

The Potential of Yucca: Global Food Security and Economic Sustainability

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ABSTRACT

Yuca, more widely known as cassava, is a root crop that grows in various tropical and subtropical climates and is particularly resilient to poor soil conditions and harsh environmental factors. As such, yuca presents itself as a potential answer to the growing food crises that the world is facing despite all our technological advancements and growth in GDP. As it was expected that up to 783 million people would face hunger in 2022, an increase of 122 million since 2019, the world and especially underdeveloped countries around the globe need an alternative food source that is both affordable and nutritious. Because of the intrinsic robust and easy-to-cultivate qualities that yuca has, we suggest in this research that yuca should be looked at as an alternative food source for regions that face food shortages and that more resources should be invested into developing farming methods and favorable cultivation environments with regard to yuca in order to resolve the increasing food crisis that the world is facing, especially with taking effects of climate change into consideration.

Introduction

Since the 1980s and the publication of the 1974 report by the Food and Agriculture Organization of the United Nations (FAO) on the extent of food shortages and hunger, we have experienced a worldwide increase in GDP and much technological progress has been achieved (FAO). However, indicators such as Prevalence of Undernourishment (PoU) indicate that malnourishment, food shortages, and hunger remain a big threat to populations in underdeveloped countries around the world.

Recent data from 2022 indicated that between 691 to 783 million people worldwide were undernourished, pointing to an increase of 122 million people since 2019 (United Nations, UN). From 2005 to 2014, there was a decrease in hunger, but from 2018 to 2022, there has been a resurgence (FAO). People experiencing severe food insecurity are likely to experience hunger, where hunger is defined as a condition where food is scarce, and individuals have gone without eating for at least an entire day, meanwhile moderate food insecurity refers to conditions where individuals may give up eating, or suffer from obesity or malnutrition, due to lack of access to nutritious foods (FAO). The future outlook for global corn and wheat harvest trends indicates a significant decline (Tripathi et al., 2016). To ensure food security for the projected 2050 global population of 9.6 billion, FAO forecasts a need for a 60% increase in global food production by 2050 to meet global food demands. Apart from FAO, Tilman et al. (2011) projects a need of at least a 100% increase in food production to meet the anticipated food demand (Tilman et al., 2011).

Yuca, or Cassava, is a woody shrub. It can be grown in diverse tropical and subtropical settings. A key food crop across much of the world's poorest regions—most notably Africa and Latin America—the large starchy roots are valued for their fleshy edible portion. The roots are customarily cylindrical in shape, covered by a tough brown outer skin with white or yellowish flesh. They reach

gigantic proportions with some roots recorded at several kilograms in weight. Yuca has several advantageous characteristics—it is resilient to poor soil conditions, particularly resistant to drought, and immune to most pests and diseases common among other plants in its ecosystem, making it an ideal crop to produce and consume under poor environmental factors. Moreover, Yuca is what you would call a low-input crop since it does not require as much labor as maize or rice demand. It can be grown in poor soil conditions. Many times, it can be consumed as a contingency crop when other crops have failed because of unfavorable weather or soil conditions. Yuca’s resilience contributes to food security for many communities that lack food sources.

Yuca is chosen as an alternative food source, for several reasons. It is economically viable; because it is a cheap crop to cultivate and it yields a plentiful harvest. Harvesting of its roots ensures food security for farmers and gives them a source of income. Moreover, versatility in the different ways that Yuca can be processed is also another advantage that Yuca has—Yuca roots can be used in producing various products, such as cassava flour, tapioca, and even cassava-based beer or spir-its. The various use-cases for Yucas creates various channels of demand and versatile sources of income for the farmers.



Figure 1. Close-up of cylindrical Yuca roots with hard brown skin and a white to yellow-brown interior. **Figure 2.** Depiction of Yuca plants in good health, even when the soil they grow in is of poor quality. **Figure 3.** Scene of a small-scale farm with a farmer tending to very healthy Yuca plants using hardly any tools; this emphasizes that Yuca farming is low maintenance in tropical agricultural conditions. (The above pictures are all generated using DALL-E).

The table below shows why selecting Yuca as the main crop source is preferable based on the data provided:

Here is a table showing why choosing Yuca as the main crop source makes sense based on

the statistics provided by the documents:

Method

We examined countries and regions suited for Yuca cultivation through a multi-faceted approach. Our method involved looking at materials from agricultural databases, academic literature, reports from affiliated organizations (such as FAO), and government publications. Also, we consulted experts in the field of tropical agriculture, which gave us valuable insights for the research. Climate data, soil types, and existing Yuca farming methods were analyzed to find regions most suited for Yuca growth. From this analysis, we concluded that Brazil, Nigeria, Thailand, Indonesia, Colombia, Vietnam, Democratic Republic of Congo, Ghana, Cameroon, and India all possess environments well suited for growing Yuca. These countries were selected based on their climates, soil types, and contribution to global Yuca production (Ikuemonisan et al., 2020).

Data analysis entailed normalization and proper outlier exclusion. Visualization and each indicator should explicitly be reviewed so that some information insight; in correlation analysis goes to check on the relationship between the indicators, and then regression. The programming language used in this data analysis was R. R is free software used worldwide. The version of R used in this study is 4.3.2.

The dataset was resourced from Kaggle [Crop Yield Forecasting Dataset] with FAO and World Database data. This dataset gives information as to country, plant name, year, pesticide, rainfall, temperature, and yield. We obviously filtered the dataset to see only cassava.

Results

Paper Research

Low yield per hectare refers to the low level of crop yield, defined as "a measurement of the amount of agricultural production harvested per unit of land area (Impact Institute)." Yuca, commonly grown in less developed countries on the African continent, shows a correlation between the countries that grow Yuca and their inadequate education systems. According to the NCBI, "Africa's low Yuca productivity reflects the use of rudimentary farming tools and equipment, the near lack of mechanization, and the lack of market options." While Africa is the highest producer of Yuca, its surprisingly low productivity raises several questions. For example, there are questions about the potential for increasing Yuca's prevalence in African nations with the development of higher yield per hectare. There are also considerations about whether improvements in the education of agricultural management skills could directly help address food insecurity in Africa. Additionally, it raises the issue of whether more nations could depend on Yuca but are held back by the educational component of growing the plant.

Crop farming in Africa is mainly done by smallholder farmers. This group of farmers continues to operate in a low input, and low output agricultural production system. Low yields are the most important factor that affects profitability and competitiveness of smallholder farmers. In addition, many smallholders lack the skills to navigate their way around the agricultural industry because they do not have the necessary talent and resources needed for commercial farming. More than 80% continue to produce at subsistence levels (Adebayo).

Farmers in sub-Saharan Africa are stuck in poverty, which acts negatively on many other dimensions of their agricultural activities; first among the reasons is that these farmers cannot be

trained well due to poverty on how to grow crops productively and efficiently. They are not capable of affording farm machinery as well as high-quality seeds and fertilizers. A US non-governmental organization, however, hopes to address these issues: improper training and resources that lead to low productivity (high food insecurity) by improving training and resources for farmers.

Can Yuca be a helpful solution to a country that lacks nutrition, possesses food insecurity, and has a low economic status? According to Ourworldindata, we found that people in Sub Saharan Africa have the highest number of people that are undernourished in the past 22 years. The word undernourishment can be defined as “eating less than the energy required to maintain an active and healthy life.” Undernourishment can lead to several repercussions such as an increased susceptibility of diseases, stunted physical and mental growth, or even death. To have a better understanding of undernourishment, it can be explored from 2 lenses: Macronutrient undernutrition and micronutrient undernutrition. Macro nutrition covers proteins, carbohydrates and fats, while micro nutrition covers vitamins and minerals. In the contemporary public, much of the attention has shifted towards macro nutrition, where calories, protein and fat are the staple nutrients used to identify the nutritional value of a product. And while it is true that macro nutrition is important to take into account, we cannot discount the importance of micro nutrients and the benefits it has on our bodies. Particularly, our immune system, cells, organs, and dietary systems need specific vitamins and minerals to sustain and rebuild itself. If our bodies lack micronutrients, our bodies become prey to diseases and viruses that can make us sick and unable to live a sustainable life.

To take one example, Nigeria suffers from low levels of food security and undernourishment to the extent that it has affected the poplaces’ ability to live healthy and sustainable lives. According to Our World In Data, Nigeria has one of the highest “Share of population with severe food insecurity” of 21.3%, which appears to have been continuously growing from the years prior. How does Yuca play a role in tackling food insecurity in Nigeria? Yuca is a root vegetable that holds both macronutrients and micronutrients.

Table 2. Table of Yuca Nutrients.

Nutrients Relative to 3.5 ounces (100 grams) of Cooked Yuca			
Macronutrients	Amount (g)	Micronutrients	Amount (% of Daily Value)
<u>Protein</u>	1.5	<u>Vitamin C</u>	20
<u>Fat</u>	3	<u>Copper</u>	12
<u>Carbs</u>	40	<u>Thiamine</u>	7
<u>Fibre</u>	2	<u>Folate</u>	6
		<u>Vitamin B</u>	6
		<u>Potassium</u>	6
		<u>Magnesium</u>	5

		<u>Niacin</u>	5
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As the table displays, Yuca possesses the essential macronutrients and micronutrients that can allow for a sustainable and healthy source of food in Nigeria. However, when considering the actual amount of the nutrients, Yuca demonstrates a very low percentage of micronutrients that does not fulfill the micronutrition of daily intake. Specifically, in Table 2, the measurement of micronutrients for Yuca are regarded as (% of Daily Value). This indicates that, for instance, Vitamin C having 20% of DV, indicates that 100 grams of Yuca provides only 20% of the daily requirement of vitamin C and the individual is encouraged to consume 80% worth more of vitamin C to satisfy the daily requirement of micronutrient sufficiency. Now looking at the remaining micronutrients, it is clear that vitamin C had the highest DV of 20% and the other micronutrients such as Niacin or Vitamin B have significantly less values that have a significantly less % of daily value.

Table 3. Comparison of micronutrients in Yuca with recommended daily value.

Micronutrients	Comparison of micronutrients in 100g of Yuca with recommended daily value.
Vitamin C	90 mg (100 grams of Yuca provides 18 mg, or 20% DV)
Copper	0.9 mg (100 grams of Yuca provides 0.108 mg, or 12% DV)
Thiamine (Vitamin B1)	1.2 mg (100 grams of Yuca provides 0.084 mg, or 7% DV)
Folate	400 mcg (100 grams of Yuca provides 24 mcg, or 6% DV)
VitaminB6	1.3 mg (100 grams of Yuca provides 0.078 mg, or 6% DV)
Potassium	4700 mg (100 grams of Yuca provides 282 mg, or 6% DV)
Magnesium	400 mg (100 grams of Yuca provides 20 mg, or 5% DV)
Niacin (Vitamin B3)	16 mg (100 grams of Yuca provides 0.8 mg, or 5% DV)

(Dietary Guidelines for Americans and the National Institutes of Health ([Health.gov](https://www.health.gov)) ([My Food Data](#)))

But remember that, Yuca is only the main carbohydrate source in the meal and will most likely be served with other complementary dishes such as vegetables or stews that contain other micronutrients. For example fufu is one of Nigeria's main national dishes. Fufu is a dish made from pounded Yuca, either fresh or fermented, and is often served with Egusi soup. Egusi soup contains egusi and watermelon seeds: this is because it provides protein as well as vitamins and minerals.

When looking at the staple food in Nigeria, they try to get macro and micronutrients by consuming Yuca and other foods.

Then, why might Nigeria still continue to be a country that is food insecure and lacks nutrition? Nigeria is one of the largest producers of Yuca, cultivating “over 34 million tonnes of tuberous roots” ([link](#)). However, “the trend in yield performance (production per hectare) remains low,” suggesting it

“is linked to ineffective agronomic practices and inefficient management of production resources (Link).” According to Investopedia, Crop yields refer to “how much grain or other crops are produced and how efficiently land is used to produce food or agricultural commodities.” In Nigeria’s case, despite Nigeria being the highest producer of the vegetable their yield per hectare was the lowest among “major contributing countries to the world Yuca market.” Table 4 displays Nigeria’s low yield (tonne/ha) in 2017 (B).

Table 4. Cassava Production Trends in Nigeria (1970–2018) Source: Ikuemonisan, Edamisan Stephen, et al. "Cassava production in Nigeria: trends, instability and decomposition analysis (1970–2018)." Heliyon 6.10 (2020).

Table 1. Yield and production of cassava by major contributing countries to world cassava market.

	Yield (tonne/ha)			Production (tonnes)			CGR	
	1970 (A)	2017 (B)	(A) - (B)	1970 (A)	2017 (B)	(A) - (B)	Yield	Production
Angola	3.56	11.61	8.06	1600000	11747938	10147938	0.086	0.145
Benin	4.40	15.55	11.15	510000	4341848	3831848	0.056	0.129
Ghana	7.50	19.13	11.63	1550000	18470762	16920762	0.051	0.148
India	14.79	20.96	6.17	5214100	4171000	-1043100	0.040	0.010
Indonesia	7.49	24.45	16.95	10478310	19046000	8567690	0.055	0.038
Thailand	15.32	23.07	7.76	3431000	30973292	27542292	0.026	0.075
Vietnam	7.21	19.28	12.07	945000	10267568	9322568	0.054	0.108
Brazil	14.55	14.36	-0.20	29464272	18876470	-10587802	0.0081	-0.0076
Congo	4.61	10.76	6.15	461000	1409211	948211	0.038	0.052
Nigeria	11.91	8.76	-3.15	10206000	59485947	49279947		

Source: Author's computation from [FAOSTAT, 2018](#).

To tackle the problem of low yield per hectare and allow the further distribution of Yuca to the people of Nigeria and internationally, the (link) suggest that the Nigerian government promote the proper agronomic practices, investing money on scientific research to fund for studies to “develop improved Yuca varieties”, and creating “appropriate reform on the contemporary land policy” with a goal to promote fair management of land within investment initiatives and development projects (Figure 4).

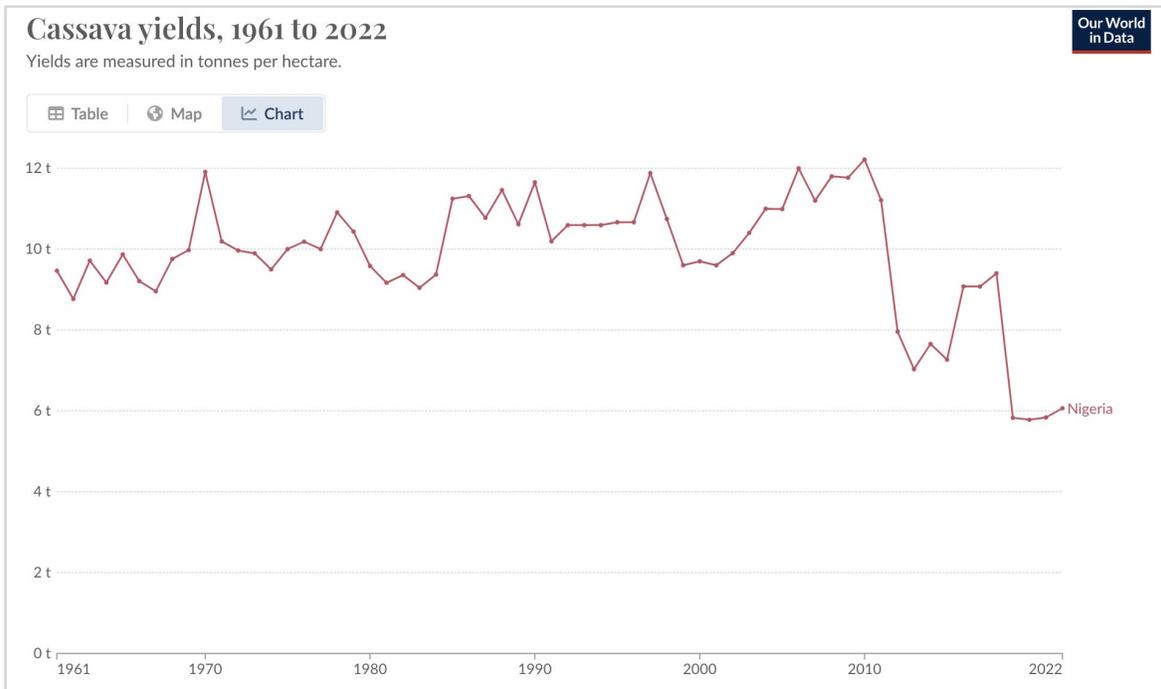


Figure 4. Yuca Yield, 1961-2022

Data Analysis

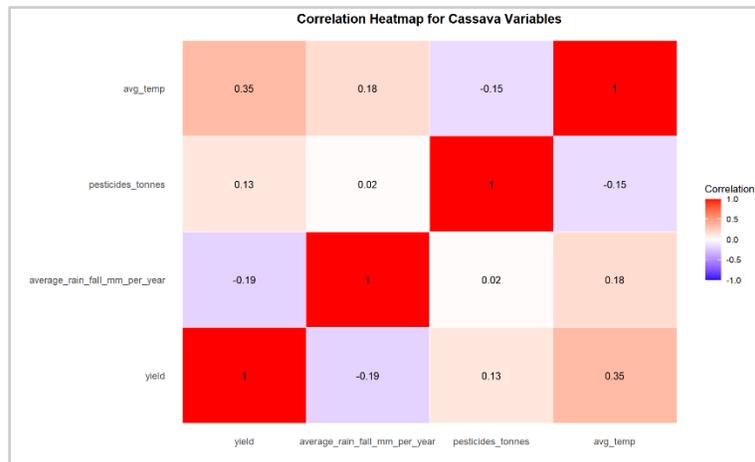


Figure. 5 Correlation analysis

The bar chart shows the average Yuca yields (in hectograms per hectare) across various countries. India has the highest yield, followed by Suriname and Thailand. As we move down the list, the yields decrease, with countries like Burkina Faso and the Central African Republic having the lowest averages (Figure 5).

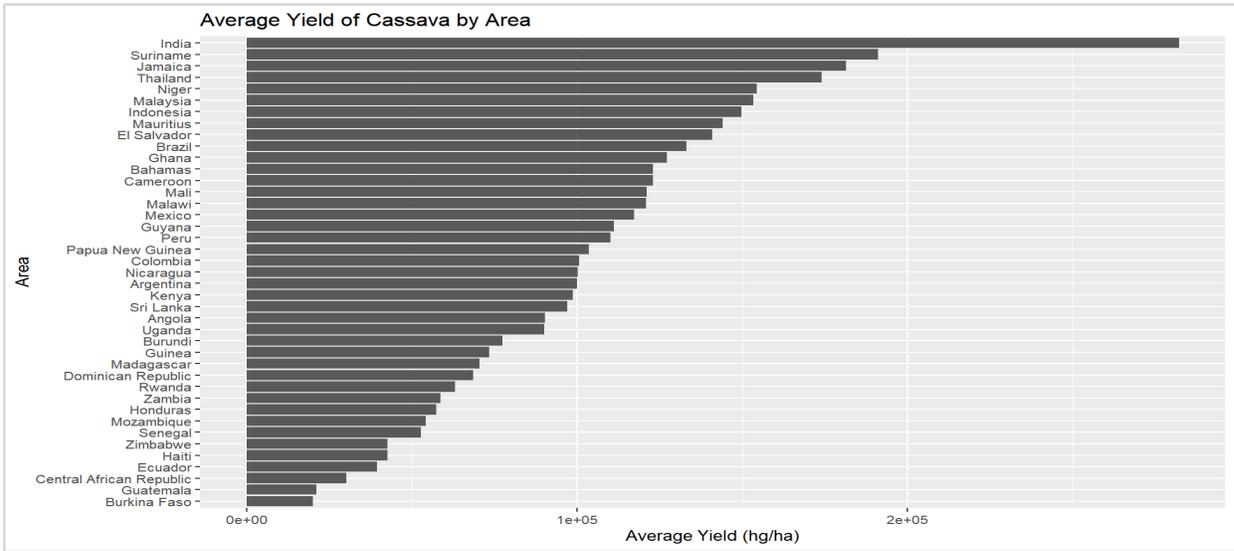


Figure 6. Visualization of average yields by country.

The average annual Yuca yield from 1990 to 2010 is shown in a line graph (hectograms per hectare). The graph displays a general upward trend, indicating an increase in yield over time. Despite some fluctuations in the mid-1990s and early 2000s, yields have notably increased, especially since 2000. This means that improvements in agricultural practices, technology, or climatic conditions contributed to increased Yuca production efficiency over the observed period (Figure 6).

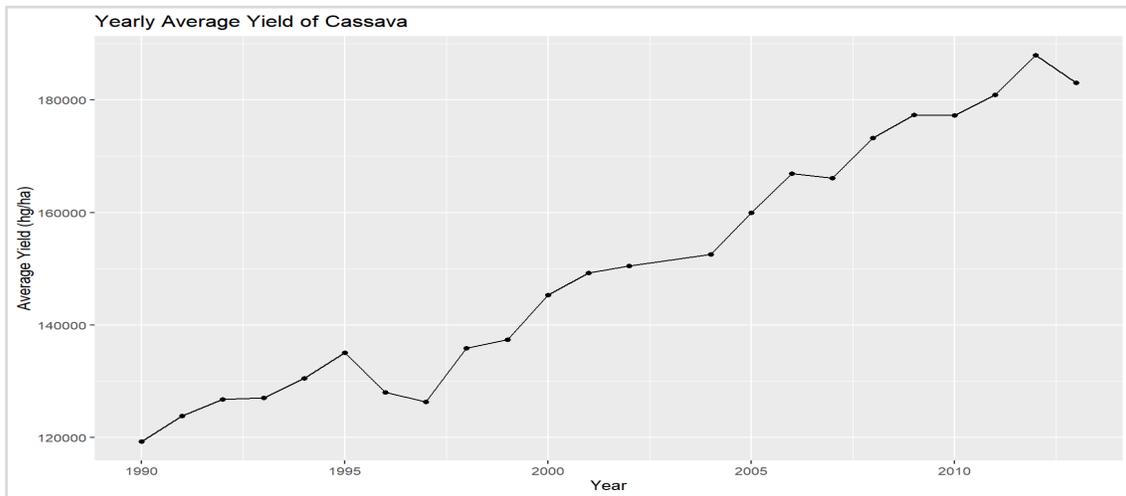


Figure 7. In Years Average Yields, Visualization of TrendsThe scatter is an average of the values for rainfall, pesticide use, temperature, and Yuca yields. It is labeled average rainfall (mm/year) on the x-axis and Yuca yield (kg/ha) on the y-axis. The color of the points was coded according to pesticide use, while the scale from purple to yellow denotes increasing levels of pesticides. The size of the points indicates average temperature. It communicates that there is a weak negative relationship between rainfall and crop yields where higher crop yields are associated with higher pesticide use and temperatures. It communicates that there is a weak negative relationship between rainfall and crop yields where higher crop yields are associated with higher pesticide use and temperatures. This

visualization highlights the complex interactions between these variables and their combined effects on Yuca yield (Figure 7).

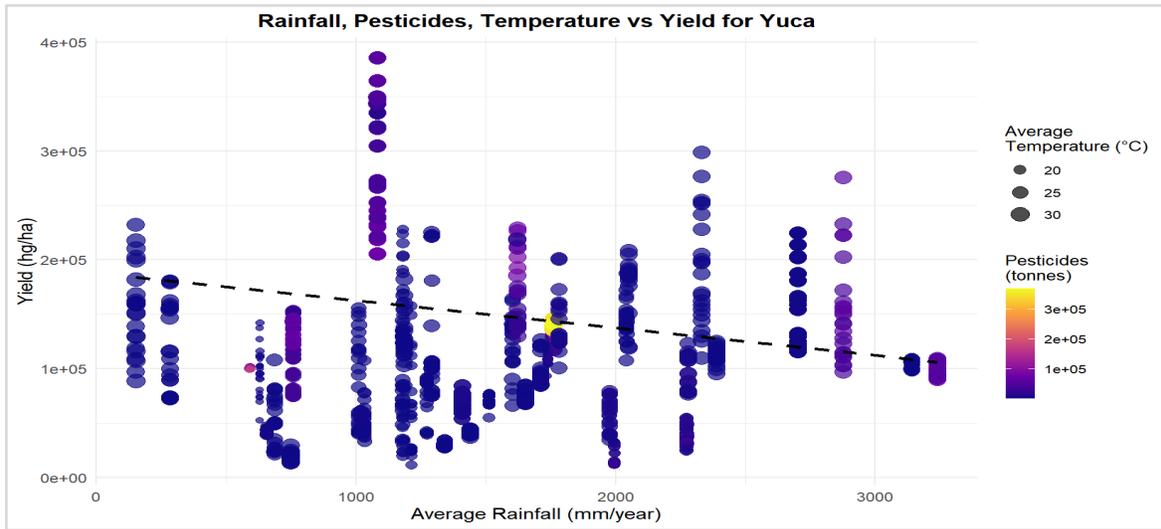


Figure 8. Visualize multiple correlations between rainfall, pesticide use, temperature and yield

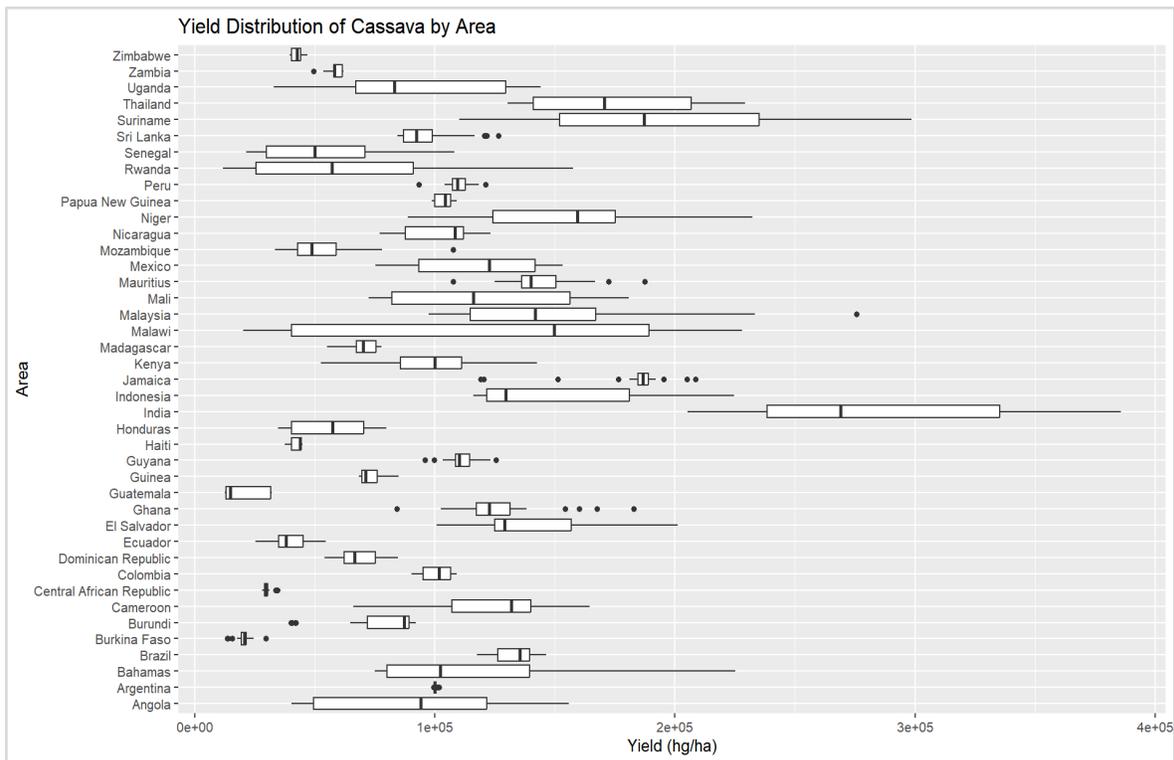


Figure 9. Yield Variability by Country

The box plot visualizes the yield variability of Yuca (in hectograms per hectare) across different countries. The x-axis represents yield, while the y-axis lists the countries. Each box represents

the interquartile range (IQR) of yields within a country, with the median yield indicated by a horizontal line within the box. This plot highlights significant yield variability both within and between countries, with some countries like Zimbabwe and Zambia showing wide ranges of yields, while others like Argentina and Angola display more consistent, lower yields (Figure 9).

Regression Analysis for Yuca Yield

Regression analysis was conducted on the relationship between Yuca yield and the three predictors: rainfall, average temperature, and pesticide use. According to the study, temperature had a more significant positive impact on yield. With each increase in temperature, the yield increased by 11,520 units. Pesticide use also positively affected it. A ton of pesticide would lead to an increase in yield by 0.2508 units. On the other hand, average rainfall had a negative effect on yield. With each additional millimeter per year, the yield reduced by 35.99 units. All predictors were statistically significant at $p < 0.001$ even though there was multicollinearity among them because none of them acted independently but rather jointly with others in influencing crop production. This means that more variables have to be added in order to increase the model's explanatory power. If the R-squared is low, model performance could be improved by adding more explanatory variables or using nonlinear models.

Regression Analysis for the Entire Crop

Variable	Interpretation
average_rain_fall_m m_per_year	An increase of 1 mm in average annual rainfall is associated with a decrease in yield by approximately 4.851 hg/ha.
pesticides_tonnes	An increase of 1 tonne in pesticide usage is associated with an increase in yield by approximately 0.1092 hg/ha.
avg_temp	An increase of 1°C in average temperature results in a decrease in yield by approximately 2,064 hg/ha compared to the baseline.
ItemMaize	The yield of maize is approximately 123,600 hg/ha lower than the baseline crop (Yuca).
ItemPlantains and others	The yield of plantains and other related crops is approximately 38,590 hg/ha lower than the baseline crop.
ItemPotatoes	The yield of potatoes is approximately 37,870 hg/ha higher than the baseline crop.
ItemRice, paddy	The yield of rice is approximately 116,500 hg/ha lower than the baseline crop.
ItemSorghum	The yield of sorghum is approximately 139,000 hg/ha lower than the baseline crop.
ItemSoybeans	The yield of soybeans is approximately 144,600 hg/ha lower than the baseline crop.

ItemSweet potatoes	The yield of sweet potatoes is approximately 36,300 hg/ha lower than the baseline crop.
ItemWheat	The yield of wheat is approximately 134,500 hg/ha lower than the baseline crop.
ItemYams	The yield of yams is approximately 41,730 hg/ha lower than the baseline crop.

The regression model indicates that all the independent variables above are statistically significant; however, not the overall model. Sixty-four percent of the performance variation is okay; that is quite high. Because it is such a high R-squared value, the present model can explain much of the variation in performance. It can be that other variables or nonlinear models do better in prediction. Though having more power of explanation than the one before, this also does not by itself floor suffice in explaining all there is to performance difference.

Discussion

In light of the food shortage issues that the world is facing, yuca presents itself as an alternative food source. It has several favorable qualities, including its resilience against heat and drought, its ability to grow in poor soil conditions and its low-maintenance trait when it comes to cultivation. Hence, as we anticipate an increase in temperature and irregular weather patterns due to climate change in the coming years and decades, yuca seems a suitable candidate as an alternate food crop that is accessible and easy to cultivate.

Secondly, cassava can build up smallholder farmers who practice subsistence and commercial agriculture since the dual nature of its growth secures the availability of food when other sources fail. Additionally, it is a smallholder crop that is easy to grow. It can be grown either as a garden or co-farming with other crops like maize. Some earlier stars found that cassava can be used not only as a staple food but also in fighting malnutrition and hunger. By reducing the prevalence of underweight children less than five years old, this could be one way of saying that the subject is important. Therefore promoting the cultivation and consumption of cassava will enhance multifunctionality in both food security and poverty reduction.

Apart from yuca benefiting underdeveloped countries in Africa such as Nigeria, if we invested resources into properly investigating how yuca can be grown elsewhere and how growing yuca could benefit other parts of the world, large parts of the globe could benefit from cultivating and consuming yuca. It, of course, would require that we invest resources into investigating further under which conditions we can increase yuca yields and a further effort to educate farmers on cultivation methods. Nonetheless, if we are successful, the whole world could reap the nutritional and economic benefits of yuca.

As such, yuca separates itself from other crops not just as another alternative crop, but the crop that could effectively curtail global hunger and reduce levels of economic disparity and poverty through providing farmers with a new food source and a new means of income. We hold this to be even more prevalent with an increase in volatility in weather conditions due to climate change. Accordingly, our position with this research paper is that we want to evoke regional and global policy makers to invest in and look into yuca as a potential super crop that can avert global food shortage and reduce poverty.

On the one hand, our conclusion with this research paper is that yuca presents itself as a

potential global super crop that could curtail hunger and be the answer to the looming global food shortage problem. On the other hand, we want to also stress the importance of carrying out regional tests and experiments to see how yuca can be cultivated in specific regions or under specific circumstances. Although yuca seems promising as a global super crop, there may be limitations to where or how or when it could be grown and harvested. We leave this task up to the regional and global leaders of the world.

Additionally, it has been confirmed that Yuca supply and agricultural education were needed in Africa and elsewhere for food security. Although Yuca is a good food source, it has been well proven through various experiments that it should not be consumed alone. However, this study should have addressed the actual supply of Yuca. Additional research is needed specifically on how Yuca can be grown and supplied to each country.

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