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Value Chain market Assessment

for each priority Area identified in the Resilient Rural Belize (RRB) Program

Product 3.5 Value Chain and Market Assessment of Carrot Production in Belize

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VALUE CHAIN AND MARKET ASSESSMENT OF CARROT PRODUCTION IN BELIZE

Conduct of Value Chain and Market Assessments for Resilient Rural Belize

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List of Acronyms and Abbreviations

BAHA	Belize Agricultural Health Authority
BBS	Belize Bureau of Standards
CATIE	Tropical Agriculture Research and Higher Education Center
CVA	Climate Vulnerability Assessment
DFC	Development Finance Corporation
FAO	Food and Agriculture Organization of the United Nations
GCF	Green Climate Fund
GOB	Government of Belize
IFAD	International Fund for Agriculture Development
MAFE	Ministry of Agriculture, Food Security and Enterprises
PCB	Pesticide Control Board
RRB	Resilient Rural Belize
SIB	Statistical Institute of Belize
VCMA	Value Chain and Market Assessment

Executive Summary

Belize is a small tropical country with relative abundance in natural resources such as land and water. It is classified as a Small Island Developing State (SIDS) because it is threatened by many impacts of Climate Change, specifically in rural areas which accommodate 54.3% of the country's population. The agricultural sector in Belize is also impacted by Climate Change as it is a major pillar of Belize's economy. This can be seen in small-scale farming focused on the vegetable production and other non-traditional crops. These climate challenges along with poor market access, poor infrastructure (such as roads) and underdeveloped production systems have rendered small scale farmers unproductive or with sub-standard produce.

To alleviate the climate induced and productivity limitations faced by small scale farmers and to strengthen food security, economic development, and reduce poverty, the Government of Belize (GOB) sought assistance from the International Fund for Agricultural Development (IFAD) to develop a program entitled "Resilient Rural Belize" (RRB) Programme. The RRB Program contracted the Tropical Agriculture Research and Higher Education Center (CATIE) to conduct a value chain analysis and market assessment, focusing on eight preselected commodities: sweet pepper, tomato, carrot, hot pepper, pineapple, cabbage, onion, and honey products. The analysis will guide interventions across and within the various value chains.

This study focuses on the structure and function of the Carrot Value Chain in Belize at the national level, examining all linkages between the actors. It identifies opportunities for strengthening horizontal and vertical linkages within the value chain, identifies end markets and makes recommendations for value chain upgrading strategies including improved production and quality of carrot.

The estimated five-year production average (2016 to 2020) of carrot in Belize is 1,154,966 pounds valued at BZ $1,732,449. Currently, the carrot processing market is unknown at this point as no concrete data has been recorded or obtained. However, it is known that carrot is utilized in the local production of hot peppers sauces. Additionally, carrots are also imported for hot sauce production due to high demand. The main consumers of fresh fruit carrot in Belize are households, restaurants, hotels, and fast-food establishments. Carrot is also processed in the production of hot peppers by Marie Sharps Fine Food Limited.

Carrot is grown primarily in the northern and western districts of the country. The Cayo District is the leading producer of carrot followed by the Stann Creek, Orange Walk and Corozal Districts. In all the districts, the main producers of carrot are members of cooperatives.

The Ministry of Agriculture, Food Security and Enterprises includes in its policy support and prioritization of vegetable production as part of the larger agricultural strategy to conduct import substitution.

Technical and financial services are provided by supporters and service providers along the value chain. Most farmers do not use financial institutions for financial assistance because they do not have the sufficient collateral (ie, land) as is required by these financial institutions.

The strengthening of the Carrot Value Chain requires the strengthening of the cooperatives as they are one of the main producers of carrot. All farmers require knowledge of good agricultural practices, which include the use of appropriate seed varieties, good land preparation, integrated pest management, rational use of agrochemicals, water conservation through efficient use of irrigation systems, post-harvest technology, processing, and others. It is also important for farmers to have the knowledge to farm as a business. In many instances during the study, it was noted that farmers did not have records of production costs or of operational revenue success or failure..

1. Introduction

Belize is a coastal tropical country which lies on the north-eastern coast of Central America, making it suitable for the cultivation of various horticultural crops. The United Nations has designated Belize as a Small Island Developing State (SIDS) because it has been greatly affected from vulnerabilities and threats like those of Small Island Developing States (SIDS). Impacts from threats such as Climate Change to Belize's agricultural sectors have prompted the adoption of many strategies, such as Climate Smart Agriculture (CSA), which is based in rural areas of Belize and affects the livelihoods of those involved in its agriculture sector.

Agriculture is extremely important to Belize's development. It provides employment, foreign exchange earnings, and is key to food and nutrition security. Approximately 172,000 hectares (7.48 percent) of Belize's total land area is suitable for agricultural use. An estimated 122,000 hectares (5.31percent) of Belize's total land area is cultivated land (FAOSTAT, 2019). The agricultural sector employs an estimated 12.24 percent of the total population of Belize, with an estimated 5.2 percent being female(FAOSTAT 2019). Primary industries in Belize include sugar, banana and citrus products, which are known to be the highest agricultural income earners. In 2020, the highest contributors to the agricultural economic output in Belize was the non-traditional sector, with grains and legumes being the highest contributor (MAFSE, 2021). The Gross Domestic Product per capita (constant) in 2019 was BZ$ 7066.09 with the agriculture sector accounting for 8.2 percent (SIB, 2021).

The Agriculture Output Value (at Producer's Price) for fruits and vegetables in Belize has been on a fluctuating downward trend; notably, the decrease from 2016 to 2020 is 27 percent (SIB, 2021). In 2019, the dominant commodities in the vegetables, roots & tubers category based on economic value were sweet pepper, Irish potato, tomatoes, plantain (bunches), cabbage, onion, and hot peppers ranking from first to seventh places, respectively (MAFSE, 2019). The Cayo District is the leading producer of carrot, followed by the Stann Creek, Orange Walk, and Corozal Districts. There is no previous study recorded on the value chain analysis and market assessment of carrot in Belize. Given the dynamics of the carrot industry and the imports that are almost similar in volume to the national production, the Ministry of Agriculture, Food Security and Enterprises has sought the assistance of local and international partners to strengthen the value chain of carrot in Belize and by extension, improve the social and economic situation of small-scale local farmers and improving food security in Belize.

This Value Chain Analysis and Market Assessment (VCMA) for carrot (*Daucus carota*) in Belize is being conducted by the Tropical Agriculture Research and Higher Education Center (CATIE) in collaboration with the International Fund for Agriculture and Development (IFAD), the Green Climate Fund (GCF) and the GOB through the Resilient Rural Belize (RRB) Programme. Although the value chain will be studied at a national level, the priority areas of the assessment are the Orange Walk and Corozal Districts, specifically focusing on the village of San Carlos and Indian Church (Orange Walk District) and Patchakan, Xiabe and Conception (Corozal District). The objectives of this VCMA are to (i) map and describe the Carrot Value Chain, including the role and relationships between the different actors (producers, transporters, packers, processors, traders, retailers, and consumers) in the value chain; (ii) discuss market potential; (iii) identify challenges and opportunities for the Carrot Value Chain; and (iii) identify and recommend adequate policy interventions based on findings to strengthen the Carrot Value Chain in Belize.

2. Methodology

The Value Chain Market Assessment (VCMA) for Carrot is presented in four phases as described by CATIE (CATIE, 2020). The details of the methods used are as follows:

2.1 Description of the Study Area

The target area for this VCMA was preselected by the Resilient Rural Belize (Belize) Project when the consultancy was initiated. The target area in the Orange Walk and Corozal Districts is home to the main Carrot producers. Table 1 lists the villages included in the target areas.

Table 1. Population of the Target Villages in the Corozal, Cayo and Orange Walk Districts, 2010

Villages Population and Number of Households, 2010				
Village	**Total**	**Males**	**Females**	**No. of HH**
San Carlos	138	74	64	29
Indian Church	267	129	138	67
Patchakan	1,374	693	681	281
Xaibe	1,575	820	755	335
Concepcion	1,256	613	643	257
San Antonio	1,847	933	914	381
Seven Miles	483	252	231	96

(Source: SIB, 2020)

2.2 Data Collection

Collection of current and relevant data was done in two steps: Collection of secondary data through desk research; Collection of primary data using targeted interviews.

Collection of secondary data through desk research

There is no pre-existing value chain analysis for carrot in the country. Raw data and information about supplies, production, transformation, and marketing were accessed from various government departments such as the Ministry of Agriculture, Food Security and Enterprises (MOA), the Belize Agricultural Health Authority (BAHA), the Statistical Institute of Belize (SIB), Belize Bureau of Standards (BBS), Resilient Rural Belize (RRB) Project personnel, Marie Sharp's Fine Foods Limited and the online portal of the Food and Agricultural Organization (FAOSTAT). Research and studies published on carrot production within the last five years in other countries

were targeted to identify innovations and technologies that could strengthen the carrot value chain in Belize. Other sought out information included carrot market trends, Carrot cultivation across Belize, quality standards, production restrictions and/or product marketing. The main actors in the value chain and relationships between the actors were also identified. The output of the desk research was an initial value chain map.

Collection of Data through Primary Research

Major players in and outside the value chain were identified based on the preliminary value chain map developed from findings from the desk research. Personal interviews were carried out while following COVID-19 regulations. Electronic and telephone communications were also carried out.

- Personal Interviews: Face-to-face interviews were conducted with leading farmers of cooperatives and field visits were scheduled to have an idea of the farming operations. Extension Officers from the Department of Agriculture, the Cooperative Department and Resilient Rural Belize were interviewed. A visit to the town/city market also initiated interviews with vendors/retailers. These interviews allowed the consultant to have a better understanding of how carrot is grown, processed, and marketed, while also gaining knowledge about labour requirements, sources that supply raw materials, buy and sell prices, annual fluctuations in demand, sources of financing and contractual relationships with clients.

- Telephone Interviews: telephone interviews were carried with persons that could not accommodate a personal interview. The collectors and intermediaries that collect or purchase fruit from the major villages in most cases refused to collaborate and provide information.

- Electronic Interviews: electronic interviews were done with persons that could not accommodate a personal interview. Three of the major agrochemical suppliers were contacted via email and they provided information mainly on agrochemicals they supply to the carrot growers. They requested that their information remain confidential.

Limitations of the Study

While farmers were willing to cooperate in the study, they had limited records of their production costs and yields; therefore, it was a challenge to verify whether they operated at a profit or a loss. Consequently, this study depended mainly on the national statistics provided by the Ministry of Agriculture, Food Security and Enterprise (MAFSE) to the Statistical Institute of Belize (SIB).

The accuracy of the national statistics presented to the value chain actors at the workshops was queried. However, this study utilized the data from the MAFSE and the SIB as they provide the only national data available.

Validation of Value Chain Map by Stakeholders

To validate the data and information collected during the desk and primary research, a workshop was carried out in San Carlos and Concepcion Villages with actors from different levels of the value chain. These actors included input suppliers, producers, intermediaries, and technical officers from the government departments and NGO's.

The Objectives of the workshop were:

- Present the results of the Value Chain and Market Analysis for Carrot to stakeholders.
- Validate the results.
- Identify and prioritize potential value chain production, processing, and marketing efficiency improvements benefiting smallholders, women, and other actors along the value chain.

The VCMA workshop consisted of the presentation of the carrot VCMA and group work to identify and prioritize needs that will help to improve or strengthen the value chain. Figure 1 shows training, technical assistance, finances, improved seeds, marketing, and infrastructure are combined priorities for this crop. Farmers have gained some experience in growing carrots, but multiple local market requirements around technical assistance and post-harvest storage facilities prove difficult to meet. In general, the local market prefers the imported carrots.

At the VCMA workshop, a presentation of the carrot VCMA was conducted using historical data collected by the Ministry of Agriculture and from information gathered from farmers, input suppliers and other focus groups. Participants were invited to validate the research findings and the VC map presented by the consultants through a group activity which allowed them to identify and prioritize needs that will help improve and strengthen the value chain.

As shown in Table 2, a double prioritization matrix was used with the participants to prioritize the problems and challenges previously identified by the consultants that were validated early in the workshop. As many as six major challenges and problems were identified and prioritized. Five of the six problems were given the same level of importance;only Purchase of Inputs was not prioritized by participants.

Table 2. Carrot VCMA double entry matrix with priorities derived by workshop participants

Problems	Finances	Input purchase	Training and TA	Improved seed	Infrastructure	Marketing
Finances		Finances	Training	Finances	Finances	Marketing
Input purchase			Training	Imp seeds	Infrastructure	Marketing
Training and TA				Imp Seeds	Infrastructure	Training
Improved Seed					Imp Seeds	Marketing
Infrastructure						Infrastructure
Marketing						

Finalization of the Report

After every validation workshop, meetings were held with the Lead Value Chain Consultant from CATIE, Local Consultants and the Agriculture Marketing Officer from the RRB Programme. During these meetings, further recommendations were made to improve the final report and to meet its objectives.

Value Chain and Climate Vulnerability Assessment Synchronization

The validation workshop of the VCMA was carried out together with the CVA. Major concern for climate change was expressed by most farmers during the CVA workshop through a focus on unexpected draughts throughout the year. These have affected the product size and post-harvest capacities of the product. In the north the majority of the carrot fields are irrigated but have a rudimentary system, leading to farmers expressing interest in learning about irrigation practices that will contribute to better production year-round. Flooding was not ranked as a major concern as their occurrence is not frequent.

Synchronization of the CVA and VCMA consultations produced a new section in this report that is not traditionally included in VCMA studies. Section 8 in this report shows findings concerning the suitability and climate adequacy changes projected on two scenarios.

3. History of Carrot Value Chain in Belize

Carrot is produced in five districts in Belize with the Cayo District being the largest producer (Figure 2), followed by the Stann Creek, Orange Walk and Corozal Districts (SIB, 2021). The production trend for the Cayo District has been showing and increase in production since 2018. Marie Sharp's Fine Foods Limited is the main processor in the Stann Creek District for the processing of Hot Pepper sauce and consumes carrots within the process from both local and imported sources. Carrot varieties grown in Belize include Fortado, Chike Improved, Coral, Bangor and Orange Glory F1. The carrot variety of preference grown in Belize is Coral, followed by Orange Glory and Bangor.

3.1 Carrot Production in Belize

The production trends in the other districts show consistant production amounts. The Covid 19 pandemic (2020-present) did not seem to have a drastic effect in production of Carrots for most districts.

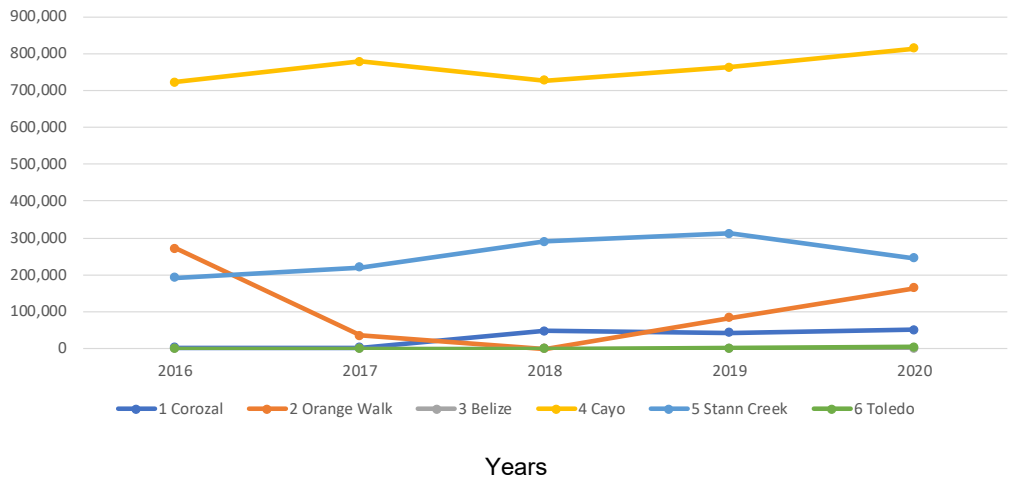


Figure 1. Total Annual Production of Carrot in Belize from 2016 to 2020

The average annual yield of carrot is 9,084 pounds per acre based on a five-year period (2016 to 2020) (Table 3). The average consumption of carrots for the same time is estimated at 2,228,709 pounds per year.

Locally, fresh carrot is targeted for i) household use, ii) tourism industry, primarily for the food suppliers in local restaurants and hotels, and iii) the processing of hot pepper sauces. Of the total consumption of carrot, which includes the total amount of carrot produced and imported, 19

percent or 420,000 pounds is processed annually for hot pepper sauce production (personal communication with Marie Sharp's Fine Food Limited).

Farmers sell the majority of their fresh produce by pound to an intermediary supplier (Collector) who resells or distributes to retailers such as market vendors. Some farmers sell directly to retailers or directly to consumers, such as large upscale restaurants and processors.

Table 3. Annual Yield of Carrot (lbs.) per District in Belize (2016 to 2020)

District	Annual Yield of Carrot per District (Lbs/acre)				
l	2016	2017	2018	2019	2020
Corozal	1,250	1,400	12,000	14,500	9,085
Orange Walk	16,000	12,000	0	14,083	15,421
Belize	0	0	0	0	0
Cayo	9,141	9,500	7,819	9,414	10,043
Stann Creek	14,769	20,000	17,097	13,562	13,598
Toledo	na	na	na	3,000	3,423

Source: SIB
na: not available

There are two production cycles of carrots in the country for farmers growing in the open field and with irrigation systems. The first production cycle is from September to December and the second is from January to March. Importations are usually in the months of August to October.

3.2 Carrot Demand in Belize

An estimated average of 2,228,709 pounds of carrots was consumed annually in Belize (five-year average from 2016 to 2020). Table 4 and Figure 2 show the total consumption of fresh carrots in Belize from 2016 to 2020. The estimated weekly consumption of carrots in Belize is 43,000 pounds per week. Over the same time period, an estimated 1,073,743 pounds of carrots were imported annually. This is comparable to the 1,154,966 pounds carrots produced locally over the same time period (2016 to 2020).

Table 4. Annual Consumption of Fresh Carrot in Belize (2016 to 2020

Year	Pounds (Lbs) of Carrot/Year			
	Consumption	Production	Imports	Illegal entry
2016	2808,002	1188,650	1619,352	0
2017	2133,610	1037,800	1095,810	0
2018	1976,873	1065,857	911,016	0
2019	2145,546	1203,929	941,617	0
2020	2079,516	1278,595	800,921	0

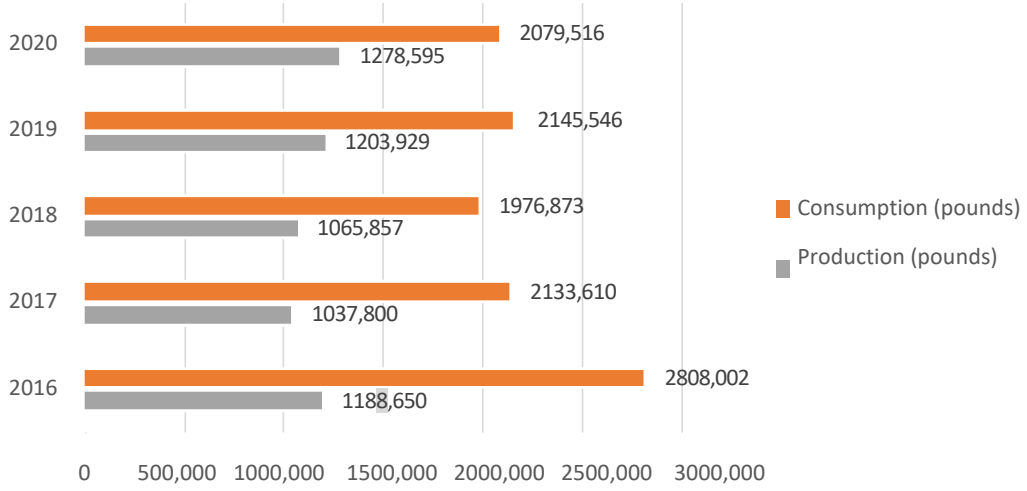


Figure 2. Annual Carrot Production and Consumption (pounds) in Belize 2016 to 2021

3.3 Quality Standards of Carrot Production in Belize

The Belize Bureau of Standards is tasked with developing, establishing, harmonizing, and promoting the use of relevant quality standards for key economic sectors and national development. By extension, developing standards for the agricultural sector is pertinent to the eight value chains identified under the IFAD RRB Programme. This provides an opportunity to revise and introduce standards for the agricultural sector.

To date, there are no established national or CARICOM regional standards for carrots. In an effort to establish a level playing field, it will be useful to ensure that standards and other elements for Quality Systems[1] are introduced and applied in all aspects of the carrots value chain.

Notwithstanding the absence of national or regional standards for carrots, relevant standards will be developed to serve as the basis from which to draw national requirements that meet the needs of the Belizean market, namely those requirements relating to fresh carrots that are included in the requirements of other relevant export markets of interest.

Currently there exists a challenge where individual farmers apply their own company/farmer requirements which may not include any standards.This creates inconsistency in size classification and seed selection criteria and results in the inability to meet processors requirements on pesticide management, agronomic practices such as land management, distinction in quality to imported carrots, among others. This emphasizes the need to ensure that standards and quality systems are embedded in the carrots value chain at all levels, thereby improving efficiencies and competitiveness as well as ensuring that the buyers and sellers needs are fulfilled. Aside from serving national needs, the application of national standards for carrots will create export opportunities for this fresh produce.

Quality Systems are made up of high-level institutions providing services in standardization, metrology (such as calibration), conformity assessment (such as inspection, testing, and certification) and accreditation to ensure that products and services meet the requirements of customers as well as pursuing other objectives such as industrial development, trade competitiveness in markets of interest, food safety, health, the environment, climate change, among others.

4. Value Chain Mapping

The Carrot Value Chain in Belize consists of input suppliers, producers, intermediaries (Collectors), processor, retailers, importers, and consumers. Other actors are classified as supporter and enablers, who provide financial and technical services or provide support towards developing policies to strengthen the value chain. Presented below in Figure 3 is the map of the Carrot Value Chain in Belize.

4.1 Value Chain Map

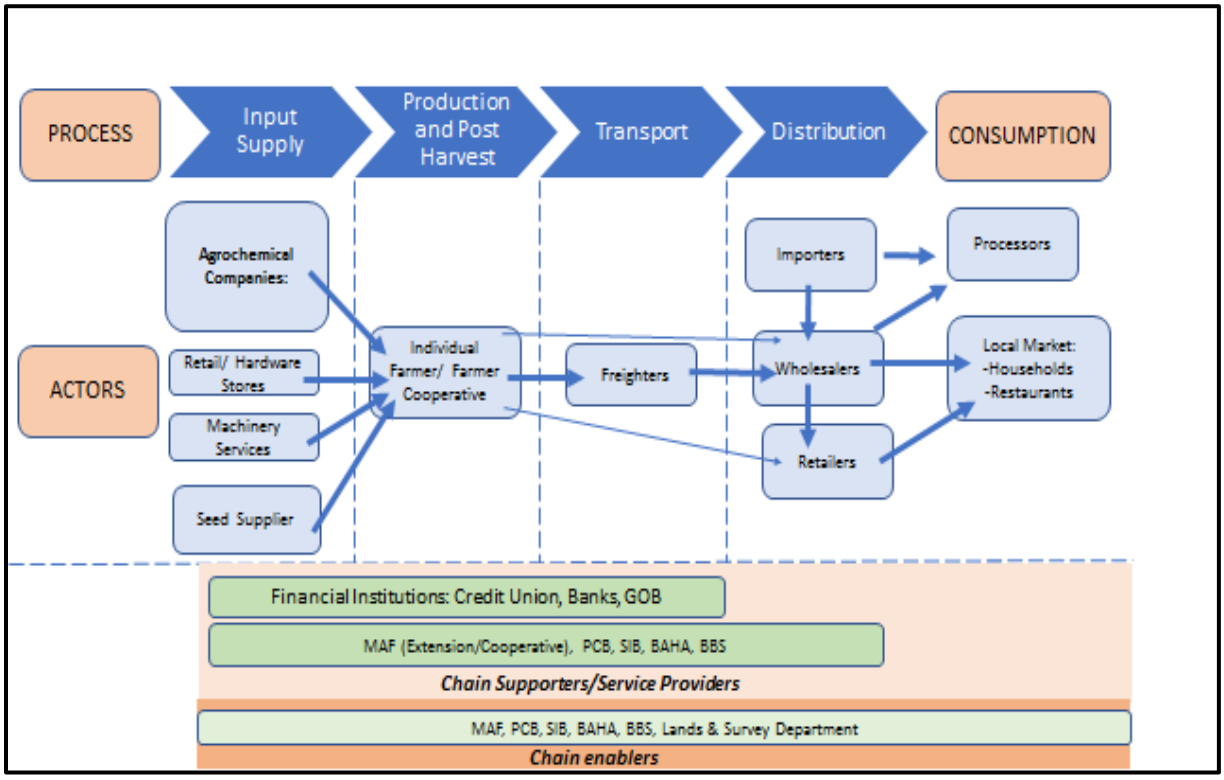


Figure 3. Value Chain Map for Carrot in Belize

4.2 Description of the Carrot Value Chain Actors and their roles

Input Suppliers

The first actors in the chain are the input suppliers. These consist mainly of the agrochemical and seeds suppliers, machinery services providers, farm equipment companies, fuel service stations, and hardware stores. The main agrochemical suppliers in the Orange Walk and Corozal Districts

for carrots are Bel-Agro Enterprise, Prosser Fertilizer and Agrotec Company Ltd. and Circle R Limited.

The main agrochemical suppliers in the Orange Walk and Corozal Districts are:

- Bel-Agro Enterprise: Is the largest Fertilizer and Agro-Chemical supplier in Belize supporting the agricultural sector with fertilizers and agricultural chemicals. The Company represents the most renowned global agricultural manufacturers. As a procurement and distribution Company in goods and services they are committed to ensuring that all orders received are handled in a competent and professional manner, thus ensuring successful final delivery and best practical uses of the product. It´s important to say that Bel-Agro mentions on its website that there is a woman in its main team, who manages Inventory Management (BELAGRO, 2022).

- Prosser Fertilizer and Agrotec Company Ltd.: It is a commerce that sells Fertilizers, Insecticides, Fungicides, Weed Killers, Sprayers, Seeds, Swimming Pool Supplies, Water Tanks, Veterinary Products, Lubricants and Tires (Findyello, 2022).

- Circle R Limited.: It is a cooperative that provide customers with outstanding products and services for your farm, mill, or family. For more than 25 years Circle R Products has gone the extra mile to provide its customers with excellent products and services. Whether you're running a farm, a mill or a family, Circle R Products stands on the foundational promise "done right" (Circle R Products, 2022).

Producers/Farmers

In the Carrot Value Chain in Belize, the main producers are in the Cayo, followed by the Stann Creek District and the Corozal Districts. Small, medium, and large-scale producers cultivate an average of 1, 2 to 3, and 5 acres, respectively.

Not all farmers are incorporated into cooperatives. For example, producers are members of cooperatives in Cayo District, but not in Stann Creek. Of the eighty-four carrot growers registered in the Cayo and Stann Creek Districts, only six are women. Women's participation was negligible in the workshops and the possibility of interviewing them was impossible. The lack of women participation in this study can have potentially been influenced by their family protective role for our society and even more influenced by the health crisis that COVID represents.

For many of these farmers, profit obtained from carrot production is not their only income source as many of them produce other crops and livestock. Many of the farmers use their family labour and other members of the cooperatives for harvesting but also use hired labour at the peak of production.

Importers

There is a major importation of fresh Carrots as the amount is almost like the national production:

- The Belize – Country Commercial Guide shows that carrots are not in the list of "Prohibited and Restricted Imports". According to the International Trade Administration, this mean that fresh carrots can be imported to Belize, but beans and rice, , like many other locally produced agricultural products, may not be imported if there is a surplus on the domestic market (2022).

  That is why the Ministry of Agriculture informed to the public that no recommendation has been given to anyone to import carrots. Harvesting for carrots started in December 2018 and is expected that farmers will supply the domestic market until June 2019 (Ministry of Agriculture, Fisheries, Forestry, the Environment, Sustainable Development and Immigration, 2019).

- Data requested from BAHA on the illegal importation/confiscation of Carrots is non-existent. No confiscations have been documented between 2016 to 2020 (BAHA, 2021).

- The Observatory of Economic Complexity (OEC, 2022) shows that Belize imported Root vegetables (carrots, turnips, beetroot, salsify, celeriac, radishes etc.) at:
  - 2020 (US$ 0.223 Millions)
  - 2019 (US$ 0.288 Millions)
  - 2018 (US$ 0.249 Millions)
  - 2017(US$ 0.241 Millions)
  - 2016 (US$ 0.261 Millions)
  - 2015 (US$ 0.228 Millions)
  - 2014 (US$ 0.280 Millions)
  - 2013 (US$ 0.255 Millions)

Intermediaries (Collectors)

Intermediaries are middlemen (mostly male) who collect and purchase carrot locally and who sometimes develop long term relationships with farmers.

In 2016, a value chain analysis at Orange Walk and Corozal Districts identified freighters. A freighter is defined as a type of middleman who plays a major role in the distribution of vagetables across the entire country. Some freighters operate as agents of sale and distribution for certain growers. Most freighters own their own vehicles, which are normally small to medium sized pick-up trucks and small flat-front diesel trucks (Carballo, 2016, pág. 11).

Carballo (2016) also identified the “wholesalers”: individuals or businesses that purchase either vegetables produced locally or imported. These can be persons that buy from farmers at the farmgate, hucksters, large stores, or supermarkets.

Retailers

Retailers include market vendors, grocery stores and supermarkets in the major towns and city.

Based in Carballo (2016, p.11), the retailers of vegetables can be:

- Supermarkets that have storage facilities/space for produce.
- Hucksters who are permanent vegetable dealers.
- Farmers who are also wholesalers in public markets of Corozal Town, Orange Walk Town, Cayo, and Belize City.
- Retailers who are normally found in public markets, where stalls are stocked with carrots and other items.
- Grocery stores (which are located conveniently almost everywhere) and retail vegetables obtained by wholesalers.
- Ambulant retailers who play their role by going from house to house selling their produce.
- Mennonites who are also seen as ambulant retailers (Northern Belize) because they are often seen selling produce along the roadside.

Consumers

Generally speaking, the most significant users of carrots are household users, the tourist resorts, restaurants, hotel restaurants, fast food establishments and processors of pepper sauces.

The consumer of carrots can get them in two places: “fresh fruit market” and “processing industry”:

- Fresh fruit market: The most significant users of fresh carrots are households. The main source of fresh carrots is the markets because they have a closer relationship with the producers, or the rotation of the product is better. Carrots are mostly consumed as a raw or cooked food, in different sauces and in soups (AGROCYCLE, 2016).

- Processing industry: The main users of processed carrots (sauces or peeled) are tourist resorts, restaurants, hotel restaurants and fast-food establishments. The main source of retail sales are grocery stores and supermarkets because they are the ones that supply business that sell food and souvenirs.

Processor

Marie Sharps's Fine Foods Limited is the major processor that consumes Carrots at 420,000 pounds of carrot per year.

Potential effect of processors controlling the market:

- Processors can define the purchase price of fresh carrots.
- They define the quality or the physical characteristics that carrots are required to have, because they are the preferred ones in the industrialization processes.
- Their influence on the amount of land that will be allocated to produce carrots that will be processed.
- The number of intermediaries will increase. Besides, processors could have a good relationship with intermediaries (collectors), because they need to keep the amount of carrots that will be processed.

The role of women in the carrot value chain

Before 1998, Belize was already producing onions, carrots, and Irish potatoes, but production was small and sporadic. One of the first women agronomists, Francine Magloire, led an applied research team to increase vegetable production. This allowed carrot and onion production to go from small to large scale, for example.

Francine, the Ministry of Agriculture´s support team (with included Jose Mai, whose main focus was on the Orange Walk District), and the agriculture extension staff sustained a period of booming production of onion, carrot, and Irish potatoes from early 2000s.

- In 2002, Belize produced 1.2 million pounds of onion, 1.4 million pounds of Irish potatoes, and a couple hundred pounds of carrots.

- By 2005, production was averaging 2-3 million pounds per year for onions and Irish potatoes, and carrot production was over half million pounds per year.

In short, a woman, Francine Magloire, led the increase in agricultural production, through applied scientific research on vegetables. This reduced poverty in rural Belize, because people received technical assistance from her and the Belizean government.

Profit Margins and Share Benefits along the Value Chain

Cost of production and prices across the value chain were obtained from the Ministry of Agriculture. Table 5 shows an analysis of the profit margins and share benefits along the value chain for fresh fruit Carrots.

The data shows (Table 5) that for the farmer, the fresh vegetable market has a high cost of inputs. A part from the high cost of inputs, the farmers do their direct selling to the local market and consumers. The second is the collector and followed by the retailer. Together, the collectors and retailers take 85.1 percent out of the total profit margin. The retailer's profit margin constitutes the highest share (55%) followed by the collector (30.17%). The farmer share profit in this analysis is 14.8% (Figure 4).

Table 5. Profit Margins and Share Benefits along the value chain for Fresh Fruit Carrot

Irrigated Carrot (Per Lb) marketing costs and benefit shares of actors				
Description	**Actors**			
	Farmers	**Collectors**	**Retailers**	**Horizontal Sum**
Purchase Price (Bz$)	0.00	0.69	0.89	1.58
Total Input Cost (Bz$)	0.35	0.20	0.20	0.75
Sale Price (Bz$)	0.69	0.89	1.46	3.04
Market Margin (Bz$)	0.69	0.20	0.57	1.46
% share of margin	47.3	13.7	39.0	100.0
Profit Margin (Bz$)	0.34	0.69	1.26	2.29
% of share of profit	**14.8**	**30.1**	**55.0**	**100.0**

Price- 5 yr average

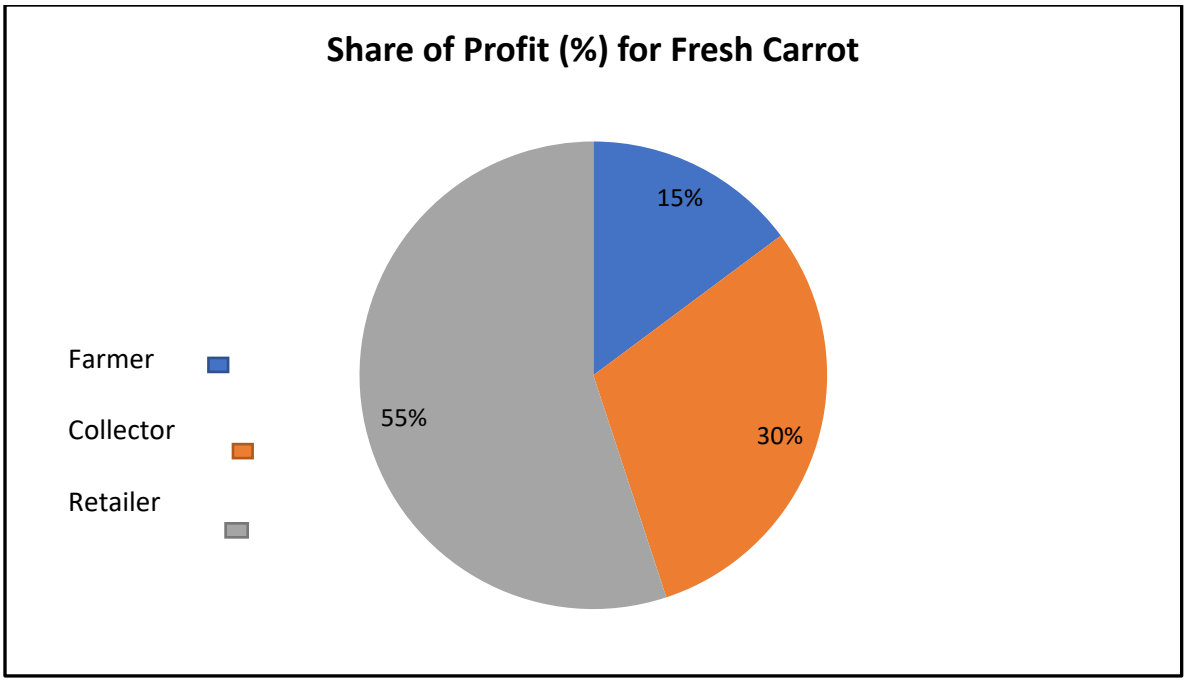


Figure 4. Share of profit of actors for the Carrot market in Belize

5. Market Analysis

Carrot can be cultivated in all districts of Belize and is available year-round. The main Carrot varieties are the Orange Glory F1 and Bangor.

5.1 Market Size

An estimated 2,228,709 pounds of carrots are consumed annually based on a five-year average from 2016 to 2020. Over the same time, the estimated weekly consumption of carrot in Belize is 42,860 pounds per week. The amount produced locally is similar to the amount imported; therefore, there is room for increasing production of carrots in Belize.

5.2 Market Channel

A significant amount of the Carrot produced by the Cooperative in the case of San Carlos and Concepcion Villages is sold to the collectors, then to retailers and finally to consumers.

The main marketing channels identified from the point of production to consumers through intermediaries for Carrots in the Belize are as follows:

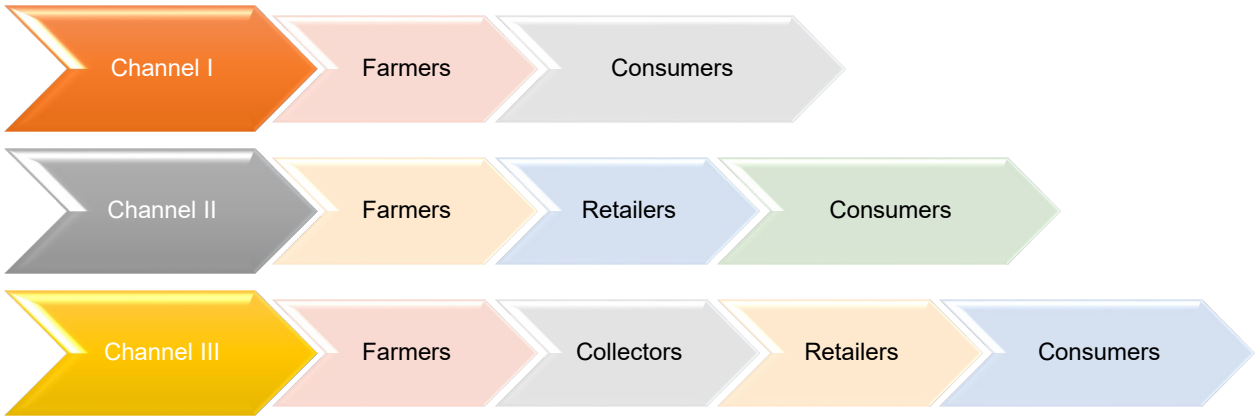
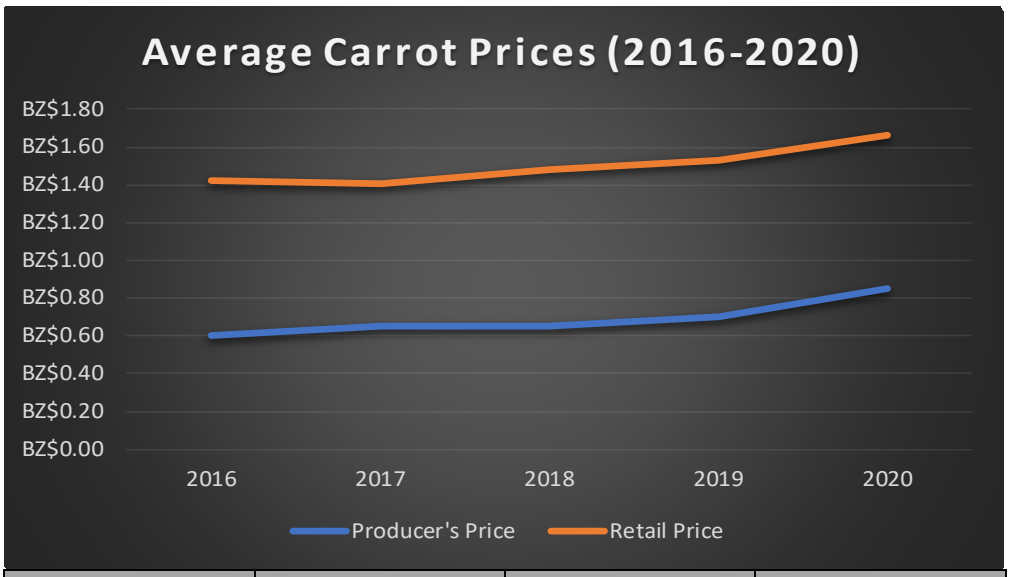


Figure 5. Main Marketing Carrot Channels

5.3 Price trend of Carrot in Belize

For the period 2016 to 2020, the average price for fresh carrot in Belize was BZ $0.69/lb (producer) and BZ $1.50/lb. (retailer) respectively. Both markets are showing increasing trends with the producer price increasing 40 percent and the retailer price increasing 20 percent with respect to 2016. Prices per pound of carrots are shown in figure 6.



Year	Average Producer´s Price	Year	Average Retail Price
2016	BZ$ 0.60	2016	BZ$ 1.42
2017	BZ$ 0.65	2017	BZ$ 1.41
2018	BZ$ 0.65	2018	BZ$ 1.48
2019	BZ$ 0.70	2019	BZ$ 1.53
2020	BZ$ 0.85	2020	BZ$ 1.66

Figure 6. Price trend for Carrot production in Belize (2016 to 2020) at Producer's Price (SIB)

The gap between both prices is showing significant stability for the period analysed, around BZ $0.80 is what separates the price received by farmer with respect to the paid by consumer at the retailer's store (Figure 6).

6. Supply Chain

The supply chain considers the production, importation, profitability, and cost of production across the value chain. The total production of Carrot in 2020 in Belize was an estimated 1,278,595 pounds valued at BZ $1,086,806 (SIB, 2020). The main suppliers of Carrot in the country are farmers, followed by importers. Farmers supply an estimated 52 percent of the national consumption while importers supply 48 percent of the national consumption.

6.1 Amount Supplied

Table 6 shows the annual supply of Carrots per district for the fresh vegetable market. The main suppliers of Carrots in Belize are individual producers and those organized in co-operatives and importers.

Table 6. Annual Average supply of Carrot (lbs) (2016 to 2020)

District	Total Annual Production (Lbs)				
	2016	2017	2018	2019	2020
Corozal	2,500	2,800	48,000	43,500	50,875
Orange Walk	272,000	36,000	0	84,500	165,000
Belize	0	0	0	0	0
Cayo	722,150	779,000	727,200	762,500	813,500
Stann Creek	192,000	220,000	290,657	311,929	244,770
Toledo	0	0	0	1,500	4,450
Total	**1188,650**	**1037,800**	**1065,857**	**1203,929**	**1278,595**

Table 7 registers fluctuations in carrots cultivated. The area planted were not reported or collected in Toledo for 3 of the 5 years in question. Data for Cayo, Stan Creek and Corazal districts are consistent and show minimum changes. Orange Walk district, however, did not reported area harvested in 2018 and, in general, is the district showing major swings in the area harvested.

Table 7. Total area of Carrot harvested (Ac) 2016 to 2020

District	Total Area Harvested (Ac.)				
	2016	2017	2018	2019	2020
Corozal	2.0	2.0	4.0	3.0	5.6
Orange Walk	17.0	3.0	0.0	6.0	10.7
Belize	0.0	0.0	0.0	0.0	0.0
Cayo	79.0	82.0	93.0	81.0	81.0
Stann Creek	13.0	11.0	17.0	23.0	18.0
Toledo	0.0	0.0	0.0	0.5	1.3
Total	**111.0**	**98.0**	**114.0**	**113.5**	**116.6**

6.2 Cost of Production

The Ministry of Agriculture estimates BZ$ 0.30 to produce a pound of Carrot for the fresh vegetable market. More detailed work is needed in conducting proper feasibility studies for this crop due to lack of accurate data.

Table 8 recaps cost structures for cultivation of carrots that were found in the literature review. Details of each cost structure can be found in Annex 3: *Cost Structures for Carrot Cultivation in Belize*. The lowest total cost of production for one acre of carrot is BZ$ 2832, and the hightest is BZ$ 4900.

The cost of producing a pound of carrot is between BZ$ 0.35 and BZ$ 0.61. Cost contingency was added to all structures following good agricultural accounting practices. This cost was estimated to be 15percent of all operating costs. Without considering the cost contingency, the cost still fluctuates between BZ$ 0.31 and BZ$ 0.53, per pound.

Components of the cost of production do not seem to be consistent between one study and the other. Table 8 shows labour expenditure as the most important, above 33 percent of the total cost of production, followed by inputs (seeds, agrochemicals, or others) with at least 23 percent. On this component, seeds are very significant in one of the studies as it represents up to 12 percent of the total cost of production. In another of the studies, the most important item of the input component is fertilizers, representing up to 28 percent of the total cost of production.

Table 8. Recap of Cost Structure for One Acre of Carrot, Belize (BZ$ &)

	One Acre Rainfed Carrot Seven Miles Village (BZ$ $ %)*		One Acre Carrots no irrigation**		One Acre Carrot (SIB)***	
Land Preparatin	BZ$453	11%	BZ$120	4%	BZ$360	7%
Labor	BZ$1,764	44%	BZ$1,528	54%	BZ$1,610	33%
Seed	BZ$492	12%	BZ$120	4%	BZ$240	5%
Herbicide	BZ$93	2%	BZ$212	7%		0%
Insecticide	BZ$42	1%	BZ$59	2%	BZ$661	13%
Fungicide	BZ$80	2%		0%		0%
Fertilizer	BZ$270	7%	BZ$296	10%	BZ$1,390	28%
Miscalleneous Cost	BZ$330	8%	BZ$128	5%		0%
Operational Cost	BZ$3,523	87%	BZ$2,463	87%	BZ$4,261	87%
Cost contingency	BZ$528	13%	BZ$369	13%	BZ$639	13%
Cos of production	BZ$4,051	100%	BZ$2,832	100%	BZ$4,900	100%
Yields in Lbs	9000		8000		8000	
Unit cost (BZ$/Lbs)	BZ$0.45		BZ$0.35		BZ$0.61	
Unit cost wo contingency	BZ$0.39		BZ$0.31		BZ$0.53	

* Cost of Production for Rainfed Carrot , Seven Miles Farmers Association in Seven Miles Village, 2021

** Carrots COP SMFA March, 2021

*** Alfonso Bautista, Statistical Officer, Statistical Institute of Belize

The cost study conducted by the Seven Miles Farmers Association in Seven Miles Village represents the only known study that takes the particularities of a specific area. As a result, it best represents the actual context of the study area. The other studies focus on Belieze as a whole and do not make any distinction about the different characteristics of the regions. Cayo District, the leader on carrot production, shows a higher yield (9000 to 10000lbs) than the yield used to calculate the cost of production in the studies (8000 to 9000 lbs). This difference in yields is even more marked in the case of Orange Walk (12000 to 16000 lbs). At minimum, assessing the relative competitiveness of the different areas of production requires specifying the cost structure at the district level. This however is out of the reach of this research.

7. Climate Change Vulnerability of the Carrot Value Chain

While value-chain dynamics is commonly analysed and described in 3-, 5- or 10-years periods, most experts will avoid market prospects or projections beyond the 10-years mark. Any climate analysis is described in longer periods. Climate dynamics is rarely described in short-periods of time as experts understand the limited predictable value of 3-, 5-, or 10-years forecasting. Climate forecasting, in general terms, will be useful for the decision-making process in the carrot value-chain if it provides relevant information on how the future climate could affect production, productivity, accessibility of resources, or any other variable affecting the likelihood of carrot business.

For this report, we bring in context of the carrot value-chain findings produced by simulation, index, and modelling explained in detail on the CVA reports. Even with the explanation given here, those who want to understand methods and techniques used to obtain these findings should read the CVA reports.

Two major sections of findings are presented below. First, we report changes on climate adequacy for the carrot production for the whole country of Belize. Using maps and a color-code to understand those changes, a general futuristic perspective to produce carrot can be described. Second, findings specifically for the ten intervention areas of the RRB program are presented. Aiming to describe the uniqueness of each area and how the uniqueness of those areas can be compared when looking at the future of carrot production, we identify losses and gains in suitability and adequacy in the baseline data adequacy percentages.

7.1 Carrot Value Chain and Changes on Climate Adequacy for Belize

By comparing current and future climate conditions, the climate vulnerability assessment team provide a first ever effort to understand possible changes in climate adequacy to produce carrot in Belize. A brief description of the method used to develop the comparison is presented here. First, current climate conditions (1970 – 2000) were defined as those referring to the historical average total annual precipitation and temperature (WorldClim 2.1). Secondly, future climate conditions were represented as the average of weather conditions over the 30-year period (2041 – 2070, the central focus in the 2050s) . This is consistent with the definition of climate by the World Meteorological Organization as the study is focused on the projected changes in precipitation and temperature.

Third, the results (comparisons) are based on an assemble of climate projections from twenty-one climate models (see Materials and Methods) and two emission scenarios (RCP2,6 and RCP8,5). Both scenarios (RCP2,6 and RCP8,5) show increases in the average temperature towards 2050. RCP2.6 shows average temperature values that exceed the baseline between 0.7°C in Belize and highlighting a higher increase up to 1.5°C from Corozol to Toledo. On the other hand, the RCP8.5 scenario shows larger increases in temperature ranging between 1.6°C and 2.5°C above the baseline in Belize and Toledo, respectively.

Fourth, the R. EcoCrop package was used to construct an adequacy index based on the climatic requirements of the species. For this, the model uses two types of ranges that are defined by a pair of parameters of each variable (temperature and precipitation). The first range is defined by the minimum and maximum temperature, as well as the minimum and maximum precipitation, in which we can find the species (absolute range).This means that beyond those limits, the conditions are not suitable for the development of the crop or the species. The second refers to the optimal ranges for both temperature and precipitation required by the species so that it can achieve its best performance. Figure 7 shows the interaction between precipitation and temperature parameters for absolute and optimal ranges.

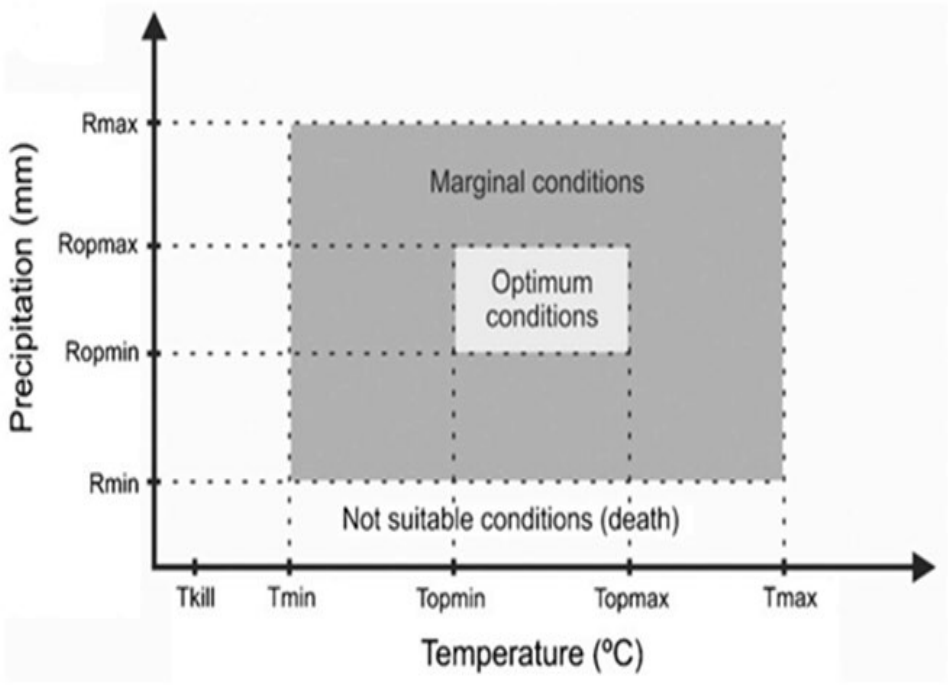


Figure 7. Interaction between precipitation and temperature parameters for absolute and optimal ranges

Below are the climatic parameters considered in the climate adequacy analysis for the carrot production, prioritized by the RRB program. Table 9 shows the optimal range of rain for production of carrot in Belize between 600 and 1200 milimeters. For the temperature, this optimal range occurs between 15-24°C .

Table 9. Climate parameters considered in the climate adequacy analysis requested for the carrot value chain prioritized by RRB

Description of parameter used in the model	**Value used**
Gmin: Minimum duration of the growing season	40
Gmax: Maximum duration of the growing season	150
Gused: Used duration of the growing season	95
Tkmp: Temperature (°C) below which the species cannot survive	-1
Tmin: Lower limit of the absolute temperature range (°C)	3
Topmin: Lower limit of the optimum temperature range (°C)	15
Topmax: Upper limit of the optimum temperature range (°C)	24
Tmax: Upper limit of the absolute temperature range (°C)	30
Rmin: Lower precipitation limit (mm) of the absolute range	400
Ropmin: Lower precipitation limit (mm) of the optimal range	600
Ropmax: Upper limit of precipitation (mm) of the optimal range	1200
Rmax: Upper precipitation limit (mm) of the absolute range	4000

Fifth, a reclassification of modelling results with EcoCrop was carried out. To process the suitability data, the results were reclassified into quintiles: the low adequacy range corresponds with all values less than 20 percent of the suitability range, thus corresponding with the very low class and the very high adequacy range corresponds to a scale greater than 80 percent in the adequacy scale we see in the results from modelling with EcoCrop. The comparison between the current climatology adaptation results and the future scenarios were also reclassified in such a way that the strong green colours correspond to the areas where gains would be experienced in climatic conditions for the crop analysed (it implies for example areas that pass from a category of low suitability to a higher category of adequacy). In contrast, brown was used to identify areas where adequacy categories are low when comparing the future versus baseline scenario.

Below are the climate adequacy maps for the carrot (*D. carota*) cultivation in Belize, the nationally selected species. Figure 8 shows the climate adequacy for cultivating carrot in Belize for the baseline (current conditions, year 2000) and both future scenarios (centered in year 2050). The suitability for the crop is color-coded. Very high suitability region for carrot almost disappears with both scenarios. Even though Belize does not show extensive area optimal for growing carrot in the base line, there are complete districts that will not have possibilities to produce carrots.

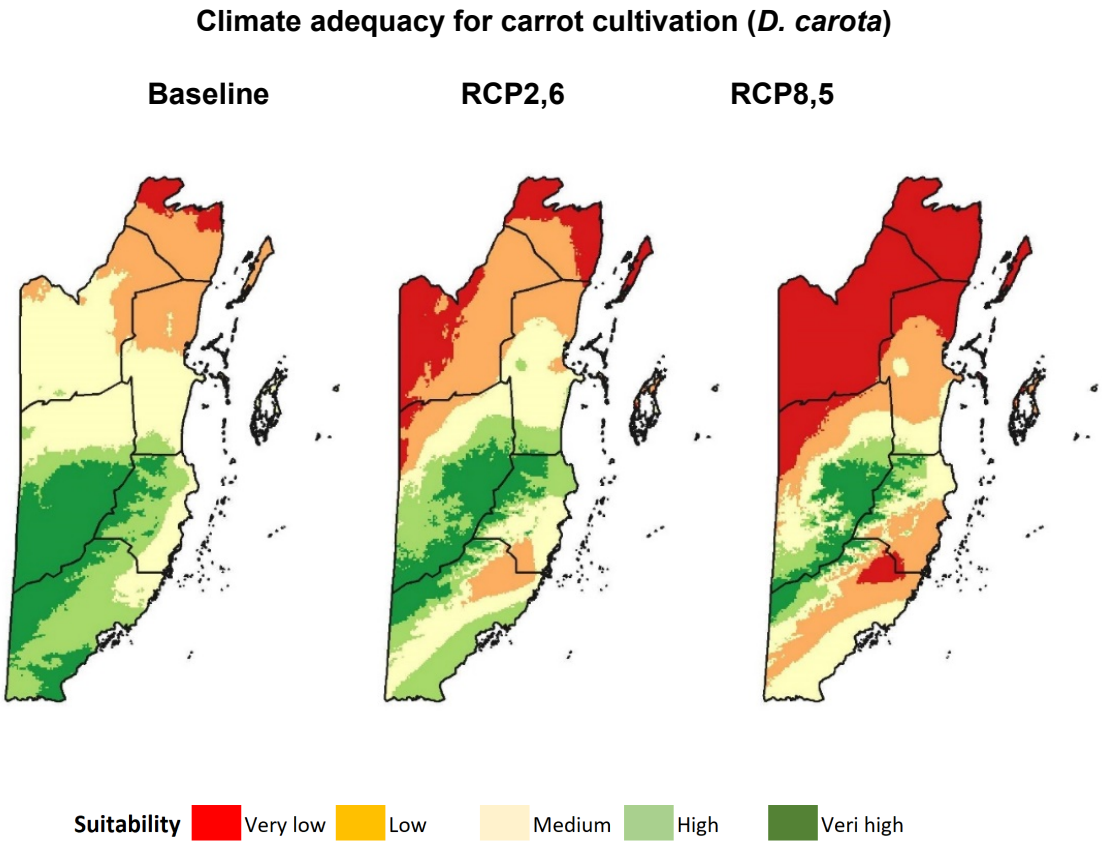


Figure 8. Map for Climate Adequacy for cultivation of Carrot (*D. carota*) for Belize for the base line and two future scenarios 2050

Figure 9 shows the general losses and gains on adequacy by comparing each scenario with the base-line climate adequacy for production of carrot in the whole country.

Under both scenarios, climate adequacy to produce carrot does see major losses in suitability - entire districts losing their suitability to cultivate carrot. Half the country is projected to have climate constraints to cultivate carrot (see figure 9). The other half of the country will see losses in suitability, meaning cultivating carrots will be more expensive in the few areas left suitable for cultivation. Considering that only temperature and precipitation variables were included in this analysis, and that other variables will also affect the exposure, clearly carrot production will see major obstacles to continue their business model as usual and a clear need to prevention and adaptation actions are needed.

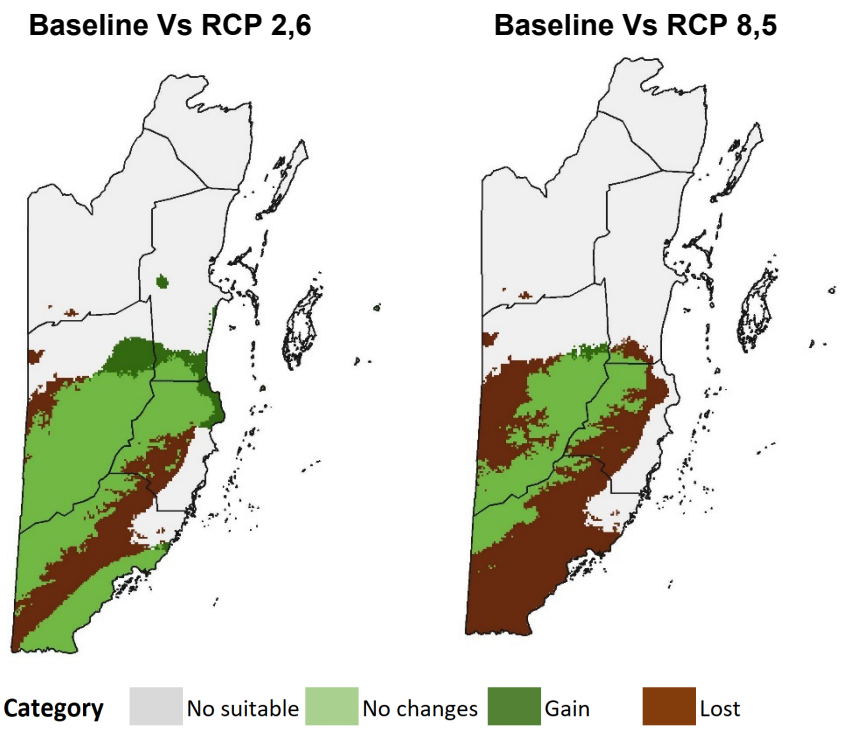


Figure 9. Mapping changes in climate adequacy with two scenarios for the carrot (D. *Carota*) cultivation in Belize.

7.2 Carrot Value-chain and Changes in Climate Adequacy for RRB's Intervention Areas

As much as the data for the whole country could tell us the story on sensibility and vulnerability for our target crop, the RRB defined ten intervention areas (Assessment Units of the rural resilience program in Belize RRB) which will show how conditions will affect our value chain.. We note, for our value chain, that the future may play out significantly different at RRB's intervention areas that at the national level. Assessment Units of the Rural Resilience Programme in Belize (RRB) are shown in figure 10.

Knowing that Cayo and Stann Creek districts are responsible for 80 or more of the total production of carrot in Belize, what happens to Areas of Intervention 4, 5, 6, and 7, will impact the supply of carrot for the future.

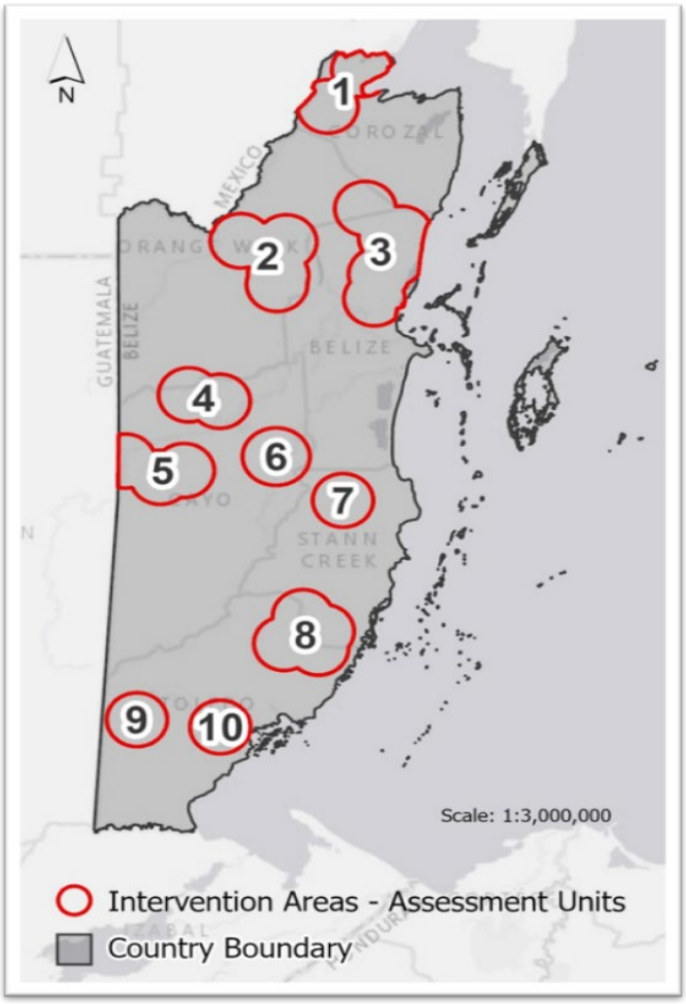


Figure 10. Mapping Intervention Areas-Assessment Units of the Resilience Rural Belize Program

Table 10 shows changes in climate adequacy between baseline and future scenarios for carrot (D. *carota*) cultivation in Belize as a percentage of each RRB programme intervention area. When the intervention area is the focus of the comparison between scenarios, we are able to identify Area of Intervention 6 as a special case where the scenarios give gains in suitability in 44 percent of the territory in question. Similarly, 3 and 4 areas will become not suitable and area 5 will see a significant reduction of suitability in 33 percentof his territory. On the other hand, Area of Intervention 7 (Stann Creek) is projected as not having changes in their suitability to produce carrot.

In general, future climate changes could be said to have a big impact for the cultivation of carrot on RRB target communities. Considering that only temperature and precipitation are included in

this analysisand that other variables will also affect the exposure to climate changes in these communities, carrot production will see major obstacles to continue their business model as usual and there will be a clear need to prevent and adapt actions that must be added to their operations.. We single out the projected impact on Area of Intervention 9, we argue that opportunity arises for specialization in cultivation of carrot for that area. For the other Areas of Intervention, substitution of crops, diversification, or technological innovation could be a source of relief for farmer and organizations alike.

Table 10. Changes in climate adequacy between baseline and future scenarios for carrot (Daucus carota) cultivation in Belize as a percentage of each RRB programme intervention area

Change direction Percentage (%)	Intervention Areas- Assessment Units									
	1	2	3	4	5	6	7	8	9	10
	RCP 2,6									
Gain					44.37					
Not Suitable	100	100	100	97.28	40.74			50.7		
Lost				2.724	31.14			46.09	26.37	47.52
No changes					28.12	55.63	100	3.215	73.63	52.48
	RCP 8,5									
Gain						44.37				
Not Suitable	100	100	100	97.28	40.74			50.7		
Lost				2.724	31.14			46.09	26.37	47.52
No changes					28.12	55.63	100	3.215	73.63	52.48

Source: Own elaborated

8. Constraints and Opportunities

The production of carrots is a priority by the Government of Belize through the Resilient Rural Belize (RRB) Program. This is very positive for the Carrot Industry; therefore, all the challenges and opportunities need to be examined in detail to strengthen the value chain. Presented in Tables 11 and 12 are challenges and opportunities identified in the Carrot Value Chain.

Table 11. Challenges and Opportunities for Carrot Value Chain in Belize

	Constraints	Opportunities
Input Supplies	**High costs of inputs:** • Very high cost of fertilizers, seeds, and pesticides. • High cost of fuel	• Farmers´ s organizations, like cooperatives, could be engaged in buying volume and transferring cost saving to individual farmers. For the carrot production, a potential reduction in fertilizers and insecticides could help significantly in reducing the cost of production. • Substitution of organic fertilizers could be explored as a cheaper alternative to chemical fertilizers. This could be analysed together with an evaluation of the timing of applications as it is understood that organic fertilizers take longer to produce effects and the farmer will need to learn the new times for application. • Expenditure on fuel can be reduced if there is greater collaboration and planning for taking orders and delivering products between the actors. • The prices of inputs (i.e., fertilizer and pesticides) may not change rapidly enough but application efficiency could be tremendous. Training on the basic for an efficient use could reduce the total bill paid by farmers.
	Seed Quality and Availability:	• Opportunity for collaboration and strengthening of relationships between farmers, agronomists, and local extension services for training on Good Agriculture Practices.

	Constraints	Opportunities
	• Seed prices are high	• Facilitate importation of seeds and establish local seeds banks to supply farmers. • It is recommended to support seed providers in finding international reliable sources. Some providers may be so small that they will not be able to carry out the best seeds even if the farmer is willing to pay for them.
Production	**Poor Knowledge of the use of inputs** • Poor knowledge of the use of pesticide application, and fertilizer programs.	• Training on the proper use of agrochemicals and equipment. • The information given to the farmer must be calibrated/reviewed together with the input provider. The training and what the farmer learns whenever he/she buys inputs need to be correlated. • Information sharing on alternatives inputs (i.e., organic fertilizers) could be promoted by local extension service.
	There are not Annual Production Plans • Especially for fruit destined for processing an annual planting plan is very important to meet supply and demand of the processor.	• Annual Production Plan (APP) should be encouraged to those seeking to secure market for processing. This in particular for the hot pepper souce related business demanding carrot. • Training in APP and/or technical assistance to organize an annual production plan for a constant supply of the vegetable. • Informal contracts are one step closer to formal (commercial) contracts and promoting APP could accelerate the qualitative shift in the way the value chain operates. The interest of processors like Marie Sharp´s on supporting the implementation of APP should be explored. • Small scale producers of carrot may not see immediate benefits of implementing an annual production plan because they may be using collectors to get to the processing plant. However, it is possible to think that those producers may benefit of coordinating their small-scale operations with a “group” annual production plan, which will bring the possibility to coordinate transportation and sell directly to the processor.

	Constraints	Opportunities
	Climate Vulnerability • Farmers depend on the seasonal rainy season or rudimentary irrigation systems and not much emphasis on climate change.	• Share information on climate change and technical assistance on irrigation systems for production. • Use the concept of "Escuela de Campo" to invite producers to learn about production under irrigation and the importance of not depending on the rainy season for their crops. • Opportunity (adaptation measure) for dealing with climate constraints could be a major component of "Escuela de Campo" training following the list of measures presented in *Table 12. Practices for adapting to climate change.*
Post-Harvest	**Road Conditions** • Poor road conditions between distribution and collection center. • Need for post-harvest facilities.	• RRB could consult with the Government area representative to address this issue. What should be avoided is fast deterioration of the road improvements because lack of maintenance or poor monitoring. Here, communities should be mostly involved in providing monitoring. • Quality of planned road could be improved if maps on vulnerability to climate change conditions are considered: those maps are being elaborated by the CVA consulting Team. • Current issue of land titles for many farmers could limited the potential of financial services and functional land markets to play their part when the infrastructure issues get to be corrected. Business plans including infrastructure requirements are needed. Although, land ownership, or lack of it to be more exact, could seriously restrict the impact of the suggested infrastructure-business plans. • Identify funding and storage facilities affordable and appropriate for the farmers willing to work together and are using Annual Production Plans
	Processing	• It should be explored why there is not a quality premium paid for those farmers following the quality standards. If the farmer does not perceive the benefit, it will be difficult for him to

	Constraints	Opportunities
	• Processors already have quality standards farmers must adhere to.	adhere to standards. Either there is no quality premium possible to offer or the standards are not clear to farmers. • Current cooperatives may be able to work much easier with the Belize Bureau of Standards, however, they need coaching and technical support to sit at a technical table to discuss the standards.
	Poor Quality Standards • This may be reason behind the preference sometime of the imported carrot.	• If national production increases, the importance of the quality standard as a requirement for carrying out business with the processor or supermarkets will become even more relevant; the production of a quality manual adapted to the farmer's language and circumstances, should be useful for the future of the value chain. • There is a need for technical assistance for farmers to better understand the standards and what agronomic practices need to be improved to meet these standards. • Organized groups or cooperatives need to understand and request the development of these standards to the Belize Bureau of Standards and lobby for possible price control against imports of carrot. The carrot sector will need a period of protection so farmer will be able to adapt to the standards.
Marketing and Distribution	**Poor Business Practices** • Poor record-keeping results in a poor understanding of the cost of production.	• The farmer needs to think and act like a businessman/businesswoman. Essential also, farmers need the knowledge to farm as a business. In most cases, training on record-keeping, cost of production estimation, and knowledge about contracts and negotiation should be the basic content of the training on entrepreneurship for farmers. • Good business practices training should also be given to the cooperatives. It was argued that cooperatives need to improve their relevance to members who need to see clear

	Constraints	Opportunities
	• Lack of formal contracts with intermediary resulting in a late payment to the farmer for products sold. • No official medium to learn about price information on the market.	examples of why belonging to a cooperative. Marketing of produce, collective negotiation, and saving on the cost of inputs, should be obtainable by strengthening the cooperatives. • Manuals and simple brochures easy to complete/read are necessary as well as make them available to hot pepper producers. • Consistency of services that provide price information to the producer can be achieved using access technologies such as cell phones. Here, it will first be necessary to launch a pilot program to define the ideal format that reaches the producer and that is easy for him/her to interpret and use.
	Poor access to finance • Financial institutions require collateral such as land titles, however, many of the farmers are squatters and do not have land titles to use as collateral to access finance.	• Poor access to finance is normally a result of limited collateral value to offer to banks, however, access can be improved if the farmer can demonstrate administrative skills: bookkeeping, inventories, etc. NGOs and similar sources of financial support should be obtainable with better business practices. • Improving cooperative capitalization could translate into better financial access for the farmer. Undercapitalization at the cooperative level limits the capacity to provide advance payments or credit to members which are critical for planting and harvesting/collection. Training in financial management at the cooperative level could increase the capacity to provide those services to farmers. • Appropriate business training with an emphasis on investment and financial management for cooperatives should reduce the need to find often high-cost credit for the organization. Even if the cooperative has low capitalization, it should not mean that it needs to work with expensive capital: learning where to borrow and knowing how to manage the loans are essential to guarantee that the cooperative is working with the cheaper capital possible.

	Constraints	**Opportunities**
		• Land ownership should be encouraged as much as possible knowing that it could grant farmers access to credit and work capital. The Lands department officials may need to train and inform farmers on the process of acquiring land legally. It is recommended that a study be conducted encompassing the 10 intervention areas of the program seeking to explain why farmers do not formalize land ownership

Table 12. Practices for adapting to climate change.

Climate constraint	**Opportunity (Adaptation measure)**	**Description of the measure**	**Link to the problem (How it improves competitiveness)**
Increase the management and sustainable use of water [2]	Use irrigation systems that provide the optimal amount of water. Carry out activities to conserve water sources, such as rivers and wells.	Use an irrigation system that considers the water requirement of the crop and evapotranspiration. The conservation of water sources includes EbA practices such as reforesting riverbeds and harvesting rainwater.	In Latin America, the agricultural sector consumes 70% of the available water, so it is recommended to optimize the use of water and protect hydrographic basins.

[2] https://blogs.iadb.org/sostenibilidad/es/cinco-medidas-de-adaptacion-para-reducir-la-vulnerabilidad-al-cambio-climatico-del-sector-agricola-en-america-latina-y-el-caribe/

Climate constraint	Opportunity (Adaptation measure)	Description of the measure	Link to the problem (How it improves competitiveness)
Efficient use of fertilizer [3]	Fertilizers must be optimized to reduce production costs and to reduce water and soil contamination problems (non-organic fertilizers)	Use the required amount. Place it in the right place, for the absorption of the plant. Don't fertilize when it rains.	Fertilizers have negative effects on the environment [4]: such as eutrophication, water toxicity, groundwater pollution, air pollution, soil and ecosystem degradation, biological imbalances, and reduced biodiversity.
Using bush as living barriers (EbA Practice)[5]	Live hedges of bushes are a practice to protect the crop from the wind and to capture carbon dioxide. In addition, nitrogen-fixing shrubs can be used to benefit the crop.	Living barriers can be used to separate cultivation areas because they can be monocultures that are planted in a staggered manner or different crops. Live barriers are also a barrier that prevents cross-contamination by pesticides, especially to avoid the presence of these in the products that are ready for harvest.	Climate change is related to the increase in greenhouse gases in the environment, so it is necessary to increase the number of plants that capture these gases (especially carbon dioxide).

[3] https://www.conservation.org/docs/default-source/publication-pdfs/cascade_modulo-4-como-enfrentar-el-cambio-climatico-desde-la-agricultura.pdf
[4] https://obtienearchivo.bcn.cl/obtienearchivo?id=repositorio/10221/27059/1/Consecuencias_ambientales_de_la_aplicacion_de_fertilizantes.pdf
[5] https://www.conservation.org/docs/default-source/publication-pdfs/cascade_modulo-4-como-enfrentar-el-cambio-climatico-desde-la-agricultura.pdf

Climate constraint	**Opportunity (Adaptation measure)**	**Description of the measure**	**Link to the problem (How it improves competitiveness)**
Integrated pest management [6]	Pest control must be done through cultural, physical, and ethological practices, with an emphasis on biological control. Although the rational use of pesticides is also recommended.	Integrated pest management should be done based on the economic threshold and the identification of the main pests. This will allow deciding the type of management that the pest will receive.	Integrated pest management is important because climate change allows pests to increase their distribution.

[6] http://repositorio.iica.int/bitstream/handle/11324/3046/BVE17068958e.pdf?sequence=1

9. Conclusions

Carrot Value-Chain with Reduce Potential. Carrot is grown primarily in Cayo (San Antonio and Seven Miles Villages) and the Stann Creek Districts. The Cayo District is the leading producer of carrot followed by the Stann Creek, Orange Walk and Corozal Districts. Producers of carrot are part of a cooperative in some districts but not in others. There are no examples of commercial agreements between different actors in the chain to take advantage of business opportunities, nor are there alliances for innovation aiming to solve the challenges they have: low productivity, supply instability, contraband, and illegal competition, need of a national seed policy and certification, among others. The Ministry of Agriculture, Food Security and Enterprises has in its policy to support and prioritize vegetable production as part of the larger agricultural strategy to conduct import substitution. Technical and financial services are provided by supporters and service providers along the value chain. Most farmers do not use financial institutions for financial assistance because they don't have sufficient collateral to meet the requirements of these financial institutions.

How to Strengthen the Carrot Value Chain. A two-tier strategy could be useful to implement into the Carrot Value Chain. First steps would include the strengthening of the cooperatives who are the main producers of carrot. All farmers require technical assistance, training in good agricultural practices, and training in basic farm business management. Second steps of the strategy would be to debunk the common belief that many cooperatives in Belize are born for the wrong reasons – mostly to take advantage of an opportunity brought up by a project. The belief communicates that when the project disappears, so does the reason for gathering in the cooperative. Currently, this belief is being corrected with help from the institutions in charge of promoting cooperatives and should be explicitly included in the capacity building and training to farmers. Strengthening the value chain in Belize requires strengthening of pre-cooperatives who could play a major production role as promoters, like we see in the example of Stann Creek. It has been argued that members do not recognize clear, explicit benefits of their membership; therefore, farmer's organizations should emphasize actions that bring about financial sustainability. All farmers require knowledge of good agricultural practices such as the use of appropriate seed varieties, good land preparation, integrated pest management, rational use of agrochemicals, efficient use of irrigation systems to conserve water, post-harvest technology, processing, and others.

Climate Vulnerability. Future climate changescould be argued to have a big impact on the cultivation of carrot in RRB target communities. Considering that only temperature and

precipitation are included in this analysis and that other variables will also affect the exposure and sensibility to climate changes in the RRB programme communities, carrot production will see major obstacles in continuing their business model as usual and a clear need for prevention and adaptation actions must be established.. We single out the projected impact on Area of Intervention 9, we argue that opportunity arises for specialization in cultivation of carrot for that area. For the other Areas of Intervention, substitution of crops, diversification, or technological innovation could be sources of relief for farmer and organizations alike.

Impact of Covid-19. The unforeseen impact of Covid-19 on logistics for carrying out the studies was overwhelming. In 2019, the dominant commodities in the tuber and vegetables category based on economic value were onion, potato, carrot and sweet pepper, respectively ranked from first to fourth places. (MAFSE, 2020). Surprisingly enough, many of the products analysed show unexpected consequences under the pandemic since 2020. First, sanitary restrictions towards mobility of people and vehicles produced a contraband reduction for several crops, mainly from Mexico. Illegal imports, legal imports, and national production before the pandemic was common to find in major markets, especially city markets. As reported in the CVMAs studies, contraband has been reduced and national production has a benefit in a less competitive market. What will happen if restriction of mobility is eliminated? Nothing in the studies suggest that producers are finding national production to be of better quality or that they are ready to give upimported goods; therefore, RRB should prepare a strategy for when contraband returns. It is expected that, without an infusion of training, investment capital, and technical assistance, many of the sectors analysed will return to a downward trend.

Secondly, Belize tourism sector meltdown under covid-19 pandemic is a reminder of how important diversification is for Belize agriculture value chains targeted by the VCMAs studies. Among agriculture officers and extensionists, opportunities to connect farmers to the tourism supply chains were not present in discussions and workshops carried out for the VCMAs studies. Such inattentive situations, due to current emphasis on national consumers and effects of the pandemic, should not diminish the tourism sector as a source of diversification. It is expected that opportunities to link farmers to the tourism supply chain will return with the increase of tourists in Belize. Here, challenges on quality and acceptance of standards that have been identified in the VCMAs studies will be paramount.

Finally, Covid-19 had everyone focusing on the short-term, losing the potential of the studies to reflect long-term strategies. For example, having no tourism makes people ignore the opportunities that the links between farmers and the tourism supply chain represent on the long

run. Similarly, many people that lost their jobs move to micro-farming, affecting the normal agricultural supply in many of the products studied. This is a logical phenomenon when there is a crisis in play.

Farmers and other actors of *the value chain may not be in position to wait* for the value chain approach to work. The length of time it takes for value-chain approaches to become viable is well understood -if it does not break up before reaching its goal. It could take four or five years, or because of, intensive, albeit often disarticulated, interventions from government agencies, NGOs, development projects, and other similar organizations. The long duration of this process will increasingly become an obstacle for smallholders, their organizations, and development agencies, due torapidly globalizing markets for agricultural products where these enterprises meet with both new opportunities and increased competition. It is imperative to identify viable shortcuts to value-chain development based on enabling political and legal frameworks, harmonized and aligned development interventions, and the delivery of effective and well-articulated technical, business development, and financial services. Nothing of these could be achieved without promoting regular dialogue between local processors, investors, and government agencies, and producers.

Priorities for the Whole Value Chain. When thinking of a value chain as a system, all stakeholders are interlinked and are mutually dependent. RRB must recognize that some interventions are prioritized differently for different actors and stakeholders. Interventions for the whole value chain require extra effort to create consensus on priorities. Through workshops carried out for the VCMAs studies, a couple of challenges and needs were consistently prioritized and presented here in Table 11. Similarly, priority among value chains should also be understood as a necessary step toward the efficient use of resources. To maximize the impact of the program, prioritizing the carrot value chain has not been well articulated, especially if we consider only the market opportunity side, which leads to very few opportunities. We need value-added opportunities and cooperatives to step up if this value chain wants to get more competitive.

10. Final comments on limitations of the study

The following list includes major challenges for achieving the best carrot value chain and market assessment:

1. It was observed that **women participating** as members, managers and leaders was limited during the workshops and in the interviews. Although suggested by some participants, covid restrictions do not seem to explain the gap in participation between men and women, nor between youth and adults. An explicit action plan for gender equity should be drafted, discussed, shared, and established with all members working with the value chain approach.

2. **Short-term Goals as a New Norm**. Covid-19 had everyone focusing on the short-term goals of an event, losing the potential of the studies to reflect long-term strategies. For example, having no tourism makes people ignore the opportunities that the link between farmers and the tourism supply chain canrepresent in the long run. Similarly, many people that lost their jobs moved to micro-farming which affected the normal agricultural supply in many of the products studied. Of course, this is just a logical attitude i crisis mode, but it could carry out serious limitations when a value chain approach is used to harnessing governmental intervention in the sector. Finally, the Belize tourism sector meltdown under covid-19 pandemic works as a reminder of how important diversification is for Belize agriculture value chains targeted by the VCMAs studies. Among agriculture officers and extensionists, opportunities to connect farmers to the tourism supply chains were not at all present in discussions and workshops carried out for the VCMAs studies. Such inattentive situation, probably due to current emphasis on national consumers and effects of the pandemic, should not diminish the tourism sector as a source of diversification. It is expected that as the tourists return to Belize, opportunities to link farmers to the tourism supply chain will also return. Here, challenges on quality and acceptance of standards that have been identified in the VCMAs studies will be paramount.

3. We found that **data inconsistency** of official sources is a serious limitation for any VCMA analysis. When data of production, yields and acre-harvested do not match, it is possible that the agencies in charge of collecting the data in Belize will need to revisit their methods of choice when producing the data. It is suggested that RRB brings this observation to SIB for further consideration.

4. **Making sense of working with value chain approaches**. During the process of carrying out the study, it was clear that not all agriculture extensionists and technicians understood what it means to work with a value chain approach. For some, the approach still works in support of farmers, which is a misunderstanding. The guiding principle is to support the whole chain by creating more options to create value. The value chain approach works if the creation of value is under the scope of the farmer or with the processor or the retailer. It was difficult to conduct value-chain workshops where farmers thought it was a space for them to present demands and discuss only issues concerning to them. RRB needs to consciously remind participants and partners the essential features of the value chain approach.

5. The major challenge for making sense while working with the value chain approach is exemplified by the **misrepresentation of what a middleman (collector) does** for the value chain. Ignored are the essential changes on space and time the middleman brings to the value of products: relocating, holding them to times that are more convenient, assuming various risks by stocking inventories. Why is the bias against middleman so persistent? This is, in part, explained by cultural perceptions as mere cheaters, but also highlights the misjudgment of the difficulty to create value within space and time. Farmers who have mastered the complexities of the production process have seldomly mastered the very different complexities of inventory management and numerous other services performed by middlemen in the process of relocating products in time and space. Value chain approaches demand integrating middlemen into the negotiation/concertation table where actions for the value-chain are being discussed; having the technical team understand this is paramount.

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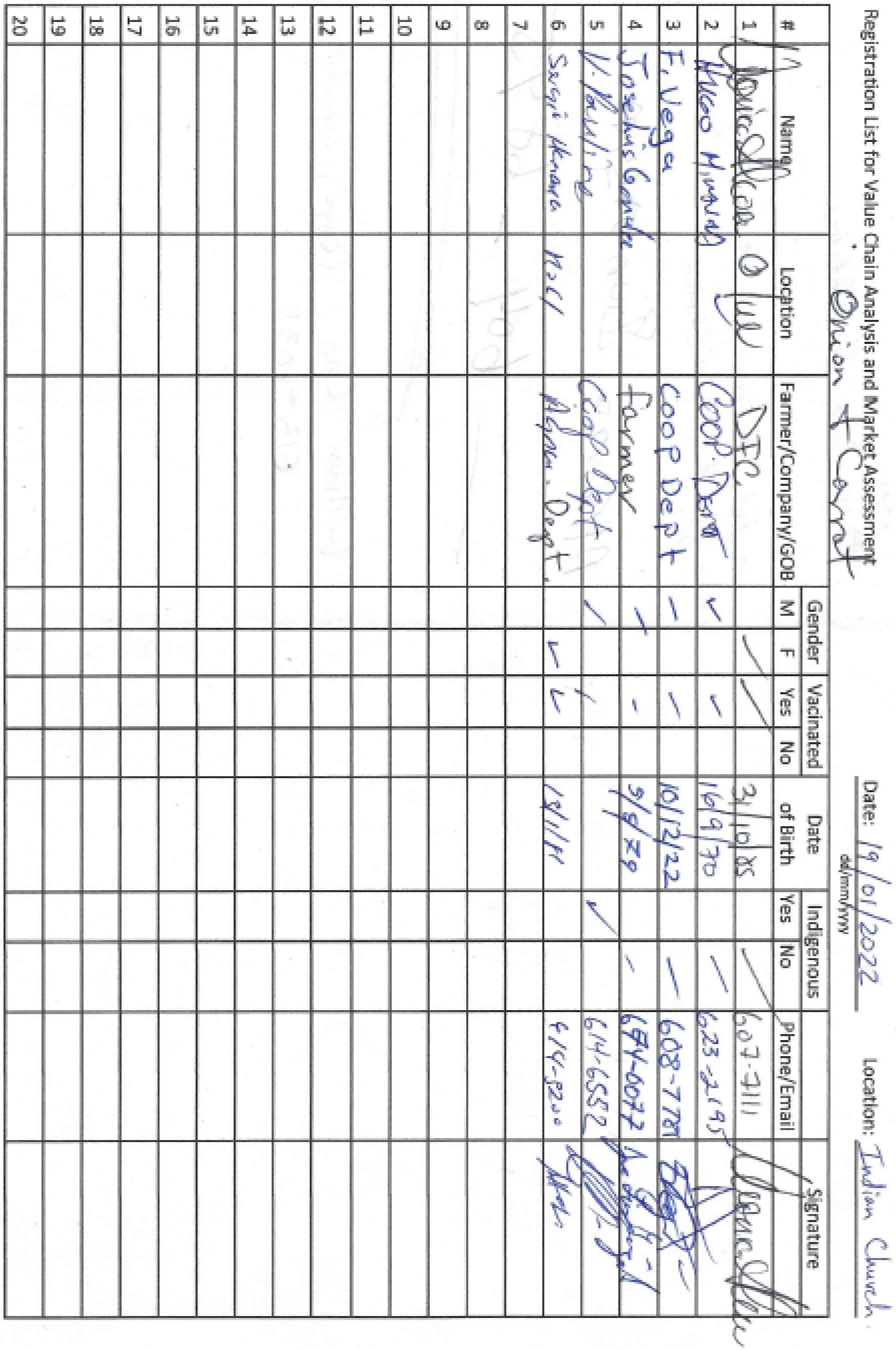
12. Annexes

12.1 Annex 1. Participants Conception Carrot Workshop and Pictures



Registration List for Value Chain Analysis and Market Assessment Onion + Carrot

Date: 19/01/2022 (dd/mm/yyyy) Location: Indian Church

#	Name	Location	Farmer/Company/GOB	Gender M	Gender F	Vacinated Yes	Vacinated No	Date of Birth	Indigenous Yes	Indigenous No	Phone/Email	Signature
1	[illegible]	[illegible]	DFC		✓	✓		3/10/85		✓	607-9111	[illegible]
2	Hilco Miranda	[illegible]	COOP. Dept	✓		✓		16/9/70		✓	623-2195	[illegible]
3	F. Vega		COOP Dept	✓		✓		10/12/22		✓	608-7707	[illegible]
4	Joseluis Gonda		Farmer	✓		✓		9/9/79		✓	674-0077	[illegible]
5	V. Paulino		Coop Dept	✓		✓			✓		614-6552	[illegible]
6	Sergi Alvaro	[illegible]	Agric. Dept.		✓	✓		[illegible]			614-8200	[illegible]
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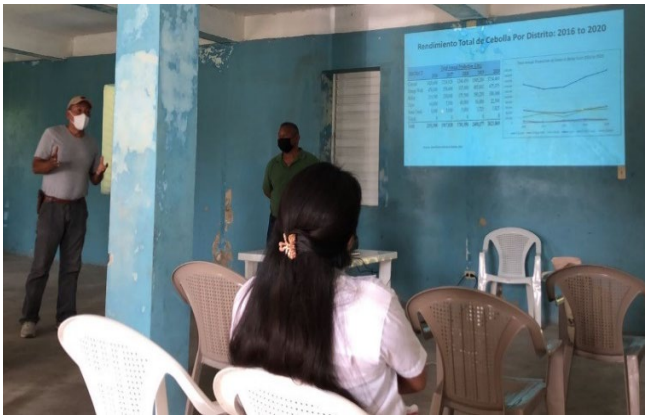
Rendimiento Total de Cebolla Por Distrito: 2016 to 2020

12.2 Annex 2: Cost structures for carrot cultivation in Belize

The cost structures found in the literature and used in the analysis of production costs of the present study are three: a) Cost of Production for Rainfed Carrot , Seven Miles Farmers Association in Seven Miles VILLAGE, 2021; b) Carrots COP SMFA March, 2021, c) Alfonso Bautista, Statistical Officer, Statistical Institute of Belize

COST OF PRODUCTION FOR RAINFED CARROTS FOR THE Seven Miles Farmers Association in Seven Miles VILLAGE

ACTIVITY	UNIT	COST/UNIT $	QUANTITY	COST $	SUB TOTAL $
Land Preparation					
Chopping	ac	225	1	225	
Ploughing	hr	65	2	130	
Ridging	hr	65	1.5	97.5	
Total Land Preparation					452.5
Labor					
Manual weed control	hrs	4.5	90	405	
Chemical weed control	hrs	4.5	5	22.5	
Monitoring	hrs	4.5	9	40.5	
Planting	hrs	4.5	9	40.5	
Opening Forrow on beds	hrs	4.5	9	40.5	
Fertilizer Application	hrs	4.5	11	49.5	
Insect/Fungicide application	hrs	4.5	14	63	
Harvesting	hrs	4.5	158	711	
PHA grading/bagging	hrs	4.5	27	121.5	
Carrots Washer	bag	1.5	180	270	
Total Labor					1764
Inputs					
Seeds	lbs	246	2	492	492
Herbicide					
Fusilade	L	50	0.5	25	
Sencor	L	225	0.3	67.5	
Total Herbicide					92.5
Insecticide					
Lash	Lt	60	0.2	12	
Jackpot	Lt	60	0.5	30	
Total Insecticide					42
Fungicide					
Vondozeb	Kg	15	1	15	
Ridomil Gold	1 pk(750g)	65	1	65	
Total Fungicide					80
Fertilizer					
Polyfeed 19-19-19	1 bag(2 Kg)	20	1	20	
14-36-12	110 lbs/bg	65	2	130	
18-18-18	110 lbs/bg	60	2	120	
Total Fertilizer					270
Miscalleneous Cost					
Carrots bags 100lb bag	bag	1	180	180	
Transportation	loads	25	6	150	
Total Post-harvest	0	0	0	0	330
TOTAL				**3523**	**3523**
Summary of costs for carrots production					
Break Even Price	**$0.35**				
Yield per acre in pound	9,000				

COST OF PRODUCTION FOR ONE ACRE OF CARROTS				
HEAD	**ACTIVITY**	**UNIT**	**COST/UNIT**	**TOTAL**
Land Preparation	Plough	1 hr.	$40.00	$40.00
	Harrow	1 hr.	$40.00	$40.00
	Bed Preparation	1 hr.	$40.00	$40.00
				$120.00
Sowing	Seeds	8 oz.	$13.00	$104.00
	Sowing	4 hrs.	$4.00	$16.00
				$120.00
Fertilizer	Urea	3 bags	$37.00	$111.00
	Phosphorus	2 bags	$37.00	$74.00
	Pottasium	3 bags	$37.00	$111.00
				$296.00
Thinning	Manual Thinning	64 hrs.	$4.00	**$256.00**
Weed Control	Manual Weed Control	192 hrs.	$4.00	**$768.00**
Irrigation	Irrigating 3 days after sowing/3 days after germination	32 hrs.	$4.00	**$128.00**
Pest Control	Sevin	16 lbs.	$11.50	$84.00
	Rat Bait	8 kgs.	$16.00	$128.00
	Labour	24 hrs.	$4.00	$96.00
				$308.00
Disease Control	Manzate	2 kgs.	$12.50	$25.00
	Benlate	1 kgs.	$34.00	$34.00
	Labour	30 hrs.	$4.00	$120.00
				$179.00
Harvesting	Manually	64 hrs.	$4.00	**$256.00**
Grand Total				**$2,431.00**

Average yield per acre = 8,000 lbs. (none irrigated)
8,000 lbs. X $0.50 = $4,000
Profit per acre = $1,569.00

Cost of Production for Carrots				
Activity	**Unit**	**Amount**	**Cost per unit**	**Total**
Plowing	Hrs	2	$ 60.00	$ 120.00
Harrowing	Hrs	2	$ 60.00	$ 120.00
Bedding	Hrs	2	$ 60.00	$ 120.00
Materials				$ -
Seeds	Bangor	2	$ 120.00	$ 240.00
18-18-18	Bags	2	$ 100.00	$ 200.00
14-36-12	Bags	2	$ 100.00	$ 200.00
Nutrileaf	Kg	1	$ 30.00	$ 30.00
Ammonium Nitrate	Bags	3	$ 45.00	$ 135.00
Potassium Nitrate	Bags	5	$ 120.00	$ 600.00
MAP	Bags	1	$ 125.00	$ 125.00
Polyfeed (Triple 19)	Bags	1	$ 100.00	$ 100.00
Insecticides				$ -
Muralla	Pks	1	$ 210.00	$ 210.00
Pegasus	liters	1	$ 75.00	$ 75.00
Regent	200 cc	1	$ 45.00	$ 45.00
Sevin	lbs	5	$ 27.00	$ 135.00
Karate	liters	1	$ 45.00	$ 45.00
New Mectin	250 cc	1	$ 85.00	$ 85.00
Indicate	Liters	3	$ 22.00	$ 66.00
Labor				$ -
Nursery Management	Days	4	$ 35.00	$ 140.00
Planting	Days	2	$ 35.00	$ 70.00
Fertilizing	Days	5	$ 35.00	$ 175.00
Weed Control	Days	20	$ 35.00	$ 700.00
Pest and Disease	Days	5	$ 35.00	$ 175.00
Harvesting	Days	10	$ 35.00	$ 350.00
				$4,261.00
Yield	8000	lbs		
Revenues	8000	at $1.00	$ 8,000.00	
Cost per acre			$ 4,261.00	$ 0.53
Estimated Income			$ 3,739.00	