

Value Chain market Assessment

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

**Product 3.7 Value Chain and
Market Assessment of Onion
Production in Belize**

May 2022

VALUE CHAIN AND MARKET ASSESSMENT OF ONION PRODUCTION IN BELIZE

Conduct of Value Chain and Market Assessments for Resilient Rural Belize

Contract Number: CO002/14/2020/2021

Supervised by

José Lisbey, MSc.

Value Chain Agricultural Officer

Resilient Rural Belize

Prepared by:

CATIE Team

Eliécer E. Vargas Ortega, PhD.

MSc. Fernando Rey Majil

MSc. Verónica Manzanero

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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
GOB	Government of Belize
IFAD	International Fund for Agriculture Development
MAFSE	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
GCF	Green Climate Fund

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 especially to its rural areas which accommodates 54.3% of the country's population. Also impacted by Climate Change is the agricultural sector, a major pillar of Belize's economy, and in particular small-scale farmers focused on the production of vegetables and other non-traditional crops. These 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), The Green Climate Fund (GCF), to develop a program entitled "Resilient Rural Belize" (RRB) Program. The RRB Program contracted the Tropical Agriculture Research and Higher Education Center (CATIE) to conduct the value chain analysis and market assessment, focusing on eight preselected commodities, namely, sweet pepper, tomato, onion, cabbage, carrot, hot pepper, pineapple, 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 Onion 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 Onion.

The Onion market in Belize is estimated at an average of 5,414,423 pounds between 2016 and 2020 and valued at BZ \$9,962,538. The processing onion market is unknown at this point as no data has been obtained but is known that processors for Hot Pepper sauces consume onions for their products, both from local production and importations. The main consumers of fresh onions in Belize are households, restaurants, hotels, and fast-food establishments and for processing the two are Marie Sharp's Fine Food Limited and Hot Mama's (currently not operating).

Onion is grown in mostly the north and west districts in the country. The Corozal District is the leading producer of Onion followed by the Orange Walk and Belize Districts. In all districts the main producers of Onion are members of cooperatives.

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 such as land as required by these financial institutions.

The strengthening of the onion value-chain requires strengthening of the cooperatives, one of the main producers of onion. 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, and efficient use of irrigation systems to conserve water, post-harvest technology, processing, and others. Important also, farmers need the knowledge to farm as a business, in most cases during the study most farmers do not have records of cost of production or knowledge if they are operating at a profit or loss.

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 State (SIDS). Impacts from threats such as Climate Change to Belize's agricultural sectors has prompted the adoption of many strategies such as Climate Smart Agriculture (CSA) to the population which is essentially based in the rural areas and whose livelihoods is based mainly in the agriculture sector.

Agriculture is extremely important to Belize's development, providing employment, foreign exchange earnings and is key to food and nutrition security. Approximately, 172,000 hectares or 7.48 percent of Belize's total land area is suitable for agricultural use. An estimated 122,000 hectares or 5.31% of Belize's total land area is cultivated land (FAOSTAT, 2019). The agricultural sector employs an estimated 12.24% of the total population of Belize and an estimated 5.2% are females (FAOSTAT 2019). Primary industries in Belize include Sugar, Banana and Citrus Products which are normally the highest agricultural income earner. In 2020, the highest contributors to the economic output in agriculture in Belize was the non-traditional sector with grains and legumes being the highest contributor (MOA, 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 tuber and vegetables category based on economic value were onion, potato, carrot, and sweet pepper ranking from first to fourth places, respectively (MOA, 2020). The Corozal District is the leading producer of Onion followed by the Orange Walk, and Belize Districts respectively. There is a previous study recorded on the value chain analysis and market assessment of Onion in Belize Carried out by FAO in 2015. Given the dynamics of an onion industry and imports that surpasses 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 Onion in Belize and by extension improving the social and economic situation of small-scale local farmers and also improving food security in Belize.

This Value Chain Analysis and Market Assessment (VCMA) for Onion (*Allium cepa*) in Belize is being conducted by the Tropical Agriculture Research and Higher Education Center (CATIE) in collaboration with the International Fund for Agriculture Development (IFAD), the Green Climate Fund (GCF), and the GOB through the Resilient Rural Belize (RRB) Project.

Although the value chain will be studied at a national level, the priority area of the assessment is the Orange Walk and Corozal Districts which encompasses the village of San Carlos and Indian Church in the Orange Walk District and Patchakan, Xiabe and Conception in the Corozal Districts. The objectives of this VCMA are to (i) map and describe the Onion value chain including the role and relationships between the different actors (producers, transporters, packers, processors, traders, retailers, and consumers) in the value chain; (ii) market potential; (iii) identify challenges and opportunities for the Onion value chain; and (iv) identify and recommend adequate policy interventions based on findings to strengthen the Onion value chain in Belize.

2. Methodology

The Value Chain Market Assessment (VCMA) for Onion 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 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 Onion producers. This includes the following villages (Table 1).

Table 1. Population of the Target Village in the Corozal Walk Districts, 2010

Belize Population by Number of Households and Average Household Size, 2021				
Village	Total	Males	Females	No. of HH
San Carlos	138	74	64	29
Indian Church	267	129	138	67
Patchakan	1374	693	681	281
Xiabie	1575	820	755	335
Concepcion	1256	613	643	257

2.2 Data Collection

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

Collection of secondary data through desk research

There is one pre-existing value chain analysis for Onion in the country done by FAO in 2015. 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 Food Products and the online portal of the Food and Agricultural Organization (FAOSTAT). Research and studies published on Onion production within the last five years in

other countries were targeted in order to identify innovations and technologies that could strengthen the Onion value chain in Belize. The market trends of Onion and cultivation of Onion across Belize, quality standards, restrictions on the production and/or the marketing of the products were also sought. 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 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 allowed interviews of vendors/retailers. These interviews allowed the consultant to have a better understanding of how Onion is grown, processed and marketed, labour requirements, sources of supply of raw materials, market prices, fluctuations in demand throughout the year, sources of financing and contractual relationships with clients. We could not meet or interview intermediary or farmers in both Orange Walk or Corozal District due to the high incidence of Covid-19.
- **Telephone Interviews:** Telephone interviews were carried out with persons that could not accommodate a personal interview, including intermediaries. We asked mainly information on the way they conduct business with farmers and supply retailers at the markets in Belmopan and Belize City.
- **Electronic Interviews:** Electronic interviews were done with persons that could not accommodate a personal interview. Via email three of the major Agrochemical suppliers were contacted and they provided information, mainly on agrochemicals they supply to the Onion growers. They requested that their information remain confidential.

Limitations of the Study

While farmers were willing to cooperate in the study, in general they had limited records of their production costs and yields. So, they could not verify if they operated at a profit or loss. Hence this study has to depend mainly on the national statistics provided by the Ministry of Agriculture to the Statistical Institute of Belize and the processor.

The national statistics presented to the value chain actors at the workshops was questioned as to the accuracy of the data. Efforts in obtaining accurate data and interpreting the data has been challenging for this study. Addressing this issue is part of the general action plan and recommendation offered in this report: reliable information generation should enhance the collaboration among actors of the onion value-chain.

Validation of Value Chain Map by Stakeholders

In order 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 Onion to stakeholders.
- Validate the results.
- Identify and prioritize potential value chain production, processing, and marketing efficiency improvements benefiting small stakeholders, women and other actors along the value chain.

Table 2. Onion 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						

The VCMA workshop consisted of the presentation of the onion VCMA and a group work to identify and prioritize needs that will help to improve or strengthen the value chain. At the VCMA workshop, a presentation of the onion 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 findings and the VC map as presented by the consultants through a group activity which allowed them to identify and prioritize needs that will help to improve or strengthen the value chain.

As shown in Table 2, a double prioritization matrix was used with the participants to prioritize problems/challenges previously identified by the consultants and validated early in the workshop. As many as 6 major challenges/problems were identified and prioritized: training and technical assistance, finances, infrastructure, improved seed, marketing, and inputs purchase. Five of the six problems were given the same level of importance, only purchase of inputs was not prioritized by participants. Farmers have gained some experience in growing onions but there is much that is required on technical assistance and post-harvest storage facilities to meet the local market requirements. It is argued that the local market prefers the imported onions.



Figure 1. Validation workshops with key stakeholders from the value chain

Vetting Validation Results with RRB Agriculture Team

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 Program. During these meetings, further recommendations were made to improve the final document and to meet its objectives.

Value Chain and Climate Vulnerability Assessment Synchronization

During the validation workshop of the VCMA most farmers expressed major concern in unexpected droughts during periods of the year. These have affected the product size and post-harvest capacities of the product. The majority of the onion fields are irrigated but have a rudimentary system. Farmers expressed interest in learning about irrigation which they believe will contribute to better production throughout the year. Floods 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 7 on this report shows the findings concerning the suitability and climate adequacy changes projected in two scenarios.

3. History of Onion Value Chain in Belize

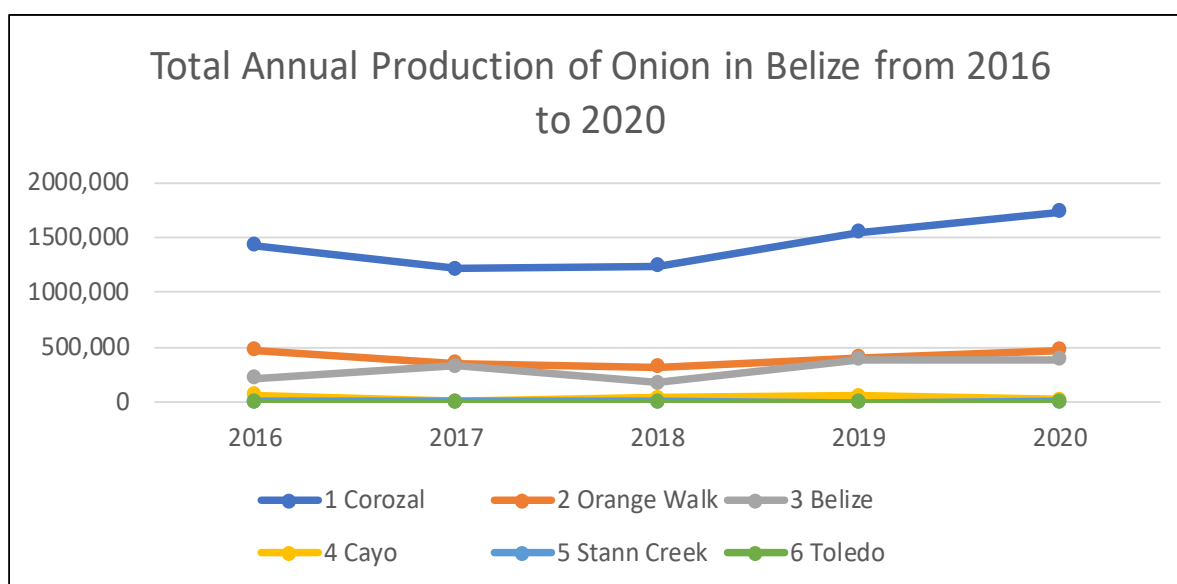
In this section of the report, a generalization about trends in production and demand for onion in Belize is presented. Some of the issues mentioned here will be reiterated in the sections 6 and 7 on market analysis and supply chain.

3.1 Production and historic trends

Onion is produced in five districts in Belize with the Corozal District being the largest producer, see Figure 2, followed by the Orange Walk and Belize Districts (MOA, 2021). The production trend for the Corozal District has been on an upward trend since 2018. The volume for 2020 was estimated around 1.75 million pounds just in Corozal. Marie Sharp's Fine Foods Limited is the main processor in the Stann Creek District for Hot Pepper sauce processing and consumes onions in the process from both local and import sources. The varieties of preference grown in Belize are Santa Ana F1 yellow variety and Don Alberto F1 white variety.

The production trends in Orange Walk and Belize districts were very much constant during the period, with a production of 500.000 pounds on average for each district. Both districts have the local fresh fruit market as their major market. According to interviews and validation workshop, the Covid 19 pandemic which started to affect the country in March of 2020 did not seem to have a drastic effect in production of onions for most districts.

Figure 2. Total Annual Production of Onion in Belize from 2016 to 2020



Derived from Figure 3 and Table 2 the national average yield per acre from 2016 to 2020 is 16.945 pounds /acre. During the period analysed, Belize average 130 acres in production producing a volume of 2,184,000 pounds per year. Onion production in Belize for the domestic market, as fresh fruit targets households and the tourism industry, primarily the food suppliers in local restaurants and hotels in the country and processors. The national average Consumption for 2016 to 2020 accounts for 96.3% of the Onions produced and imported, which is estimated at 5,414,423 pounds.

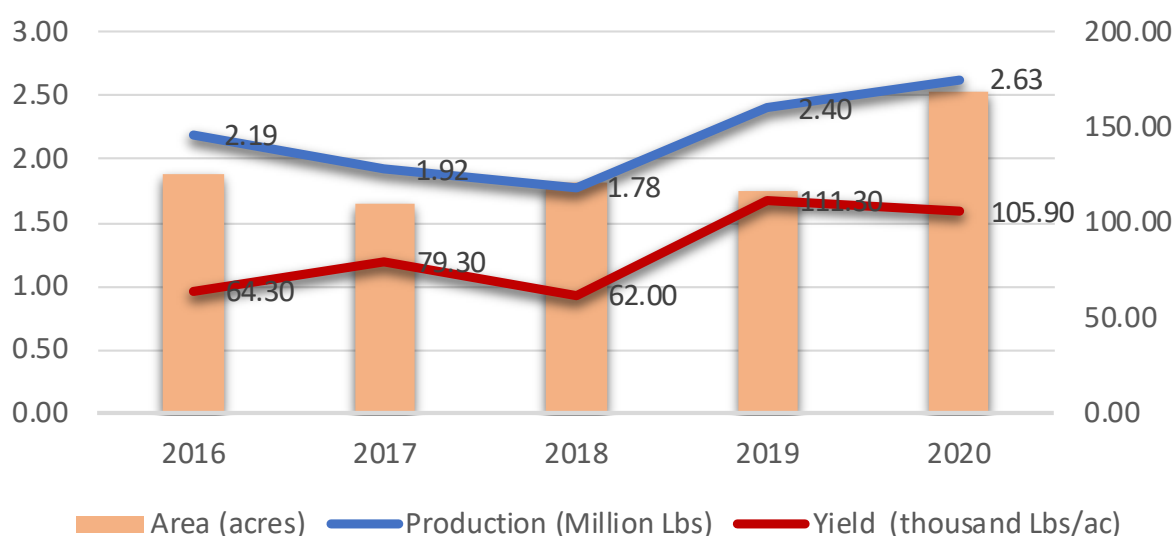


Figure 3. Total Onion Area Harvested, Production and Yield in Belize (2016 to 2020)

Processing accounts for 3.7% (verbal communication with Marie Sharp's Fine Food Limited) of the national average consumption for 2016 to 2020, which is estimated at 200,000 pounds/year. Farmers sell the majority of their fresh produce by pound to an intermediary supplier (Collector) who resells/distribute to retailers such as market vendors. Some farmers sell directly to retailers or directly to consumers such as large upscale restaurants and processors.

Yields by district show some districts reporting recently very good average, i.e., Stann Creek went from 5 000 pounds. in 2016 to almost 35 000 pounds. in 2020 (See table 3). However, fluctuations in yields seems to be the norm with districts reporting one-half differences from one year to the next one. See for example Corozal yields from 2019 to 2020.

Table 3. Total Onion yields in Belize (2016 to 2020) by district and in pounds

District	Annual Average Yield of Onion per District (Pounds.)				
	2016	2017	2018	2019	2020
Corozal	18,527	19,628	18,036	20,252	13,657
Orange Walk	17,000	13,785	8,568	21,136	25,004
Belize	14,536	26,400	17,550	23,229	22,428
Cayo	9,199	9,500	7,819	9,414	10,043
Stann Creek	5,000	10,000	10,000	37,250	34,773
Toledo	0	0	0	0	0

There are two production cycles of Onions 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. Given the differences of these distinctive production cycles, it would be ideal to have yields by production cycle, however, data in that respect was unavailable.

3.2 Onion Demand in Belize

Belize, between 2016 and 2020, consume annually an average of 5,414,423 pounds. of onion. Even though, illegal (contraband) onion is part of the consumption, it was impossible to find an estimate from reliable sources. Table 4 shows the yearly total consumption of fresh Onions in Belize for the past 5 years. The estimated weekly consumption of onions during the period analysed was estimated at 104,123 pounds. Fresh onion was imported into Belize at an average of 3,231,279 pounds/year for the period of 2016 and 2021. This surpasses the local production and shows a lucrative business for importers which are still trying to respond to demand not satisfied by local production.

Table 4. Annual consumption of Fresh Onion in Belize (2016 to 2020) Pounds (Pounds) of Onion / Year

Year	Pounds (Pounds) of Onion/Year			
	Consumption	Production	Imports	Illegal entry
2016	4962,502	2191,900	2770,602	0
2017	4798,070	1917,828	2880,242	0
2018	4830,426	1781,950	3048,476	0
2019	5640,546	2400,177	3240,369	0
2020	6840,569	2623,869	4216,700	0

Although imports consistently have represented more than the national production during the study period, that balance in favour of imports has been extended recently. In 2016, national production and imports were somehow balanced, by 2020 imports almost doubled national production. National production in Belize is showing signs of losing competitiveness against imports.

As indicated previously, onions are also demanded by processors. Marie Sharp's Fine Foods Limited is the main processor in the Stann Creek District for Hot Pepper sauce processing and consumes onions in the process from both local and import sources. A verbal communication with Marie Sharp's Fine Food Limited indicates that, on average, they have demanded 200,000 pounds/year for the 2016-2020 period. Considering that, for example the national consumption of onions for 2020 was around 6 800 000 pounds that means that 3% is derived demand.

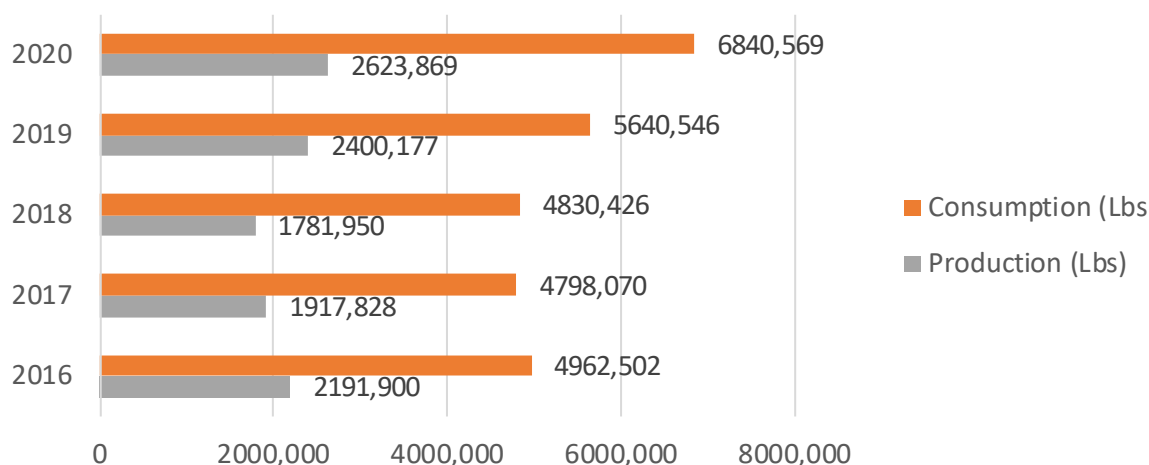


Figure 4. Annual Onion Production and Consumption (Pounds.) in Belize 2016 to 2021.

Data on processed Onion in Belize (2016 to 2020) has no official source, therefore obtaining that information is, at this moment, entirely dependent on the industry. The consulting team communicated with the industry on several occasions. Although, the industry shows willingness to provide data, at the moment of writing this report, we have not received such data.

3.3 Quality Standards of Onion Production in Belize

The Belize Bureau of Standards is tasked with developing quality standards for agricultural commodities in Belize. To date, there are only three quality standards drafted for agricultural commodities. The BBS will use the Onion quality standards that exist in:

CARICOM Regional Organization for Standards and Quality (CROSQ), 2nd Floor Nicholas House 29 & 30 Broad Street Bridgetown, St Michael Barbados T: 246.622.7670 | F: 246.622.7678. Website: <http://www.crosq.org> © CROSQ 2010 – All rights reserved Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission.

CARICOM REGIONAL STANDARD: Specification for grades of fresh agricultural produce. Part 4: Onions CRS 24: Part 4: 2010

The BBS have put in place recommendations for the agricultural sector pertinent to the 8 value chains identified under the IFAD RRB Programme. In 2004, Belize established the national standard for onions as compulsory (BZS 13: 2004) which requires revision and harmonization with current best practices. To establish a level playing field, it will be imperative to ensure that

standards and other elements for Quality Systems¹ are introduced and applied in all aspects of the onion value chain.

What follows is the description of the national standard specification for onions (BZS 13: 2004). The national standard requirements include but not limited to the following:

- a. onions must be whole, firm, and clean.
- b. shape, flavour, and odour characteristic of the variety.
- c. free from bruises; foreign matter; holes and damages caused by pests; damage caused by extreme temperatures; foreign smell and/or taste.
- d. classification across three classes namely Premium “Extra Class”, I and II.
- e. size designations namely large, medium, small, and extra small.
- f. tolerance levels across size and classifications.
- g. packaging and labelling.
- h. contaminants in relation to heavy metals and pesticide residues; and
- i. food hygiene requirements.
- j. growing and harvesting to adhere to Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs).

It is argued by the BBS that “currently there exists challenges in relation to size classification, seed selection criteria, pesticide management, agronomic practices, distinction in quality to imported onions, among others”. This underpins the need to ensure that standards and quality systems are embedded in the onion value chain at all levels thereby not only improving efficiencies and competitiveness but ensuring that the buyers and sellers needs are fulfilled.

¹ 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 Onion Value Chain in Belize consists of input suppliers, producers, intermediaries (Collectors), processor, retailers, and consumers. Other actors are classified as supporter and enablers, and they provide financial and technical services or provide support to in developing policies to strengthen the value chain. Presented below in Figure 5 is the map of the Onion value chain in Belize.

4.1 Value Chain Map

The value chain for onions in Belize is short and focused on fresh product: less than 4% of onions supply end in transformation to sauces. Even a unique characteristic is the presence of farmer's cooperative (Figure 5)

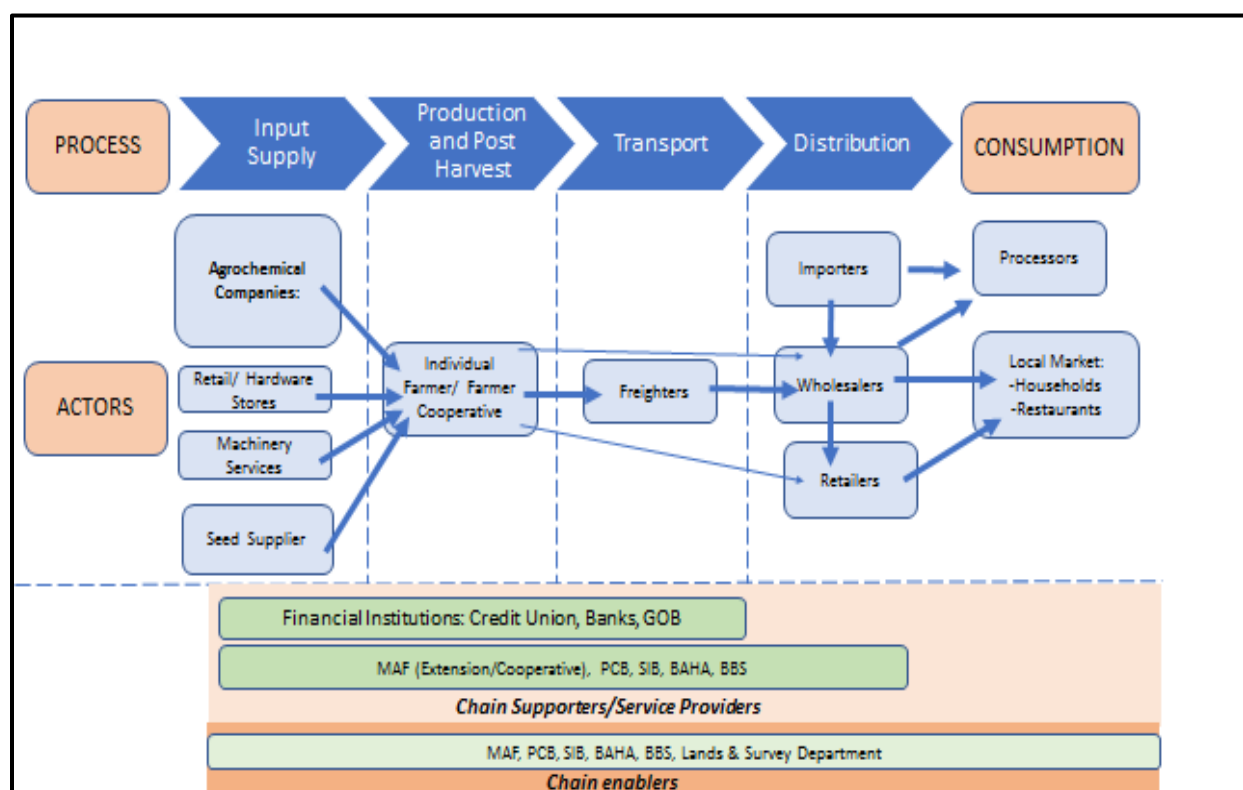


Figure 5. Value Chain Map for Onion in Belize

4.2 Description of the Onion 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 seed 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 Onions are Bel-Agro Enterprise, Prosser Fertilizer and Agrotec Company Ltd. and Circle R Limited. For Stann Creek and Cayo districts Agriprec, Agro Vet. Jiron and Son's Ltd as well as Prosser Fertilizer provide many products to farmers. The larger stores can provide onion seeds, insecticides, fungicides, herbicides, fertilizers, onion netted bags, small equipment, and irrigation equipment (Carballo, 2016).

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 provides customers with outstanding products and services for farm, mill, or family use. For more than 25 years Circle R Products have 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 Onion value chain in Belize, the main producers are in the Corozal District and followed by the Orange Walk and Belize Districts. There are individual farmers and farmers that belong to Cooperatives. In San Carlos Village, the majority of the Onion farmers belong to the **New River Farmers' Co-operative Society Ltd.** Currently, this cooperative has 39 members. In the Corozal District is the **Concepcion Farmers Group**, this group has 22 members (RRB 2020).

Small, medium, and large-scale onion producers cultivate 0.5, 3, and 7 acres, respectively. Most are open field with irrigation and oriented to the local market. Most are members of cooperative and male producers. For Corozal and Orange Walk districts 73 farmers were identified, only 3 of them are women.

For many of these farmers, profit obtained from Onion production is not their only income source as many of them do 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.

In 2016, it was estimated that 60 farmers produced onions from villages in the Corozal, Little Belize and Orange Walk. They undertake planting, harvesting and post-harvest operations (Carballo, 2016).

Importers

There is a major importation of fresh fruit Onions as the amount surpasses the national production and is a lucrative business for importers. Importation of onions is done through legal and illegal channels:

- The Belize – Country Commercial Guide shows that onions are not on the list of “Prohibited and Restricted Imports”. This means that fresh onions can be imported to Belize (International Trade Administration, 2022).
- Data requested from BAHA on the illegal importation/confiscation of Onions is non-existent. No confiscations have been documented between 2016 to 2020 (BAHA, 2021).
- The Belize Marketing & Development Corporation (BMDC), a statutory body of the Government of Belize, is the main importer of onions (Carballo, 2016, pág. 10).

- The Observatory of Economic Complexity (OEC, 2022) shows that Belize imported onions at:
 - 2020 (US\$ 2.15 Million)
 - 2019 (US\$ 1.23 Million)
 - 2018 (US\$ 1.46 Million)
 - 2017(US\$ 1.28 Million)
 - 2016 (US\$ 1.46 Million)
 - 2015 (US\$ 0.69 Million)
 - 2014 (US\$ 0.80 Million)
 - 2013 (US\$ 0.79 Million)

Business supporters:

The Vegetable Interdiction Unit is comprised of officials from the Belize Agricultural Health Authority (BAHA), Customs, the Police’s Mobile Interdiction Team (MIT), the Belize Defence Force (BDF) and the respective Police divisions. According to the National Extension Service, the Vegetable Interdiction Unit “was established to mitigate against contraband and similar illegal activities that threaten the quality, availability, phytosanitary measures and price of local vegetable commodities”.

On the other hand, the Belize Marketing and Development Corporation (BMDC) is a statutory body under the Ministry of Agriculture, Food Security and Enterprise with the mandate to assist in the economic development of Belize by ensuring food security, enhancing product development, providing marketing services for small agro-businesses, and operating on an environmentally friendly, sustainable, and viable basis. As such, it offers showcasing and marketing for products both locally and globally.

Intermediaries (Collectors)

Intermediaries are middlemen who collect and purchase Onion locally and who sometimes develop long term relationships with farmers.

In 2016, other value chain analysis of onion identified freighters. A freighter is a type of middleman which plays a major role in the distribution of onions 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 (2026), identified the “wholesalers”, who are individuals or businesses that purchase either onions 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, 18):

- Supermarkets have storage facilities/space for produce.
- Hucksters are permanent vegetable dealers.
- Farmers are also wholesalers in public markets of Corozal Town, Orange Walk Town and Belize City.
- Retailers are normally found in public markets, where stalls are stocked with onions, as well as other items.
- Grocery stores, which are located conveniently almost everywhere, also retail onions which are obtained from wholesalers.
- Ambulant retailers play their role by going from house to house selling their produce.
- Mennonites are also seen as ambulant retailers (Northern Belize), because they often seen selling produce along the roadside.
- There are four main suppliers or of onions to the market, namely:
 - Local Farmers – mainly from January to July;
 - BMDC imports – mainly from August to January;
 - Other Individual importers – no specific time; and
 - Illegal/Contraband – throughout the year.

Consumers

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

The consumers of Onion created a market that is considered simple and unsophisticated, as onions are mainly sold as a fresh product through existing market channels. Three main categories of onions are consumed (yellow <is the most desired>, white <satisfy the market in the absence of yellow onion>, and red), and all of them are sold as dry bulb onions (Carballo, 2016)

Carballo (2016) estimated the size of fresh onion market at 108,000 lbs per week, or approximately 5,616,000 lbs per year.

Table 5. Onion Consumption Analysis (Carballo, 2016).

Legal Weekly Consumption	Illegal/Contraband (20% of Consumption)	Total Weekly Consumption	Total Yearly Consumption
90,000 lb.	18,000 lb.	108,000 lb.	5,616,000 lb.

Carballo (2016, p. 13) estimated the local demand with data from domestic production and legally authorized imports. Additionally, the estimate for illegal or contraband onions was derived from consultations with stakeholders, including farmers and custom officials.

Processor

There are cottage and commercial processors which use onions in their product formulations, it's important to note that cottage processors usually get their supplies from wholesalers (Carballo, 2016, pág. 11).

- Processors such as Marie Sharpe import onions that are used in the production of their sauces (Ibidem).
- Other established processors use imported onions in their operations, given reliability of supplies (Ibidem).
- Marie Sharp's Fine Foods Limited is the major processor that consumes onions at 200,000 pounds of Onions per year.

The role of women in the onion value chain

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

Francine and the Ministry of Agriculture's support team (included Jose Mai, focusing on the Orange Walk District), and the agriculture extension staff sustained a period of boom production of onion, carrot, and Irish potatoes from the 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.

4.3 Profit Margins and Shared Benefits along the value chain

Cost of production and prices across the value chain were obtained from the Ministry of Agriculture. Table 6 shows an analysis of the profit margins and share benefits along the value chain for fresh fruit Onions. Consumer price is around Bz\$ 1.84 per pound. Retailers buy onions for Bz\$0.75 from collectors which implies their commercialization margin is more than double of the purchase price, 59% gross margin.

Collectors on average purchase onions for Bz\$ 0.68 from farmers, and since they sell it to retailers for Bz\$ 0.75, their commercialization margin is around 10%. The data shows that for the farmer the cost of inputs is high around 50% of his selling price. It is reported that sometimes the farmer does direct selling to the local market and consumers which increases his gross margin.

Table 6. Profit Margins and Shared Benefits along the value chain for Fresh Fruit Onion

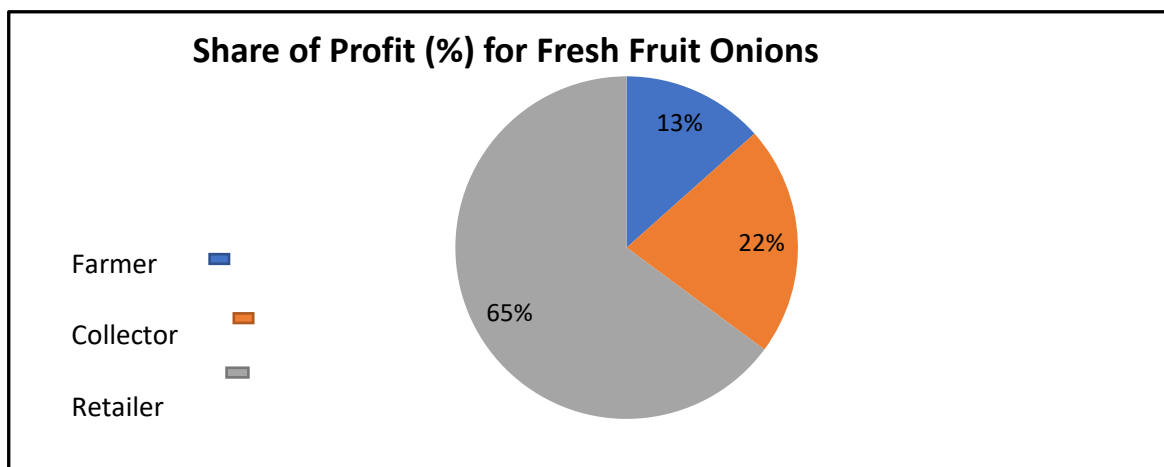
Average Onion (Lb) marketing costs and benefit shares of actors				
Description	Actors			
	Farmers	Collectors	Retailers	Horizontal Sum
Purchase Price (Bz\$)	0.00	0.68	0.75	1.43
Total Input Cost (Bz\$)	0.34	0.20	0.20	0.74
Sale Price (Bz\$)	0.68	0.75	1.84	3.27
Market Margin (Bz\$)	0.68	0.07	1.09	1.84
% share of margin	37.0	3.8	59.2	100.0
Profit Margin (Bz\$)	0.34	0.55	1.64	2.53
% of share of profit	13.4	21.7	64.8	100.0

Price-5 yr average

By estimating total input cost for each of the actors in the value chain, it is possible to get a proxy of profit margins. Thus farmers, collectors, and retailers could be making for each pound, profits of 0.34, 0.07, and 0.89 Bz\$, respectively. However, profit margins require information on

investment, administration cost and other costs that we were not able to obtain. The percentage of share of profit for each actor is presented in Figure 6.

Figure 6. Share of profit of actors for the Onion fresh fruit market in Belize.



5. Market Analysis

Onion is cultivated mainly in the northern and western districts of Belize and is available year-round. The main Onion varieties are the Santa Ana F1, yellow variety and the Don Alberto F1, white variety.

5.1 Market Size

The estimated weekly consumption of Onions in Belize is 104,123 pounds per week. Between 2016 and 2020 it was estimated that an average of 5, 414,423 pounds. of onion was consumed in Belize per year. The amount produced locally does not meet the market demands, therefore, there is a need for importation. In general, for most vegetables the production and shipping costs are cheaper in the import countries. The population also prefers the imported onions and other vegetables mostly because of colour attributes or just the perception of a better product, perception that participants in the workshop were not able to explain.

5.2 Market Channel

A significant amount of the Onion produced by the Cooperative in the case of San Carlos and Concepcion Villages is sold to collectors, then to retailers and finally to consumers. This by far is the most important marketing channel for national production and brings the question of why the cooperatives have not tried to sell directly to retailers. Two possible details came from interviews: first, onions may not be the most important product for all farmers in the cooperative, also importers and distributors play a major role and control many of the selling points in the end-markets.

The main marketing channels identified from the point of production to consumers through intermediaries for Onions in Belize are shown in Figure 7.

However, all those channels carry out also imported onions which compete in price, quality, and volume. According to farmers, imports do affect them all year long. It is not clear if farmers and their organizations are able to differentiate between competition from legal imports or contraband Onion.

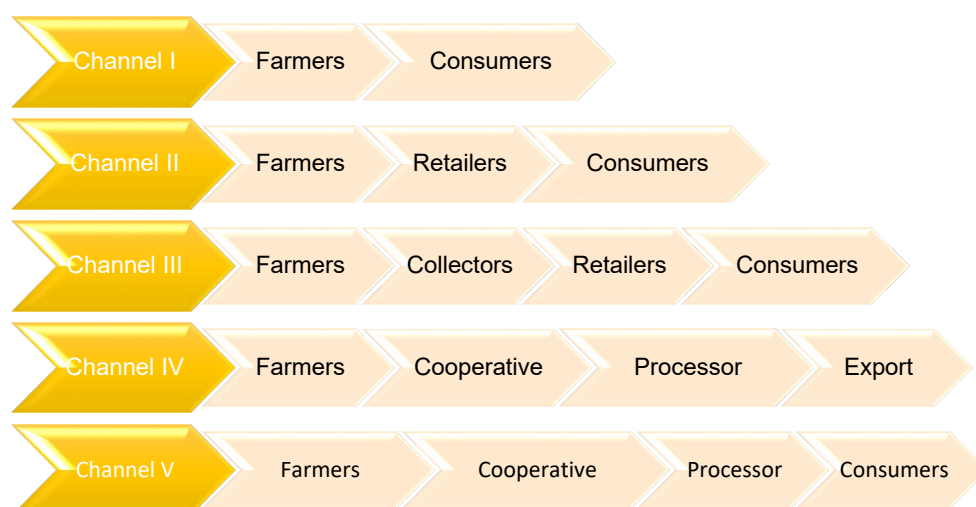


Figure 7. Main Marketing Channels for Onion

5.3 Price trend of Onion in Belize

During the period from 2016 to 2020, the producer and retail price-gap for a pound of onion shows almost no fluctuation. The average prices for onion in Belize are Bz \$0.68/lb. and Bz \$1.84/lb. for the producer and the retailer, respectively.

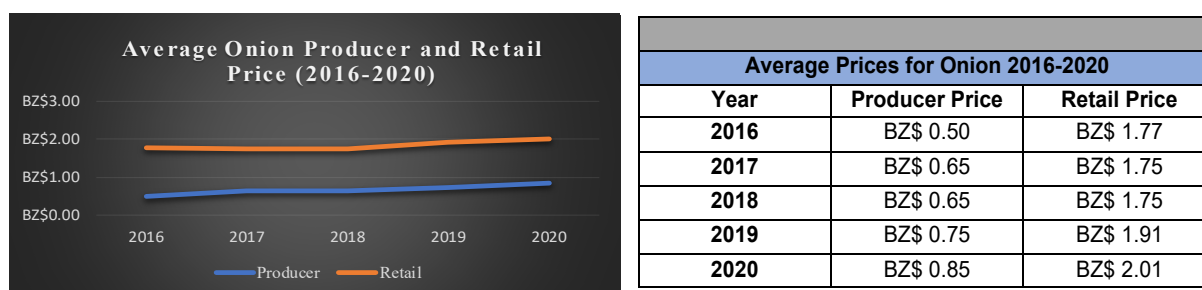


Figure 8. Price Trend for Onion Production in Belize (2016 to 2020) at Producer's Price (SIB)

During 2016 and 2020, producer price increased from Bz\$0.50 in 2016 to Bz\$0.85 in 2020 while the retail price increased from Bz\$1.77 in 2016 to Bz\$2.01 in 2020. The gap on prices has been constant during that period for around Bz\$1.12.

6. Supply Chain

The supply chain considers the production, importation, profitability and cost of production across the value chain. Belize has limited information and it is common to find incongruencies and questionable numbers. What follows is the most current and reliable information available for Onion. The data was presented at the workshops with producers and other members/actors of the value chain for its validation.

6.1 Amount Supplied

The total production of Onion in 2020 in the country was estimated at 2,623,869 pounds and valued at BZ \$4,827, 919 (SIB, 2020). The main suppliers of Onion in Belize are importers with an estimated 62% of the national consumption. Farmers supply about 38% of the national consumption.

Table 7 shows the annual supply of Onions per district for the Onion market. The main suppliers of Onions in Belize are importers, individual producers and those organized in co-operatives. Corozal District has been the major producer of onions.

Table 7. Annual Supply of Onion (pounds) (2016 to 2020)

District	Total Annual Production (Pounds)				
	2016	2017	2018	2019	2020
Corozal	1426,600	1216,928	1244,450	1545,200	1734,469
Orange Walk	476,000	358,400	317,500	405,002	475,075
Belize	219,500	330,000	175,500	390,250	388,000
Cayo	64,800	7,500	40,000	56,000	22,500
Stann Creek	5,000	5,000	5,000	3,725	3,825
Toledo	0	0	0	0	0
Total	2191,900	1917,828	1781,950	2400,177	2623,869

On average, the contribution of Corozal District to the national production during the 2016-2020 period has been about 65%. Table 8 registers total area dedicated to the production of onions by

district for the period 2016 - 2020. Using the total area harvested and production for each of the districts, an average yield per district was estimated and is shown in the last column of Table 8.

Most districts have average yields about 19 000 pounds per acre except for Cayo District showing consistently a lower average yield (8 000 pounds/year). As a matter of fact, Cayo District has underperformed every year with yields below the country's average (Table 8 and Table 9).

Table 8. Total Area of Onion Harvested (Ac) 2016 to 2020.

District	Total Area Harvested (Ac.)					Average Yield
	2016	2017	2018	2019	2020	
Corozal	77.00	62.00	69.00	76.00	127.00	18036
Orange Walk	28.00	26.00	37.00	19.00	19.00	17134
Belize	15.00	13.00	10.00	17.00	17.00	20669
Cayo	5.00	8.00	5.00	4.00	6.00	7930
Stann Creek	1.00	0.50	0.50	0.10	0.11	19405
Toledo	0.00	0.00	0.00	0.00	0.00	0
Total Belize	126.0	109.5	121.5	116.1	169.1	

A note must be made about Corozal historical yields given the importance of this district for the Onion sector. For Corozal in 2020, a lower yield is reported, 14000 pounds/Ac. This yield is inconsistent with the historical behaviour since Corozal's yields have always been above the country's average. We expect this discrepancy to be corrected after data review by officials (it may be an issue of timing and reporting). However, if future official publications contain the same data, it will be paramount to understand what happened in 2020 with the yield for the Corozal district since what happens in this district will probably dictate the behaviour of the sector as a whole.

Table 9. Onion Yield per acre by District of Belize, in pounds for the period 2016 to 2020

District	Total Area Harvested (Ac.)					Average 2016/2020
	2016	2017	2018	2019	2020	
Corozal	18527	19628	18036	20332	13657	18036
Orange Walk	17000	13785	8568	21316	25004	17134
Belize	14633	25385	17550	22956	22824	20669
Cayo	12960	938	8000	14000	3750	7930
Stann Creek	5000	10000	10000	37250	34773	19405
Toledo	0	0	0	0	0	0

Source: Own elaboration using Tables 6 and 7

6.2 Cost of Production

The Ministry of Agriculture estimates that BZ\$ 0.34 is needed to produce a pound of Onion for the Belize market. Due to lack of accurate data to confirm this, more detailed work is needed in conducting proper feasibility studies for this crop. A recent estimate for the cost structure of production of onion is summarized in Table 10. The detailed numbers of the original source are given in ANNEX 3. *Cost of Production for One Acre of Onion, Belize, 2021* of this report.

Table 10 shows that the estimated cost for one acre of Onion is almost BZ\$ 5000, and the cost per pound produced is around BZ\$ 0.49. Our calculation includes a 15% contingency cost which does not appear in the original source. However, even if we do not use the contingency percentage, the cost per pound of onion is BZ\$ 0.43. Arguably, the poor quality and availability of cost information for this important crop, reflects some of the challenges that RRB needs to confront. Even the cooperatives are not able to provide basic cost structures/information. Coping with constant competition from importers, and hypothesized loss of competitiveness, cost information is essential.

Table 10. Onion Cost of Production for one Acre (BZ\$ and %), 2021

	Cost of One Acre of Onion (BZ\$ and percentage)		
Preparation Land/seed		\$ 335.00	6.78%
Inputs		\$ 1,523.00	30.81%
Seed	\$ 850.00		17.20%
Fertilizer	\$ 430.00		8.70%
other agrochemicals	\$ 243.00		4.92%
Labor		\$ 490.00	9.91%
Harvesting	\$ 210.00		4.25%
Other labour	\$ 280.00		5.66%
Material/equipment		\$ 1,950.00	39.45%
Total Operational Cost		\$ 4,298.00	86.96%
Contingencies		644.7	13.04%
Cost of Production		\$ 4,942.70	100.00%
Yield (Pounds/acre)	10000		
Cost per Pound		\$ 0.49	

Table 10 also shows how the different components of the production cost contribute to the cost of production per acre of onion. Materials and equipment component makes up 39% and Input 31% of the total cost. Labour represents around 10%, where harvesting is almost half of that percentage. During the participatory workshop with onion producers, they mentioned the challenges that the price of seed represented for their production. As shown in our calculation, seed represents at least 17% (BZ\$ 850) of the production cost. Clearly, this single item has a greater affect than all the labour cost. A similar argument applies to the cost of fertilizers when compared with labour cost. A final note about Table 10, the materials and equipment component has a cost for Drip Line Roll and a cost for Gas listed as the major contributors.

However, the real challenge is getting information about contraband and understand how it affects the bottom-line of the farmer and price competitiveness of the value chain. Given the high cost of seed and agrochemicals for Onion production, reasons behind those high prices should be investigated, this subject was a concern that farmers presented during both workshops and interviews.

7. Climate Change Vulnerability and the Onion (*Allium cepa*) Value-chain

While value-chain dynamics is commonly analyzed and described in 3, 5, or 10 year periods, and most experts will avoid market prospects or projections beyond the 10 year mark, any climate analysis is described in longer periods. Climate dynamics is rarely described in short periods of years as experts understand the limited predictable value of 3, 5, or 10 year forecasting. In addition, climate forecasting, in general terms, will be useful for the decision-making process in the Onion 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 livelihood of the Onion business.

For this report, we bring into context the Onion 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 the findings are presented below. First, we report changes in climate adequacy for Onion production for the whole country of Belize. Using maps and a colour code to understand those changes, a general futuristic perspective to produce Onion can be described. Second, findings specifically for the 10 intervention areas of the RRB program are presented. Aiming to describe the uniqueness of each area and how this could bring a similar or very different picture of the future for Onion production, we identify losses and gains in suitability or adequacy in percentages of the adequacy from the base line data.

7.1 Onion Value Chain and Changes in Climate Adequacy for Belize

By comparing current climate conditions and future climate conditions, the climate vulnerability assessment team provides a first ever effort to understand possible changes in climate adequacy for the production of Onion 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 the weather conditions over the 30-year period 2041 – 2070 (i.e. centered in the 2050s), consistent with the definition of climate by the World Meteorological Organization. Again, focusing on the projected changes in precipitation and temperature.

Third, the results (comparisons) are based on a construction of climate projections from a 21 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 Corozal up to 1.5°C in 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 which are defined by a pair of parameters of each variable (temperature and precipitation). The first range is that defined by the minimum and maximum temperature, as well as the minimum and maximum precipitation, in which we can find the species (absolute range); that is, 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 9 shows the interaction between precipitation and temperature parameters for absolute and optimal ranges.

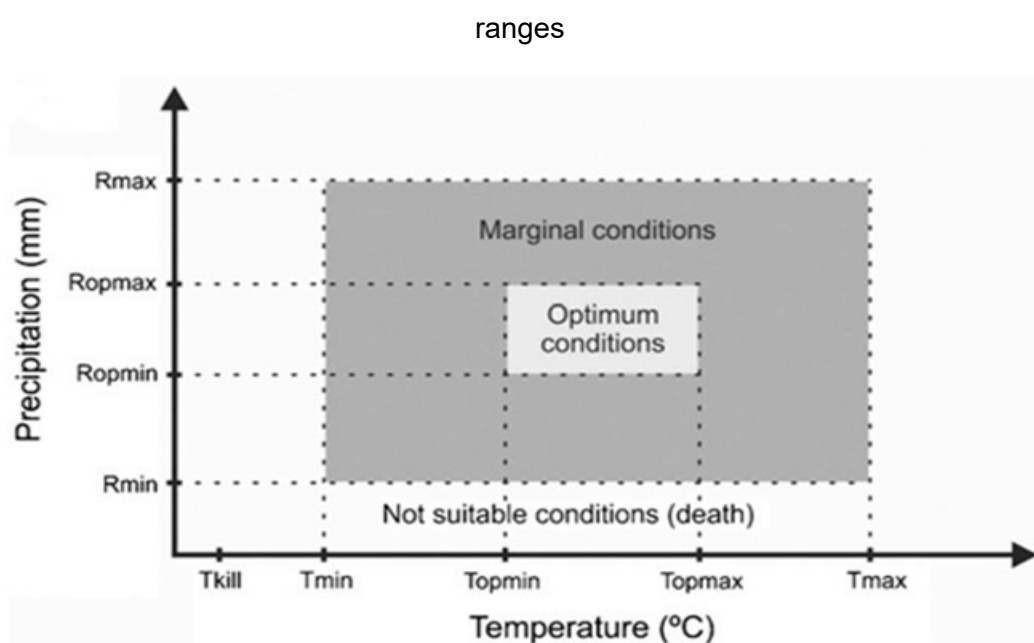


Figure 9. Interaction between Precipitation and Temperature Parameters for Absolute and Optimal

Table 11 shows climatic parameters considered in the climate adequacy analysis for Onion production, prioritized in the RRB project. The optimum range in temperature is between 12 and 24 C° and the precipitation between 350 and 600 mm.

Table 11. Climate Parameters Considered in the Climate Adequacy Analysis Requested for the Onion Value Chain Prioritized in the RRB project

Description of parameter used in the model	Value used
Gmin: Minimum duration of the growing season	85
Gmax: Maximum duration of the growing season	175
Gused: Used duration of the growing season	130
Tkmp: Temperature (°C) below which the species cannot survive	0
Tmin: Lower limit of the absolute temperature range (°C)	4
Topmin: Lower limit of the optimum temperature range (°C)	12
Topmax: Upper limit of the optimum temperature range (°C)	25
Tmax: Upper limit of the absolute temperature range (°C)	30
Rmin: Lower precipitation limit (mm) of the absolute range	300
Ropmin: Lower precipitation limit (mm) of the optimal range	350
Ropmax: Upper limit of precipitation (mm) of the optimal range	600
Rmax: Upper precipitation limit (mm) of the absolute range	2800

Fifth, a reclassification of modelling results with EcoCrop was carried out. To process the suitability data, the results were reclassified into quintiles; thus, the value of less than 20% of the suitability range corresponds to the very low class, while the very high adequacy range (dark green colour) corresponds to a scale greater than 80% in the adequacy scale resulting from modelling with EcoCrop. On the other hand, the comparison between the results of the adaptation according to the current climatology and the future scenarios were also reclassified in such a way that the dark green colour correspond to the areas where gains would be experienced in climatic conditions for the crop analyzed (it implies, for example, areas that pass from a category of low suitability to a category of higher 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 Onion (*Allium cepa*) cultivation in Belize using the selected species at the national level. Figure 10 maps the climate adequacy for cultivating Onion 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. Figure 10 maps the general losses and gains in adequacy comparing each scenario with the base-line climate adequacy for Onion production in the whole country.

Under both scenarios, climate adequacy to produce Onion will be reduced in areas of the southeast and northern regions (Figure 10). Whenever the analysis focuses on areas losing or gaining suitability for the cultivation of Onion, Figure 11 shows that RCP8,5 scenario is more critical: the extension of area losing suitability are much more significant, visually represented by the brown areas.

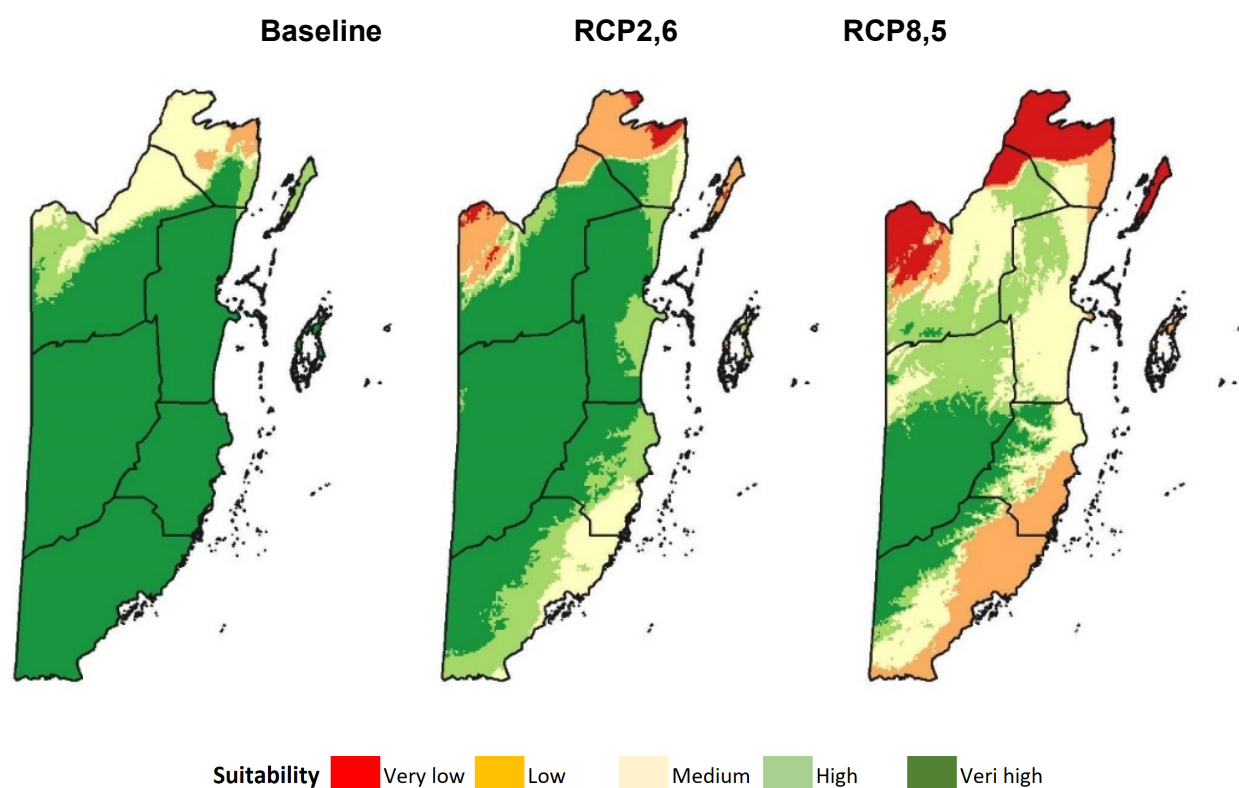


Figure 10. Comparison of Climate Adequacy for Onion (*A. cepa*) between Baseline Conditions and two scenarios for the year 2050

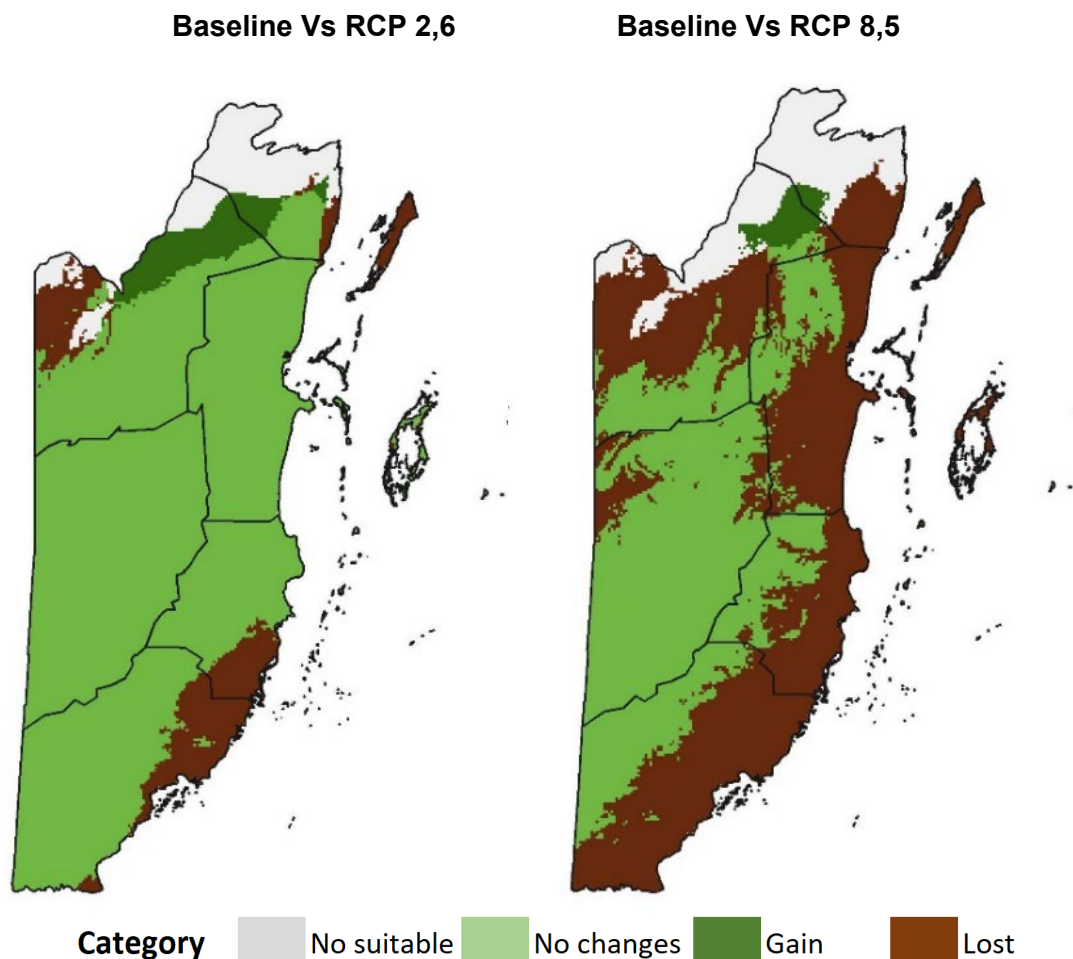


Figure 11. Gain and Losses in Climate Adequacy Under two different Scenarios of Climate Change for Onion Production in Belize

7.2 Onion Value Chain and Changes in Climate Adequacy for RRB 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 10 intervention areas (Assessment Units of the Rural Resilience Program in Belize RRB) and it is in those areas where knowing how conditions will affect our value chain has been prioritized. We note, for our value chain, the future may play significantly different at RRB's intervention areas than at the national level. Assessment Units of the Rural Resilience Program in Belize (RRB) are shown in Figure 12.

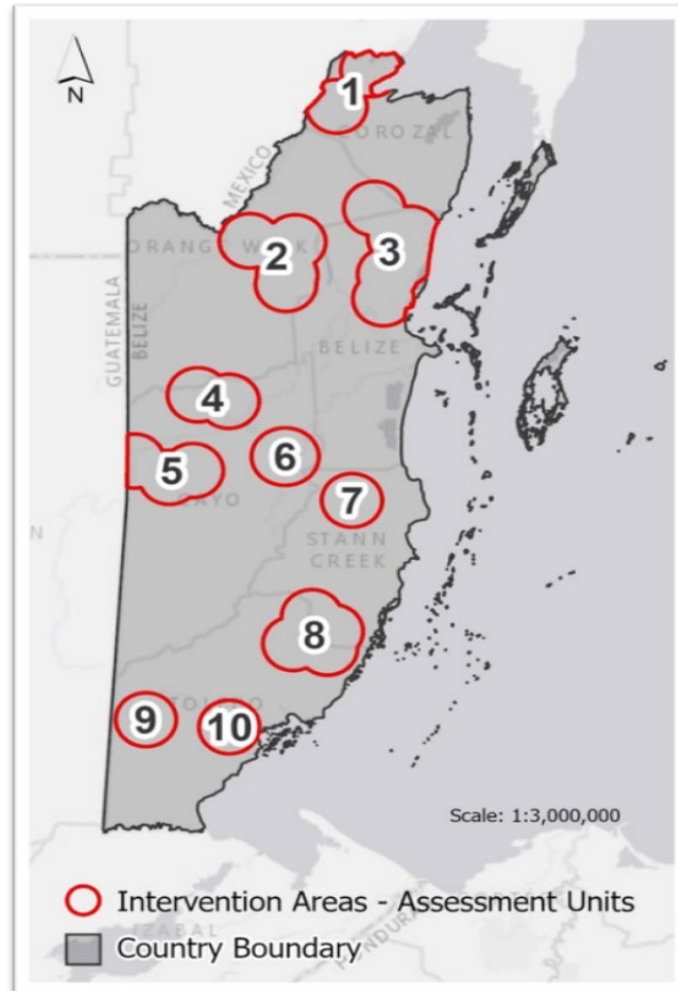


Figure 12. Mapping Intervention Areas-Assessment Units of the Resilience Rural Belize Program

Table 12 shows changes in climate adequacy between baseline and future scenarios for onion (*A. cepa*) cultivation in Belize as a percentage of each RRB programme intervention area. When an intervention area is the focus of the comparison between scenarios, and not for the whole country, it is possible to identify areas of intervention in Toledo District as the major loser of suitability for Onion cultivation. Similarly, the intervention area in Corozal District is projected to be completely (100%) unsuitable to produce Onion. This last finding could be misleading if we take in consideration that Corozal District is the major producer of Onion. Will Corozal District be forced out of the production of Onion? Not at all. Our modelling takes into consideration precipitation and temperature but have not taken into consideration the production technology. Corozal production depends on irrigation (superficial), therefore if the natural conditions for growing onions become less adequate, it does not necessarily mean it will be unsuitable using

irrigation. However, we should make a note on the importance of modelling irrigation/water accessibility for the district.

Table 12 shows that some intervention areas, noticeably areas 8, 9 and 2, will experience major losses in their suitability and adequacy for Onion production. This implies that RRB should prepare a long run plan for introducing adaptation practices for farmers in these villages. The loss in climatic capacity for cultivation in these and other areas of intervention means that seasonality of rainfall will be increasingly risky and costly. For intervention area 3 located in the northern part of Belize District, a small gain in suitability is projected. In general, future climate changes could be argued to have a limited impact for the cultivation of Onion in RRB target communities if irrigation technologies are efficiently implemented.

Table 12. Changes in Climate Adequacy between Baseline and Future Scenarios for Onion (*A. cepa*) Growing in Belize, in percentage of Land in Each Intervention Area

Change direction Percentage (%)	Intervention Areas- Assessment Units									
	1	2	3	4	5	6	7	8	9	10
	RCP 2,6									
Gain		18.9	3.04							
Not Suitable	100									
Loss			0.08					62.8		8.36
No changes		81.1	96.9	100	100	100	100	37.2	100	91.6
	RCP 8,5									
	1	2	3	4	5	6	7	8	9	10
	RCP 8,5									
Gain			2.82							
Not Suitable	100	18.9	0.23							
Loss		73	57.7	4.33	24.8	25.6	18.3	93.7	7.05	99.7
No changes		8.11	39.3	95.7	75.2	74.4	81.7	6.32	93	0.26

Source: authors of the CVA report, in draft

8. Constraints and Opportunities

The production of Onion is being given priority by the Government of Belize through the Resilient Rural Belize (RRB) Program. This in itself is very positive for the Onion Industry; therefore, all the challenges and opportunities need to be examined in detail to strengthen the value chain. Table 13 presents the constraints and opportunities identified in our Onion Value Chain and End-Market Assessment. It also confirms many of the finding of Carballo (2016). Carballo (2016) analyzed the Baseline Survey Report conducted by FAO (2015) and reported that major production constraints are related to: a) Establishment of the crop (initial fertilization, planting equipment), cultivation practices, moisture management, and pest and disease control; b) Post-harvest problems include a lack of curing facilities, which adversely impacts the shelf life of the onions; and, c) Improper storage also leads to high post-harvest losses, which are recorded between 10 to 15 percent.

Table 13. Challenges and Opportunities for Onion Value Chain in Belize

Chain link	Constraints	Opportunities
Input Supplies	High costs of inputs: <ul style="list-style-type: none"> Very high cost of fertilizers, seeds, and pesticides. 	<ul style="list-style-type: none"> Farmers' s organizations, like cooperatives, could be engaged in buying volume and transferring cost savings to individual farmers. For the onion, a potential reduction in the cost of seed could help significantly in reducing the cost of production. Substituting organic fertilizers could be explored as a cheaper alternative to chemical fertilizers. This could be analyzed 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.

Chain link	Constraints	Opportunities
		<ul style="list-style-type: none"> The prices of inputs (i.e., fertilizer and pesticides) may not change rapidly enough but efficiency in the application could be tremendous. Training on the basics of efficient use could reduce the total bill paid by farmers.
	Seed Quality and Availability: <ul style="list-style-type: none"> Seed prices are high 	<ul style="list-style-type: none"> Opportunity for collaboration and strengthening of relationships between farmers, agronomists, and local extension services for training in Good Agriculture Practices. Facilitate importation of seeds and establish local seed banks to supply farmers. Are international prices for onion seed more expensive than other countries? Why? These questions could help to find alternatives for this constraint. 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 use the best seeds even if the farmer is willing to pay for them.
	Poor Knowledge of the use of inputs <ul style="list-style-type: none"> Poor knowledge of the use of pesticide application, and fertilizer programs. 	<ul style="list-style-type: none"> Training on the proper use of agrochemicals and/or organic or more sustainable alternatives, Also, training for equipment use in irrigation. The information given to the farmer must be calibrated/reviewed together with the input provider. The training and what the farmer learns whenever they buy inputs need to be correlated. Information sharing on alternative inputs (i.e., organic fertilizers) could be promoted by local extension services.
Production	Annual Production Plans (APP) are not common practice.	<ul style="list-style-type: none"> Training in APP and/or technical assistance to organize an annual production plan for a constant supply of Onion.

Chain link	Constraints	Opportunities
	<ul style="list-style-type: none"> Especially for Onion destined for the local market, an APP is very important to meet demand and avoid oversupply. 	<ul style="list-style-type: none"> 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. Onion small-scale producers may not see immediate benefits from implementing an annual production plan because they may be using collectors to get to market. However, it is possible to think that those producers may benefit from coordinating their small-scale operations with a “group” annual production plan, which will bring the possibility to coordinate transportation and direct sales to include better price conditions.
Harvest and Post-Harvest	Climate Vulnerability <ul style="list-style-type: none"> Farmers depend on the seasonal rainy season and not much emphasis on climate change. Post-harvest facilities are not common or bad conditions, limiting the capacity to cure and store the product. 	<ul style="list-style-type: none"> Share information on climate change and technical assistance on irrigation systems for Onion 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. Possible opportunity from international funding to access grants for construction of post-harvest facilities as a tool to mitigate climate change impacts for farmers. Post-harvest storage units operated by cooperatives and farmers organizations could extend the capacity to store onions which will make the producer less attached to seasonal prices. Intermediaries (collectors) should be invited to partner in this type of opportunities because their consulting on timing for selling will be essential for the success of this marketing strategy.
	Road Conditions	<ul style="list-style-type: none"> RRB could consult with the Government area representative to address this issue. What should be avoided is a fast deterioration of the road improvements

Chain link	Constraints	Opportunities
	<ul style="list-style-type: none"> Poor road conditions between distribution and collection center. 	<p>because of lack of maintenance or poor monitoring. Here, communities should be most involved in providing monitoring.</p> <ul style="list-style-type: none"> Identify funding and storage facilities affordable and appropriate for the farmers. Lack of infrastructure limits the development of value chains – year-round road access, 24/7 electricity, and secure telephone and internet connections were mentioned by participants. One of several of these factors together with minimum post-harvesting facilities, constrain operations at several of the value chain analyzed. Improving infrastructure will decrease transaction costs and internal and external communication with a significant gain in productivity and competitiveness. However, the current issue of land titles for many farmers could limit the potential of financial services and functional land markets to play their part once the infrastructure issues are corrected. Business plans including infrastructure requirements are needed, but land ownership, or lack of it to be more exact, could seriously restrict the impact of the suggested infrastructure-business plans.
Quality Standards and Processing	<p>Limited option of transformation</p> <ul style="list-style-type: none"> Quality is deficient Need for post-harvest facilities. No transformation or processing of reject product. 	<ul style="list-style-type: none"> Channelling the potential of onion processing requires a) engaging and supporting women enterprises, b) revitalizing farmer post-harvest infrastructure allowing storage for longer periods minimizing damage losses, and c) harnessing local knowledge in crafting-transformation of onions, taking advantage of market trends that seek alternative products to industrial products. It should be explored why there is not a quality premium paid for those farmers following the quality standards. If a farmer does not perceive the benefit, it will be difficult for him to adhere to standards. Either there is no quality premium possible to offer, or the standards are not clear to farmers.

Chain link	Constraints	Opportunities
		<ul style="list-style-type: none"> • If production increases the importance of the quality standard as a requirement for carrying out business with the processor it 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. • Current cooperatives may be able to work much easier with the Belize Bureau of Standards, but they need coaching and technical support to sit at a technical table to discuss the standards.
Marketing and Distribution	<ul style="list-style-type: none"> • Quality standards are not followed throughout the whole value chain • Rejected produce by the processor 	<ul style="list-style-type: none"> • Processors have quality standards farmers should adhere to. 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 standards for the fresh market or support the industry standard. • Conduct a study that demonstrates how much rejection could be reduced with best practices and adherence to the quality standard.
	<p>Poor Business Practices</p> <ul style="list-style-type: none"> • Poor record-keeping results in a poor understanding of the cost of production • Lack of formal contracts with intermediary resulting in a late payment to a farmer for produce sold 	<ul style="list-style-type: none"> • A farmer needs to think and act like a businessman/businesswoman, it is essential for farmers to have 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 examples of why belonging to a cooperative is beneficial. Marketing

Chain link	Constraints	Opportunities
Marketing and Distribution	<ul style="list-style-type: none"> No official medium to learn about price information on the market 	<p>of produce, collective negotiation, and saving on the cost of inputs, should be obtainable by strengthening the cooperatives.</p> <ul style="list-style-type: none"> Manuals and simple brochures which are easy to complete/read are necessary for Onion 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 them to interpret and use.
	<p>Poor access to finance</p> <p>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.</p>	<ul style="list-style-type: none"> 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 cheapest capital possible.

Chain link	Constraints	Opportunities
		<ul style="list-style-type: none"> 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 14. 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.	<p>Use an irrigation system that considers the water requirement of the crop and evapotranspiration.</p> <p>The conservation of water sources includes Ecosystem-based Adaptation (EbA) practices such as</p>	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)
	Carry out activities to conserve water sources, such as rivers and wells.	reforesting riverbeds and harvesting rainwater.	
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,	Living barriers can be used to separate cultivation areas, because they can be monocultures that are	Climate change is related to the increase in greenhouse gases in the environment, so it is necessary to increase the number of plants

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)
	nitrogen-fixing shrubs can be used to benefit the crop.	<p>planted in a staggered manner or different crops.</p> <p>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.</p>	that capture these gases (especially carbon dioxide).
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

Onion value chain with limited potential. Onion is grown in the northern and western districts in the country. The Corozal District is the leading producer of Onion followed by the Orange Walk and Corozal Districts. The main producers of Onion are part of a cooperative. Even large-scale producers are not given commercial arrangement to improve the value chain. There are market limitations because there are illegal imports of onion and, at the same time, poor care of the post-harvest product. In addition, we see that producer organizations are weak and excessive intermediation are rampant with small producers who, because of their volume produced, do not see great options for marketing their product.

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 such as land as required by these financial institutions.

Weak organizational processes are the standard not the exception – Farmers' organizations have yet to consolidate their governance, management, and overall organizational structures. First-tier organizations may benefit from formal relations with their members especially with strong communication and coordination procedures for production and marketing. Systems for monitoring and evaluating performance are also needed. Finally, avoiding confusion on the division of responsibilities between the management committee and community-based leaders or administrators could improve the decision making and increase accountability. These and other barriers must be eliminated with appropriate business training.

Strengthening cooperatives. A common belief is that many cooperatives in Belize are started for the wrong reasons – mostly to take advantage of an opportunity brought up by a project. When the project disappears, so does the reason for gathering in the cooperative. This is currently reported and 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 promoter of changes in the value chain. It has been argued that members do not recognize clear, explicit benefit 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.

Limited processing/post-harvesting capacity. Moving from post-harvest treatments or simple first-stage processing is proving a challenge. Among other things, this reflects lack of technical capacities and skills, low access to capital for investment in processing equipment and machinery, restricted access to services for processing, or reduced opportunities in local markets for higher-value processed products. The major potential to correct the issues of post-harvesting issues is among the farmers themselves: we expect that programs like farmer to farmers or “Escuela de Campo” they could discover these practical and appropriate solutions for the Belizean context. Channelling the potential of onion processing requires a) engaging and supporting women enterprises, b) revitalizing farmer post-harvest infrastructure allowing storage for longer periods minimizing damage losses, and c) harnessing local knowledge in crafting-transformation of onions, taking advantage of market trends that seek alternative products to industrial products.

Onion value chain and Covid-19 pandemic. The unforeseen impact of Covid-19 on logistics for carrying out the studies was overwhelming. Carrying out interviews and workshops in pandemic requires extra planning and most importantly the flexibility to adapt. Surprisingly enough, many of the products analyzed show unexpected consequences under the pandemic since 2020 as has been reported in the interviews with Onion producers and other stakeholders of the value chain. First, sanitary restrictions for mobility of people and vehicles produced a contraband reduction for Onion, mainly from Mexico. Illegal imports, legal imports, and national production before the pandemic was common to find in major market, especially city markets. As reported, contraband has been reduced and national production has benefit in a less competitive market. What will happen if restriction of mobility is eliminated? Nothing in the studies suggested that producers are finding national production to be of better quality or that they are ready to give up the imported 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 those sectors analyzed including Onion will return to a downward trend.

Secondly, Belize tourism sectors meltdown under Covid-19 pandemic serves as a reminder of how important diversification is for Belize agriculture value chains targeted by the VCMA 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 VCMA 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 as well return. Here, challenges on quality and acceptance of standards that have been already identified in the VCMA studies will be paramount.

Finally, Covid-19 had everyone focusing on the short sightedness, losing the potential of the studies to reflect long term strategies. For example, having no tourism makes people ignore the opportunities that linking farmers to tourism supply chain represents in 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. Of course, this is just a logical attitude under a crisis mode, but it could have serious limitations when a value chain approach is used to harness governmental intervention in the sector.

Priorities for the whole value chain. When thinking of a value chain as a system, all stakeholders are interlinked, and all are mutually dependent. RRB must recognize that some interventions are prioritized differently for different actors/stakeholders. Interventions for the whole value chain requires extra effort to create a consensus on priorities. Through workshops carried out for the VCMA studies, a couple of challenges/needs were consistently noted and presented here in Table 13. 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 for this Onion value chain priority should be given to market potential, the suitability for cultivation (even under climate change scenarios), and the value-added opportunities that cooperatives could help to create.

Managing expectations. It is well understood the length of time it takes for value chain approaches to become viable if it doesn't break down before reaching its goal. It could take 4 or 5 years despite, or at times because of, intensive, even if often disarticulated, interventions from government agencies, NGOs, development projects, and the like. The long duration of this process will increasingly become an obstacle for smallholders, their organizations, and development agencies, given rapidly 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 producers, local processors, investors, and government agencies.

10. Final comments on limitations of the study

In general, an argument can be made regarding limitations of this study. The following list includes major challenges for achieving the best Onion 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-19 restrictions do not seem to fully 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 put in place with all members working with the value chain approach.
2. **Short sightedness as the new norm.** 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 linking farmers to tourism supply chain represents in the long run. Similarly, many people that lost their jobs, moved to micro farming affecting the normal agricultural supply in many of the products studied. Of course, this is just a logical attitude under a crisis mode, but it could carry out serious limitations when a value chain approach is used to harness governmental intervention in the sector. Finally, Belize tourism sectors meltdown under Covid-19 pandemic serves as a reminder of how important diversification is for Belize agriculture value chains targeted by the VCMA studies. Among agriculture officers and extensionists, opportunities to connect farmers to the tourism supply chains were not at all present during discussions and workshops carried out for the VCMA studies. Such an 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 as well return. Here, challenges on quality and acceptance of standards that have been already identified in the VCMA 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 acres-harvested do not match, it is possible that Belize's agencies in charge of collecting the data will need to revisit the way that they are producing the data. It is suggested that RRB bring 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 extensionist and technicians understood what it is to work with a value chain approach. For some, the approach still works mostly to support farmers, which is a misunderstanding. The guiding principle is to support the whole chain by creating more options to create value. If the creation of value is under the scope of the farmer or with the processor, that is fine with the value chain approach. It was difficult to conduct value-chain workshops were 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 it 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 the middleman so persistent? Part is explained by cultural perceptions as mere cheaters, part the misjudging of how difficult is to create value of space and time. Farmers having mastered the complexities of the production process have seldom also 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.

11. References

1. Food and Agriculture Organization of the United Nations Statistics. 2019. FAOSTAT: <https://www.fao.org/faostat/en/#data>
2. International Fund for Agricultural Development (IFAD). 2018. Rural Resilient Belize Detailed Programme Design Report 4702-BZ
3. Ministry of Agriculture, Food Security and Enterprises. Annual Reports (2002-2010) and Agricultural Production Reports (2017-2020): <https://www.agriculture.gov.bz/document-center>
4. Ministry of Agriculture, Food Security and Enterprises. 2015. National Agricultural and Food Policy of Belize 2015 to 2030.
5. Rural Resilient Belize Programme. 2019. Organizational Development Plant for Nago Bank.
6. Statistical Institute of Belize, 2021: <http://sib.org.bz/statistics/>
7. Rural Resilient Belize Programme. 2020. Organizational Development Plant for Maya Green Growers Co-operative Society Ltd.
8. <https://www.tridge.com/intelligences/bell-pepper/production>
9. Vargas-Ortega, E. 2021. Detailed Value Chain and End Market Assessment Methodology Report (VCMA). Tropical Agricultural and Higher Research Education Center (CATIE) and Resilient Rural Belize (RRB) Programme (Belize).

12. Annexes

12.1 ANNEX 1. List of participants in the different workshop

Registration List for Value Chain Analysis and Market Assessment

Onion + Corn

Date: 19/01/2022 Location: Indian Church

#	Name	Location	Farmer/Company/SOB	Gender		Vaccinated		Date of Birth	Indigenous		Phone/Email	Signature
				M	F	Yes	No		Yes	No		
1	Josefina	Jul	DFC					3/10/85			603-3111	[Signature]
2	Alvaro Hernandez		Coop. Dept					16/9/70			623-2195	[Signature]
3	F. Vega		Coop Dept					10/12/22			608-7781	[Signature]
4	Jose Luis Gaudin		Farmer					9/9/79			674-0072	[Signature]
5	V. Pauline		Coop Dept								614-6532	[Signature]
6	Suzie Henara	Holl	Agricu. Dept.					18/11/11			414-9200	[Signature]
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ATTENDANCE LIST

Workshop Concepcion Village = Onions + Carrot 01/21/22

#	Name	M or F	Vaccinated		Date of Birth	Indigenous		Position/Function/ Organization (Alcald, Chalperson, other)	Phone & Email	Signature
			Yes	No		Yes	No			
1	ANITA CRUZ	M	✓		24/10/11		✓	OIC DEC 01	610 0917	
2	REYNALDO EK	M	✓		30/4/97		✓	SCD DFC 02	668 8652	
3	Orlando EK	M	✓		26-9-83	✓		CUF <small>Comunicación y Organización</small>	602-2851	
4	Carlos EK	M	✓		02-03-85	✓		CUF <small>Comunicación y Organización</small>	624-0517	
5	Roberto	M	✓		26/07/83				654 7018	
6	Denise Cruz	F	✓		23/07/92		✓	Consultant	610-5834	
7	Brinda Fieb	M	✓		22/09/00		✓		605-9311	
8	Oscar Reyes								632 3842	

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ATTENDANCE LIST




Workshop Concepcion Village : Onondy Camot's 01/21/22

#	Name	M or F	Vaccinated		Date of Birth	Indigenous		Position/Function/Organization (Alcaldes, Chairperson, other)	Phone & Email	Signature
			Yes	No		Yes	No			
1	Leocadio Alcosas	M	✓		22/2/70		✓		6756866	<i>[Signature]</i>
2	Marta Novelo	F	-		19/1/64				6062350	<i>[Signature]</i>
3	Silvia Ayala	F	-		24/4/57				6528187	<i>[Signature]</i>
4	Juanis Mann	M	✓		21/03/87		-	RDS Consultant	657940	<i>[Signature]</i>
1	Hyko Miranda	M	✓		16/6/70			Coord. Concepcion Vegetable Farmers	6232195	<i>[Signature]</i>
2	Dora Reyes	F	✓		17/01/87				662-2330	<i>[Signature]</i>
3	Axel Ruiz	M	✓		13/03/00			Rec. S.	6086515	<i>[Signature]</i>
4	Miguel Perez	M	✓		24/02/92			Custo Pay Unavailable Farmer	629-8386	<i>[Signature]</i>

ATTENDANCE LIST

Workshop: Conception Village: Onions & Carrots

01/21/22

#	Name	M or F	Vaccinated		Date of Birth	Indigenous		Position/Function (Alcalde, Chairperson, other)	Phone & Email	Signature
			Yes	No		Yes	No			
17	Leonardo Stiel	M	✓		-	-	-	Prof Corp		
18	Blanca A. Carrera	M	✓		15 Aug 1955	✓		MCA		
19	Joe Lisby	M								
20										

12.2 ANNEX 2. Pictures of participants in the different workshops



Concepción: Onions and Carrots

12.3 ANNEX 3. Cost of Production for One Acre of Onion, Belize, 2021

Cost of Production for Onions				
Activity	Unit	Amount	Cost per unit	Total
Plowing	Hrs	2	\$ 60.00	\$ 120.00
Harrowing	Hrs	2	\$ 60.00	\$ 120.00
Bedding	Hrs	1	\$ 60.00	\$ 60.00
Seed Treatment	Day	1	\$ 35.00	\$ 35.00
Materials				\$ -
Seeds	Mercedez	2	\$ 425.00	\$ 850.00
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
Fusilade	Liter	1	\$ 60.00	\$ 60.00
Bravo	Pack	1	\$ 54.00	\$ 54.00
Silvacur	Liter	1	\$ 45.00	\$ 45.00
Ridomil	Pack	1	\$ 36.00	\$ 36.00
Tamaron	Liter	1	\$ 48.00	\$ 48.00
Labor				\$ -
Planting	Day	1	\$ 35.00	\$ 35.00
Fertilizing	Day	2	\$ 35.00	\$ 70.00
Foliar	Day	1	\$ 35.00	\$ 35.00
Mulching	Day	1	\$ 35.00	\$ 35.00
Weedcontrol	Day	1	\$ 35.00	\$ 35.00
Disease/Pest	Day	2	\$ 35.00	\$ 70.00
Harvesting	Man days	6	\$ 35.00	\$ 210.00
Other				\$ -
Bags	Pack	1	\$ 450.00	\$ 450.00
Gas	Gal	45	\$ 13.00	\$ 585.00
Oil	Quart	2	\$ 10.00	\$ 20.00
Selling	Days	3	\$ 35.00	\$ 105.00
Drip Line Roll	Rolls	1	\$ 790.00	\$ 790.00
				\$4,298.00
Yield	10000 lbs			
Revenues	10000 lbs * @\$0.65		\$ 6,500.00	