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Exploring Growth: A Multifaceted Approach to Development in the Stann Creek District of Belize

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**Exploring Growth: A Multifaceted Approach to Development in the Stann Creek District
of Belize**

by

Brady A. Voss

Advisor: Dr. Amy Farmer

**An Honors Thesis in partial fulfillment of the requirements for the degree Bachelor of
Science in Business Administration in Finance.**

**Sam M. Walton College of Business
University of Arkansas
Fayetteville, Arkansas**

May 11, 2024

Introduction

In the summer of 2023, I had the opportunity to conduct in-country research for the Ministry of Agriculture (MOA) in Belize while interning abroad with the international non-profit Peacework. The research involved three main projects: conducting surveys to gauge market awareness of dragon fruit, estimating the cost of production (COP) of habanero peppers, and drafting a business plan for the Hopkins Farmers' Cooperative (HFC). This multifaceted project aimed to assist the MOA in collecting data and achieving its research objectives, ultimately contributing to economic development in the Stann Creek District. The MOA's mission is to serve as a vital economic pillar, ensuring food and nutrition security, with a vision of fostering innovation, competitiveness, diversification, and sustainability. This research played a crucial role not only in supporting the MOA's mission and vision but also in the broader impact of economic development on the whole of Belize.

Background

Belize, formerly known as British Honduras, is an east-central Caribbean country in Central America with a population of around 400,000 people (Alford et al., 2022). Its economy is still in a developmental stage and relies primarily on tourism and agriculture. It is comprised of six districts: Corozal, Orange Walk, Belize, Toledo, Cayo, and Stann Creek. The research for this project was primarily completed in the Stann Creek District. Each of the three projects serves a distinct purpose and contributes uniquely to the economic development of Stann Creek.

Dragon Fruit Survey

Traditionally, farming in the Stann Creek District revolved around sugar cane due to the lasting effects of colonialism. Over time, there has been a significant shift towards cultivating habanero peppers; however, farmers are constrained by limitations on the quantity of peppers they can sell each season. Recognizing this, the MOA aimed to gather data to support the growth of dragon fruit, aiding farmers in diversifying their crops. Dangriga, the district's capital situated on the eastern coast, has a population of approximately 9,000 people (Dangriga Town Council, n.d.). Given the focus on tourism in Dangriga and Hopkins, the Stann Creek District presents an opportune location for economic growth, serving as a region where farmers can meet the high demand of consumers.

Heidy Cob-Canto, an extension officer of vegetable production for the MOA, served as the lead supervisor for this project. The MOA is limited in its capacity to issue surveys and collect data due to it only having one vehicle to cover the entire district. The officers are stretched thin in their ability to rapidly implement change, and this project aimed to alleviate some of these constraints. To assess the target markets in Dangriga, it is crucial to differentiate between fresh markets and superstores. Fresh markets serve as key indicators of market availability and consumer demand for fresh goods. Dangriga boasts at least 10 individual fresh market stands selling dragon fruit, with an average price of 5.9 BZ\$ per lb. and a bi-weekly order quantity of at least 20 lbs. Supermarkets, however, are not supplied by local farmers to the same extent as fresh markets.

Recognizing the significance of fresh markets in meeting Dangriga's food security needs, it's imperative to provide farmers with relevant data regarding consumer preferences and demand. Collaborating with local farmers in the small farm agriculture industry is crucial in addressing this disparity and combating food insecurity. To begin, it's essential to clarify the definition of food insecurity. Health scientist Laurel Stevenson defines food insecurity as the uncertain availability or access to high-quality, nutritious food (Stevenson et al., 2022). Many

Belizeans substitute nutritious food with cheap, low-quality processed imports from the United States, further distancing them from locally farmed produce.

According to the Food and Agriculture Organization of the United Nations, approximately 45.5% of the Belizean population was affected by moderate or severe food insecurity in 2021 (FAO, 2021). Key contributing factors include income, employment, and proximity to food markets. In Dangriga, about 40.47% of households experience moderate to severe food insecurity (FAO, 2021), highlighting the urgent need to understand market awareness and the availability of fresh fruits like dragon fruit.

Cost of Production of Habanero Peppers

The objective of this project was to estimate the COP for growing hot peppers in the Stann Creek District of Belize. COP serves as a vital metric for assessing business efficiency and profitability. By determining the production cost, the MOA can provide farmers with an accurate measure for evaluating the average cost of cultivating hot peppers per acre. This project plays a crucial role in aiding the MOA in updating and refining its records, especially given the absence of data from 2019 to the present due to the COVID-19 pandemic. Farmers have encountered steep prices stemming from supply chain bottlenecks and global inflation, significantly elevating their production costs. Many farmers struggle to turn a profit and lack the necessary data to accurately assess their costs and revenues.

In the agriculture segment, the International Trade Association reports that non-traditional sectors in Belize include hot pepper sauces, processed jams, jellies, extracts, and pastes (ITA, 2022). According to the Inter-American Development Bank Group, pepper production is one of the main agribusiness sectors in Belize, with a significant portion of its products earmarked for exports (IDB Invest Helps Boost Employment and Export Growth in Belize through Marie Sharp Fine Foods, 2022). The primary player in the non-traditional sector is Marie Sharp Fine Food Limited, which holds a dominant position as the major purchaser of hot peppers. The MOA manages an annual contract with Marie Sharp to establish the number of peppers they will purchase, enabling farmers to plan their production accordingly.

However, Belize is renowned for its distinct wet and dry seasons, posing challenges for farmers to meet the hot pepper quota while managing water conservation effectively. Many farmers rely on natural irrigation from rainfall during wet seasons and implement strategies such as storing water in large tanks to reduce irrigation costs during dry seasons. The Caribbean Agricultural Research and Development Institute advocates for the use of drip irrigation techniques to minimize water consumption and lower irrigation infrastructure expenses (Water-smart farming practices for the dry season, n.d.). Given that much of Belize's agriculture relies on rainfall, farmers must prioritize effective irrigation strategies to control costs and sustain production. Additionally, the pepper plant loses approximately 150-190 liters of water per acre through transpiration in a single growing season (FAO Trust Fund for Food Security and Safety - Government of Italy Contribution, 2011). This water loss underscores the importance of irrigation in maintaining the health and quality of peppers. Therefore, farmers must augment the supply of supplemental water during dry conditions to enhance the profitability of the pepper business.

Additionally, employing herbicides, insecticides, and fungicides is a crucial practice that farmers must adopt to mitigate the risk of losing entire fields to pests or diseases. According to the University of Connecticut, successful farmers structure their pest management plans around these persistent issues and integrate solutions into their standard operating procedures (Stearns, 2021). Implementing integrated pest management (IPM) systems reduces the COP and leads to

higher yields, thereby increasing the profitability of hot pepper production. Farmers must prioritize IPM techniques in hot pepper cultivation to minimize pest, disease, and weed incidences while improving soil fertility.

Cooperative Business Plan

It's noteworthy that the HFC reports to the Department of Cooperatives (DOC) rather than the MOA. The DOC is a sister branch to the MOA within the Belizean government. Edwardo Leiva, a cooperative officer for the DOC, served as the lead supervisor for this project. He emphasized that the cooperative's objective is to provide employment and opportunities for farmers in the future, highlighting that the project's focus was on developing the cooperative as a whole, rather than individual members.

The HFC is situated in Hopkins, a small coastal town south of the district's capital, Dangriga. Initially comprising over 100 members, the cooperative's membership has dwindled to 15. The cooperative owns 50 acres of farmland outside Hopkins, with each member having access to cultivate crops on 1 acre. Currently, 13 of these acres are designated for growing cassava, the primary ingredient in the cooperative's cereal. However, the building on the farmland's property is currently unusable for processing due to sanitation issues, bat infestation, and lack of electricity. Consequently, the HFC has sought a temporary production facility in Hopkins. Unfortunately, the only available property capable of providing the necessary electricity is a bar that belongs to one of the members. This arrangement has not only slowed production but also hindered the cooperative's growth capacity. Furthermore, it has resulted in the blending of cooperative and member assets, leading to confusion and lack of clarity in bookkeeping, further harming the cooperative's operations. In addition to internal challenges, the cooperative has been engaged in discussions with the government for over a decade, seeking funding in the form of grants to invest in solar panels for the processing facility, with an estimated investment of 70,000 BZ\$. However, the grant application was rejected, leaving the cooperative constrained to producing cereal within its current limitations.

Labeled as a cereal producer, HFC competes with all other local and imported cereal products sold within the markets. The cooperative prices its products at 15 BZ\$ which equates to the prices of American, imported cereal, but it lacks the marketing ability and supply to sell in mass. Due to American marketing, the perception of "traditional" cereal starkly contrasts the product the cooperative sells. Rather than the sugary, colorful cereal in a box, the HFC sells its product in powder form without additives, which is more nutritious. Comparing the quality, HFC's cereal lacks preservatives, making it a health-conscious option which places it at an advantage as a school meal supplier. With its established consumers and connections, the cooperative maintains its credibility within Hopkins and has the opportunity to be a cereal supplier when it gets its processing facility operational.

Given that the cereal is made by farmers, there is a potential threat of new entrants that other cassava, rice, and plantain farmers can enter the market to diversify their products. The benefit of HFC is that it has already established a market presence within Hopkins and the neighboring districts and owns a large portion of equipment and materials to bring the raw goods to the final product. Farmers attempting to enter the market will deal with gathering the necessary equipment, acquiring a food-safe facility, and establishing reliable distribution methods. This puts the HFC at an advantage, as they already have the equipment and forms of distribution, but it is still in need of a long-term processing facility. The cooperative can capitalize on its current position, continuing to put it in front of future competitors and be the frontrunner of cereal production in Belize.

Project Details

Dragon Fruit Survey

This study served as a benchmark investigation into respondents' market awareness of dragon fruit, also known as pitaya, in Dangriga, Belize. It aimed to aid the MOA in researching general market awareness and consumer knowledge regarding dragon fruit. The survey was conducted with a convenience sample of 25 respondents, gathering information on their general knowledge and awareness of dragon fruit. The IRB-approved survey took place on-site, with respondents randomly selected from various fresh markets in Dangriga. Respondents provided verbal feedback as the survey questions were read aloud. The collected data was analyzed using Microsoft Excel. Since the survey was conducted with a convenience sample, it may not perfectly represent the dragon fruit customer population. Thus, a profile of the sample classification questions was utilized to understand the nature of the participants. The questionnaire is included in Appendix A.1, pg. 12-13 outlines the survey questions.

The results are presented in Appendix A.2, pg. 14, and indicate the following: A majority of survey respondents were familiar with the existence of dragon fruit, with 82.6% recognizing either its name or photo. As pictured in Appendix A.3, pg. 15, dragon fruit is predominantly available at fruit markets situated on Ramos Rd. and Ecumenical St., which may explain why some participants were unfamiliar with it. The overall consensus of the survey findings includes an average weekly fruit expense of 26 BZ\$, awareness of its health benefits at 19%, participants having tasted dragon fruit at 61.9%, a positive likelihood of purchasing it at 66.7%, and a willingness to pay 5 BZ\$ for it. The data gathered from the survey proved invaluable to the MOA, indicating overwhelming awareness of dragon fruit and a positive interest in purchasing it in Dangriga. As a result, the MOA can now encourage farmers within the Stann Creek District to begin cultivating dragon fruit and diversify their crop variety.

Cost of Production of Habanero Peppers

To understand the MOA's desired methods, the Food and Agriculture Organization's *Hot Pepper Production Manual* from 2011 was provided - which included extensive guidelines for the hot pepper production process - alongside a crop calendar of hot peppers, and a basic Excel document for calculating the COP. Initial research involved becoming acquainted with the production manual to understand the primary inputs for COP, including land preparation, nursery management, field management, corn barriers, materials and equipment, and transportation. The manual provided subcategories for these inputs to quantify the production cost of both fresh and processed peppers more accurately. For instance, nursery management was categorized into materials, fertilization and insect control, and labor costs. Similarly, field management was divided into fertilizers, herbicides, insecticides, fungicides, and labor costs. This segmentation of inputs enables a more precise calculation of COP, allowing easy comparison with current records for farmers.

Furthermore, the next step in estimating the COP involved gathering current prices from local suppliers. Various agricultural suppliers operate within the Stann Creek District, including Hummingbird Distributors, Prosser Fertilizer, and Reimer's Feed Mill. Fortunately, the wholesale branch of Prosser Fertilizer in Big Creek was able to provide a full list of required inputs to find the current price available. Collecting current pricing inputs for the COP is crucial for assessing the present cost of producing hot peppers. In addition to visiting suppliers, the MOA arranged in-person meetings with farmers in Cow Pen and Roseville to gather information about their COP inputs, particularly labor costs. Many farmers in the region do not include labor costs in their records due to the narrow profit margins resulting from high costs and low

revenues. Including labor costs would often result in farmers reporting a net loss from their crop output which provides a more accurate reflection of the true COP and revenues generated by farmers.

Recognizing these factors was crucial for developing an accurate financial model that projected the current COP per acre for hot peppers. The major inputs are listed in Appendix B.1, pg. 16-17, including land preparation, nursery management, field management, corn barriers, materials and equipment, and transportation. Each input was estimated by multiplying the unit cost by the quantity to determine the total cost per acre. The sum of all inputs equated to the total COP, which was then divided by the assumed total yield per acre of 15,000 lbs. to find the cost to produce 1 lb. of hot peppers. Two Excel sheets were created to forecast the COP of fresh and processed peppers, with each sheet highlighting the change in input prices since 2019. Additionally, accurately accounting for the total materials and equipment cost necessitates estimating the total cost of irrigation. To calculate irrigation expenses, the cost per item was multiplied by the depreciation rate over the specified crop cycle to determine the price per acre. Refer to Appendix B.2, pg. 18 for further clarification.

Next, the final sheet evaluated the cost-benefit analysis of hot peppers per acre, detailed in Appendix B.3, pg. 19. This sheet featured a sensitivity analysis that projected the total income from pepper sales using a price-per-yield multiplier. The total income was calculated based on the MOA's standard benchmark of 15,000 lbs. sold at \$1.15 per lb. Finally, the updated COP was subtracted from the estimated income to determine the projected net income farmers could anticipate per acre of hot pepper production. The completed financial model was subsequently released to the MOA for distribution to farmers in Stann Creek.

Cooperative Business Plan

The outline of the business plan for the HFC consisted of a recommendation, business strategy, SWOT analysis, market analysis, food and safety quality, and final summary. The recommendation concluded that the cooperative should find a rental property with power in Hopkins during the months needed for the full-time production of cereal. The immediate priority of the cooperative should focus on growing itself as a profitable, sustainable, and efficient entity. Only then will the cooperative be in a position to capitalize on its overarching goal of cereal production, utilizing its valuable assets of land, equipment, and facilities.

The business strategy initially focused on the possibility of getting power to the cooperative's building in the long run, which could be possible if the cooperative could accumulate more revenue and profit. When the HFC gains profits, it becomes a more viable option for investors, like the government, to give grants or loans to get power to the building. For the cooperative to gain revenue and profit, it must have good management, financial transparency, and an increase in processing. By setting up strong management and clear goals, it signals to the rest of the members of the cooperative that positive change is coming. It also maintains a balance of power within the cooperative, so individuals are not benefitting out of their self-gain. The next important step is financial transparency. There has to be a clear line between the cooperative's assets, revenues, costs, and profits and those of the members. This allows the HFC to gain its profits, which can be put towards projects that will benefit all the members. Lastly, increasing processing is an overall long-term focus of the HFC. Overall, the focus on profit, good management, and financial transparency is a fundamental business strategy that will help increase processing.

In assessing the current state of the HFC, an essential tool to analyze the business is a SWOT analysis - strengths, weaknesses, opportunities, and threats. Utilizing this method

provides a comprehensive understanding of the cooperative's trajectory and helps formulate an effective strategy. Strengths include valuable assets (i.e. farmland, equipment, building), established market presence, processing equipment, trade skills, and being the sole producer of cereal in Hopkins. Weaknesses include the absence of large-scale processing, insufficient capital and revenue, absence of irrigation and farm machinery, poor bookkeeping, sunk costs in processing equipment and building, food safety and quality control, and lack of transparency regarding cooperative/member-owned assets. Opportunities lie in maximizing current assets, capitalizing on the Belize/Central America market, and leveraging facilities and equipment for profit with non-members. Threats include competition from other traditional cereal brands, potential loss of members throughout the year, and concerns regarding financial transparency.

Utilizing Porter's Five Forces, the fundamental weaknesses and strengths of the current cereal industry within Belize were analyzed. The most prominent forces, regarding the HFC, were the industry competition, the threat of new entrants, and the threat of substitutes. A deeper understanding and knowledge of these forces will enable the cooperative to formulate a sustainable strategy to increase its competitive advantage. For example, the threat of substitutes showcases that being a breakfast commodity, cereal is substitutable with alternatives such as breakfast smoothies, oats, muesli, toast, etc. that can offer similar nutritional value for a similar price point. HFC should prioritize nutritional fact labeling to set apart their product from other packaged goods in the supermarkets. Most of the HFC's goods do not have labeling, so consumers lack knowledge of the serving size, calories per serving, proteins, vitamins, etc. This critical detail can provide the HFC with an advantage in the market and potentially garner attention from health-conscious consumers.

The food safety and quality assessment revealed that the Belize Agricultural Health Administration (BAHA) provides resources on food safety and quality for agricultural practices and processing. Currently, adjustments are needed in the cereal packaging labeling to meet packaged goods standards. This includes listing all ingredients and quantities, as well as providing batch numbers, net weight, and expiration dates. Additionally, BAHA mandates that food processing facilities obtain the Hazard Analysis and Critical Control Point certificate for sanitation and safety certification, essential for export products. Long-term use of the cooperative building would require steps to address cleanliness, sanitization, and bat infestation removal to ensure facility utilization. Each Central American country has unique import and export regulations, illustrated by Guatemala's requirement for licensed imports with active sanitary operation permits registered with their Ministry of Health. Spanish labeling adhering to their language and food law regulations, including comprehensive food, nutritional, and manufacturing information in Spanish, is also mandated. Complying with these licenses and label requirements would be crucial for the cooperative's expansion beyond Belize. Though USA exportation isn't a current HFC goal, understanding US import requirements is essential. The FDA and USDA oversee imports of processed goods into the United States. FDA clearance necessitates importer registration, adherence to labeling requirements, compliance with food standards, and notification upon goods' entry. The USDA focuses primarily on grains like wheat, corn, oats, and barley; if present in cereals, these grains may be subject to USDA standards and inspections.

The final summary concludes that to align with the cooperative's goals, the HFC should secure a temporary lease at a site with electricity access. As outlined in the business strategy, the HFC aims for self-sufficiency without relying on government grants for production. Once this is achieved, consistent cereal processing can commence. With a stable supply, the HFC can then

focus on marketing and expanding its consumer base to boost cooperative revenue. As the cooperative expands, government and investor interest may increase, potentially leading to investments in electricity at the original processing facility site.

Project Evaluation

Dragon Fruit Survey

This initial project marked the beginning of my research journey in Belize, offering valuable insights into the challenges I would encounter over the subsequent eight weeks. Initially, the MOA provided us with survey questions and procedural guidelines, which proved beneficial. However, issues arose during the survey issuance and data analysis phases. Some survey questions were phrased ambiguously, leading to confusion among respondents and potentially biasing their answers towards what the MOA was seeking. Moreover, upon analyzing the dataset, it became evident that while 25 respondents provided general percentages, it wasn't a sufficient sample size to accurately gauge awareness and demand across the population. Although the project successfully provided the MOA with temporary information, in hindsight, I recognize the need to survey a larger and more diverse pool of respondents with a more comprehensive survey tool to obtain more insightful results.

Cost of Production of Habanero Peppers

Among my research endeavors in Belize, this project proved to be the most rewarding. However, due to the MOA's limited resources, particularly having only one vehicle, I couldn't visit a farm until week four, significantly constraining my fieldwork. Despite these challenges, I managed to gather the necessary data for the MOA. The initial hurdle arose from the scarcity of pricing information for farming equipment and chemicals at local stores, hampering the creation of an accurate model. Additionally, a prevalent issue emerged as most farmers didn't include labor costs when recording expenses, despite dedicating extensive hours to their farms. Although these challenges persisted, the project successfully documented a 5% increase in the COP alongside detailed fluctuations in production requirements for individual items. The MOA utilized this data to educate aspiring farmers entering the industry.

Cooperative Business Plan

Working with the HFC presented numerous challenges during this trip. The complexity of factors influencing the business plan writing process often felt overwhelming, making it challenging to determine where to begin. One significant challenge was navigating the conflicting interests between the cooperative members and the DOC. While the cooperative sought government funding to install electricity in their processing facility, the DOC prioritized establishing sound bookkeeping and ensuring the cooperative's profitability. This conflict posed difficulties during face-to-face interactions with the HFC, as my role shifted towards unbiased consulting. Additionally, the lack of a solid internal hierarchy within the cooperative hindered the acquisition of reliable financial documents and the implementation of lasting changes. With time, I developed a strategic approach that aimed to benefit both the HFC and the DOC, requiring both parties to set aside short-term goals in favor of pursuing long-term success.

Personal Evaluation

Traveling to Belize allowed me to gain hands-on, person-to-person experience that was ultimately the foundation for my research and thesis. Before landing in-country, the only form of information that I was able to obtain was from varying online resources. However, after numerous interactions with farmers on their land or consumers in the market, I was able to gather valuable data that was pivotal in furthering my research. Without my trip to Belize, it would not have been possible to acquire the necessary information and knowledge needed to properly

research each project. After my return, I had tangible data that feasibly supported my research and allowed me to further assess the varying approaches to economic development in Belize.

Additionally, this trip provided ample opportunity for professional development and growth. Learning how to effectively coordinate with my supervisor, conduct business meetings and site visits, and present a business plan to the HFC were all situations to progress my professional capabilities. Also, I was able to meet with several seasoned farmers who provided me with much insight into the production process and the reality of rising costs in the production of habaneros.

Overall, each project that I researched in Belize was a sufficiently difficult challenge for me as it required a thorough understanding of agricultural practices that take into scope market dynamics and economic factors. Collecting accurate pricing inputs and conducting a comprehensive analysis can be difficult, but it reflects the importance of making informed decisions. These projects taught me skills such as marketing research, data analysis, financial modeling, formal writing, and economic research. These skills are incredibly transferable to other academic disciplines, especially with the current need for comprehensive data skills. This research is of utmost value to my field of study as it provides an economic impact through resource optimization, sustainability, and profitability. The proposed activity also holds local relevance to the Stann Creek District, while providing significant assistance to local farmers. Also, with the help of the MOA, this project was especially feasible with my given resources. It was a reasonable project for me to pursue, and it offered a tangible experience that supports my degree and expands upon my experiences within the Walton Honors Program. As I am pursuing a major in finance and minors in economics and marketing, the experience gained from an international economic research project has served as a concrete culmination of my collegiate education.

Future Suggestions

Given the dynamic nature of this program, offering concrete, easily implementable suggestions year after year presents a challenge. Because Belize is a developing country, the infrastructure and managerial capacity are in a state of constant flux, hindering the ability to achieve lasting change. For instance, during the eight-week trip, my in-country supervisor was transferred to another department after six weeks, leaving me without a point of contact with the MOA for the remainder of the program. Consequently, I had to compile my data and pass it along to the DOC for handling and sorting. Additionally, there is a multitude of projects deserving of research and funding, but the process of selecting these projects each year proves to be problematic.

Despite the challenges, it's essential to acknowledge the resilience and adaptability of the students selected for this program. They receive thorough preparation from the University of Arkansas and mentorship from Dr. Amy Farmer. However, improvements to the program could be made in two key areas: pre-departure preparation and in-country research.

Given the variability of projects from year to year, it's crucial (albeit difficult) for students to establish a baseline of research and understanding related to their project. One potential solution could involve utilizing a platform like SharePoint or Google Drive, where past students can compile data and research for the benefit of future students. This would prevent duplication of efforts and grant access to hard-to-find data.

In-country research stands as the most vital aspect of the project, facilitating the collection of tangible data and the implementation of proposed ideas. However, numerous variables often lie beyond the students' control. To enhance in-country research, I propose

increasing communication between students, the in-country supervisor, and the faculty mentor. In my experience, communication with our in-country supervisor was challenging, hindering our ability to accomplish significant work within the allotted time frame. While this may not always be the case, I believe increased oversight from our faculty mentor in liaising with the in-country supervisor could lead to a more impactful and productive summer.

Conclusion

Overall, I am grateful for my time in Belize. Few students have the opportunity to gain hands-on experience with economic development in a developing country, let alone live there for two months. This trip was undoubtedly one of the most transformative experiences physically, mentally, academically, professionally, and socially. It challenged me to humbly seek knowledge and reconsider what I considered day-to-day necessities. Time and again, the people of Belize reminded me of the simple joys of life, despite what I perceived as economic inefficiencies.

Regarding research, these projects would not have been feasible without being conducted in-country. Gathering insights and data from stores, farmers, and the MOA was only achievable by physically being present in Belize. In a developing country, change occurs slowly. It takes time to address systemic issues and implement reforms. It requires patience to collaborate with understaffed government entities operating with limited resources. Nonetheless, this research demonstrated that change is attainable over time. Seeing success in our financial model, obtaining insights from surveys, and collaborating with cooperative members all demonstrated a shared commitment to advancing well-being.

Moreover, the guidance from my advisor, Dr. Amy Farmer, was crucial to the trip's success. Living and working with a group of ten students without an in-country faculty advisor initially seemed daunting, but Dr. Farmer provided unwavering support throughout our time in Belize. She made it her top priority to ensure I was cared for in all aspects. I would encourage individuals pursuing education to step out of their comfort zone and participate in a program outside of the United States. Not only will this test your academic knowledge, but it will also broaden your worldview and deepen your understanding of humanity.

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Appendix A

Dragon Fruit Survey

A.1 – Survey

Thank you for participating in this study. The following contains information about our study and your rights as a research participant.

Project Title: Special Projects in Belize

Investigators: Amy Farmer, PhD.

Purpose: This is a survey research study designed to collect information to support projects in Belize and student research.

Procedures: Proceeding with the based survey will imply your consent to participate in this study. This survey contains questions asking about your preferences or experiences with Belize development projects. We also ask some basic demographic questions. The survey will take less than 10 minutes to complete.

Risks of Participation: The risks associated with this study are minimal. The risks are not greater than those ordinarily encountered in daily life. Moreover, you may stop the survey at any time.

Benefits: This research will assist researchers and industry participants to better understand user preferences and offer products that users desire.

Confidentiality: The researchers will not have access to your name. At no point will a data file be constructed in which your name is linked with your responses. The data will be stored by the principal investigator in his office with no intention of distributing the data. Data will be confidential to the extent allowed by law and University policy. The project's research records may be reviewed by departments at the University of Arkansas responsible for regulatory and research oversight.

Contacts: If you have any questions or concerns about this project, please contact Dr. Amy Famer +1-479-575-6093, amyf@uark.edu. If you have questions about your rights while taking part in the study or have concerns about the treatment of research participants, please call the Institutional Review Board (IRB) office of the University of Arkansas at +1-479-575-2208 or email Ro Windwalker at irb@uark.edu

Participant Rights: Your participation in this study is voluntary. You may choose not to participate or, if you agree to participate, you can withdraw your participation at any time without penalty or loss of benefits to which you are otherwise entitled.

Consent: I have read and fully understand the consent form. I understand that my participation is voluntary. By completing this survey, I am indicating that I am at least 18 years of age and that I freely and voluntarily consent for my responses to be used in the study as described.

Ministry of Agriculture Dragon Fruit/Pitaya Survey

Do you buy fruit in a regular week? Yes ☐ No ☐

If “yes,” how much money do you spend on fruit in a regular week? _____

Do you know what Dragon Fruit or Pitaya is? Yes ☐ No ☐

Did you know that there are more than 1 kind of Dragon Fruit/Pitaya? Yes ☐ No ☐

Do you know the health benefits of Dragon Fruit/Pitaya? Yes ☐ No ☐

Have you tasted Dragon Fruit/Pitaya before? Yes ☐ No ☐

If “yes” what are your thoughts? _____

Would you purchase Dragon Fruit/Pitaya again? Yes ☐ No ☐

If “no” why not? _____

What price would you be willing to pay per pound for Dragon Fruit/Pitaya? _____

La Encuesta de Fruta de Dragón/Pitahaya del Ministerio de Agricultura

¿Compra fruta en una semana normal? Sí ☐ No ☐

Si la respuesta es “sí” ¿cuánto dinero gasta en frutas en una semana regular? _____

¿Sabes qué es la fruta de dragón o Pitahaya? Sí ☐ No ☐

¿Sabías que hay más de 1 tipo de fruta de dragón o Pitahaya? Sí ☐ No ☐

¿Conoces los beneficios para la salud de la fruta de dragón o Pitahaya? Sí ☐ No ☐

¿Has probado la fruta de dragón o Pitahaya antes? Sí ☐ No ☐

En caso afirmativo, ¿cuales son sus pensamientos? _____

¿Volverías a comprar Pitahaya? Sí ☐ No ☐

Si es “no”, ¿por qué no? _____

¿Qué precio estaría dispuesto a pagar por libra? _____

A.2 – Excel Outputs

PURCHASE FRUIT	COUNT OF RESPONDENTS
NO	8.70%
YES	91.30%
GRAND TOTAL	100.00%

BENEFIT AWARENESS	COUNT OF RESPONDENTS
NO	80.95%
YES	19.05%
GRAND TOTAL	100.00%

AWARENESS	COUNT OF RESPONDENTS
NO	17.39%
YES	82.61%
GRAND TOTAL	100.00%

TASTE	COUNT OF RESPONDENTS
NO	38.10%
YES	61.90%
GRAND TOTAL	100.00%

VARIETY AWARENESS	COUNT OF RESPONDENTS
NO	66.67%
YES	33.33%
GRAND TOTAL	100.00%

PURCHASE LIKELIHOOD	COUNT OF RESPONDENTS
NO	33.33%
YES	66.67%
GRAND TOTAL	100.00%

A.3 – Survey Map



Cost of Production of Habanero Peppers

COP Fresh Pepper 2023							
HOT PEPPER COST OF PRODUCTION - 1 Acre (3630 plants)				Fresh Fruit Spacing-4' x 4'			
Irrigation Production System							
INPUTS AND MATERIALS	Unit	Quantity	Unit Cost	Total cost	1 acre	TOTAL	Comments
1. LAND PREPARATION							
Ploughing **	hr	1.5	\$66.67	\$100.00			
Harrowing	hr	1	\$40.00	\$40.00			
Cambering	hr	1	\$40.00	\$40.00			
TOTAL LAND PREPARATION				\$180.00		\$180.00	
2. NURSERY MANAGEMENT							
Materials							
Planting trays - 50 holes	tray	73	\$5.50	\$401.50			
Seeds	oz	1	\$45.00	\$45.00			
Germinating mix 2 Cu ft	bale	5	\$52.25	\$261.25		\$707.75	
Fertilization and Insect Control							
Polyfeed 12-43-12 (2 kg)	lbs	3	\$20.00	\$13.64			3 application (1 lb/application)
Confidor 52 gr	pk	1	\$56.20	\$56.20		\$69.84	1 application (13 g/4 gal H2O)
Labour cost							
Preparing mix and sowing seeds	hr	3	\$10.89	\$32.67			3 persons Total hr: 3
Irrigation (foliar, insect control, water)	day	42	\$1.82	\$76.44		\$109.11	1 person Total hr: 0.5
TOTAL NURSERY EXPENSES				\$886.70			
3. FIELD MANAGEMENT							
Fertilizers							
14-36-12 (50 KG)	lb	227	\$95.00	\$196.05			1 application (1 oz/plant)
18-18-18 **	lb	227	\$125.90	\$259.81			1 application (1 oz/plant)
Polyfeed vegetative (12-43-12) (25 kg)	lb	20	\$202.50	\$73.64			4 application (5lb/apl)
Polyfeed flowering (19-19-19) (25 kg)	lb	30	\$176.50	\$96.27			3 application (10 lb/apl)
Poly feed fruiting (20-5-30) (25 kg)	lb	28	\$156.50	\$79.67			4 application (7 lb/apl)
KMAG (25 kg)	lb	227	\$85.00	\$350.82		\$1,056.26	1 application (1 oz/plant)
Herbicides							
Gramoxone	liter	2.43	\$11.25	\$27.34			3 application (0.81 liter/acre)or (6 cup bayer/4-5 gal water)
Fusilade(fluazifop--butyl)	liter	1.5	\$12.50	\$18.75		\$46.09	3 application (0.5 liter/acre)(3-4 cup bayer for 4-5 gal water)
Insecticides							
Indicator 5	liter	1	\$23.00	\$23.00			1 Bayer cup in 16 liters of water
Adherent	liter	1	\$24.89	\$24.89			Sticker - 1 Bayer cup per knapsack
Regent-100 ml	liter	0.36	\$55.37	\$0.20			3 application (0.12 lt/acre)or (24 ml/4 galwater)
Pegasus - 1 liter	liter	0.32	\$154.14	\$49.32			2 application (0.16 lt/acre)
New Mectin	liter	1.22	\$360.00	\$439.20			2 application (0.61 lt/acre)
Actara-13 gr (rotated with confidor)	gram	324	\$12.95	\$322.75			2 application (162 gm/acre)
Confidor-52 gr	gram	200	\$58.80	\$226.15		\$1,085.52	2 application (100 gm/acre)
Fungicides							
Phyton	liter	1.2	\$165.00	\$198.00			3 application (0.4 lt/acre)
Knight 72 SC	liter	2.73	\$37.25	\$101.69			3 application (0.91lt/acre)
Ridomil - 750 gram	gram	1620	\$71.76	\$155.00			2 application (0.81kg/acre)
Antracol-750 gram	gram	1830	\$35.00	\$85.40		\$540.09	3 application (0.61 kg/acre)
Labour Cost							
Transplanting and Fertilization (14-36-12)	hr	48	\$3.63	\$174.24			6 person
Granular Fertilization (18-18-18 & KMAG)	hr	22	\$3.63	\$79.86			2 person
Foliar Fertilization+Insect+Fungicide (\$3.63/hr)	day	11	\$21.78	\$239.58			2 person - Total hrs:3
Weed control- manual	hr	47	\$3.63	\$170.61			2 person
Weed control - chemical (\$3.63/hr)	day	3	\$36.30	\$108.90			2 person - Total hrs:5
Irrigation set up	day	1	\$25.00	\$75.00			3 person
Harvesting (12 days)	hr	357	\$3.63	\$1,295.91		\$2,144.10	6 person
TOTAL FIELD MANAGEMENT				\$4,877.06			

4. Corn Barrier (3 row)						
Corn seed (1600 plants)	lb	5	\$1.00	\$5.00		
Lannate	lt	1	\$40.00	\$40.00		1 application (1 lt/acre)
Fertilizer 18-18-18	lb	200	\$66.00	\$120.00		2 application (1 oz per plant)
Labour-Planting	day	1	\$25.00	\$25.00		1 person
Labour -Fertilizing	day	2	\$25.00	\$50.00	\$240.00	1 appliction at planting; 2nd at green height
TOTAL CORN BARRIER				\$240.00		
5. MATERIALS AND EQUIPMENTS						
Irrigation				\$ 2,791.50		
Knap snack sprayers (amortized)	only	4	\$ 39.25	\$157.00		
Harvesting Crates (amortized)	only	10	\$1.40	\$14.00		
Sticky traps	only	33	\$6.00	\$198.00		
Nursery				\$ 209.51		
TOTAL CAPITAL COST				\$3,370.01	\$ 3,370.01	
5. TRANSPORTATION						
Fuel (20 miles/gallon)(6 gal/R trip) Total:12	gallon	72	\$12.00	\$ 864.00	\$ 864.00	Estimated
GRAND TOTAL				\$9,548.76	\$ 9,548.76	
6. Contingency	%	15		\$ 1,432.31		
TOTAL COST OF PRODUCTION				\$10,981.08		

Total Production Cost	\$ 10,981.08
Total yield/acre (lbs)	15,000
Cost to produce 1lb of hot pepper	\$ 0.73

Price Increase
Price Decrease
Uncertainty

Cost of Production Difference	0.03
% Change in Cost of Production	4.80%

B.2 – Irrigation Estimates

2023 Prices

Irrigation:	Cost	Depreciation rate	Dep. Price
well	\$ 4,000.00	over 10 crop cycle	\$ 400.00
pump 4 hp gasoline	\$ 1,000.00	over 5 crop cycle	\$ 200.00
bi-wall	\$ 625.00	one crop cycle	\$ 625.00
filter	\$ 350.00	10 crop cycle	\$ 35.00
main pipe	\$ 550.00	10 crop cycle	\$ 55.00
secondary pipe	\$ 550.00	10 crop cycle	\$ 55.00
connectors	\$ 70.00	10 crop cycle	\$ 7.00
air relief valve	\$ 35.00	10 crop cycle	\$ 3.50
fuel		166 gallons at \$8.50/gal regular (Minimum Crop Cycle, 166 Days)	\$1,411.00
		Note:4HP Honda Pump = 1 gal gasoline = 3 hrs	
		Total	\$ 2,791.50
Nursery	\$ 628.52	3 years	\$ 209.51
knapsack sprayer(Rapid)	\$157.00	4 years	\$ 39.25
harvesting crates	\$ 14.00	10 years	\$ 1.40

Sensitivity Analysis: Quantity sold at market

price/yield	9000	11000	13000	15000	17000	19000	20000
\$ 1.50	\$13,500.00	\$16,500.00	\$19,500.00	\$22,500.00	\$25,500.00	\$28,500.00	\$30,000.00
\$ 1.00	\$9,000.00	\$11,000.00	\$13,000.00	\$15,000.00	\$17,000.00	\$19,000.00	\$20,000.00
\$ 0.90	\$8,100.00	\$9,900.00	\$11,700.00	\$13,500.00	\$15,300.00	\$17,100.00	\$18,000.00
\$ 0.80	\$7,200.00	\$8,800.00	\$10,400.00	\$12,000.00	\$13,600.00	\$15,200.00	\$16,000.00
\$ 0.70	\$6,300.00	\$7,700.00	\$9,100.00	\$10,500.00	\$11,900.00	\$13,300.00	\$14,000.00
\$ 0.60	\$5,400.00	\$6,600.00	\$7,800.00	\$9,000.00	\$10,200.00	\$11,400.00	\$12,000.00
\$ 0.50	\$4,500.00	\$5,500.00	\$6,500.00	\$7,500.00	\$8,500.00	\$9,500.00	\$10,000.00

At 12,000 lbs per acre the farmer has to be paid at least \$1.00 to make a profit.

Cost/Benefit Analysis:		
Income	Fresh: 12,000 lbs at \$1.00	\$12,000.00
	Process:1500 lbs at \$0.50	\$750.00
	Total income	\$12,750.00
Expenditure		\$10,981.08
	Estimated NET INCOME	\$1,768.92

B.3 – Cost Benefit Analysis

2023

Sensitivity Analysis:

price/yield	8000	14000	15000	16000	17000	18000	19000	20000
\$1.15	\$9,200.00	\$16,100.00	\$17,250.00	\$18,400.00	\$19,550.00	\$20,700.00	\$21,850.00	\$23,000.00
\$1.00	\$10,580.00	\$14,000.00	\$15,000.00	\$16,000.00	\$17,000.00	\$18,000.00	\$19,000.00	\$20,000.00
\$0.95	\$12,167.00	\$13,300.00	\$14,250.00	\$15,200.00	\$16,150.00	\$17,100.00	\$18,050.00	\$19,000.00
\$0.90	\$13,992.05	\$12,600.00	\$13,500.00	\$14,400.00	\$15,300.00	\$16,200.00	\$17,100.00	\$18,000.00
\$0.85	\$16,090.86	\$11,900.00	\$12,750.00	\$13,600.00	\$14,450.00	\$15,300.00	\$16,150.00	\$17,000.00
\$0.80	\$18,504.49	\$11,200.00	\$12,000.00	\$12,800.00	\$13,600.00	\$14,400.00	\$15,200.00	\$16,000.00
\$0.75	\$21,280.16	\$10,500.00	\$11,250.00	\$12,000.00	\$12,750.00	\$13,500.00	\$14,250.00	\$15,000.00
\$0.70	\$24,472.18	\$9,800.00	\$10,500.00	\$11,200.00	\$11,900.00	\$12,600.00	\$13,300.00	\$14,000.00

At 14,500 lbs per acre the farmer has to be paid at least \$0.75 to make profit.

Cost/Benefit Analysis: Process Pepper			
Income		Process: 20000 lbs at \$0.73	\$14,600.00
		Total income	\$14,600.00
Expenditure			\$12,161.13
		Estimated NET INCOME	\$2,438.87

Cost/Benefit Analysis: Fresh Pepper			
Income		Fresh: 15000 lbs at \$1.15	\$17,250.00
		Total income	\$17,250.00
Expenditure			\$10,981.08
		Estimated NET INCOME	\$6,268.92