Cultivando el Futuro: Developing Comprehensive Greenhouse Resources for Rural Farmers in Cuenca, Ecuador

An Interactive Qualifying Project Report
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
degree of Bachelor of Science

By:

Julia Dolley
Emiliano Solà
Celeste Vargas
Sophia Woodward

Date Submitted: 1 May 2024
Project Center: Cuenca, Ecuador

Report Submitted to:

Marisol Peñaloza
Ruby Moss
Cultivando el Futuro

Professor William San Martín
Professor Sarah Strauss
Worcester Polytechnic Institute

Abstract

As climate change escalates across the world, the effects have begun to adversely impact many communities' agricultural practices, access to food, and understanding of their environment as they now experience it. One such country experiencing these difficulties is Ecuador, whose food sovereignty has been greatly impacted by climate change. Our sponsor, Marisol Peñaloza and her organization, Cultivando el Futuro, tasked us with aiding in their goal of increasing food sovereignty. We participated in their project of helping with the distribution of greenhouses to rural communities outside of Cuenca, Ecuador. We aimed to assess current agricultural practices and obstacles affecting crop success. This provided the foundation to create our deliverables; an online *Agroecological Guide* of resources local to each community and a *Manual of Greenhouse Best Practices* in order to educate farmers on adapting their techniques to the new realities of their climates. Our findings with locals, interviews, and participant observation identified a need for education on water conservation, crop diversity, climate change, and modern technology, which were highlighted in our *Manual of Greenhouse Best Practices*. Additionally, future recommendations were provided to our sponsor, which included increasing the accessibility of our educational resources, ensuring longevity of our deliverables, providing stable contacts for the greenhouses, and hosting educational workshops based on our manual.

Resumen

A medida que el cambio climático se intensifica en todo el mundo, los efectos han comenzado a afectar negativamente las prácticas agrícolas, el acceso a los alimentos y la comprensión de su entorno tal como lo experimentan ahora muchas comunidades. Uno de esos países que experimenta tales dificultades es Ecuador, cuya soberanía alimentaria se ha visto muy afectada por el cambio climático. Nuestra patrocinadora, Marisol Peñaloza y su organización, Cultivando el Futuro, nos encargaron ayudarlos en su objetivo de aumentar la soberanía alimentaria. Nosotros participamos en su proyecto de ayudar con la distribución de invernaderos a comunidades rurales fuera de Cuenca, Ecuador. Nuestro objetivo era evaluar las prácticas agrícolas actuales y los obstáculos que afectan el éxito de los cultivos. Esto proporcionó la base para crear nuestros entregables; una *Guía Agroecológica* en línea de recursos locales de cada comunidad y un *Manual de Buenas Prácticas de Invernaderos* con el fin de educar a los agricultores en la adaptación de sus técnicas a las nuevas realidades de sus climas. Nuestros hallazgos con lugareños, entrevistas y observación participante identificaron la necesidad de educación sobre la conservación del agua, la diversidad de cultivos, el cambio climático y la tecnología moderna, que se destacaron en nuestro *Manual de Buenas Prácticas de Invernaderos*. Además, se brindaron recomendaciones futuras a nuestro patrocinador, que incluyeron aumentar la accesibilidad de nuestros recursos educativos, garantizar la longevidad de nuestros entregables, proporcionar contactos estables para los invernaderos y organizar talleres educativos basados en nuestro manual.

Executive Summary

Nations all around the world are suffering from the effects of climate change and must begin to adapt their lifestyles to these changes. In agriculture-reliant societies like the Ecuadorian communities of Turi, Sayausí, and Victoria del Portete, the situation has worsened over the past few years. It is becoming increasingly more difficult to farm products at the same scale as before, posing a challenge to a society that relies on their own agricultural production for personal consumption and commercial use.

The vice mayor of Cuenca, Marisol Peñaloza, and her flourishing organization, Cultivando el Futuro, have developed an initiative to provide greenhouses to these communities, with the goal of aiding more parishes in the future. This is to aid in their movement of supporting food sovereignty rights in the rural parishes of Cuenca, Ecuador. Greenhouses provide these communities with a climate-controlled environment wherein they can grow their crops safely and efficiently. Using interviews with local farmers and greenhouse experts, we accomplished the following objectives: identifying current agricultural practices and obstacles to crop success, documenting resources in an *Agroecological Guide*, and providing the greenhouse benefactors with a *Manual of Greenhouse Best Practices*.

We organized our project into two deliverables:

Our first deliverable was a *Manual of Greenhouse Best Practices*. Over the course of the seven weeks, the team worked closely with the volunteers of Cultivando el Futuro in order to gather information from local farmers about their knowledge of greenhouses, as well as their experiences with farming in recent years. Our manual outlines a wide range of topics including but not limited to; why greenhouses are important, general greenhouse maintenance, and navigating the changes in climate. Additionally, included in the manual are suggestions for improving crop success, for example, recipes of natural remedies for making insecticides and nurturing infected plants.

This manual was drafted based on interviews with the farmers in the three rural communities along with experts in greenhouse management, the book *Ancestral Plantas Medicinales*, and archival research. The *Manual of Greenhouse Best Practices* is meant to be distributed throughout the beneficiary communities, allowing them to use it as a guide as they begin to manage their new greenhouse. This distribution process was sending a digital copy of the manual to the elected local leaders in each community to have them spread it to the rest of the parish. We recommended this method because it is easier to circulate and does not require printing.

Our second deliverable was an *Agroecological Guide* on Google Maps. The purpose of this map was to document all the greenhouse locations, seed banks, and other important sites such as *ferias agroecológicas*, markets, and places where locals sell their artisanal and agricultural products. In our interviews with the farmers, we asked them what sites they would like to see documented in this guide in order to cater it to their specific needs. The guide serves as a source so that the people in rural communities can access these resources. This documentation of resources on a digital platform allocates them all in one place for easy access and visibility. Instead of having coordinates as placeholders, the *Agroecological Guide* brings those locations and the people behind them to life.

This *Agroecological Guide* is accessible through a QR code and a provided link. We recommended that in order to ensure that our guide reaches the right audience, these QR codes

are posted in the *Centro de Acopio*, in the back of our *Manual of Greenhouse Best Practices*, and on social media. Since this is also accessible through a link, we recommended distributing this to the assigned local leaders in each community to have them spread it to the rest of the parish as needed.

These deliverables were based on the information collected from the selected three rural parishes of Cuenca. We recommended that as this project grows, the *Manual of Greenhouse Best Practices* and *Agroecological Guide* grow with it. We hoped to create this guide as a foundation for educational greenhouse workshops and are hopeful for future elaboration on the knowledge in the material we provided. We also recommend that as more greenhouses are established, our sponsors update the *Agroecological Guide* to reflect the new greenhouses and community resources. Through the increasing problem of climate change facing Ecuador, this greenhouse movement places them in a unique position to stay ahead of the changes in the environment. Educating the people about this important topic enables them to understand the importance of greenhouse technology. This can improve their everyday production and could set a course for future development.

Informe Ejecutivo

Las naciones de todo el mundo están sufriendo de los efectos del cambio climático y deben comenzar a adaptar sus estilos de vida a estos cambios. En sociedades que dependen de la agricultura, como las comunidades ecuatorianas de Turi, Sayausí y Victoria del Portete, la situación ha empeorado en los últimos años. Cada vez es más difícil cultivar productos a la misma escala que antes, lo que plantea un desafío para una sociedad que depende de su propia producción agrícola para consumo personal y uso comercial.

La vicealcaldesa de Cuenca, Marisol Peñaloza, y su organización floreciente, Cultivando el Futuro, han desarrollado una iniciativa para dotar de invernaderos a estas comunidades, con el objetivo de ayudar a más parroquias en el futuro. Esto es para ayudar en su movimiento de apoyo a los derechos de soberanía alimentaria en las parroquias rurales de Cuenca, Ecuador. Los invernaderos brindan a estas comunidades un ambiente con clima controlado en el que pueden cultivar sus cultivos de manera segura y eficiente. Utilizando entrevistas con agricultores locales y expertos en invernaderos, logramos los siguientes objetivos: identificar las prácticas agrícolas actuales y los obstáculos para el éxito de los cultivos, documentar los recursos en una *Guía Agroecológica* y proporcionar a los benefactores de los invernaderos un *Manual de Buenas Prácticas de Invernaderos*.

Organizamos nuestro proyecto por dos entregables:

Nuestro primer producto fue un *Manual de Buenas Prácticas en Invernaderos*. A lo largo de las siete semanas, el equipo trabajó estrechamente con los voluntarios de Cultivando el Futuro, para recopilar información de los agricultores locales sobre sus conocimientos de invernaderos, así como sus experiencias con la agricultura en los últimos años. Nuestro manual describe una amplia gama de temas que incluyen, entre otros; por qué los invernaderos son importantes, el mantenimiento general de los invernaderos y cómo afrontar los cambios en el clima. Además, en el manual se incluyen sugerencias para mejorar el éxito de los cultivos, por ejemplo, recetas de remedios naturales para fabricar insecticidas y cuidar plantas infectadas.

Este manual se redactó a partir de entrevistas con los agricultores de las tres comunidades rurales junto con expertos en manejo de invernaderos, el libro *Plantas Medicinales Ancestrales* e investigaciones de archivos. El *Manual de Buenas Prácticas de Invernaderos* está destinado a ser distribuido entre las comunidades beneficiarias, permitiéndoles utilizarlo como guía cuando comiencen a administrar su nuevo invernadero. Este proceso de distribución consistirá en enviar una copia digital del manual a los líderes locales electos de cada comunidad para que lo difundan al resto de la parroquia. Recomendamos este método porque es más fácil de circular y no requiere impresión.

Nuestro segundo entregable fue una *Guía Agroecológica* en Google Maps. El propósito de este mapa fue documentar todas las ubicaciones de invernaderos, bancos de semillas y otros sitios importantes como ferias agroecológicas, mercados y lugares donde los locales venden sus productos agrícolas y artesanales. En nuestras entrevistas con los agricultores, les preguntamos qué sitios les gustaría que se documentaran en esta guía para satisfacer sus necesidades específicas. La guía sirve como fuente para que las personas de las comunidades rurales puedan acceder a estos recursos. Esta documentación de recursos en una plataforma digital los asigna todos en un solo lugar para facilitar el acceso y la visibilidad. En lugar de tener coordenadas como marcadores de posición, la *Guía Agroecológica* da vida a esos lugares y a las personas detrás de ellos.

Esta *Guía Agroecológica* será accesible a través de un código QR y un enlace proporcionado. Recomendamos que para garantizar que nuestra guía llegue al público adecuado, estos códigos QR se publiquen en el Centro de Acopio, en la parte posterior de nuestro *Manual de Buenas Prácticas de Invernaderos* y en las redes sociales. Dado que también se puede acceder a esto a través de un enlace, recomendamos distribuirlo a los líderes locales asignados en cada comunidad para que lo difundan al resto de la parroquia según sea necesario.

Estos entregables se basaron en la información recopilada de las tres parroquias rurales seleccionadas de Cuenca. Recomendamos que a medida que este proyecto crezca, crezca con él el *Manual de Buenas Prácticas de Invernaderos* y la *Guía Agroecológica*. Esperábamos crear esta guía como base para talleres educativos sobre invernaderos y tenemos la esperanza de una futura elaboración del conocimiento contenido en el material que proporcionamos. También recomendamos que a medida que se establezcan más invernaderos, nuestros patrocinadores actualicen la *Guía Agroecológica* para reflejar los nuevos invernaderos y los recursos comunitarios. A través del creciente problema del cambio climático que enfrenta Ecuador, este movimiento de invernadero los coloca en una posición única para adelantarse a los cambios en el medio ambiente. Educar a la gente sobre este importante tema les permite comprender la importancia de la tecnología de invernaderos. Esto puede mejorar su producción diaria y podría marcar el rumbo para el desarrollo futuro.

Acknowledgements

Throughout our incredible journey here in Cuenca, we would first like to thank our wonderful sponsor, Marisol Peñaloza. She extended a warm welcome to us and was vital in providing us with the resources to complete our project to its full extent. Additionally, we would like to thank her colleague, Ruby Moss, for her guidance throughout the completion of our project and work in the rural *parroquias*. The volunteers of Cultivando el Futuro, Amanda and Anahí, were also a great help when it came to learning the history and ambitions of the organization, producing thoughtful and meaningful questions for our interviews, and building special connections with the farmers we worked with. As well, it was a pleasure being able to meet and work the strong farming women of Sayausí at the *Mingas* and being invited into their lovely homes. And finally, we cannot thank our advisors enough, William San Martín, Sarah Strauss, and Guilherme Dourado, for their invaluable mentorship, recommendation, and direction throughout the past 14 weeks. The team feels blessed with this experience and will truly miss our time in Cuenca.

Agradecimientos

A lo largo de nuestro viaje increíble aquí en Cuenca, primero nos gustaría agradecer a nuestra patrocinadora maravillosa, Marisol Peñaloza. Nos brindó una bienvenida cálida y fue vital al brindarnos los recursos para completar nuestro proyecto en toda su extensión. Además, nos gustaría agradecer a su colega, Ruby Moss, por su orientación durante la finalización de nuestro proyecto y trabajo en las parroquias rurales. Las voluntarias de Cultivando el Futuro, Amanda y Anahí, también fueron de gran ayuda para conocer la historia y las ambiciones de la organización, generar preguntas significativas para nuestras entrevistas y construir conexiones especiales con los agricultores con los que trabajamos. Además, fue un placer poder conocer y trabajar en las Mingas con las mujeres fuertes de Sayausí y ser invitados a sus hogares hermosos. Y, por último, no podemos agradecer lo suficiente a nuestros asesores, William San Martín, Sarah Strauss y Guilherme Dourado, por su tutoría invaluable, recomendación y dirección durante las últimas 14 semanas. El equipo se siente bendecido con esta experiencia y realmente extrañará nuestro tiempo en Cuenca.

Authorship

Topic	Author	Editor
Abstract	Sophia	Emiliano
Resumen	Julia	Sophia
Table of Contents	Sophia	Julia
Table of Figures	Sophia	Julia
Executive Summary	Julia	Sophia
Informe Ejecutivo	Julia	Sophia
1.0 Introduction	Celeste	Sophia & Emiliano
1.0 Introducción	Sophia	Emiliano & Celeste
2.0 Background	Sophia	Emiliano
2.1 Agricultural Challenges in Ecuador	Celeste, Sophia & Emiliano	Julia, Sophia & Emiliano
2.2 Health and Wellness in Rural Communities	Emiliano	Sophia
2.3 The Use of Greenhouses	Julia	Emiliano
2.4 Food Scarcity on a Global Stage	Sophia	Emiliano
2.5 Ecuadorian Legislation	Celeste	Sophia
3.0 Methodology	Celeste & Julia	Emiliano & Sophia
3.1 Identify Current Agricultural Practices	Celeste & Julia	Emiliano & Sophia

and Obstacles to Crop Success		
3.2 Documentation of Resources	Celeste & Julia	Emiliano & Sophia
3.3 Provide Greenhouse Benefactors with Educational Aid	Celeste & Julia	Emiliano & Sophia
4.0 Findings	Celeste	All
4.1 Interviews with Community Members	Sophia & Celeste	Emiliano & Julia
4.2 Interviews with Experts	Emiliano	Celeste & Sophia
4.3 Participation in *Mingas* and Community Observation	Julia	Emiliano & Celeste
5.0 Discussion	Celeste	Emiliano & Julia
5.1 Interviews with Community Members	Sophia & Emiliano	Emiliano & Celeste
5.2 Interviews with Experts	Sophia & Emiliano	Emiliano & Celeste
5.3 Participation in *Mingas* and Community Observation	Emiliano	Julia & Sophia
6.0 Recommendations	Celeste	Emiliano & Julia
6.1 Accessibility	Julia	Emiliano & Celeste
6.2 Proper Hand-Off	Julia	Sophia & Celeste
6.3 Stable Contact	Julia	Emiliano & Celeste

6.4 Future Workshops	Julia	Sophia & Emiliano
Works Cited	Sophia	All
Appendix A: Sponsor Description	All	Sophia
Appendix B: Protocols	All	Julia
Appendix C: Cover Page and Link to *Manual of Greenhouse Best Practices*	All	All
Appendix D: Cover Page and Link to *Agroecological Guide*	Sophia	Julia, Celeste, & Emiliano
Appendix E: Cover Page and Link to Instructions on How to Create or Modify *Agroecological Guide*	Sophia	Julia, Celeste, & Emiliano

Table of Contents:

Table of Figures:

1.0 Introduction

Abundant biodiversity, the high peaks of the Andes mountains, and the unique wildlife of the Galápagos islands can all be found within the beautiful Latin American country, Ecuador. Cuenca, Ecuador is located in the Azuay Province within the steep altitudes of the Andes Mountains. Outside of this bustling city are dozens of small, rural farming communities that heavily rely upon their own capability to grow crops for their own kitchens, or to be sold in local markets and between families for economic benefits. However, this has been negatively affected in recent years predominantly due to the effects of climate change. This includes a lower quality in soil, harsher weather and storms, and often shorter seasons for productive crop growth, which deeply affects the rural farmers of Cuenca and their ability to sustain themselves on their own farms (Cunha, 2015). As well, there has been a swell in the global food shortage crisis due to a combination of factors including COVID-19, large-scale wars, and climate change (Yates, 2023). In Ecuador, families in the rural parishes of Cuenca are affected more than their city counterparts. This causes both a steep price increase and a deterioration in food quality, leading city vendors to sell poor quality products to the consumer, further intensifying the food insecurity that rural families already face.

In Ecuador from 1960 to 2010, the average precipitation has increased by 66% and the average temperature has increased by 1.4°C (Primera Contribución Determinada a Nivel Nacional para el Acuerdo de París bajo la Convención Marco de Naciones Unidas Sobre Cambio Climático, 2019). These drastic changes in the environment have had an effect on many agricultural communities in Ecuador. As rural farmers are struggling to stay financially self-sufficient from their farms, they are forced to follow unsustainable agricultural industry standards such as monocultures, which further impacts the lack of diversity of native crops and decreases the consumption of a balanced diet (Melby et. al, 2020).

The scope of this project encompasses three rural communities outside of Cuenca which includes Turi, Sayausí, and Victoria del Portete. Cultivando el Futuro (CeF), founded by our sponsor, Marisol Peñaloza, is an organization working with these communities since 2020 in collaboration with the Municipality of Cuenca. CeF provides support in various forms such as seed banks and economic educational workshops for female heads of households (Albarracín et al., 2022). The communities themselves have also been self-advocating, appearing in both local and state government offices to discuss their struggles (El Nuevo, 2017). In these communities, we plan to assist farmers who have been presented with the responsibility of managing these new greenhouses and the difficulties of selling their products by creating a *Manual of Greenhouse Best Practices* and an *Agroecological Guide*.

The previous projects completed under CeF were focused on seed banks. These seed banks helped distribute materials to 700 families that could be used for familial or agricultural use (Albarracín et al., 2022). Specifically, 8,700 seeds of vegetables and legumes as well as 21 biosafety kits were distributed amongst the rural parishes of Cuenca. That project focused on the front line of addressing the barriers to home agriculture, specifically the inadequate access to seeds. It also allowed for an influx of available crops to grow but left a lingering obstacle on how to grow at an efficient and constant scale. With our sponsor, our project has continued improving food sovereignty by focusing on how to adequately facilitate the growth of these crops despite fluctuating temperatures and climatic conditions. With the presence of variable changes, greenhouses aid in creating a stable environment for improved agricultural production.

The goal of our project was to educate farmers on greenhouse farming practices in rural communities affected by climate change. We had three objectives, the first of which included identifying the current agricultural practices and obstacles to crop success in the local communities. The purpose of this was to gain an understanding of what techniques and agricultural methods are commonly used in rural areas by farmers, as well as the increasing struggles in crop success. This was so we could later adapt these practices for successful use within the greenhouses. Our second goal was to document agricultural and economic resources and locations in each of the local communities. Through documenting these resources in Google Maps, we hoped to provide an accessible space for farmers to share with tourists and locals their produce and artisanal goods. Thirdly, we aimed to provide new greenhouse owners with a well-organized, educational manual to help them adapt to the changing climate and their new agricultural space. Possible implications and outcomes of our project include improving food sovereignty in the communities we worked in, as well as creating a dependency on alternative sustainable solutions to climate change.

1.0 Introducción

La biodiversidad abundante, los altos picos de las montañas de los Andes y la vida silvestre única de las islas Galápagos se pueden encontrar dentro del hermoso país latinoamericano, Ecuador. Cuenca, Ecuador está ubicada en la provincia de Azuay dentro de las altitudes escarpadas de la Cordillera de los Andes. Fuera de esta ciudad hay docenas de pequeñas comunidades agrícolas rurales que dependen en gran medida de su propia capacidad para cultivar cultivos para sus propias cocinas o para venderlos en los mercados locales y entre familias para obtener beneficios económicos. Sin embargo, esto se ha visto afectado negativamente en los últimos años debido principalmente a los efectos del cambio climático. Esto incluye una menor calidad del suelo, climas y tormentas más severos y, a menudo, temporadas más cortas para el crecimiento productivo de los cultivos, lo que afecta profundamente a los agricultores rurales de Cuenca y su capacidad para sustentarse en sus propias fincas (Cunha, 2015). Además, ha habido un aumento en la crisis mundial de escasez de alimentos debido a una combinación de factores que incluyen el COVID-19, las guerras a gran escala y el cambio climático (Yates, 2023). En Ecuador, las familias de las parroquias rurales de Cuenca se ven más afectadas que las de la ciudad. Esto provoca un fuerte aumento de precios y un deterioro de la calidad de los alimentos, lo que lleva a los vendedores urbanos a vender productos de mala calidad al consumidor, intensificando aún más la inseguridad alimentaria a la que se enfrentan las familias rurales.

En Ecuador de 1960 a 2010, la precipitación promedio ha aumentado un 66% y la temperatura promedio ha aumentado 1,4°C (Primera Contribución Determinada a Nivel Nacional para el Acuerdo de París bajo la Convención Marco de Naciones Unidas Sobre Cambio Climático, 2019). Estos cambios drásticos en el medio ambiente han tenido un efecto en muchas comunidades agrícolas del Ecuador. A medida que los agricultores rurales luchan por mantenerse financieramente autosuficientes en sus granjas, se ven obligados a seguir estándares industriales agrícolas insostenibles, como los de los monocultivos, los que impactan aún más la falta de diversidad de cultivos nativos y disminuyen el consumo de una dieta equilibrada (Melby et.al, 2020).

El alcance de este proyecto abarca tres comunidades rurales fuera de Cuenca que incluyen Sayausí, Victoria del Portete y Turi. Nuestra patrocinadora Marisol Peñaloza es la fundadora de Cultivando el Futuro (CeF), una organización que trabaja con estas comunidades desde 2020 en colaboración con la Municipalidad de Cuenca, brindando apoyo en diversas formas como bancos de semillas y talleres de educación económica para mujeres cabeza de familia. (Albarracín et al., 2022). Las propias comunidades también han sido autogestoras, apareciendo en oficinas gubernamentales locales y estatales para discutir sus luchas y necesidades, como apareciendo en un diálogo agrícola en la oficina del gobernador para discutir salud, seguridad y economía (El Nuevo, 2017). En estas comunidades planeamos ayudar a los agricultores a quienes se les ha presentado la responsabilidad del manejo de estos nuevos invernaderos y las dificultades de vender sus productos mediante la creación de un *Manual de Buenas Prácticas de Invernaderos*, y una *Guía Agroecológica* en línea.

Los proyectos anteriores completados en el marco del CeF se centraron en los bancos de semillas. Estos bancos de semillas ayudaron a distribuir materiales a 700 familias que podrían ser utilizados para uso familiar o agrícola (Albarracín et al., 2022). En concreto, se distribuyeron 8.700 semillas de hortalizas y legumbres, así como 21 kits de bioseguridad entre las parroquias rurales de Cuenca. Ese proyecto se centró en la primera línea para abordar las barreras a la agricultura nacional, específicamente el acceso inadecuado a las semillas. También permitió el

crecimiento de una afluencia de cultivos disponibles, pero dejó un obstáculo persistente sobre cómo crecer a una escala eficiente y constante. Con nuestro patrocinador CeF, nuestro proyecto ha seguido mejorando la soberanía alimentaria centrándose en cómo facilitar adecuadamente el crecimiento de estos cultivos a pesar de las fluctuaciones de temperaturas y condiciones climáticas. Con la presencia de cambios ambientales externos variables, los invernaderos ayudan a crear un entorno estable para mejorar la producción agrícola.

El objetivo de nuestro proyecto fue educar a los agricultores sobre prácticas agrícolas en invernaderos en comunidades rurales afectadas por el cambio climático. Tuvimos tres objetivos, el primero de los cuales incluía identificar las prácticas agrícolas actuales y los obstáculos para el éxito de los cultivos en las comunidades locales. El objetivo de esto fue comprender qué técnicas y métodos agrícolas suelen utilizar los agricultores en las zonas rurales, así como las crecientes luchas por el éxito de los cultivos. Esto fue para que luego pudiéramos adaptar estas prácticas para su uso exitoso dentro de los invernaderos. Nuestro segundo objetivo fue documentar los recursos y ubicaciones agrícolas y económicas en cada una de las comunidades locales. Al documentar estos recursos en Google Maps, esperamos brindar un espacio accesible para que los agricultores compartan con turistas y lugareños sus productos artesanales. En tercer lugar, nuestro objetivo fue proporcionar a los nuevos propietarios de invernaderos un manual educativo bien organizado para ayudarles a adaptarse al clima cambiante y a su nuevo espacio agrícola. Las posibles implicaciones y resultados de nuestro proyecto incluyen mejorar la soberanía alimentaria en las comunidades en las que trabajamos, así como crear una dependencia de soluciones alternativas sostenibles al cambio climático.

2.0 Background

As of the 2010 national census illustrated in Figure 1, Ecuador is a country with roughly 17.5 million residents living on 256,370 km sq of land (Instituto Nacional de Estadística y Censos, 2016). That being said, only 19% of the land in Ecuador is used for farming (Instituto Nacional de Estadística y Censos, 2016). Additionally, 49.2% of rural populations live below the country's poverty line (Encuesta Nacional de Empleo, Desempleo y Subempleo, 2021) and 900,000 tons of food are wasted or lost each year in Ecuador (The Global FoodBanking Network, 2022). Food insecurity is a prevalent issue across the country; Ecuador has the second highest child malnutrition rate in Latin America at 27% nationally (Desnutrición Crónica Infantil | UNICEF, 2023). Furthermore, according to the *Global FoodBanking Network* (2022), during the span of time between 2018 and 2020, roughly 33% of the Ecuadorian population had experienced food insecurity.

POBLACIÓN DEL ECUADOR, SEGÚN PROVINCIA

Provincia	2010					2020				
	Mujeres		Hombres		Total	Mujeres		Hombres		Total
	Nº	%	Nº	%		Nº	%	Nº	%	
Azuay	389.435	52,7	350.085	47,3	739.520	459.159	52,1	422.235	47,9	881.394
Bolívar	97.764	51,0	93.867	49,0	191.631	107.504	51,2	102.429	48,8	209.933
Cañar	125.603	53,3	110.211	46,7	235.814	147.041	52,3	134.355	47,7	281.396
Carchi	86.886	50,6	84.860	49,4	171.746	94.102	50,4	92.767	49,6	186.869
Chimborazo	248.496	52,2	227.759	47,8	476.255	273.201	52,1	250.803	47,9	524.004
Cotopaxi	218.389	51,4	206.274	48,6	424.663	251.010	51,4	237.706	48,6	488.716
El Oro	308.027	49,3	316.833	50,7	624.860	354.069	49,5	361.682	50,5	715.751
Esmeraldas	271.159	49,1	280.553	50,9	551.712	318.952	49,6	324.702	50,4	643.654
Galápagos	12.398	47,9	13.486	52,1	25.884	16.086	48,7	16.956	51,3	33.042
Guayas	1.896.005	50,2	1.882.715	49,8	3.778.720	2.215.071	50,5	2.172.363	49,5	4.387.434
Imbabura	212.271	51,3	201.386	48,7	413.657	244.051	51,2	232.206	48,8	476.257
Loja	237.636	50,8	230.035	49,2	467.671	264.335	50,7	256.819	49,3	521.154
Los Ríos	393.011	48,8	412.503	51,2	805.514	454.373	49,3	467.390	50,7	921.763
Manabí	705.377	49,7	714.971	50,3	1.420.348	781.200	50,0	780.879	50,0	1.562.079
Morona Santiago	75.665	49,4	77.498	50,6	153.163	95.363	48,5	101.172	51,5	196.535
Napo	52.476	49,1	54.477	50,9	106.953	65.630	49,1	68.075	50,9	133.705
Orellana	64.696	47,0	73.090	53,0	137.786	75.718	46,9	85.620	53,1	161.338
Pastaza	42.756	49,4	43.714	50,6	86.470	55.881	48,9	58.321	51,1	114.202
Pichincha	1.366.718	51,2	1.301.235	48,8	2.667.953	1.653.014	51,2	1.575.219	48,8	3.228.233
Santa Elena	156.434	49,2	161.813	50,8	318.247	197.082	49,1	204.096	50,9	401.178
Sto. Dgo. Tsáchilas	190.321	50,2	189.057	49,8	379.378	230.723	50,3	227.857	49,7	458.580
Sucumbíos	85.553	47,2	95.734	52,8	181.287	109.526	47,5	120.977	52,5	230.503
Tungurahua	269.687	51,5	254.361	48,5	524.048	304.217	51,5	286.383	48,5	590.600
Zamora Chinchipe	45.718	48,0	49.476	52,0	95.194	57.378	47,6	63.038	52,4	120.416
Zonas no delimitada	15.872	47,0	17.882	53,0	33.754	20.020	47,8	21.887	52,2	41.907
Total	**7.568.353**	**50,4**	**7.443.875**	**49,6**	**15.012.228**	**8.844.706**	**50,5**	**8.665.937**	**49,5**	**17.510.643**

Fuente: INEC-Censo de población 2010, y Proyecciones de la población ecuatoriana

Figure 1: Population of Ecuador by Province (Consejo Nacional para la Igualidad de Género, 2021)

The problem of food insecurity in Ecuador is predominantly higher in its rural communities, such as those around Cuenca, than in Ecuador's largest cities. Compared to the national average, rural areas in Ecuador experience child malnutrition at an average of 30% (Desnutrición Crónica Infantil | UNICEF, 2023).

As of recent years, one of the main proposed solutions to this issue has been to focus on improving access to domestic agricultural production and adapting procedures to match their changing climate. Our sponsor, Marisol Peñaloza, founder of Cultivando el Futuro (CeF), has

been focusing on providing resources to build greenhouses for local agricultural production in afflicted rural communities. In addition to our sponsor, there are many groups that have taken an interest in promoting food security and sovereignty across the country. Two of such groups are the *World Food Programme*, which is an international organization focused on addressing food insecurity and food sustainability (*Ecuador | World Food Programme*, 2023), and *El Programa de Agricultura Urbana en Cuenca*, which is a local organization formed by the Municipality of Cuenca focusing on the dissemination of agricultural practices (*Programa de Agricultura Urbana en Cuenca (PAUC) | LATINNO*, n.d.).

2.1 Agricultural Challenges in Ecuador

Cuenca is the capital city of the Azuay Province within Ecuador. This city is located in the South of Ecuador within the Andes Mountain range, at an average altitude of 2,789 meters, or about 9,150 feet (Mapas Topográficos, n.d.). Considering these factors and its UNESCO heritage declaration, Cuenca's economy has a large focus on tourism (Fundación Turismo Cuenca, 2019). Due to this, those who rely on agriculture rather than tourism face distinctive economic struggles.

Cuenca is uniquely challenged agriculturally in its geographical location as well as its ecological environment. For those living in the rural towns surrounding Cuenca that do not profit as much from tourism, access to cheap and good quality agricultural products can be difficult. Given the high altitude and its mountainous terrain, there are many factors that can negatively impact the success of agriculture. This is presented in a multitude of challenges including shorter seasons for crop production, lower quality soil, and extreme weather events (Cunha, 2015). The combination of these qualities means that these communities fall into the category of rural towns with higher poverty and food insecurity rates.

In Ecuador, especially within the Azuay province, family farming is one of the most common types of agriculture and produces about 60% of the food demanded by the local population (Verdugo et al., 2023). Family farming is defined as "[...] an agricultural holding which is managed and operated by a household and where farm labour is largely supplied by that household" (Food and Agriculture Organization of the United Nations, n.d.). This practice became popular in Latin America in the late 1800s (Verdugo et al., 2023). According to the same study, about 86% of the technology used in family farming is ancestral, meaning they depend on farming techniques passed on by their ancestors. Comparatively, only about 14% depend on plowing technology. Additionally, the usage of an agricultural calendar, or following a set schedule for each type of crop, was reported around 91% and of rotation practices, the practice of using different crops after each harvest season at 97%.

These practices, however, have grown inefficient over time. One issue with family farming, as pointed out by a journal focusing on climatic change, is that family farms are more susceptible to environmental and climatic change (Álvarez et al., 2021). Ecuador has a rich history of the usage of these ancestral production methods, but recent environmental changes have destabilized the use of these practices and led to a surge in agroecological practices since the 80's (Atiencie et al., n.d.).

Agroecological practices, defined as "[...] a holistic and integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of sustainable agriculture and food systems," have been widely used to combat the effects of climate change (*Food and Agriculture Organization of the United Nations*, n.d.). This

switch to agroecological principals has set out to remedy the growing divide between current agricultural practices and changes in their communities. Through agroecological principles, Ecuadorian farmers can hope to increase soil health, water preservation, and biodiversity conservation all the while adapting to any environmental changes in order to achieve a more stable industry (Verdugo et al. 2023).

2.1.1 Climate Change Impacts Within Ecuador

On a broader scale, besides the limited accessible farmland, Ecuador has recently faced the similar challenges as many Latin American and equatorial countries. With the global rise in temperatures, Ecuador's diverse ecosystems have been uniquely sensitive to change in temperature. According to a study released by the Ecuadorian government and by the *Instituto Nacional de Meteorología e Hidrología* (INMH), from 1960 to 2010, the precipitation average increased 66% and temperature increased 1.4°C across the nation (Primera Contribución Determinada a Nivel Nacional para el Acuerdo de París bajo la Convención Marco de Naciones Unidas Sobre Cambio Climático, 2019). A temperature increase of 1.4°C is close to what the State of Climate Action 2023 has declared as a global limit before climate change becomes incredibly difficult to reverse (Intergovernmental Panel on Climate Change (IPCC), 2022). The *World Food Programme* reports that in the recent decade, the frequency of natural disasters related to climate change has increased in Ecuador and subsequently damaged food and nutritional security in the country (*Ecuador | World Food Programme*, 2023). With these changes in temperature and weather patterns, current native crops and farming methods may no longer be plentiful. In turn, these changes may lead to a decline in crops and crop quality making it harder for local Ecuadorians to sustain themselves through their agricultural means (World Bank, 2011). As a result, Ecuadorians need to adapt to new farming techniques that better fit the changes their farms are experiencing. Although many organizations, governments, and researchers have proposed ideas, an end to food insecurity has yet to be fully realized.

2.1.2 Improved Agricultural Methods for Rural Farming

For rural farmers living in areas that face unreliable environmental and climate variables, such as those around Cuenca, this can be risky to the well-being and output of their crops. This is especially alarming, as farmers in this region rely heavily upon the production of their family's farms. However, farming using traditional biodiverse crops can increase sustainable production, food and nutrition security, and overall economic development in rural communities (Oyarzun et al. 2013).

Agrobiodiversity, known as the variety of plants and animals used in agriculture, has been used successfully in other Andean regions to address food sovereignty. For instance, the *Instituto Nacional de Innovación Agraria* (INIA) of Perú, aims to utilize the methods of agrobiodiversity to improve the living conditions and sustainability of indigenous farmers (Canal 26, 2023). INIA has recognized nine agrobiodiversity zones in the peasant farming communities of the Peruvian Andes. These communities have cultivated agrobiodiversity, promoted sustainable tourism, and currently receive assistance from the state in protecting agrobiodiversity (Dávila, n.d.).

Additionally, bolstering biodiversity can create an agricultural ecosystem that is resilient to external biological and environmental factors that can normally weaken a rural farming community (Oyarzun et al. 2013). Having an otherwise limited variety of crops increases the

susceptibility of the farm to the negative effects of climate change, which is a growing issue that Cuencan farmers are experiencing. Increasing biodiversity in rural farms by growing a wider variety of Andean crops is a simple yet effective method that could be used by the rural farmers of Cuenca to combat the devastating effects of climate change.

In addition to using agrobiodiversity in rural farming methods, utilizing technical irrigation systems in farming is another method to promote more sustainable farming and food sovereignty in rural Ecuador. Readily available water resources, especially in the rural farming communities of Ecuador, have depleted in abundance due to the effects of climate change, deforestation, and degraded soils (Banco Mundial, 2021). The combination of these three factors also causes the rainy seasons to be more unpredictable, making crops less likely to survive (Banco Mundial, 2021). The small farming communities of Ecuador, especially in Azuay, complain that traditional irrigation methods reduce crop productivity and wastewater stores (El Productor, 2020). The technical irrigation method works with the use of sprinklers and micro-sprinklers, as opposed to the traditional method of having water flow through ditches in the ground (Banco Mundial, 2021). This method can help in the conservation of water compared to current methods, aiding farmers throughout the dry seasons.

Lack of water resources, in addition to the aforementioned environmental factors, can be devastating to the food security and income of small farming families. However, there are organizations who aid in agricultural water conservation. *Proyecto de Irrigación Tecnificada* (PIT), administered by Ecuador's Ministry of Agriculture and Farming, has recently benefited over 167 rural farming families in the Cañar canton, as well as an additional six Ecuadorian provinces with technical irrigation, increasing productivity of small rural farms (El Productor, 2021). As a solution to water insufficiency, modernizing irrigation systems for small and medium producers have greatly improved the living conditions of the families and sustainability of their farms (Banco Mundial, 2021). Given that CeF focuses on the optimization of water resources, the successes of technical irrigation are important to consider when working with the rural communities of Cuenca. These irrigation and agrobiodiversity methods were observed to identify what is most effective and efficient in greenhouses.

In addition, the establishment of seed banks is an emerging method used to combat the lack of seed diversity facing many communities around the world. A seed bank can take the form of many different structures based on the needs and available resources of local communities; however, they are commonly used as storage of seeds of the best crops after the harvesting season, ensuring seed security and diversity for the next growing season (Leon-Lobos, 2012). As discussed previously, monoculture farms are the most common in the agriculture industry worldwide, which has led to a loss of seed diversity and a decline in general crop turnover due to diseases being easily spread (Melby et. al, 2020). In recent years, seed banks have become a popular method to combat this, ensuring that local farmers have accessibility to diverse seed populations each year (Borja et. al, 2016).

Recently in Cuenca, the Sayausí Rural Seed Bank was opened in 2021 by Tania Peñaloza. This bank has been utilized by multiple rural communities surrounding Cuenca. In 2023, a group of Worcester Polytechnic Institute students worked on promoting this seed bank to make it better accessible to these communities (Barbosa, et. al 2023). This is not the first seed bank to exist in Ecuador, as Quito has their own *Banco de Semillas de Quito* containing over 47 million seeds (El Universo, 2011) and Tabacundo storing *La Red de Guardianes de Semillas*, which encompasses seeds from both Ecuador and Colombia (Erazo, 2010). These banks have

been integral in implementing agrobiodiversity methods, specifically ensuring the survival of native plant species and the accessibility of seeds to local farmers.

2.1.3 Food Insecurity and Food Sovereignty in Ecuador

Food security, as stated by the Food and Agriculture Organization of the United Nations (FAO), is the idea that safe and nutritious food necessary for daily life is available at all times to lead a healthy lifestyle (Cordero-Ahiman, 2022). Alternatively, food sovereignty is defined as the right of the people to have access to adequate food in correspondence with their respective cultural identities and traditions (Food and Agricultural Organization, 2024). While very similar to the idea of food security, food sovereignty differs in the fact that it places a heavy emphasis on the support and improvement of local, peasant agriculture (Cordero-Ahiman, 2022). The food sovereignty movement is practiced in Ecuador by working on optimizing food systems, ending hunger, preserving biodiversity in rural farms, and fighting the effects of climate change (Cordero-Ahiman, 2022). Food sovereignty is an especially important concept as it prioritizes the support of agricultural production from local and rural farmers and the rights of community members to have access to water, clean soil, and non-genetically modified seeds (Cordero-Ahiman, 2022). The primary objectives of our project are to optimize the use of water and soil resources, improve production of rural farms, and promote nutritional education, which greatly aligns with the focus of food sovereignty.

2.2 Health and Wellness in Rural Communities

When working with agriculture, it is imperative to consider the dietary health of the farmers and community in totality in these rural areas. In these communities, households fulfill most of their diet from their own cultivations, with women in the area reportedly consuming 53% of their food from their own crops and domestic animals (Melby et. al, 2020).

Rural communities surrounding Cuenca and in Ecuador generally have diverse agricultural practices, with multiple agricultural societies focusing on different agricultural needs, such as a *la Asociación de Productores Agroecológicos del Austro* (APAAUSTRO) or el Proyecto de Agricultura Urbana (PAU) (Puertas, 2001). These associations, both past and ongoing, still struggle in the improvement of health of the rural communities, described as a "double burden" of both malnutrition and obesity (Freire et. al, 2018).

Ecuadorian rural communities have a long-standing issue of dietary troubles, with children under five years old having a stunt in growth and their mothers having higher rates of obesity since the 1980s (Freire et al. 2018). In turn, these communities are also more susceptible to diseases associated with obesity, such as hemorrhaging, diabetes, and generally higher mortality rates (Freire et al. 2018). This is attributed to the increased accessibility to highly processed foods, as they are cheaper and more plentiful than nutrient dense food, which also causes stunting in growth due to the lack of nutrients (Freire et. al, 2018).

Additionally, rural farmers in these communities find themselves in a tough space, where their economic needs overshadow their dietary needs. In Ecuador, almost 2 million people are employed in the agricultural industry; over 1.3 million of which live in rural areas and represent 62% of the rural economy (Daza, 2015). Because of the growing dependency on agricultural industry, monocultures of popular commercial crops are slowly replacing native and diverse crops grown for consumption, which creates a direct correlation to the decreasing intake of varied nutrients (Melby et. al, 2020). This is not to say these communities are ignorant to the

impact of these practices on their health. In fact, these farmers are actively advocating for their needs to both local and state legislation, an example being in July 2017 where 400 farmers from the Azuay region came to an “Agricultural Dialogue” to address their needs in health, safety, and economy (El Nuevo, 2017).

2.3 The Use of Greenhouses

A greenhouse is a structure that aids in the production of crops by controlling internal temperature and humidity. These structures are highly beneficial for areas in which the climate is ever-changing to preserve crop yields. A non-constant atmosphere can lead to inconsistent agricultural development, which in turn leads not only to a drop in the economy, but a drop in food security. The implementation of greenhouse technology allows for control over areas that seem uncontrollable.

2.3.1 Internal Aspects of Greenhouse Technology

Certain internal aspects of a greenhouse must be controlled for functionality. These include, but are not limited to, temperature, carbon dioxide, and water**.** Based on the crop type, the temperature is one of the most important aspects to be controlled. Items that are grown in greenhouses, both crops and plants, fall into different categories based on the conditions that are sufficient for life. One challenge about greenhouse temperature is the changing of the internal temperature as a response to that on the outside. The climate in Ecuador changes between months and from January to April, the country experiences a rainy climate (Virgin Farms Team, 2022). The warmer months in Ecuador last from January 15th - May 2nd and temperatures were recorded with an average of 61°F. March is categorized as the hottest month in Cuenca with an average high temperature of 63°F (Weather Spark, 2024).

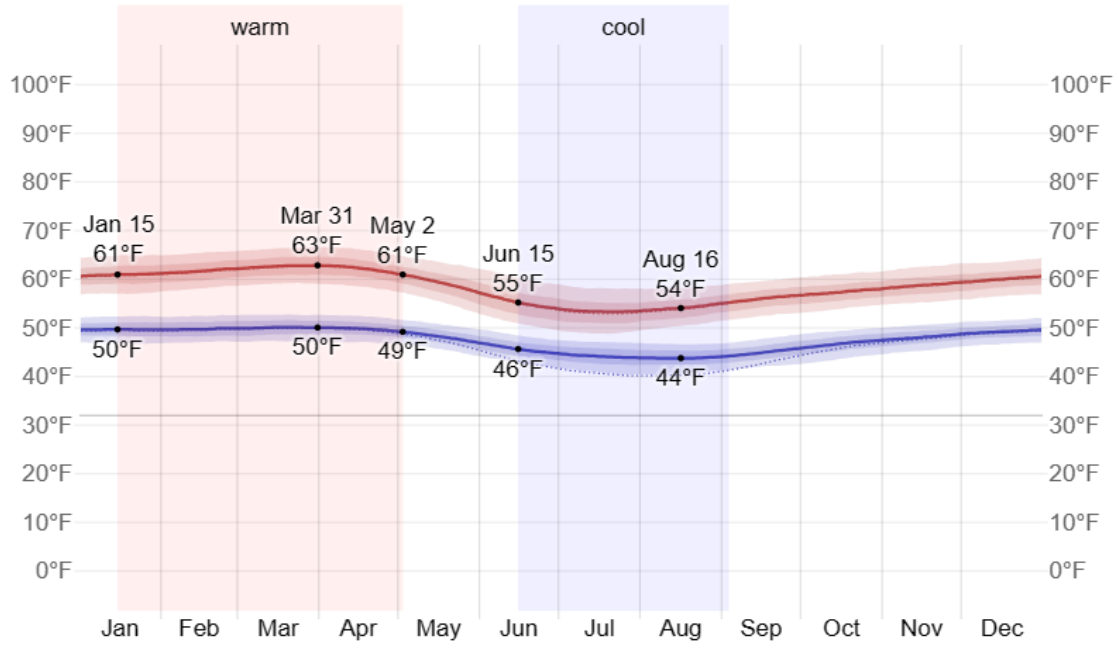


Figure 2: Average High and Low Temperatures in Cuenca (WeatherSpark, 2024)

External temperature or climate conditions force the greenhouses to have an ever-fluctuating temperature to respond to the stimulus from the outside; that is why monitoring them is important. One of the most important ways to facilitate plant growth is by attending to the appropriate level of carbon dioxide. If the current amount of carbon dioxide fluctuates slightly within the greenhouse, this can detrimentally affect the process of photosynthesis in plants, causing a downward spiral in plant growth (Poudel et. al, 2023). Irrigation, and means of water distribution, are other important internal aspects of a greenhouse. There are many different ways of irrigating crops through drip tubes, sprinklers, or hand hoses. Each of these methods has its advantages and disadvantages, but most importantly, overhead sprinkles are known to use large amounts of water that are unnecessary; in some conditions, they can be detrimental to the plant's health. In contrast, drip systems are known to be most reliable and can be possessed with greater control (Lanier, 2015).

2.3.2 Greenhouse Structure

During greenhouse construction, many different forms of building are favorable for different crops. One crucial factor of greenhouse construction is geometry. The geometric structure of the greenhouse is favorable for solar radiation and the growing conditions of the plants inside (Achour et. al, 2021). One of the most important parts of the geometric structure is the roof because that is where a high amount of solar radiation enters. With that being said, designs that limit the amount of solar radiation can be deemed unfit for specific crop types because of how it affects their growing conditions.

While geometric shape is important, the materials used to construct the greenhouse have equal importance as well. Ecuadorian greenhouses are typically made of plastic to construct walls and roofs and use concrete to stabilize the metal frame. The greenhouse design that is utilized in this project is a semi-hydroponic greenhouse. In hydroponic greenhouses, there is no

soil, instead the plant's roots are suspended in water (Mahoney, 2022). Hydroponic greenhouses rely on a water-based nutrient delivery system to deliver the required materials that are essential for plant growth (Tyler, 2023). The roots of the plants are also open to oxygen allowing them to grow healthy and efficiently absorb nutrients. Hydroponic greenhouses are favorable for sustainability because of the large output that can be produced with minimal resources (Mahoney, 2022). These greenhouses use significantly less water, are favorable for year-round climate-controlled cultivation, and maximize space (Tyler, 2023).

Another important aspect of greenhouse technology is how these greenhouses are constructed in Cuenca's rural communities. Greenhouses, like other community-oriented projects, are often built through *Mingas*. The word *Minga* comes from the indigenous *Kichwa* word "*minka*" and refers to the allocation of local resources in order to provide help for a community task (La Hora, 2016). This tradition was built on the love for the land and the idea that by living in a community it is also one's job to help with the upkeep of it. This important cultural context is valuable to note because it shows the joint dedication that the Ecuadorian people feel for the land or, "*Madre Tierra.*"

2.3.3 Greenhouse Success

Farmers have found success in using these advances in greenhouse technology to keep their crops producing the best yields. In one instance, greenhouses were used in the Machachi Valley in Ecuador to control the vibrant color and consistent growth of roses. The farmers realized that for the production of their roses, they had to adjust the type of greenhouse plastic and control the temperature and humidity. These farmers discuss the importance of producing vibrant roses and how the quality of the roses grown in the greenhouse setting is highly distinguishable from those grown without (Virgin Farms Team, 2022). Another success story comes from Shell, Ecuador, where a greenhouse initiative was adapted in response to a failed cacao harvest in the jungle. These cacao plants were sent to Ecuador and were sent to villages without sufficient training on how to care for and tend to the plants, as well as the region being hit with an immense amount of rain. In response, the plants were exported to a newly built greenhouse which now houses 20,000 cacao plants. Not only is this a success, but staff members are providing training to people who live in the community of Shell to show them how to grow these trees (Kurtenback, 2017). These local success stories provide a framework for investigating positive components of local greenhouse production.

2.3.4 Greenhouse Challenges

While greenhouses provide a lot of positive yields, one of the major shortcomings of greenhouse production is cost. In the colder months, the financial upkeep of the greenhouse becomes steep. Since there is not enough sunlight, there is a higher cost value to keep the systems running. There are also infrastructure costs and material costs that contribute to production. Many additives enhance agricultural yield in greenhouses such as ventilation, grow lights, and irrigation systems which increase the costly nature of these structures (Knowledge Sourcing Intelligence, 2022). Another cost involved is the materials needed for construction. Greenhouse plastic differs from normal plastic because it possesses higher properties of durability and weathering. This also means that the cost of greenhouse plastic is higher than normal. The wear of plastic also needs to be replenished every two to three years to keep the greenhouse both effective and functional (Knapp, 2017).

2.4 Food Scarcity on a Global Stage

2.4.1 International Aid for Ecuador

Ecuador's issues are not unknown to the world though, and there exist many organizations invested in helping Ecuador both domestically and internationally. Some international organizations previously mentioned include the *World Food Programme*, the *Global FoodBanking Network*, and the *Global Food Donation Policy Atlas*. All of which attempt to analyze some of the underlying causes of Ecuador's situation to best strategize and propose a viable solution. The *World Food Programme* acknowledges that in recent years, Ecuador's situation has been exacerbated by inflation, the crisis of Ukraine, immigration, and social unrest (*Ecuador | World Food Programme*, 2023). Ukraine is one of the world's largest grain producers, and being in a state of war has made trade more difficult, which has in turn affected the price of grains on a global scale (Yates, 2023). With these current events along with the pandemic and international focus on the war in Israel, international food banks and organizations have seen a decline in funding from larger, wealthier countries such as the United States. Ecuador especially has seen a decline in funding as immediately preceding the pandemic the country showed gross domestic product, which became an excuse to cease funding for many (*Ecuador | World Food Programme*, 2023). This has brought consequences for local communities in Ecuador. Since the start of the pandemic, the country's poverty rate has risen nearly 5% in 2022, so the country still demonstrates a need for international aid (*Ecuador | World Food Programme*, 2023). The *World Food Programme*, like others, focuses on providing assistance to smaller communities that are disproportionately affected by food insecurity.

2.4.2 Increasing Awareness around Food Insecurity and Safety

As mentioned, Ecuador is facing a lack of visibility internationally compared to other countries facing similar levels of need. One past Interactive Qualifying Project from Worcester Polytechnic Institute completed with our sponsor in Cuenca had the goal of increasing visibility of their program and resources their program offers to their community (Spratt et al., 2021). This project concluded that the most optimal method to deliver content and foster an informed community would be through an easily accessible website. An online presence would offer a remote library for educational resources and training.

2.5 Ecuadorian Legislation for Food Sovereignty

Because food sovereignty is crucial for the success of its rural farmers, Ecuador has become the first country to adopt food sovereignty into its constitution (Cordero-Ahiman, 2022). The *Ley Orgánica del Régimen de la Soberanía Alimentaria* (LORSA), published as an official law in Ecuador in 2009, has the main objectives of protecting agrobiodiversity, improving public access to land and water, promoting the production of small and medium farmers, declaring Ecuador free of genetically modified crops and seeds, and to eradicate malnutrition (Cordero-Ahiman, 2022). Cultivando el Futuro, a supporter of the food sovereignty movement in Ecuador, supports the objectives that LORSA is intending to achieve.

The *Ley Para Prevenir y Reducir la Pérdida y el Desperdicio de Alimentos y Mitigar el Hambre de las Personas en Situación de Vulnerabilidad Alimentaria*, also known as the FLW Law, was passed by Ecuador in 2022 (Zambrano, 2014). The focus of this law, similar to

LORSA, is to reduce country-wide food insecurity. This law bans the waste of food that contributes to the 900,000 tons of food waste in Ecuador annually, and instead encourages alternative methods like donating food to a food bank, using it as animal feed, composting, or using it to produce renewable energy (Zambrano, 2014). This law is expected to help alleviate the widespread hunger and malnutrition that Ecuadorians face.

In addition to the laws put in place by the government, Ecuador is also funding research projects to progress the food sovereignty movement. *Fondo de Investigación para la Agrobiodiversidad, Semillas y Agricultura Sustentable* (FIASA) released an open call for Ecuador to share their findings in sustainable and efficient agriculture for Andean farming communities (El Nuevo Ecuador, 2023). These projects will be executed by universities and organizations to promote agricultural research and improve the livelihoods of Ecuadorian producers.

The above topics provide us with a strong foundation and understanding of the existing struggles and support systems in the rural parishes of Ecuador. This was essential to know before beginning our research methodologies in these communities to ensure that the information we gathered was new and relevant. Additionally, this understanding gave us cultural context to help enable in depth investigations and discussions with the rural farmers of Cuenca. This research also allowed us to narrow down our main objectives in better assisting the three rural parishes of Turi, Victoria del Portete, and Sayausí. The following chapter details our two project deliverables and how we aimed to boost the longevity of successful greenhouse farming in rural Cuenca.

3.0 Methodology

The goal of this project was to pilot the education of farmers in the communities of Turi, Sayausí, and Victoria del Portete, in the construction and use of new greenhouse technology. We achieved this through identifying current agricultural practices used in these parishes, documenting resources in an online *Agroecological Guide* and developing an informational manual on greenhouse management. To assist the Cultivando el Futuro (CeF) initiative, we investigated current farming methods in relation to recent environmental changes and utilized this data to propose additional solutions. The following objectives were used to achieve the project's goal:

1. Identify Current Agricultural Practices and Obstacles to Crop Success
2. Document Resources
3. Provide Greenhouse Benefactors with Educational Aid

This chapter outlines the investigation methods and techniques the team utilized to complete each objective.

3.1 Identify Current Agricultural Practices and Obstacles to Crop Success

In order to properly address any prominent difficulties within the current greenhouses and agroecological farming already established in these rural communities, interviewing farmers was essential. Understanding the personal experiences of these farmers aided in ensuring that our *Manual of Greenhouse Best Practices* was informative, as well as created a system to continuously improve greenhouse efficiency. Additionally, understanding the barriers that exist for community members attempting to find local resources through navigating the web, was essential in the creation of the *Agroecological Guide* in Objective 2. We completed two separate forms of data collection, which included interviews and community observations. Through these methods, our team identified farming practices pertaining to each parish and the technological challenges facing these farmers.

3.1.1 Gather Information About Current Agricultural Practices Through Interviews

The team gathered detailed information about the common agricultural techniques that are practiced in Turi, Sayausí, and Victoria del Portete. To achieve this, we created a list of interview questions and collaborated with CeF volunteers to produce a well-rounded questionnaire (Appendix B.1). These questions were open-ended to allow the interviewees to share in-depth, qualitative data and unique responses (Johnson, 2017). Prior to conducting interviews, all protocols, interview questions, and ethical statements were submitted to WPI's Institutional Review Board. This approval ensured research ethics were maintained throughout the duration of our project when interviewing human subjects. These interview questions were conducted with eight farmers from both Sayausí and Victoria del Portete, and two from Turi. The team interviewed community members such as local leaders, engineers, and farmers who participate in greenhouse farming and traditional farming. The interviews were recorded using the Voice Memos application on an iPhone and uploaded to a secure file storage system. The questions and subsequent responses were in Spanish and were later reviewed. These responses were then uploaded into a speech-to-text transcription program called Good Tapes to be coded

later on through Qualitative Content Analysis (Biggs et al., 2021). These findings and improvements were utilized in Objective 3, to later create our informative *Manual of Greenhouse Best Practices*.

3.1.2 Participation and Observation of Community Engagement

In order to better understand the parishes, we attended several *Mingas*, which are a traditional collective community event of labor and support. The specific *Mingas* we attended were planned by the local parish to aid in the construction of the community greenhouses, which fostered local service and engagement. *Mingas* were also a way the team was able to form friendly relationships with the rural farmers. While attending these *Mingas*, we observed varying methods of agricultural practices and preparation of land before and during cultivation. The team utilized observational methods at these *Mingas* to gather preliminary data on any challenges with farming in these communities. Before collecting data, the team asked for consent from participating parties to be observed and photographed. This method included real-time observation in the field, recording our findings by hand, and taking pictures for data collection (Biggs, 2021).

3.2 Document Resources

We also documented local resources on a digital platform so that they were easily accessible to the local communities. This *Agroecological Guide* provided the communities with specific locations of greenhouses, seed banks, and vendor markets. The details included in these locations provided descriptions of goods produced by the farmers and their respective vending locations. We used Google Maps, a popular online map that provides many accessibility features, such as precise location tracking. Through this, we enabled people with minimal technological experience in the rural communities to have easy access to all relevant agroecological locations.

3.2.1 Allocation of Resources on a Digital Platform

This process began with identifying the desired, family-owned locations from the three rural communities. This was done through interviewing a local leader and asking for any greenhouses, vending locations, or seed banks that are of relevance to place on the community map. To achieve this, we followed the same interview procedure outlined in Objective 1.1. For documentation of resources, photos and observations were taken of the sites as outlined in Objective 1.2. Other valuable information for the *Agroecological Guide* was also collected, such as hours of operation, precise location coordinates, resource descriptions, and contact information. As a team, we made a private Google Map that documented the local resources with descriptions of the products sold and relevant photos of the locations. After completing the *Agroecological Guide*, the team created a public link and a QR code to access the guide. The link was provided to our sponsor for distribution on their social media. A screenshot of the cover page and link to this document can be found in Appendix D.

3.2.2 Future Documentation of Resources on a Digital Platform

The CeF volunteers plan on continuing our project after the completion of our stay in Cuenca. This includes adding more greenhouses and resources from different parishes across the Azuay province to our *Agroecological Guide*. To allow the volunteers to continue this aspect in

an efficient and simple manner, we created a document that outlined the steps necessary to add more locations and information to the *Agroecological Guide*. This was done by recording the required steps we took while adding the resources from Turi, Sayausí, and Victoria del Portete. These steps were laid out in an instructional document written in Spanish, so the process could be easily followed by future volunteers. A screenshot of the cover page and link to this document can be found in Appendix E.

3.3 Provide Greenhouse Benefactors with Educational Aid

In order to ensure new greenhouse benefactors in the rural parishes have resources for the upkeep of their greenhouses, we created a *Manual of Greenhouse Best Practices*. This manual included a wide range of helpful ideas and possible methods for maintaining a successful greenhouse. This is so that new greenhouse farmers in the rural parishes of Cuenca can have access to an informational resource on greenhouses.

3.3.1 Create the *Manual of Greenhouse Best Practices*

This manual was formed through a combination of interviews, observation, and archival research. The interviews were conducted with farmers who have had previous greenhouse experience and farmers who were new to greenhouse technology. This was done to gain an understanding of what information would be most useful in the manual. These interviews were conducted as outlined in Objective 1.1. Another helpful aspect of constructing the manual was the observation of the *Mingas* we attended. From observing the *Mingas*, we gained valuable insight on how the land is commonly prepared before cultivation. These observations were conducted as outlined in Objective 1.2. By combining interviews with people of varied experience, community observations, and archival research, the team was able to identify areas of importance needed for the manual. This manual was then approved by our sponsor to be distributed to the rural farming communities of Cuenca. A screenshot and link to this document can be found in Appendix C.

Using the data from the interviews, observations, and archival research, the team identified the main challenges with traditional farming and greenhouse farming. The interview transcripts were coded by identifying common trends and responses through Qualitative Content Analysis (Biggs et al., 2021). These findings were then utilized to compile the *Manual of Greenhouse Best Practices*.

4.0 Findings

In this chapter, we discuss the team's observations from each of the three rural parishes of Turi, Sayausí, and Victoria del Portete. Our findings were obtained from the interviews, participation in *Mingas*, and community observation carried out during the methodologies in Chapter 3. These observations were valuable to us as they were later used to create our project deliverables - the *Manual of Greenhouse Best Practices* and the *Agroecological Guide*. Below, we also introduce the three rural parishes we conducted our research in over a two-month period.

Turi, March 23rd 2024

Resting at the top of the mountain 30 minutes away from the city center, the Turi greenhouse overlooks the rest of the parroquia*. Surrounding the greenhouse are a multitude of crops including rows of corn, mint, lettuce, potatoes, and onions. Reaching the greenhouse requires driving up windy, dirt roads, passing by local churches,* miradores*, and businesses to get to its location on the side of the mountain. The greenhouse is built next to a small winery that produces artisanal goods such as blackberry and peach wines, and pineapple marmalades. On this beautiful Saturday afternoon, we attended the greenhouse inauguration as the mayor, vice-mayor and dozens of Turi locals stood in attendance to celebrate the completion of the greenhouse over homemade* cuy*, corn, potatoes,* chicha*, and sweet wines.*

Figure 3: Image of Turi Greenhouse, Taken by Celeste

Sayausí, April 2nd 2024

Roughly 20 minutes outside the city center, the Sayausí greenhouse sits on the side of a bustling road, nestled between tall, green mountains overlooking the Río Matadero*. The greenhouse sits in the mouth of the famed* El Cajas *National Park. This greenhouse, already having been established for two months, is owned by seven strong, independent women with significant years of experience in Ecuadorian ancestral agriculture. These resilient women all work jointly to tend to all aspects of the greenhouse, sharing with us their excitement to learn more and their appreciation for the newly built greenhouse.*


Figure 4: Image of the Sayausí Greenhouse **Figure 5:** Sayausí Farming Women Both Taken by Sophia

Victoria del Portete, April 8th 2024

Victoria del Portete is located 45 minutes outside the Cuenca city center; it is hidden in the mountains, a more isolated community than the rest of the parishes. Given its colder climate, farmers in the parish rely on the monoculture of corn, with their main livelihood concentrated in livestock. The Victoria del Portete greenhouse is located in a homey neighborhood, surrounded by several houses, backyard farms, and friendly animals like dogs, cows, and horses. The planned greenhouse, much larger than in the other two parishes, is situated on a slight downhill over soft, cultivated dirt. The welcoming farmers of Victoria del Portete served us delicious pan dulce *and* té aromático *while eager to learn more about how to use their new greenhouse.*

Figure 6: Victoria del Portete Greenhouse Site under Construction, Taken by Emiliano

4.1 Interviews with Community Members

4.1.1 Water Struggles

Throughout our interview process with members of all the three communities, we learned that all rural farmers and parishes struggled with a lack of readily available water resources.

In Turi for instance, the farmers have had a long-standing history of lacking sufficient water for their homes and farms. According to one farmer, the greenhouse in Turi is heavily dependent on rain water, *"¿El agua? O sea, prácticamente lo que es del invernadero son de las aguas lluvias, lo que recogen aquí"*[1] (T2). When speaking to one of the previous leaders of the *Mingas*, we learned of the generational struggle to create water systems through the mountains. Similar to Turi, a Sayausí farmer expresses their struggles with potable water, *"Tenemos aquí este riachuelo que tenemos agua... Es agua entubada. No tenemos agua potabilizada aquí. Somos... Un pequeño grupo que tenemos agua entubada. Hicimos unos tanques con el grupo en Mingas y obtenemos el agua"*[2](S1).

Sayausí also experiences struggles when it comes to having an adequate rainwater supply for their crops. The dry seasons have the greatest impact on their water resources. The main issue is that the farming women know how to collect rainwater in an efficient manner; however, during the dry seasons, the lack of precipitation hinders their abilities to collect the rainwater for their crops. For example, one of our interviewees from Sayausí stated, *"Claro, bastante el verano no hay agua. Nosotros tenemos que poner agua del río a veces a mano"*[3] (S4). The *Río Matadero*, the large river flowing next to the greenhouse, could be a viable option for crop irrigation, except it is too steep to access to use as a consistent water resource.

Victoria del Portete has also recently struggled with the inability to collect sufficient rainwater during their dry seasons. Instead of conducting individual interviews, the team did the interview in a group setting with seven farmers of all varying backgrounds and demographics. *"El agua es de la lluvia. De la lluvia, porque no hay regadío. Sí, sí. En la sierra siempre no hay regadío"*[4] (VdP2) stated from one of our interviewees, and additionally, *"Y necesitamos de una zona que verdaderamente es zona productora, pero por falta de tecnificación… Para eso tenemos que tener un estado de regadío para, por ejemplo, los pastos"*[5] (VdP2). From our interviews, it was a common consensus that all the farmers wanted to learn about water collection and conservation.

Although differing in specifics across the three parishes, water insufficiencies had seemed to be an overarching theme affecting these rural farmers. The farmers emotionally agreed that their water resource issues have been accelerated by climate change. The subject of water was identified as one of the most important topics to be added to our *Manual of Greenhouse Best Practices*.

[1] "The water? That is to say, practically all of the water used by the greenhouse is rain, that we gather here."

[2] "We have here the stream where we get water… It is tubed water. We do not have potable water here.We… are a small group that has tubed water. We make tanks with the group in Mingas where we obtain water."

[3] "Of course, a fair amount of the summer there is no water. We have to add water from the river or sometimes by hand."

[4] "It is water from the rain. From the rain, because there is no irrigation. Yes, yes. In the mountain range there is always no irrigation."

[5] "And we need a zone that honestly is a production zone, but we lack the application of technology. For this we have to have a state of irrigation for, for example, the pastures."

All quotations were translated by both Sophia Woodward and Emiliano Solà.

4.1.2 Crop Rotations and Planting Calendars

Crop rotations and planting calendars were two more themes we researched that appeared in our interviews. One Sayausí farmer with a couple years of experience expressed concerns about the efficiency of their ancestral practices, *"[...] en qué fechas mover la tierra aunque ahora ya está todo cambiado antiguamente teníamos el de la luna que en luna tierna no se sembraba, se sembraba pero ya no está funcionando o sea ya no está funcionando ahora no sé qué pasa si está todo cambiado"*[6] (S1). From her experience with the effects of climate change, their planting patterns for their crops were disturbed and they struggled to identify when to seed effectively.

Similarly, another group of farmers from Victoria del Portete informed us that due to environmental challenges, they only grow corn year-round, *"Maíz, frejol, navitas, sí. Así es [...] coles, lechugas, acelgas, coliflores, brócolis, de todo eso, navitos, cebollita, ajo, de todo ya, nosotros no"*[7] (VdP1). We were told that frost was one of the largest factors limiting their ability to increase their crop diversity. In Turi, we found that it varied greatly as one farmer informed us, *"por lo general, siempre se maneja un solo tema del cultivo y no, no, la gente no ha avanzado en poder ir más allá y nos hemos quedado siempre con los cultivos ancestrales"*[8] (T1). We also learned that next to the greenhouse the farmers from Turi were able to make use of a small germination room where they produced a variety of plantings to grow year-round (see Figure 7).

Figure 7: Turi Germination Room, Taken by Sophia

Through our investigations, we found varying levels of education and experience with crop rotation and planting calendars in outdoor farming. As the greenhouses could help provide a

[6] "[...] on what days, on what days we move the earth, although now everything is changing. Formerly we had the day of the moon, on the full moon we would not plant, we would plant, but now it is not functioning or that is to say it is not functioning now. I do not know what's happening but everything is changing."

[7] "Corn, beans, native plants, yes. Likewise [...], cabbages, lettuce, chard, cauliflowers, broccoli, all of that, navitos, onions, garlic, by everyone yes, us no."

[8] "In general, you always manage one type of crop and no, no, the people have not advanced in going forward and we remain always with ancestral crops."

safer and more controlled environment for more diverse cultivation, we decided to add resources about crop diversity to our manual.

4.1.3 Technological Obstacles

One of the largest detriments to the three communities was technological accessibility. When asked to rate their confidence with using a phone on a scale from 1-5, one Sayausí farmer claimed, *"Uno, tal vez, [...] Eh sí más que nada no hay tiempo para dedicarnos a la tecnología porque el hecho de ser ama de casa y salir al campo no nos da tiempo en las noches ya terminamos cansadas vamos a descansar a dormir decimos y al siguiente día termine como es empezamos en la mañana, Las actividades y no no no hay tiempo para la tecnología mucho"*[9] (S1). This farmer spoke for both herself and her community, informing us that with their long work hours, they simply do not have the time or energy to learn the basics of smart devices. Another farmer claimed if they needed help with technology, they would resort to asking their younger relatives.

In contrast, the use of new farming machines in their work has been helpful for land preparation. When speaking about machinery with the Victoria del Portete farmers, one stated, *"Sí, ahorita en la actualidad se hace una sola mano, a veces se hace dos manos con el tractor. Se hace con el tractor"*[10] (VdP1). From our interviews, most of the land preparation in all parishes was done with machinery, however the rest of the farming was done by hand. This trend was continued in Turi with a farmer informing us about the technology and tools they use, *"Bueno, nosotros trabajamos actualmente, contratamos una aradora, a veces desde el GAD parroquial, a veces son privadas y también con el pico, el azadón"*[11] (T1). All the aforementioned farmers expressed interest in learning more or increasing their usage of technology.

4.1.4 Soil Health

One aspect that was important in the success of farming was the health of the soil. When we investigated recent challenges around farming, one woman from Sayausí responded, *"Eh, si es que la gente deja de producir, sí, porque la tierra, se pierden los nutrientes de la tierra, entonces tenemos que producir constantemente para que la tierra esté activa y sea productiva"*[12] (S2). This told us that nutritional deficiency in the soil was a new issue that also affected their crop schedules. This pattern was supported by responses from another farmer in Victoria del Portete who told us about their dependency on fertilizer, *"Se siembra, se siembra con abono. Abono de gallina o con abono químic*o*"*[13] (VdP2). In Turi, they made sure to point out that their

[9] "One, perhaps, […] Eh, yes, more than anything there is no time to dedicate ourselves to technology because being a housewife and going out to the farm does not give us time, as we end up tired, and we go to rest and sleep, and say we will start the next day instead, and ends as it restarts in the morning. The activities cause a lack of time for technology."

[10] "Yes, right now a lot is done by hand, sometimes with two hands with the help of the tractor. It is done with the tractor."

[11] "Well, currently we work, we hire a plow, sometimes from the GAD of the parish, some private, and we also use the pick, the hoe."

[12] "Eh, if people stop producing, yes, because the land, if the nutrients from the land are lost, then we have to constantly produce so that the land is active and productive."

[13] "When planting, we plant with fertilizer. Chicken fertilizer or chemical fertilizer."

fertilizer was organic, *"Ahora con las máquinas, antes se trabajaba siempre con el pico, se preparaba la tierra, se abona también con los abonos que son naturales, que son de las gallinas, de los cuis, que también nosotros les criamos"*[14] (T1). From our interviews, we learned about the dependence on both natural and synthetic methods to supplement the lack of nutrients in the soil. This topic contributed to our discussions with experts as well as soil health themes included in our manual.

4.1.5 Climate Change

Climate change was a topic we explored within our background chapter as it is one of the predominant reasons for the greenhouses our sponsor is establishing. We wanted to gauge the community's understanding of climate change and its effect on their agricultural practices in order to determine how in depth we should discuss it in our *Manual of Greenhouse Best Practices*. When asked if they believed climate change was affecting their practices, one farmer from Sayausí stated, *"Sí, sí, influye mucho porque hay temporadas muy grandes de verano y otras temporadas muy grandes de invierno. Entonces no sabemos cuándo va a ser invierno, cuándo va a ser verano. Solo sabemos que hace mucho, muchos días mucho calor y no hay agua. Y otros días mucho invierno y eso no es muy saludable"*[15] (S2). Others in Sayausí had also mentioned it sometimes being so hot that they had to avoid being outside for certain hours of the day. The sentiment of hotter and drier summers was echoed in our Victoria del Portete interview, *"Porque antes, antes tenía aquí, se tenía los meses que llovían justamente, pues se sembraba justamente por los meses que llueven. En la actualidad ahora no llueve"*[16] (VdP2). In contrast, Turi has been experiencing more and more frosts that harm their plants, *"entonces ahora se forman como capas de hielo eso antes no había eso antes no había se conocía solo la helada pero ahora hay capas de hielo que se hacen aquí"*[17] (T1). The combination of heat and lack of consistent water sources meant that any solution proposed by us would have to address many different weather scenarios.

The farmer from Sayausi also went on to discuss the direct effect of the heat on their crops and practices,*"Yo pienso que, o sea, ya vamos viendo más o menos, por ejemplo, está ahora mucho sol. Tratamos de no sembrar solamente semillas como que vayan dentro de la tierra. Entonces es más fácil sembrar esas plantas que las otras que ya vienen germinadas porque ellas se mueren si no las llegamos todo el tiempo"*[18] (S2). We learned that the heat also heavily affects the sprouting of crops in the initial stages of their farming. This was very important to us as we gave advice on initial use in the greenhouse within the manual.

---

[14] "Now we use the machines, since before we always worked with the pick to prepare the earth, and fertilized with natural fertilizers from chickens and guinea pigs that we raise."

[15] "Yes, yes, it influences a lot because there are very long summer seasons and very long winter seasons. So we don't know when winter or summer will start. We only know that there are very, very hot days and there is no water. And other days it is very winter-y, and is not healthy."

[16] "Because before, before we had here, we had the months where it rained on a schedule (precisely), and we planted precisely during the months that it rained. Nowadays, it is not raining."

[17] "So now they form ice sheets that weren't there before, as we only known frost before, but now there are ice sheets being made here."

[18] "I think that, in other words, we are seeing more or less, for example, there is now a lot of sun. We try not to sow only seeds that go into the earth. Then it is easier to plant those plants than the others that are already germinated because they die if we do not come all the time."

4.1.6 Commercial Opportunities

Another point we wanted to investigate was mercantilism in these areas. The goal of the greenhouses was to increase food sovereignty in the area and assist their commercial selling as well. For our *Agroecological Guide*, we would need to know areas of interest in relation to the greenhouses, i.e. markets they might sell at. When interviewing in Sayausí, two farmers, S1 and S3, both sell their goods but on different scales. S1 stated, *"[...] yo vendo al nivel familiar o sea o si por decirle somos una familia extensa que están en la ciudad"*[19] (S1). S3 informed us that she does in fact sell at the market, *"[...] Le sacamos al mercado algún poquito que tenemos porque también lo que más hacemos es más para el consumo, pero sí lo vendemos. Sí, sembramos un poquito más y entonces eso lo sacamos al mercado"*[20] (S3). We learned that for Sayausí, selling crops was largely dependent on the quality and quantity of their yields. At the greenhouse in Turi, we saw firsthand the artisanal products that farmers make and sell using produce they grow. They informed us that on weekends, they sell their wines and marmalades at the *Mirador de Turi*, a large lookout point that attracts many tourists and vendors. A different farmer from the same community responded, *"No, es para consumo familia"*[21] (T1), when asked if they sell at markets. In our third community, Victoria del Portete, we learned they did not sell much, if any, of their food, as one farmer stated *"Pero eso es, sí, solo para el consumo de cada persona. Solo para el consumo de cada persona"*[22] (VdP1). It was important to acknowledge that within Victoria del Portete, environmental factors make it difficult to grow much produce besides corn and therefore, the community does not have the same access to sales as other communities.

Another interesting theme we learned was that the communities were very proud of labeling their products as "organic." One farmer that sells to their family informed us that, *"les aviso a mi familia digo tengo esta cantidad porque es orgánico y sembramos orgánico entonces más y más es familiar"*[23] (S1). This branding is especially important as it relates to their marketing and advantage above their competition. In general, we found that most farming produce is used to sustain the farmers and their families, and that any excess is used for selling. It became apparent that the purpose of these communities' agriculture is for self-sustainment, with the exception of the greenhouse in Turi. The accessibility to markets in and outside Cuenca varies depending on the community and be reflected in our *Agroecological Guide*.

4.2 Interviews with Experts

4.2.1 Elena

Elena is a farmer residing in the parish of Turi, who has owned her greenhouse for the past two years. Unlike the other two experts interviewed below, Elena possesses experience in

[19] "I sell at the family level that is to say or it is to tell them we are a extended family that are in the city."

[20] "We bring to the market something small that we have because as well what we do most is for consumption, but yes we do sell it. Yes, we plant a little more and then this is what we bring to the market."

[21] "No, it is for family consumption."

[22] "But this is, yes, only for the consumption of each person. Only for the consumption of each person."

[23] "I advise my family saying I have this quantity because it is organic and we grow organic so more and more its familiar."

both greenhouses and traditional farming. This has allowed comparison between the two practices and modified her pre-existing practices to best suit her in her switch.

Her interview confirmed what we had learned in other interviews, giving suggestions for crop rotation and groupings, as well as general greenhouse upkeep. However, a repeating theme from her interview was the importance of water usage. Turi has been no different from the rest of Ecuador, where climate change has pushed the seasons to be extreme. The usual moderate and predictable dry and wet seasons have led to scorching dry summers that burn crops, and cold winters that result in frost in plants. Elena described the dry season as the worst of the two, where the lack of rainfall and poor irrigation habits being the largest cause of crop loss. Elena puts the sentiment well, *"Porque un agricultor no puede hacer nada sin el agua."*[24] However, with the implementation of her recent greenhouse, Elena has been able to be conservative with her water usage. To ensure that her plants have consistent water throughout the year, she collects rainwater in barrels during the wet season, and has begun using greywater from her home to irrigate her tomatoes. Greywater is defined as lightly used water from sources such as sinks and showers and is a common method for water conservation. Elena was quick to affirm how climate change has affected her and her need to adapt, where the combination of improving practices and using a greenhouse has ensured her livelihood of agriculture is still productive.

4.2.2 Daniela

Daniela is a chemist who began her farming journey after obtaining her greenhouse during the COVID-19 pandemic; she has been a guide for those working in the Sayausí greenhouse.

During the interview, many of her tips were repeated from the workshops described above, in section 4.3; however, she also gave imperative information about her ability to learn and collaborate. Daniela stated, *"Como hicimos en pandemia, entonces no se podía recurrir, digamos, a los profesionales físicamente. Pero YouTube, Google, como digo, nos sirvió muchísimo, muchísimo para poder ir implementando el invernadero y poder ir poniendo ahí las plantas."*[25] Her drive to find resources on her own, in lieu of being able to speak with professionals in person, was vital in her success as a greenhouse owner. Her research was expansive, searching specifically what greenhouse and materials would work the best in her environment, and ensuring that the greenhouse was a deterrent to climate change.

4.2.3 Renata

In contrast with the two other interviewed experts, Renata is a generational farmer from Southern Chile who has limited experience with greenhouses. However, her farming experience in the United States, along with strong media literacy and technological skills, have given her crucial knowledge in agroecological farming. The main purpose of interviewing her was to give us a better understanding of common farming terminology in Spanish; however, her experience of the native crops in the area led to recommendations relevant to our cause. Specifically, she had countless recipes of cheap and organic pesticide and fungicide sprays that could be created. Renata stated, *"Entonces hay ciertos productos dentro de tu casa que tú los puedes usar, se*

[24] "Because a farmer can do nothing without water."

[25] "Like what we did in the pandemic, then we cannot turn to, we say, to the professionals physically. But Youtube, Google, as I say, it served us a lot, a lot to be able to go implement the greenhouse and to be able to put plants there."

diluyen en agua y eso te ayuda a tener que ir como tirándoles encima y eso te los va a proteger,"[26] understanding many of the farmers in these region lack the money and knowledge of how to properly access and use most commercial pesticides. This information, especially the specific recipes, provided a valuable addition to the manual, since the local crops grown in these communities could be much more easily accessible than commercial chemicals.

4.3 Participation in *Mingas* and Community Observation

4.3.1 Land Preparation

During participation in *Mingas*, such as the visit to Sayausí on April 2nd, we witnessed land preparation by using machinery such as a rototiller, which broke up and loosened the soil prior to seeding. While this practice was not specifically observed in Victoria del Portete, when prompted with questions about land preparation, the farmers also responded that they use machinery, such as a tractor, in the pre-seeding process. We were also informed by the farmers that this process can be done by hand if machine technology is not present. One slight difference between parishes was that the rototiller was rented from the Municipality of Sayausí, whereas the residents of the Victoria del Portete owned a traditional tractor. Whether machinery is involved or not, from our observations we gained valuable insight into the importance of this step in the cultivation process.

4.3.2 Irrigation Methods

Collecting rainfall is common among locations, but people in Victoria del Portete voiced concerns about struggling to obtain the necessary amount to feed their crops and did not have a plan for implementing an irrigation system for their greenhouse as mentioned in section 4.1.1. However, two of the constructed greenhouses have implemented irrigation systems to relay nutrients to the plants. Irrigation systems common in Ecuador are water flow systems that move through ditches in the land. In Sayausí, the back quadrant of the land was dug up to string an irrigation tube into the infrastructure to provide water to the soil. On a similar note, the first visit to Turi on March 14th, the group noticed a pit filled with pre-collected water was positioned to the left of the greenhouse. After closer observation, we learned that water is filtered for large sediments before being used in the greenhouses, providing the plants with clean water.

4.3.3 Preliminary Crop Growth

From observing farming practices, we gained valuable insight into the specifics of what crops the farmers are growing and how they plan to cultivate them. One interesting piece of information learned about the specifics of growing from Turi, was that the seedlings are grown in tiny square grids (Figure 7). This allows the seeds to begin their growing process in a controlled environment before transplanting them into the soil. This practice was unique to Turi but can be included in our *Manual of Greenhouse Best Practices* as a recommendation to support seedlings in their preliminary germination stage. Victoria del Portete and Sayausí practice more traditional

[26] "Then there are certain products within your house that you can use, dilute them in water and this well help you have to go like throwing above and this will help you protect them."

methods of seed planting. The above observations on crop specifics were utilized to provide preliminary farming recommendations in our *Manual of Greenhouse Best Practices*.

5.0 Discussion

In this chapter, the team discusses in further detail the conclusions drawn from the previous chapter. This includes the observations from the interviews with community members, interviews with local experts, and participation in *Mingas*. These discussions outline the team's thoughts on the following topics and how they served as important aspects in our deliverables, the *Manual of Greenhouse Best Practices* and the *Agroecological Guide*.

5.1 Interviews with Community Members

5.1.1 Water Struggles

From our interviews with community members, we learned that they believe that climate change is a threat facing their farms and has predominantly affected their access to water. This is important to note as we create our manual, especially as we can recommend water conservative irrigation systems and crops that are less water intensive.

These farmers have had difficulties with maintaining the health of their crops through the more frequent extreme weather events, as stated in the interviews from Victoria del Portete in our findings. Greenhouses are good for helping maintain a controlled climate for plants, but our findings also informed us to acknowledge the risk of these weather events on the stability and health of the greenhouse. This includes the increased risk of hail damaging the outside of the greenhouse and the inside becoming too hot for farmers to safely work inside. These conclusions are addressed in our *Manual of Greenhouse Best Practices*.

5.1.2 Crop Rotation and Planting Calendars

We learned about the lack of information on crop rotations and challenges around planting calendars as a result of climate change. In our findings, this was stated in our Victoria del Portete interview, as the farmers planted the same crops year-round. This supported our discussion on the benefits of crop diversity and disadvantages of monocultures in our *Manual of Greenhouse Best Practices*. Additionally, this included suggestions of crops that are still native to the region but are better adapted for the changing climate. It was also mentioned that they had a dependence on natural fertilizers to account for soil health but struggled to know what nutrients plants lacked. Using this, we added information on nutrients as well as types of natural fertilizers and home remedies in our *Manual of Greenhouse Best Practices.*

5.1.3 Selling

Outside of the community of Turi, most of the farmers utilizing the greenhouse do not sell their produce frequently, and if so, they sell locally rather than in the city. From this, we realized how little commercial knowledge these farmers know or understand, which led to the creation of a section in our manual revolving around commercialization. This section, as also suggested by our sponsor, describes accessible *ferias agroecológicas* where local farmers can sell their organic produce to members outside of their community. Additionally, our *Agroecological Guide* reflects the locations of the vendor markets so they can be easily identified by our users.

5.2 Interviews with Experts

5.2.1 Elena

From our first interview with Elena, we were able to find topics to incorporate within our manual. Firstly, Elena had the perspective of learning greenhouse technology with the background of an ancestral farmer. This point of view is imperative when we wrote our manual, as many of these farmers are in the same shoes as Elena when she first started. This interview also allowed us to learn practices that are not internet accessible, but that can be adapted for traditional farmers. This includes allowing livestock, such as guinea pigs and chickens, into the greenhouse to eat pests as well as methods of rainwater collection. These are essential additions, ensuring that the information we are adding is familiar and are not overcomplicated for the reader.

5.2.2 Daniela

Before our scheduled interview with Daniela, we were able to observe a workshop she hosted for the farmers at the Sayausí greenhouse. Observing this workshop not only gave us information on natural remedies for nutrient deficiency and soil health, but also allowed us to witness how rural farmers learn. The women participating were very eager to learn, however, they struggled because of their limited education. When participating in a card exercise, half of the women had issues with their vision and the rest struggled with reading words, as many were unrecognizable to them. This was crucial to understand when writing our manual. The information we put in, however complex, must be accessible to a wide audience. Topics must be explained very basically with as many visuals as possible, as well as larger text.

During our interview with Daniela, there was some repetition from the information gathered in the workshop, like natural pesticide and fungicide recommendations. However, Daniela is someone who had no farming experience before obtaining her greenhouse, so much of our interview revolved around how she taught herself. As she built her greenhouse during the COVID-19 pandemic, she had limited access to educational resources and was unable to get in-person aid from professionals. Consequently, she turned to the internet and provided us with resources to utilize in our manual. This interview was imperative for understanding how farmers learn and obtaining additional resources for our manual.

5.2.3 Renata

Despite Renata not being a Cuenca native, her knowledge of Andean farming was integral in the creation of our manual. During our interview, Renata was able to give us in-depth knowledge of common agricultural practices and tools, providing us with essential vocabulary vital for our research. Additionally, after the interview, Renata sent a variety of natural and organic recipes utilizing native crops as alternatives to chemical pesticides and insecticides. Every recipe was added into our manual and gave us a reference of which medicinal plants to elaborate on.

5.3 Participation in *Mingas* and Community Observation

5.3.1 Land Preparation

In our *Minga* participation, we were able to make some key observations of the access farmers have to farming machinery and the necessary steps before planting. As discussed in our findings chapter, the farmers in the parishes of Victoria del Portete and Sayausí had access to machinery like a tractor and a rented rototiller. Knowing that they have access to these technologies allowed us to include information about this machinery and how they can use this machinery in sustainable practices.

5.3.2 Irrigation Methods

Two vital findings we explored were the current irrigation systems in place and how they are failing. As discussed, Victoria del Portete struggles with water as they rely solely on rain for watering their crops. However, with the changing climates, their dry seasons are becoming especially brutal. This highlights a need that is paralleled in Sayausí, where their water problems are not insignificant as they struggle to properly collect rainwater for the dry seasons. This lack of knowledge has exasperated their already existing struggles with crop success. This was essential to add to our manual, discussing different water saving irrigation methods, as well as proper water collection and storage to ensure they are stable throughout their dry seasons.

In contrast, when participating in the *Mingas* hosted in Turi, on March 14th, we were able to observe the water conservation methods they were implementing. This was a watering hole dug for the purpose of feeding into the drip irrigation system inside the greenhouse. Since this was also a method used locally, it was critical to include into the manual, as it was cost effective and simple to create.

5.3.3 Preliminary Crop Growth

In our findings chapter, we discussed the germination process used in the make-shift nursery in Turi. This contrasts with Victoria del Portete and Sayausí, where farmers utilized direct ground seeding. This distinction was also seen through how successful crops made it through germination, as Turi had a higher success rate compared to the two other parishes. This is essential, as this is an addition to the manual to promote crop success, especially with the help of the controlled environment of a greenhouse.

6.0 Recommendations

Upon the completion of our research and deliverables, the *Manual of Greenhouse Best Practices* and the *Agroecological Guide*, we laid out additional recommendations for our sponsors that can be utilized to extend the longevity of our project. This includes methods that can broaden the accessibility of our manual, ensure an efficient hand-off of our resources, determine future stability of our guide, and provide beneficial ideas for future, educational workshops to be hosted.

6.1 Accessibility

One important aspect of our *Manual of Greenhouse Best Practices* was ensuring that the language was accessible to all levels of education. When surveying the farmers, we established that a significant number of farmers lacked education past primary school among the different parishes. In order to cater to this, the team assessed language choices while still conveying the message in our manual. Another useful part of the manual was the use of pictures and diagrams that were thoughtfully picked out to articulate the words on the page. One improvement would be ensuring the manual encompasses all levels of language comprehension. This means using language that is understandable yet descriptive; it also means utilizing graphics more than words. While we feel our manual did a good job of addressing this issue, we wish that more progress could have been made. One main suggestion we have for improving accessibility is to have our manual be read over by one of the local farmers, in order to gather their input on topics that they did not understand or want further elaboration on.

To further the reach of our manual, we also recommend providing an audio copy of our manual that can be distributed along with the text version of the manual. On the topic of education, there is a possibility that some of the farmers cannot read our manual in its entirety. Having an audio copy eliminates the barrier of reading comprehension. This audio recording would be best handled by a native speaker, one of the community's local leaders, or even the vice mayor.

6.2 Proper Hand-Off

Through the creation of our *Agroecological Guide*, we were able to document important resources from the three rural communities of Turi, Sayausí, and Victoria del Portete. As a team, we want the map to continue as Cultivando el Futuro reaches its helping hand into other rural communities. This includes passing on our email address used to create the guide to the Cultivando el Futuro volunteers. We also provided details on how to access and proceed with a new documentation procedure for new resources in the coming years. One other recommendation would be to allocate all of these resources to a website as a home base for Cultivando el Futuro. By having this smooth transition of resources, we hope that our work on the *Agroecological Guide* started a platform for future documentation of resources in the new parishes.

6.3 Stable Contact

We believe assigning a stable, local contact is imperative in the future success of the project. A part of our deliverable relies heavily on having a local leader as a contact, this person must be a consistent member of the surrounding community. This can be done by selecting one of the local farmers who is tending to the greenhouse. This is so that if any questions arise about the location or its purpose, this person is the expert with the answers to any concerns. We want to urge that the main contacts in the *Agroecological Guide* are updated as soon as they change. Establishing local leaders and keeping up-to-date information about the locations allows for the guide to be a constant, reliable resource for the people in the rural communities.

6.4 Future Workshops

The *Manual of Greenhouse Best Practices* can also double as an outline for a workshop about Greenhouse Maintenance. This manual could be updated and revised to be used as a teaching plan for communities receiving their new greenhouses. We hope that the manual is a starting point for the future of greenhouse education. Since we are passing it on to the Cultivando el Futuro volunteers as a pdf, we recommend that they host workshops in these communities about the greenhouse that helps aid in the longevity.

One thing we obtained through interviews was that a majority of farmers lacked confidence in how to use their cellular phone technology. Many expressed concerns or lack of time in their days to learn how to use their phones. Implementing a technology workshop to show them the basics of how their devices work would be beneficial to ensuring the longevity of our project. Since our *Agroecological Guide* is to be presented on Google Maps, we want to ensure that it can be accessible to anyone who needs it. An additional recommendation for the future of the project is self-documentation of resources on our *Agroecological Guide*. We recommend a workshop detailing the process of putting resources on Google Maps. This is so that people in rural communities can utilize this tool to put their locations and resources into one platform. This future goal goes hand-in-hand with preparing technological workshops so that the people in rural parishes feel confident with using a new platform.

Works Cited

Álvarez, P., Carlos Navarro Racines, Jesús David Martínez, & Lauren Sarruf. (2021, August 6). *Latin America: climate information and family farming | PreventionWeb*. https://www.preventionweb.net/news/climate-information-and-family-farming-stories-three-climate-smart-villages-latin-america

Atiencie, G., Vallejo, X., & Andrade, M. (n.d.). Análisis de la aplicación de principios agroecológicos en la provincia de Azuay, Ecuador. *LetrasVerdes*. https://doi.org/https://doi.org/10.17141/letrasverdes.27.2020.3972

Biggs, R., de Vos, A., Preiser, R., Clements, H., Maciejewski, K., & Schlüter, M. (Eds.). (2021). Qualitative Content Analysis. In *The Routledge Handbook of Research Methods for Social-Ecological Systems* (pp. 270–281). Routledge.

Biggs, R. (2021). Participatory Data Collection. In *The Routledge Handbook of Research Methods for Social-Ecological Systems*. Taylor & Francis.

Consejo Nacional para la Igualidad de Género. (2021). *Población del Ecuador, Según Provincia*. República del Ecuador. https://www.igualdadgenero.gob.ec/wp-content/uploads/downloads/2021/09/POBLACION-DEL-ECUADOR-SEGUN-PROVINCIA.pdf

Cordero-Ahiman, O. V. (2022). Ley Orgánica del Régimen de la Soberanía Alimentaria de Ecuador. *Revista Chilena de Nutrición*, *49*, 34–38. https://doi.org/10.4067/s0717-75182022000400034

Cunha, S. F. (2015). The Future of Mountain Agriculture. *Mountain Research and Development*, *35*(2), 215–216. https://doi.org/10.1659/mrd.mm158

Desnutrición Crónica Infantil | UNICEF. (2023). https://www.unicef.org/ecuador/desnutrici%C3%B3n-cr%C3%B3nica-infantil

Instituto Nacional de Estadística y Censos. (2016). *Módulo Ambiental de la Encuesta de Superficie y Producción Agropecuaria Continua*. https://www.ecuadorencifras.gob.ec/documentos/web-inec/Encuestas_Ambientales/Informacion_ambiental_en_la_agricultura/2016/informe_ejecutivo_ESPAC_2016.pdf

Intergovernmental Panel on Climate Change (IPCC) (Ed.). (2022). Summary for Policymakers. In *Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C above Pre-industrial Levels in Context of Strengthening Response to Climate Change, Sustainable Development, and Efforts to Eradicate Poverty* (pp. 1–24). Cambridge University Press. https://doi.org/10.1017/9781009157940.001

Knapp, G. (2017). Mountain Agriculture for Global Markets: The Case of Greenhouse Floriculture in Ecuador. *Annals of the American Association of Geographers*, *107*(2), 511–519. https://www.jstor.org/stable/45387918

Knowledge Sourcing Intelligence. (2022). *Ecuador Greenhouse Market Size: Industry Report, 2022 – 2027*. Knowledge Sourcing Intelligence LLP. https://www.knowledge-sourcing.com/report/ecuador-greenhouse-market

Programa de Agricultura Urbana en Cuenca (PAUC) | LATINNO. (n.d.). LATINNO. Retrieved February 1, 2024, from https://www.latinno.net/es/case/8143/

Spratt, A. A., Looney, T. C., Smith, E. L., & Gerov Armas, A. (2021, March 18). *Utilizing Technology to Promote Food Sovereignty in Cuenca, Ecuador*. https://digital.wpi.edu/pdfviewer/hh63sz77z

Verdugo, G., Cuadrado, G., & Castillo, Y. (2023). Family Farming as a Contribution to Food Sovereignty, Case Guarainag Parish. *Agriculture*, *13*(9), 1827. https://doi.org/10.3390/agriculture13091827

Virgin Farms Team. (2022, February 3). *The role of greenhouses in rose production*. https://www.floraldaily.com/article/9396828/the-role-of-greenhouses-in-rose-production/

Weather Spark. (2024). *Cuenca Climate, Weather By Month, Average Temperature (Ecuador) - Weather Spark*. https://weatherspark.com/y/19348/Average-Weather-in-Cuenca-Ecuador-Year-Round

WFP Ecuador Country Brief. (2023). World Food Programme. https://docs.wfp.org/api/documents/WFP-0000155414/download/

Yates, A. (2023, July 9). *Food Insecurity: Ecuador and the Global Poor – UAB Institute for Human Rights Blog*. https://sites.uab.edu/humanrights/2023/07/09/food-insecurity-ecuador-and-the-global-poor/

Appendix A: Sponsor Description

Our sponsor, Cultivando el Futuro, is headed by Ecuadorian councilwoman Marisol Peñaloza. She was voted into Cuenca's legislation in 2019, with her main focus of representing the rural women and farmers in the area. Her mission in being a government official and work in nonprofits focuses on the agricultural landscape in Ecuador. Her aim is to create a sustainable economy in Cuenca with an equally sustainable production, as well as attempting to promote food security in the country. Our sponsor, Cultivando el Futuro, is primarily funded by the public and by the local government with the oversight of Marisol Peñaloza through her ties to nonprofit organizations, such as the Peace Corps. For this reason, there is no defined structure or main division of labor, as labor is split up according to work as it arises. The main authority figure is Marisol, while funding from the government and nonprofits is a limitation of the organization.

Other organizations in Cuenca that work to solve similar problems of food sovereignty and security are organizations such as Hearts of Gold, Banco de Alimentos, Snow Angels, and the Cuenca Soup Kitchen. These organizations help families in both rural and urban communities with a similar goal as Cultivando El Futuro. Most recently, 15,000 seeds were donated from Cultivando El Futuro to rural and urban communities to help increase agricultural yield (Marisol Peñaloza Bacuilima - Vicealcaldesa de Cuenca, 2023). Hearts of Gold, or *"Corazones de Oro,"* is a nonprofit that was founded in 2013. As a whole, they helped open the first food bank in Ecuador and have also served as an educator in food security for other nonprofits. The Quito Food Bank recognized the large amount of wasted food in Ecuador and turned it around to help with food rescue, storage, and distribution of food. Snow Angels help to better the lives of the people in Ecuador. This organization focuses its work on basic human needs and on providing meal supplements to families and also offering other medical resources. Our sponsor, Marisol Peñaloza, partnered with this particular organization to deliver food kits to both urban and rural families and also food and cleaning supplies to Casa Violeta, a foundation for victims of domestic violence. Finally, the Cuenca Soup Kitchen provides food for people in need. They serve five meals a week and before COVID-19 provided meal services as well. This organization also partners with the Hearts of Gold Foundation to provide meals and even supplemental clothing donations to rural and urban families.

These organizations use connections to other organizations and research groups to propose solutions to their problems. As displayed, many of these organizations partner either with each other or with Councilwoman Marisol Peñaloza. Teaming up and using additional political power can help them with fundraising and assisting in helping the people of Cuenca.

The project Cultivando el Futuro has three focal points: one on addressing rising food scarcity and a decline in agricultural production in Cuenca, expanding local seed banks, and thirdly on increasing the visibility of the organization itself. Two of our given tasks are to help construct greenhouses and also to help host informational workshops on food safety and nutrition for the people living in and around Cuenca. Constructing greenhouses helps Cultivando el Futuro address the effect of global warming and climate change on domestic agricultural production in Cuenca. Although this does not solve the issue entirely, it helps to alleviate some of the stress of food scarcity in the community. We were also asked to give workshops on food safety. This is important because as climate change affects the agricultural production in Ecuador, crops of lesser quality have become more and more common. It is important to both address food scarcity

as well as food safety as just because they have access to some amount of crops does not mean that the crops are safe to eat.

Food Sovereignty is an important concept that places emphasis in transforming food systems, ending hunger, preserving biodiversity and fighting the effects of climate change. One of the many goals of Cultivando el Futuro is to promote the idea of food sovereignty in Ecuador, especially in the rural communities that are hit hardest from lack of food. Ecuador has become one of the first countries to introduce the concept of food sovereignty into their system of laws. This is known as "*Ley Orgánica del Régimen de la Soberanía Alimentaria*" (LORSA). The goal of this law is to appreciate Ecuador's ancient food cultures and practices. This law was approved and published in 2009, having several focuses on the different aspects of food sovereignty. The most important goals of this law, were to have more access and use to water and land, most importantly for those in rural Ecuadorian communities, protect agrodiversity, research and support family and peasant agriculture, promote agricultural production for small and medium producers, bolster health and food safety to make Ecuador a country that is free of genetically modified organisms, and reduce malnutrition and increase nutritious consumption across the country. By promoting the idea of food sovereignty and developing better agricultural practices throughout Ecuador, the goals of Cultivando el Futuro greatly align with the goals of LORSA.

Our final task given to us is to increase the online presence of the organization. They say that we can do this by adding new pages and posting about our work and the organization's work on their website. From the two past IQPs, "Utilizing Technology to Promote Food Sovereignty in Cuenca, Ecuador" and "Cultivando El Futuro: Youth Agriculture," we have seen the organization's continued interest in increasing their online presence with a website. From our investigation, no such website is readily available at a quick Google search, and finding information on the organization is incredibly difficult. Increasing their online presence has been a goal of theirs since at least 2021 based on the 2021 IQP's investigation, "Utilizing Technology to Promote Food Sovereignty in Cuenca, Ecuador."

Appendix B: Protocols

B.0 Ethical Statements

Interview Ethical Statement:

Somos un grupo de estudiantes estadounidenses del Instituto de Worcester Polytechnic en Massachusetts y estamos trabajando con Cultivando El Futuro para construir invernaderos y diseñar talleres agrícolas y educacionales. Estamos encuestando personas locales para mejorar nuestro conocimiento agrícola. Su participación en esta encuesta es voluntaria y puede retirarse cuando lo quiera. Sus respuestas pueden hacerse públicas cuando se publique nuestro informe, como las citas anónimas. Por favor, recuerda que sus respuestas serán anónimas. Ningunos nombres ni información de identificación van a aparecer en nuestros reportajes del proyecto ni publicaciones, ya que cualquier información de identificación será destruida. Si le interesa, podemos proveer una copia de nuestros resultados por un enlace a la conclusión de nuestro estudio. Contáctenos por correo electrónico a cultivandoelfuturowpi@gmail.com

If recorded:

Esta encuesta será recordada por un teléfono celular o cámara. La grabación es privada y solamente es usada para información anónima. Si usted no está cómodo con una grabación, puede retirarse cuando quiera.

B.1 Interviews with Local Farmers

Objetivo General

Profundizar en la experiencia, actividades realizadas y conocimientos adquiridos por los beneficiarios durante la primera fase del proyecto "Cultivando el Futuro," con el propósito de formular propuestas de nuevas actividades a ser implementadas en la siguiente fase del proyecto.

Objetivos Específicos

1. Caracterizar a las personas que conforman la población beneficiaria del proyecto
2. Identificar las actividades llevadas a cabo por los beneficiarios dentro del proyecto.
3. Describir los beneficios tanto en términos de conocimiento como de recursos materiales adquiridos por los integrantes gracias a su participación en el proyecto.

4. Explorar las actividades que los participantes desean que continúen en la siguiente fase del proyecto y aquellas que les gustaría que se introduzcan como nuevas implementaciones.

Guión de la Entrevista Semiestructurada:
Objetivo: Conocer la experiencia, actividades realizadas y conocimientos adquiridos por los beneficiarios durante la primera fase del proyecto "Cultivando el Futuro," con el propósito de formular propuestas de nuevas actividades a ser implementadas en la siguiente fase del proyecto.
Fecha:
Nombre del participante:
¿Qué edad tiene?:
¿Cuál es su género?:
¿Cuál es su nivel educativo?:
¿Cuál es su ocupación actual?:
¿En dónde vive?:
¿Cuál es su nacionalidad?
¿Cómo se identifica étnicamente?
¿Usted es jefe de hogar? Si o No.
¿Pertenece a alguna organización?
Agricultura
- ¿Tiene experiencia con la agricultura? ¿Cuánto tiempo se lleva dedicando a la agricultura? Describa sus prácticas agrícolas más usadas y porque funcionan para usted. ¿Hay algunas que no funcionan? - ¿De dónde obtiene su agua? - ¿Puedes contarnos los pasos que sigues antes de sembrar? - ¿Qué herramientas/maquinaria utiliza durante su agricultura? - ¿Puede comentarnos alguna práctica o tecnología innovadora que haya adoptado para mejorar la eficiencia o el rendimiento? - ¿Practica usted la rotación de cultivos y, de ser así, cuál es su calendario de rotación? - ¿Cómo se controla la salud de los cultivos? - ¿Cree que la agricultura se ha vuelto más difícil con el paso de los años? - ¿Usted cree que el cambio climático ha influido en cómo realiza sus prácticas

agrícolas?
- ¿Cómo se ha adaptado la comunidad a los cambios en el medio ambiente en lo que respecta a las prácticas agrícolas?
- ¿Cuáles aspectos negativos del clima o medioambiental están afectando la producción de los cultivos?
- ¿Hay algún nuevo desafío que enfrente con el clima que afecte tus prácticas agrícolas?

Preguntas de Experiencia Tecnológica de Invernaderos

Por favor, describa su experiencia con tecnología de invernaderos.
- (I) ¿Hay algún desafío relacionado con su invernadero actual?
- ¿Hay algo que quiera aprender más sobre los invernaderos?
- ¿Hay algún nuevo desafío que usted enfrente con el clima que afecte sus prácticas agrícolas?
- (1-5) ¿A qué escala está seguro en su habilidad de manejar un invernadero?
- (1-5) ¿A qué escala cree que usted se beneficiaría de un taller sobre invernaderos?

Experiencia y actividades

- ¿Qué le motivó a participar en el proyecto y qué le ha inspirado durante este proceso?
- ¿Cuáles han sido las actividades en las que has participado dentro del proyecto "Cultivando el Futuro"?
- ¿Han tenido capacitaciones? ¿Qué temas ha visto en las capacitaciones?
- ¿Ha puesto en práctica lo aprendido en las diversas capacitaciones que recibió?
- ¿Qué actividades considera que más les han ayudado / servido y porque?
- ¿Qué aprendizajes destacarías de su participación en el proyecto "Cultivando el Futuro"?

Beneficios adquiridos

- ¿Qué recursos materiales, como herramientas, equipos o insumos, ha recibido o utilizado como parte del proyecto?
- ¿Los insumos agrícolas que recibió lo utilizó para consumo personal o también le sirvió para actividades comerciales?
- ¿Cómo fue su experiencia con la producción una vez que sembró los cultivos/ Crío los animales?
- ¿Sabe que es un banco de semillas? ¿Ha usado alguno antes?

Actividades que continúen y nuevas propuestas

- ¿Hay alguna actividad que le gustaría que se mantenga en futuras etapas del proyecto? ¿Por qué?
- ¿Qué sugerencias o propuestas tendría para mejorar o implementar nuevas actividades en el proyecto en el futuro?
- ¿Hay algún tema o área específica que le gustaría que el proyecto abordará en futuras etapas?

Tecnología
- ¿Qué papel considera que debería tener la tecnología y la innovación en el desarrollo de actividades del proyecto? - ¿Usted cree que sería útil tener la información de los recursos generados por el proyecto en una plataforma como Google Maps? ¿Por qué? - ¿Tiene recursos tecnológicos en la comunidad? - ¿Qué tipo de tecnología tienes (teléfono/computadora)? ¿Sabes cómo usarlo? - ¿En una escala del 1 al 5 cuál es su nivel de confianza con la tecnología?

B.2 Interviews with Experts

Guión de la Entrevista con Expertos:
Contexto
- ¿Por cuántos años usa un invernadero? ¿Cultiva antes? - ¿Qué benefició del invernadero? En temas de cultivos, uso de agua, etc - ¿Experimentó algún desafío durante aprendiendo cómo usar el invernadero? - ¿Hay algunos conocimientos que quiere que supiera sobre el invernadero antes de obtenerlo? - ¿Hay algunos recursos útiles que recomendaría?
Practicas
- ¿Existen prácticas agrícolas tradicionales o indígenas que todavía se utilizan en esta región? - ¿Practica usted la rotación de cultivos y, de ser así, cuál es su calendario de rotación? - ¿Qué consideraciones debe tener en cuenta a la hora de planificar una rotación de cultivos? - ¿Puede hablarnos de su enfoque en la gestión del agua y el riego?
Tecnología
- ¿Cuáles son las herramientas comunes que se utilizan en el invernadero, como maquinaria?

- ¿Puede comentarnos alguna práctica o tecnología innovadora que haya adoptado para mejorar la eficiencia o el rendimiento? ¿Esto ha estado relacionado con el cambio climático?

Preparación del Suelo

- ¿Puede explicarnos los pasos antes de sembrar la tierra?
- ¿Es la preparación diferente en invierno y en verano (cuando hace más calor o más frío)?
- ¿Cómo se maneja la fertilidad del suelo y el manejo de nutrientes?
- ¿Tiene consejo cultivar en tierra inclinada?

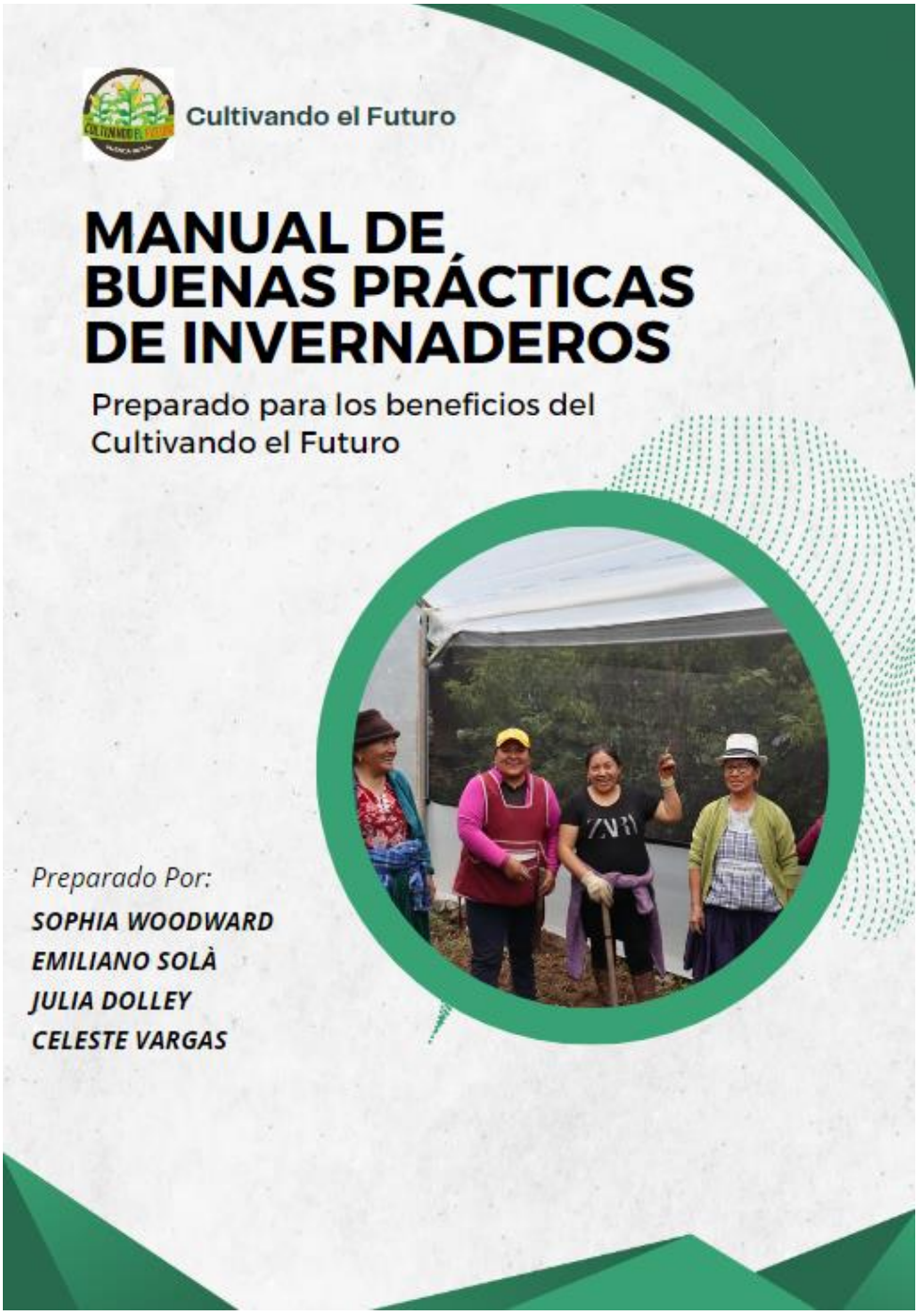
Climas Diferentes

- ¿Qué hace cuando hay heladas en los cultivos?
- ¿Qué hace cuando hace mucho calor?

Plagas e Infestaciones

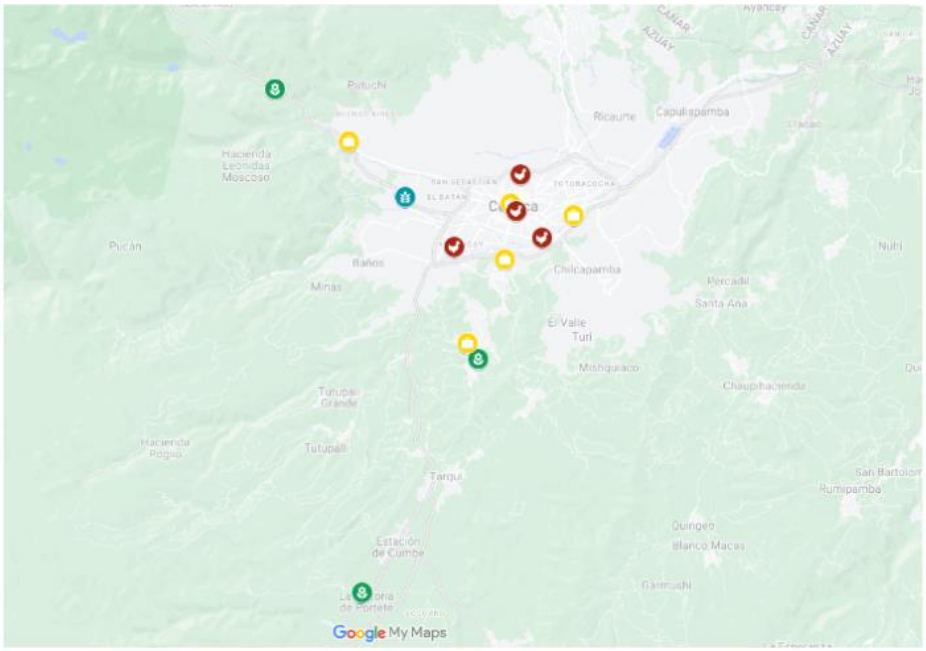
- ¿Qué hace con los insectos/enfermedades en los cultivos?
    - Hay algunas recomendaciones de alternativas naturales para evitar plagas e insectos?
- ¿Cómo puede controlar la salud de los cultivos?

Appendix C: Cover Page and Link to *Manual of Greenhouse Best Practices*



Appendix D: Cover Page and Link to *Agroecological Guide*

Guía Agroecológica de Cuenca



Leyenda:

Feria *Tienda de Semillas*

Mercado *Invernadero*

Ubicaciones en Cuenca

Agropecuaria San Joaquín

Descripción: Una tienda que vende herramientas agrícolas y semillas.
Contacto: +593 7 417 7520

Appendix E: Cover Page and Link to Instructions on How to Create or Modify *Agroecological Guide*

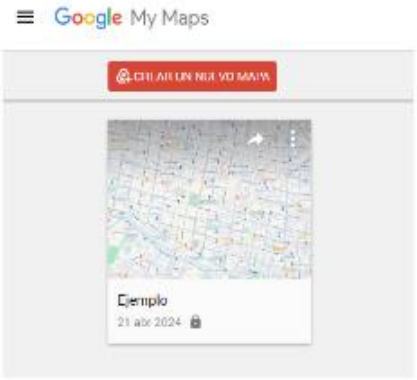
Cómo Crear o Cambiar a la Guía Agroecológica de Cuenca

Cuenta:

Usuario: [redacted]
Contraseña: [redacted]

Definiciones:

- Mapa: Un archivo de lugares en relación con sus ubicaciones en google maps.



- Capa: Un grupo de lugares conjuntados por un tema o nombre que ud. elige. (Ej. todos se ubican en Cuenca, son mercados, etc.)

- Sitio: Un lugar con por lo menos un nombre y una ubicación.