands, however, are often not supported by legal paperwork, leaving farming families vulnerable to expulsion. Younger members of the community also suffer from a lack of land and resource access. Insecurity of land tenure has led to widespread uncertainty, which in turn has limited long-term investments in the land.

5.1.7 OUTCOMES FROM THE PROJECT IMPLEMENTATION

Community incomes have improved through a range of alternative livelihood activities that include livestock rearing, cultivation of biodiverse crops, and agroforestry. Agricultural diversification through planting fruit-bearing trees such as breadfruit as well as strawberries, starch tubers, and a wide range of food products has supported local food security and improved livelihoods. The group facilitated collective marketing activities by providing a channel for local farmers to deliver their crops to market and establish fair prices. A relationship has been forged with the rural agricultural agency, which notifies the association when specific crops are in demand. This arrangement has proven effective for turmeric, breadfruit, and potatoes

5.2 AGROFORESTRY SYSTEMS

Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economic interactions between the different components.

This definition implies that:

- Agroforestry normally involves two or more species of plants (or plants and animals), at least one of which is a woody perennial;
- An agroforestry system always has two or more outputs;
- The cycle of an agroforestry system is always more than one year; and
- Even the simplest agroforestry system is more complex, ecologically (structurally and functionally) and economically, than a monocropping system.

It needs to be reemphasized that one concept is common to all these diverse agroforestry systems: the purposeful growing or deliberate retention of trees with crops and/or animals in interacting combinations for multiple products or benefits from the same management unit. This is the essence of agroforestry. Additionally, there are three attributes which, theoretically, all agroforestry systems possess. These are: Productivity, Sustainability and Adoptability (the word "adopt" here means "accept," and it may be distinguished from another commonly-used word adapt, which implies "modify" or "change"). Agroforestry has already been accepted by the farming community. However, the implication here is that improved or new agroforestry technologies that are introduced into new areas should also conform to local farming practices.

Agroforestry systems in Jamaica have been applied primarily to smallholders who are mainly subsistence farmers cultivating in hilly areas where farming practices have contributed to severe land degradation. Land that should have remained under forest cover has been cleared for other uses, e.g. coffee production, that is not compatible with soil and water conservation. Furthermore, the forest cover has been under serious pressure for the production of yam sticks, charcoal, resort and residential development, timber extraction, grazing and cropping.

Over the past 60 years successive agroforestry projects have tried to address unacceptable levels of soil erosion and degradation of watersheds caused primarily by the activities of hillside farmers. The approach to solving the problem has been dominated by physical soil conservation methods, designed to allow the farmer to continue to produce annual crops but with reduced erosion (NEPA, 2013).

The Jamaica National Forestry Action Plan (NFAP) of 1990 listed as priority projects, the introduction of agroforestry systems in the Blue Mountains and land use control in Upper Watersheds. The NFAP as a whole has not yet been fully implemented because of funding constraints over the years. However, in 1991, the IDB executed a pre-feasibility study of the re-afforestation of six watersheds - Yallahs, Rio Minho, Black River, Cave River, Great River and Rio Grande. Follow up negotiations took place for the immediate investment feasibility studies in forestry, agroforestry and infrastructure development in these watersheds, leaving others to undergo pre- feasibility analysis (NEPA, 2010).

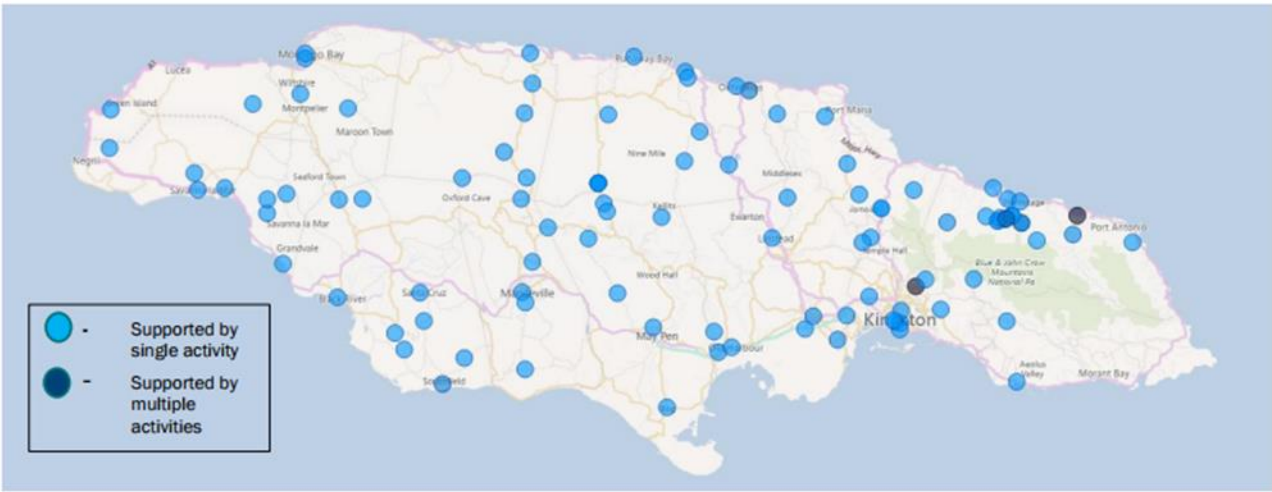
Also, in 1991, the FAO financed a one-year project whose purpose, *inter alia*, was to assist in introducing agroforestry concepts to yam farmers on a community basis. The project identified the harvesting of yam sticks as a contributing factor to forest degradation and recommended to farmers the establishment of high density plantations for the production of yam sticks but this recommendation has never been acted upon by the Ministry of Agriculture. Tree species planted would be carefully selected with durability and healthy life-spans in mind. The FAO project identified tree species which would be appropriate for this system *Spathodia companulata* (Waterman tree), *Gliricidia sepium* (Quick Stick), and *Erythrina corallodendrum*, with *Eucalyptus robusta* rated as having the greatest potential. Farmers knew this stick and regarded it highly (Beckford, Campbell and Barker, 2011). This tree has a life-span of three to four years and can be coppice managed. *Causarina equisetfolia* was also thought to be an excellent choice as it coppiced well in central Jamaica and produced a good quality yam stick tree species in the system to form part of a live yam stick system. The South Trelawny Environmental Agency (STEA) had attempted to introduce and disseminate the hedgerow and alley cropping system among yam farmers in some south Trelawny communities. *Calliandra calothynus*, a fast-growing tree with nitrogen fixing properties with proven effective use was recommended for this practice. The stems of *Calliandra* are sturdy and make very good yam sticks when mature with a minimum two-year life-span according to the FAO (Beckford, Campbell and Barker, 2011)(Beckford, Campbell and Barker, 2011). With its capacity to incorporate a cut and carry yam stick system, the hedgerow and alley cropping system could provide farmers with a practical cost-effective way of procuring yam sticks. The total demand for yam sticks would unlikely to be met for most farmers, but for small growers in particular, the system could represent a useful source of yam sticks given that the cost of obtaining yam sticks is well over 40 percent of overall yam production cost. Widespread use of this system could also reduce the need for yam sticks from other sources and lead to a reduction of pressures on natural forests and woodlands. Despite the benefits these systems are uncommon in yam farming systems in Jamaica today.

However, despite a number of programs and the expenditure of substantial financial resources, primarily through direct farmer subsidies, little success was achieved. This was primarily due to the lack of resources by small farmers to maintain these practices post project completion. There is still, however, considerable scope for the expansion of agroforestry among hillside farmers as demonstrated by the recent interventions of the Forestry Department and by the JAREEACH project in highly degraded watershed communities in Jamaica.

5.2.1 CASE STUDY 5. JAMAICA RURAL ECONOMY AND ECOSYSTEMS ADAPTING TO CLIMATE CHANGE (JAREEACH) *PROTECTING LIVES AND LIVELIHOODS FROM THE IMPACTS OF CLIMATE CHANGE* PROJECT

The JAMAICA RURAL ECONOMY AND ECOSYSTEMS ADAPTING TO CLIMATE CHANGE (JAREEACH) executed by ACDI VOCA and funded by USAID have been targeting farming communities in watershed areas of Jamaica and training farmers in climate resilient farming practices (ACDI-VOCA, 2017). This project has established several pilot agroforestry sites and trained 88 farmers (76 percent male and 23 percent female) in applied improved technologies (bee farming, agroforestry, and land husbandry innovations). A total of 559 people (324 males and 235 females) in four communities have received training, technical assistance, and grant funding that supported the adoption of climate smart agriculture and natural resource management best practices and increased rural income. Approximately 300 farmers have graduated from 17 climate-smart agriculture schools in agroforestry and horticulture under the project. The project has reached 2 146 youth (ages 25 and under) with 100 graduating from five climate-change agent training groups. Over 5 074 project beneficiaries now have greater capacity to adapt to the impacts of climate variability and change. Farmers now utilize agroforestry farm planning and practice rotational-sequential intercropping of vegetables and short-term food crops.

Figure 5.1 Geographical distribution of Ja REEACH project beneficiaries across Jamaica



Source: ACDI VOCA 2017: Annual Report 2017

5.2.1.1 DESCRIPTION OF THE AGROECOLOGY SYSTEM

Several watershed communities have established 21 agroforestry demonstration plots that show the conservation of ecosystems and natural resources. Over 936 farmers now apply individual innovations on farm plots. Over 234 hectares of degraded areas have been reforested and rehabilitated with the planting of fruit and timber trees in upper watershed areas. Farmers practice rotational sequential intercropping of vegetables and short-term food crops (tomatoes, cabbage, onions, red beans, ginger, pumpkins, cucumber) in fruit mixed tree orchards (mango, ackee, pimento, coconut, coffee, cocoa, etc.). Fruit-based home gardens: demonstrating improving yield quality with the introduction of new valuable fruit trees and food crop species. Beekeeping is a part of this system. Windbreaks and other line plantings with fruit and/or timber trees in farm boundaries is practiced in addition to shaded coffee and shaded cocoa. Fodder banks act as substitutes for purchased feedstuff for small domestic animals

5.2.1.2 FRUIT AGROFORESTRY TRAINING IN JAMES HILL BRINGS AGROPROCESSING OPPORTUNITIES

The James Hill Farming group in Clarendon, trained by JaREEACH in agroforestry best practices, are now reaping the fruits of their labour. The agroforestry farmer field school provided them with guava seedlings that have grown into mature fruit trees. The successful group have gone into agro processing to produce jams, jellies, and purees from guava. They have already produced several batches. They are seeking to expand to process the guava fruits into natural juice to supply the schools and shops within the community.

5.2.1.3 GOLDEN VALLEY APICULTURE GROUP IN EASTERN JAMAICA TASTE SWEET SUCCESS

The St. Thomas-based female led group, consists of 10 members, seven women and three men above 45 years of age is one of the most successful agroforestry groups to date. The Golden Valley farming group began with a starter unit of 13 hives and tree seedlings. The group now has a colony of well over 60 bee hives. The tree seedlings, most which have reached maturity, facilitate pollination and provide a ready food source for the bees. This mode of agroforestry balances livelihood protection and environmental preservation as the trees aid in mitigating against climate change. The group has its own brand for their products. Their operations, benefit more than 100 households in the community. The group have started a revolving livestock project from proceeds of the sale of honey. Four members have received 100 baby chicks and eight bags of starter rations while another member has received a goat.

5.2.1.4 SWIFT RIVER WATERSHED, PORTLAND

Communities in the Swift River Watershed have participated in a livelihood expansion programme with 21 farmers across communities receiving beekeeping equipment (ACDI-VOCA, 2017). This project is being executed under the JaREEACH in collaboration with the College of Agriculture Science and Education (CASE) and RADA. Four agriculture learning plots have been established in watershed communities and at CASE to support hands on training of farmers and approximately 100 students. The community groups have harvested 52 litres of honey and established 14 acres of breadfruit. This initiative is expected to transform the watershed communities into a honey hub. Bees, fruit and timber trees are to be provided to the programme to ensure continued preservation and protection of the ecosystem.

5.2.2 CHALLENGES AND FUTURE CONSIDERATIONS

Despite success they still face droughts and the onset of the rainy season. However rearing livestock is expected to offset any fallout in the beekeeping due to bad weather.

5.2.3 OPPORTUNITIES

These case studies demonstrate the potential of integrating beekeeping in agroforestry systems with value added products as an incentive for women and youth engagement. The ecosystem services provided would include a diversity of nectar sources in the system to support honey and pollen production. Another activity that could be considered would by the production of local bees wax for the industry due to the limited availability of this resource.

5.2.4 FORESTRY DEPARTMENT AGROFORESTRY INITIATIVES

5.2.4.1 YALLAHS/HOPE RIVER WATERSHED MANAGEMENT AREA

Integrated management of the Yallahs Hope River Watershed Management Area involves agroforestry on private lands and re-afforestation on Government lands. The objective of this project is to reduce pressure on natural resources in the Yallahs River and Hope River Watersheds of the Blue Mountains by increasing the practice of sustainable land management (SLM) resulting in improved management of Biological Diversity and enhanced flow of ecosystem services that sustain local livelihoods.

5.2.4.2 RIO GRANDE WATER SHED, PORTLAND

The communities of Bellevue, Moore Town and Cornwall Barracks, Jamaica, are home to about 2,000 people. A significant percentage of the population consists of self-employed farmers, followed in number by traders, carvers and rafters. The farmers' livelihoods depend upon a form of hillside farming that both contributes significantly to erosion and is greatly threatened by it. The traders (*higglers*) are mostly female and deal mostly in cash crops acquired from the small farmers—making them equally as vulnerable.

The local ecosystem is naturally lush and forested, and prone to heavy annual rainfall. Because storms and prevailing winds generally approach from the east, the Portland region is exceptionally vulnerable to devastation by tropical storms or hurricanes. The Rio Grande Watershed is particularly susceptible to flooding and landslides as a result of its topography and fast flowing rivers. Due to population growth and increased hillside farming, more and more trees have been removed, and wind and water have increased soil erosion rates.

Land degradation and biodiversity are both threatened by poor farming practices and deforestation. The poor practices such as the methods used to prepare land for planting result in the unnecessary removal of native vegetation and the exposure of the soil to the elements. This has resulted in the loss of native flora and the related loss of native fauna as result of habitat loss. It has also resulted in a loss of soil fertility, the erosion of soil and reduced water quality within the Rio Grande watershed.

This **Community-Based Adaptation** project will benefit the communities within the watershed by allowing them to farm sustainably, reducing erosion and landslides while increasing water quality. Reforestation projects, crop diversification pilots, and farming best practices workshops/demonstrations will all be carried out with farmers and community members. The incorporation of cover crops and conservation tillage will serve to not only mitigate against climate change impacts but also to reduce the vulnerability of farms in the target area to the risks associated with climate change. An education program will allow the community to become more knowledgeable about its surrounding environment, how climate change is affecting it, and how to prevent damage. Because this is a watershed enhancement project, anyone who uses the roads, water, or depends on agricultural goods produced in this area will benefit.

5.2.5 JOAM LAUNCHES ENVIRONMENTAL FOUNDATION OF JAMAICA (EFJ) FUNDED AGROFORESTRY AND BEEKEEPING PROJECT

The project will fund the planting of nectar bearing species following organic principles, provide beekeeping equipment and train beekeepers in climate smart natural beekeeping. The project started in July 2017 and will end in June 2020. The project will be conducted in the parishes of St. Thomas and Portland

5.2.6 DESCRIPTION OF THE AGROECOLOGY SYSTEM

Woodford (pop. 1 800) and Cascade (pop. 800) are primarily banana and coffee growing communities located near the Holywell Recreation Area in the Blue and John Crow Mountains

National Park (BJCMNP), Jamaica. Cash crops are cultivated on steep slopes, often using unsustainable agricultural practices such as slash and burn. These communities are already at risk from soil degradation, but with climate change, there is likely to be an increase in erosion and landslides. More rainfall of high intensity is expected to fall, increases in severe weather are projected, and longer and more intense periods of drought will make soils more susceptible to increasing erosion pressures. Increasing temperatures and reduced rainfall – driven by climate change and exacerbated locally by unsustainable land management practices that alter the local microclimate are now, and are projected to continue to reduce the cool and moist microclimate that favours cool-adapted crops, particularly coffee.

Based on this threat, there is concern that climate change may lead farmers (particularly coffee farmers) to move further up the mountains seeking the cool, misty conditions that favour Blue Mountain Coffee and other crops. Agricultural encroachment is an existing pressure on the National Park, and baseline measures are not likely to be sufficient in preventing further encroachment when additional climate change pressures are taken into account. Farms already border the Blue and John Crow Mountains National Park/Forest Reserve. Any upward movement of the farms will encroach upon this protected area, which is of international significance for its biological diversity.

This **Community-Based Adaptation** project aimed to increase communities' capacity to adapt their agricultural systems to climate change. Communities benefitted from more sustainable agricultural practices through improved productivity as well as reduced vulnerability to climate change impacts, particularly increased soil erosion. Best practices were highlighted for replication in surrounding communities, nationally, and through global adaptation knowledge platforms.

5.2.6.1 OUTCOME FROM THE PROJECT

- Increased capacity for applying soil conservation techniques in steep slope environments in cost-effective soil conservation methods.
- forest and tree cover promoted on vulnerable slopes
- tree planting on degraded land within and outside Park
- farmers practicing agro-forestry

5.3 INTEGRATED CROP /AQUACULTURE SYSTEMS

5.3.1 CASE STUDY 4 AQUAPONICS/INTEGRATED CROP AQUACULTURE SYSTEMS

INMED has been working to improve the health, education, safety and opportunities of Jamaica's most vulnerable citizens through adaptive agriculture, school gardening, climate change adaptation, nutrition education, positive youth development and teacher training programs since 2002. Tanesha Wallace is one of the many interested farmers who will be participating in the program. For the past year, she has been experimenting with a home aquaponics system comprising a plastic bin of catfish and four shelves of vegetable plantings. It has been a labour of love, but it hasn't been promising as a source of income—that is, until she learned of INMED's new program in Jamaica. As one of the program's first participants, Tanesha and other budding entrepreneurs will learn the many advantages of aquaponics for improving food security; adapting to climate change; providing greater access to fresh, nutritious and local food; protecting the environment; and bolstering community development.

5.3.1.1 DESCRIPTION OF THE AGROECOSYSTEM

Aquaponics is an innovative food production technique that combines aquaculture (fish farming) with hydroponics (soilless crop production in water) in a closed symbiotic system. Advantages of aquaponics include crop production at least 10 times higher than traditionally farmed plots of equivalent size, 85 percent to 90 percent less water consumption than traditional irrigation, low energy consumption, year-round crop production and flood and drought resilience.

5.3.1.2 OUTCOMES FROM THE PROJECT

An analysis of the following agroecological system attributes, Productivity-Efficiency; Diversity; Maturity; and Aquaculture Integration of crop aquaculture integrated systems based on nitrogen flows, in order to determine the level of sustainability of the system. This project will result not only in the improvement the water quality of aquaculture effluent, but also maximises the use of the resources involved in fish and vegetable production.

5.3.1.3 CHALLENGES AND FUTURE CONSIDERATIONS

- Ensuring that the nutrients produced by the fish are bioavailable to the plants. This issue is related to the nitrification by bacteria,
- Ensuring that the plants grown are commercially viable

5.3.1.4 OPPORTUNITIES

Leafy greens and herbs are recommended in lower-nutrient systems. Because Jamaica already has a greenhouse/hydroponic industry, there is an established market for vegetables and herbs produced in this way.

Aquaponic science has resource efficiency at its heart. Water, nutrients, human capital, and energy inputs are all used to create more products than separate plant and fish growth would on their own. In the case of water, the resource is used repeatedly since multiple plant and fish crops can be grown in the same water.

In terms of s resource efficiency, aquaponics can make a contribution to the important field of nitrogen management.

Table 5.1 Summarizes the case studies presented in this document.

Table 5.1 Summary of Case Studies Based on the FAO 10 elements of agroecology

Case Study	Description of agroecological system	Opportunities for involvement of women and youth
INTEGRATED DIVERSIFIED ORGANIC FARMING SYSTEM ROWAN'S ROYALE	**Diversity; Nutrient conservation and recycling; Agroforestry; Water conservation and recycling Soil conservation**	Yes
DURGA'S DEN FARM	**Diversity; Cocreation of knowledge; Water conservation and recycling**	Yes
SOURCE FARM FOUNDATION AND ECOVILLAGE	**Diversity; Cocreation of knowledge; circular economy**	Yes
JEFFEREY TOWN FARMERS	**Diversity: Efficiency Human and Social Value; Cocreation of knowledge; Circular economy;**	Yes

ASSOCIATION	**Social Land and resource governance**	
JA REACH ADAPTING TO CLIMATE CHANGE PROJECT	**Diversity: Efficiency Human and Social Value; Cocreation of knowledge; Circular economy; Social Land and resource governance**	Yes
JOAM AGROFORESTRY AND BEEKEEPING PROJECT	**Diversity: Efficiency Human and Social Value; Cocreation of knowledge; Circular economy; Social Land and resource governance**	Yes
AQUAPONICS PROJECT	**Diversity: Recycling and Synergies: Efficiency**	yes

6 RECOMMENDATIONS

In Jamaica the negative impacts of natural phenomenon are clearly seen with increased flooding events and extended dry seasons affecting the quality of life in several vulnerable communities. Hence the call to consolidate the evidence base in Jamaica for the benefits of the transformation of agriculture production and food systems where applicable based on agroecological principles.

Mainstreaming agroecology will therefore require a fundamental cultural and philosophical shift in how we as a society define 'productive' and 'efficient' agriculture. In recent times agroecology has begun to be promoted in both developed and developing countries by non-government organisations, international development organisations and others seeking more sustainable food production and consumption systems. Though difficult to quantify in Jamaica, there is some growing body of anecdotal evidence and small-scale studies that have highlighted the environmental and social benefits that agroecological practices can bring.

There are strategies for diversification at the farm and community level that can be more widely implemented in Jamaica. Crop and livestock diversification and synergies can enhance the resiliency of agroecosystems and protect farmer livelihoods in several ways including providing diverse sources of food and income thus enabling communities to recover from external shocks.

The agroecological strategy for Jamaican agriculture systems must be such that enhances climate resilience in communities as this is one of the most critical areas for development. Hence farming communities must be encouraged to integrate where applicable agroecological principles into their food and production systems.

Such systems must be managed by well-organized social networks which are critical in enhancing a farmer's capacity for response to external shocks. In building reactive capacity there is need to work with farmers knowledge, their management skills their access to resources and diversity of enterprises.

6.1 WOMEN & YOUTH ENGAGEMENT

According to a study on small scale farming in the Caribbean (Graham, 2012) it was stated that with regard to gender issues and education, that the data showed that females entered the farming system around age 30 to35 doing tasks such as weeding, harvesting and marketing though males were dominant in marketing. The median age of female land holders was 55 years. However, it was noted that the data recognized only one holder in the farm family unless joint ownership expressed, hence the female counterpart may not always be recorded as a holder.

In Jamaica rural young people are involved in farming as early as age 15 years, however when the data from RADA ABIS is examined generally youth of both genders under the age of 25 years are not registered as farmers.

The engagement of rural youth in agricultural systems more than women continues to be a challenge for sustainability. The youth are bombarded daily by poor images of the agriculture profession, as in most cases farm income alone is insufficient to provide for all the needs of the family hence external sources must be found to make ends meet. This would threaten family farming due to the lack of succession. The apparent average age of farmers in Jamaica still remains above 45 years is increasing while pressures such as; price competition from commercial farming, high entry barriers for new farmers, negative social stigma surrounding the profession, and rural exodus, among other factors, erode the pool of eager young farmers willing and able to replace their older counterparts. There is the concern that to date the sub-region has provided no positive indicators, sufficient to attract the desirable level of participation of youth in farm activities.

Farming is seen as a labour-intensive activity especially if you are a small farmer with limited access to technologies that improve efficiency and output of the system. Limited access to suitable land is a deterrent to youth. Those who still venture into farming in this category will face several challenges with land tenure and will not be able to engage in farming activities that are sustainably managed. It must be noted that every production sector requires a capital investment. The high cost of inputs such as feed in the case of livestock, fertilizers and other chemical inputs plays a big part in the requirement of substantial capital to practice farming commercially. Based on this, most youths find it difficult to raise the funds needed to start even when the interest is there. However, youth engagement would need the formation of environmental clubs for unemployed youth to learn about conservation management, the 4H clubs could also be possible outlets. Community training centres would be a good avenue to engage youth. The case study of Jefferey Town with the radio station and computer centre has worked in youth engagement in their community.

According to Ishemo and Bushell (2017) most women immigrants came to the Caribbean to be plantation workers, not housewives, and their labour contributed to the development of the European industrial capital. In addition to their position as peasant farmers, women have continued to play an important role in the agrarian labour force, as they did in the days of slavery. The majority of women farmers, and by extension in rural Jamaica, have received formal education and can read and write (Ishemo, A and Bushell, 2017).

Jamaican women have maintained their dominance in the market place through higglering i.e. the buying and selling of agricultural produce. The sustainability of small-scale farming cannot be realized without this dynamic marketing network of women higglers. While higglering is a significant activity in the agricultural sector, it is still regarded as low status. With this social stigma attached, many of the women involved are those who are struggling to improve their livelihood, with hopes of achieving a sense of independence. The current reality is that all women farmers in Jamaica view farming as an extension of their domestic responsibilities. They concentrate mainly on subsistence production of food crops, and small-scale farming remains the main source of income for the majority of the rural women (Ishemo, A and Bushell, 2017). However, from the Ishemo and Bushell (2017) study, Jamaican women farmers who were interviewed stated that they couldn’t make a living with just farming, many have had to hold down other employment to help support their families. The issue of sustaining income from farming, and just as importantly, sustaining production for domestic consumption was highlighted by the women.

Another important issue pointed out by the women farmers was the lack of accessibility of prime farmlands, particularly to flat lands closer to road networks. In fact, most of these women farmers have family land, but most are located in the hilly interior, isolated and hard to accommodate profitable farming activity. However, several opportunities from case studies were identified for women and youth engagement which satisfied to some degree the ten tenets of FAO’s agroecological principles.

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