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Sustaining the Pura Vida: Building Food Security in a Changing Climate

Although Costa Rica is recognized for its environmental leadership, the country continues to face significant challenges from climate change, particularly within its agricultural sector. Changing rainfall patterns, rising temperatures, and increased crop diseases are contributing to soil erosion and declining crop yields. Addressing these challenges through sustainable agricultural practices can help Costa Rica build long-term climate resilience while strengthening food security.

Introduction

Located in Central America, Costa Rica is bordered by Nicaragua to the north and Panama to the south-southeast. This sovereign country is surrounded by water on both sides, with the Pacific Ocean to the west and south, and the Caribbean Sea to the east. It is fairly warm and tropical with a dry season (December to April) and a rainy season (May to November). The combinations of lots of rainforests with frequent rain, and volcanoes with fertile soil, create favorable conditions for farming crops. While most of Costa Rica's land is considered rural, 83% of its population is living in its urban cities, including in the largest city and capital, San José (Kranes, 2019).

The people of Costa Rica follow and live their lives based on the Pura Vida lifestyle, which emphasizes a simple and joyful life. This lifestyle is often tied to Costa Rica’s pride in nature, outdoor life, and well-being. Costa Rica has a growing population of 5.16 million people, with roughly 3.2 people per household and an average annual income of $9,840. Many Costa Ricans work in industries such as hospitality, tourism, and agriculture; sectors that are closely connected to the country's natural environment and Pura Vida identity. Agriculture is also an important part of Costa Rica's economy and cultural identity. While coffee is often thought of as the largest crop, bananas, pineapples, and sugarcane are actually the leaders in production, volume, and export respectively.

A typical Costa Rican diet includes foods such as beans, fruit, rice, and corn. Costa Rica is known as a “blue zone”, meaning it's known for its longer and healthier lives due to factors including a healthy diet and a stress free way of living (i.e., Pura Vida). Families generally have access to free, public education as well as private education which can range from $300-$800 a month. Around 99% of the population has access to a water source; however, only 82% have continuous access to a reliable water source (Kranes, 2019) meaning the water is accessible when needed and free from contamination. As of 2020, 90% of families have access to electricity (Kranes, 2019).

The Importance of Agriculture

Agriculture plays a vital role in Costa Rica's economy and food system, providing job opportunities as well as adding to the country's export revenue; however, it's also the most threatened by climate change. The country's diverse climate and fertile volcanic soils allow for the production of both staple crops (e.g., rice, corn, beans) and cash crops (e.g., bananas, sugarcane, oil palm). These crops depend on relatively stable rainfall patterns and temperatures. As an example, coffee is primarily cultivated in Costa Rica's highland regions, where cooler temperatures and volcanic soils create ideal growing conditions. In contrast, bananas and pineapples are grown in the humid Caribbean lowlands, while rice production is concentrated in the Pacific region, particularly in Guanacaste. These geographic differences make each crop vulnerable to distinct climate-related risks. Lots of crops grown in Costa Rica are produced by small farmers and family farms with the average farm size being 64 acres, so climate change isn't just impacting yield sizes it's also impacting family incomes. These family farms often lack large-scale technology, such as irrigation systems and crop insurance, which increases their vulnerability to climate change.

The following map shows the 8 coffee production regions of the country:

Object 1: Map of Costa Rica Growing Regions



Source: Costa Rican Coffee Institute (ICAFE)

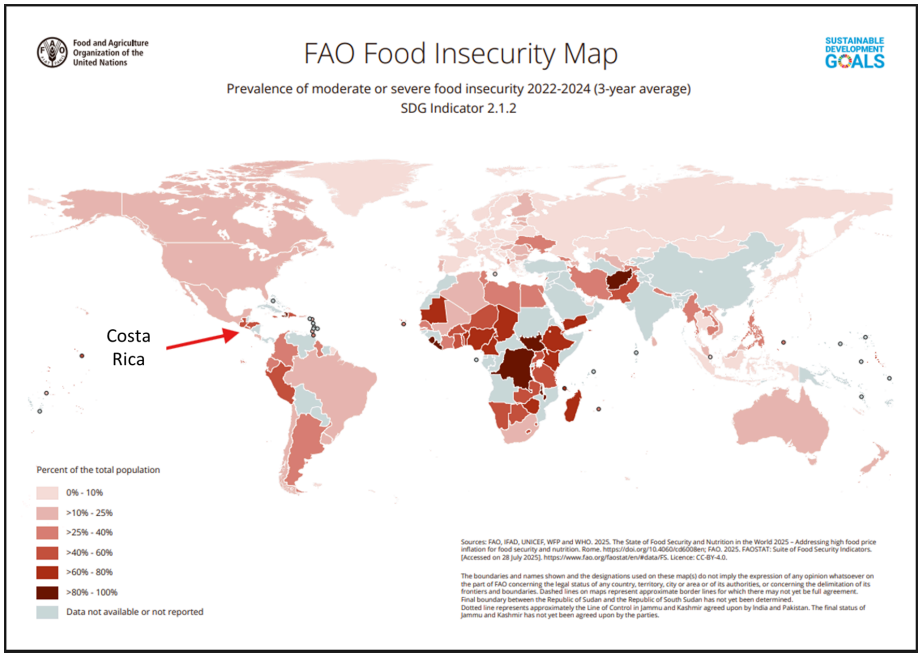
Climate change in Costa Rica comes in various forms including: floods, landslides, storm surges, rising sea levels and increasing temperatures. The average temperature has increased between 0.2°C and 0.3°C per decade since 1970. Coffee plants require a specific temperature range between 15°C–24°C (World Bank Group, 2021), rich soil, high humidity, and consistent rainfall. Due to the rising temperatures in high regions like Tarrazú, which is one of the main regions where coffee is being grown, increased temperatures and inconsistent rainfall is leading to disrupted coffee bean development and irregular coffee bean harvesting. Furthermore, irregular rainfall is negatively impacting rice production and yield sizes; excessive droughts or flooding has lowered the grain quality and has resulted in lodging, meaning plants fall over or are weakened which makes harvesting difficult. The overall irregular rainfall, either being too heavy and causing flooding, or not raining enough, hence causing a drought, also leads to soil erosion. All of these factors also increase production costs for the small farmers, eventually hurting their productivity and yield size, and affecting the overall Gross Domestic Product (GDP) or the total dollar value of everything a country produces.

Food Insecurity

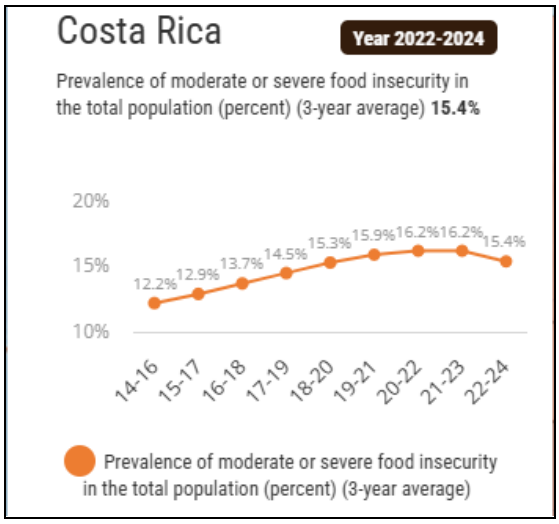
As climate change continues to negatively impact crop yields and food availability, food insecurity is becoming a growing problem in Costa Rica. A person is food insecure when they lack regular access to enough safe and nutritious food for normal growth and development and an active and healthy life. This may be due to unavailability of food and/or lack of resources to obtain food. Food insecurity can be measured at different levels of severity:

- People who are **moderately** food insecure are uncertain about their ability to obtain food and have had to reduce the quality and/or quantity of the food they eat to get by.
- People experiencing **severe** food insecurity have typically run out of food and, at worst, gone a day or more without eating.

The Food and Agriculture Organization of the United Nations (FAO) measures food insecurity using the Food Insecurity Experience Scale (FIES). Estimates of severe food insecurity based on the FIES provide an additional lens for assessing the extent of hunger. The map below shows the prevalence of moderate and severe food insecurity in the world. Children tend to be more vulnerable and at risk for malnutrition or food insecurity. For example, refugee populations and indigenous communities who tend to have less political power and resources are more prone to food and water insecurity.



The following chart published by the Food and Agriculture Organization of the United Nations (FAO) shows the 3-year average for Costa Rica to be 15.4% of the total population to be food insecure. Without continuing to address the impact of climate change on Costa Rica, this number will likely only increase.



Economic & Social Consequences

The economic consequences of climate change on Costa Rica's agricultural sector extends far beyond the crop fields, affecting rural livelihoods, national income, and food security. As crop yields decrease, smallholder farmers experience direct income losses because many depend on crops such as beans, coffee, and bananas for their livelihoods. When crop yields decrease for Costa Rica's largest exported crops (i.e., bananas, pineapples, sugarcane) a portion of the country's national revenue is lost reducing the inflow of foreign currency, which is vital for maintaining the stability of the country.

A reduction in the GDP and in the average household earnings of smallhold farmers, not only hurts the country's economy it also hurts the citizens of Costa Rica and impacts their livelihoods.Due to bean and rice production dropping, Costa Rica will need to depend more on imports from other countries rather than producing their own food. Greater dependence on imports can expose Costa Rican consumers to global food prices, exchange rates, and transportation costs, potentially making food less affordable for lower-income families.

These economic consequences of climate change impacts on agricultural crop yields also have various social consequences. Lower crop yields can reduce family incomes and impair a family's ability to afford education, healthcare, insurance, and other necessities. It may also lead to farmers needing a larger income to support their families which could lead to farmers migrating from rural areas to urban cities in search of increased job opportunities such as in the hospitality industry. A decline in the number of smallholder farmers could reduce agricultural production while placing additional pressure on commercial farms and urban resources.

Social consequences of climate change and increased food insecurity can also result in diet quality declines or micronutrient deficiencies as well as chronic disease over time in adults. Children can be particularly vulnerable, as poor diet quality may contribute to increased illness, lower school attendance and performance, and long-term economic consequences.

Existing Efforts

The issue of climate change and the impacts on food security are not unknown to Costa Rica. In fact, there are efforts underway to help minimize the impacts including coordinated policies by the National

Decarbonisation Plan (NDP) to reduce greenhouse gas emissions and move the country toward a net-zero impact by 2050. Introducing low-carbon measures in the agriculture sector which includes a Low-Carbon Livestock Strategy and actions to expand the use of low-carbon agriculture technologies and practices. Forest protection and carbon sink maintenance, keeping forests as a climate solution and using things like electric vehicles and renewable energy to reduce the impact on the environment are either in place or being considered.

Neighboring countries, like Guatemala, Honduras, Nicaragua and Panama are all experiencing similar issues with climate change including stronger storms, flooding, drought, agricultural losses, and ecosystem degradation similar to Costa Rica. Much like Costa Rica, they have also tried things like expanding forest protection, promoting drought resistant crops, and introducing agroforestry systems which were successful in improving soil health and stabilizing yields; but there have been limitations with these solutions such as lack of financing or resources (e.g., farming technologies, tree seedlings, fencing, grants and investors).

By examining what has worked—and what has not—in neighboring countries, Costa Rica can adapt successful regional approaches to its own agricultural system. It makes sense for Costa Rica to further expand their efforts related to agroforestry and consider ways to increase access to food. This makes sense because Costa Rica already has a strong ecosystem and environmental institutions, with access to more finances. Costa Rica is also facing the same challenges as the other countries that tried similar solutions and had a level of success with agroforestry and conservation aligned with Costa Rica's existing environmental values and policies.

Without sustainable and adaptable strategies, climate change will continue to intensify pressure on Costa Rica's agricultural sector and food security. These consequences will essentially intensify the negative effects of climate change on Costa Rica's Agricultural sector. To mitigate the effects, Costa Rica needs to implement more sustainable and feasible solutions.

Solutions

While the Happy Planet Index ranks Costa Rica first in the world for environmentally-friendly practices, the country is also the world's number one producer of pineapples, a crop that can require substantial fertilizer inputs. With the help of the International Atomic Energy Agency (IAEA) and the FAO, Costa Rican experts are exploring the use of nuclear technology to help producers grow pineapples and other crops more efficiently and ecologically. More specifically, they are testing how a new type of soil additive (e.g., biochar) could help reduce the use of pesticides and fertilizers as well as greenhouse gas emissions reducing the impacts of climate change through both mitigation (reducing atmospheric greenhouse gases) and adaptation (building climate resilience). In other parts of the world, biochar has shown that it can improve soil fertility while helping to reduce the negative impact of chemicals on the environment.

Driven by a growing environmental movement and by pressure from Western consumers, Costa Rica has established strong regulations for pineapple producers, banning certain chemicals and promoting sustainable practices. The possibility of reducing fertilizer and pesticide use while allowing farmers to continue earning a living and growing the crops the world demands is the balance that all sides are looking for.

While working to help producers grow crops more efficiently and ecologically, Costa Rica should also continue implementing agroforestry systems and expanding efficient irrigation infrastructure. Agroforestry addresses heat and soil degradation, while irrigation systems combat prolonged drought conditions, creating a more resilient agricultural system overall.

Agroforestry is a sustainable land management system that intentionally integrates trees and shrubs into crop and animal farming systems to create environmental, economic, and social benefits. As an example, planting trees near crops creates windbreaks and shade for crops and livestock, reducing stress from high heat, heavy rain, or drought. Trees can also help reduce soil erosion, improve water infiltration, and provide riparian buffers that protect water quality from runoff. Agroforestry also enhances biodiversity, improves soil and water quality, boosts farm income, and aids in carbon sequestration. Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide to reduce global warming, acting as a key climate mitigation tool. It involves removing carbon dioxide from the atmosphere and locking it away in natural sinks (forests, oceans, soil) or via geological storage.

Agroforestry credits in Costa Rica are primarily managed through the national Payments for Environmental Services Program (PES/PSA) and compensates landowners for integrating trees with crops or livestock, providing direct payments for carbon sequestration, biodiversity protection, and soil enhancement. A potential opportunity for enhancing the program, or for ensuring funding into the future would be to have companies who are not following best practices for reducing the impacts of climate change pay into the program to fund those making the changes needed.

Agroforestry Proposed Goals:

- **Environmental Impact:** Sequester an additional 500,000 tons of CO2 equivalent through increased tree canopy cover on agricultural lands.
- **Economic Resilience**: Decrease farmer vulnerability to market fluctuations by ensuring 20% of farm income is derived from secondary agroforestry products (e.g., fruit, timber, or honey).
- **Land Restoration**: Restore 25,000 hectares of degraded pastureland using silvopastoral techniques (trees + cattle).

Agroforestry Proposed Strategies:

- **Strategy A**: The PES Integration Model Modernizes the existing Pago por Servicios Ambientales (Payment for Environmental Services) to include specific "Agroforestry Credits" that pay farmers for the density and variety of trees planted.
- **Strategy B**: Technical Extension & Education Deploy "Mobile Innovation Labs" in rural regions like Guanacaste and the Osa Peninsula to provide hands-on training for grafting, shade management, and soil health.
- **Strategy C**: "Green-Label" Market Access Partner with the Ministry of Agriculture and Livestock (MAG) to create a "Carbon-Neutral Plus" certification for exports, targeting premium European and North American markets

Some limitations to this approach include very long wait times for trees to age which can be unrealistic for farmers as well as the opposing viewpoints of the Ministry of Environment (MINAE) pushing for more tree cover, while the Ministry of Agriculture (MAG) is focused on maximizing immediate crop volume, often resulting in fewer trees. Furthermore, the need to measure over 10,000 acres of soil organic matter and other things can get very expensive.

Making this project a reality would require coordination among multiple partners. Costa Rica's CSA initiatives typically involve government ministries, research institutions, international development organizations, and producer groups working together. Key government organizations would include the Ministry of Agriculture and Livestock and the Ministry of Environment and Energy. Universities and

research institutions could support scientific research and technical development. International organizations such as the World Bank, European Union, and FAO could provide funding and technical assistance.

Policies would need to be in place for the project to be successful; specifically, the national CSA policy framework and clear agricultural emissions reduction targets. Supporting policies could include subsidies and tax incentives for farmers adopting climate-smart technologies, strong protection of Indigenous land rights and traditional land-use systems, legal recognition of agroforestry systems, and soil-health monitoring requirements.

Another potential solution to solve food insecurity in Costa Rica is to increase household access to food. Costa Rica is considered an upper-middle income country, yet the national poverty rate is about 20%. When food takes up a larger portion of a family's budget, poverty becomes the primary risk factor to food insecurity. Furthermore, dependence on food imports can expose a country to global prices, exchange rates, and disruptions in international logistics.

In Costa Rica, food insecurity can be less about the physical availability of food and more about whether households have the resources to access and purchase nutritious food. One potential solution to help with food access is providing free or reduced lunches at schools. This approach would prioritize children, who can be particularly vulnerable to the effects of food insecurity. Funding for the program could come from government reimbursements, penalties for noncompliance with environmental policies, and support from nonprofit organizations. The program would ideally work with nonprofit organizations to help ensure specific nutritional guidelines are met and that additional funding can be obtained as needed.

Food Accessibility Proposed Goals:

- **Reduced Food Insecurity:** Using the measure available, monitor and reduce the number of cases of severe vs moderate food insecurity.
- **Improved Targeting Accuracy**: Increase the number of eligible households and individuals reached by assistance programs while improving response times.

Food Accessibility Proposed Strategies:

- **Strategy A**: Free or reduced breakfast and lunches offered in schools; focusing first on those schools in which there is a known need and then expanding.This program should include both public and private schools.
- **Strategy B**: Layered benefits can help customize what eligible households need, such as providing a base level of cash support with child focused add-ons tied to school performance / attendance, and even short-term increases when a crisis hits (e.g., flood, job loss).

Some limitations to this solution include funding constraints, dependencies on global food prices, government errors such as lack of documents or digital infrastructure delays. Programs like free school lunches would require consistent government funding which can be hard to acquire and expensive for the government. For rural households or indigenous communities, getting help with food benefits from the government could be a long process if there's lack of documents or technology. This solution helps give people in Costa Rica increased access to food but does not give the country increased independence; therefore, they still have to depend on imports and increased global food prices can increase expenses even more.

Making this solution a reality is however very possible for Costa Rica. Costa Rica already has various existing social programs surrounding schools; this solution would just require the programs to expand. Costa Ricans have shown support to similar programs like free lunches demonstrating that the community will likely support the idea. International organizations such as the Food & Agriculture Organization (FAO), World Food Program (WFP), and Inter-American Development Bank (IDB) often support food-access programs making them a potential funding agent for Costa Rica helping the barriers surrounding costs. The FAO and WFP support Costa Rica today by enhancing local food procurement, fostering climate-resilient farming, and updating food guidelines to reduce obesity and waste, particularly benefiting smallholder farmers and children.

While agroforestry addresses the impacts of climate change by stabilizing crop yield sizes, and food accessibility addresses the impact of food security as a result of climate change; in Costa Rica, improving irrigation infrastructure is a cornerstone of Climate-Smart Agriculture (CSA). It acts as an "insurance policy" that addresses climate change through three main pathways: (1) Adaptation to Erratic Rainfall, (2) Economic Resilience for Farmers, and (3) Mitigation of Environmental Impact.

Climate change has made Costa Rica's rainfall unpredictable, with more frequent and severe droughts resulting in the need to adapt to erratic rainfall. To help combat this, Costa Rica needs a reliable water supply through modernized systems, such as reservoirs and drip-feed irrigation, ensuring farmers have water during dry spells. A reliable water supply also allows for an extended growing season allowing farmers to produce year-round and diversify their crops, rather than relying on a single rain-fed season.

Economic resilience for farmers is enhanced when infrastructure upgrades help stabilize the rural economy. Irrigated agriculture - the application of water to land, typically sourced from wells, rivers, or lakes, to assist in growing crops when rainfall is insufficient - can allow for twice the crops as rain-fed systems. Implementing high-efficiency systems (e.g., drip irrigation) can reduce the need for agrochemicals and energy, lowering the financial burden on smallholder farmers. A farm with its own water reservoir or modern irrigation is more competitive and better able to withstand "climate shocks" keeping crops consistent as well as their income.

Tying this solution back to agroforestry, having a stable water supply supports practices like agroforestry which captures carbon and improves soil health - a direct impact to climate change. Furthermore, advanced irrigation schedules reduce the runoff of nitrogen-based fertilizers, which are a source of greenhouse gas emissions.

Irrigation infrastructure Proposed Goals:

- **Close the Yield Gap:** Increase output for primary crops like rice and sugarcane, which currently face significant productivity gaps due to poor drainage or inconsistent water supply.
- **Year-Round Production:** Enable multiple harvest cycles per year by providing a reliable water source during the dry season, specifically in regions like Guanacaste.

Irrigation Infrastructure Proposed Strategies:

- **Strategy A**: Green Financing - Working with groups like the World Bank and FAO to make "climate-proof" infrastructure more affordable through low-interest loans or grants.
- **Strategy B:** Smart Automation - Implementing automated canal gates and sensors that monitor soil moisture allowing for "just-in-time" irrigation or implementing drip and micro-sprinkler systems that deliver water directly to roots, reducing evaporation in high-heat areas like Guanacaste.

Costa Rica is currently scaling up several large-scale and community-level irrigation projects, often with backing from international development banks. However, despite this benefit, only a small portion of Costa Rica's agricultural land was equipped for irrigation as of 2018. This is partially because Costa Rica has faced a persistent fiscal deficit, which restricts the government's ability to fund massive public works. Large dams and national canal networks would require substantial upfront investment that Costa Rica may struggle to finance without additional international support. Complex government decision-making processes can also delay infrastructure projects. Many smallholder farmers are hesitant to adopt expensive "smart" systems because they cannot afford the risk if the technology fails or if a single bad season leaves them unable to pay back a "green loan".

Conclusion

Costa Rica's struggle with climate change, declining crop yields, and rising food insecurity shows how deeply environmental, economic, and social systems are connected. As extreme weather, soil degradation, and unpredictable rainfall continue to threaten the country's most important crops, smallholder farmers and low‑income families face growing instability in both income and access to food. Yet Costa Rica also has the tools, institutions, and environmental values needed to build a more resilient future. By expanding agroforestry, improving irrigation infrastructure, and supporting farmers through stronger policies, financing, and education, the country can protect its agricultural sector while strengthening long‑term food security. Addressing these challenges with sustainable, community‑centered solutions honors Costa Rica's Pura Vida philosophy and ensures that future generations can thrive in a healthier, more stable food system while protecting the environment and food source that provides the ability to live the Pura Vida lifestyle.

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