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Food for export

An Analysis of Haiti's Agricultural Export Potential in the Nord-Ouest Department

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Abstract

This study explores the agricultural export potential of Haiti's Nord-Ouest Department, a region historically marked by food insecurity, high poverty rates, and geographical isolation. Despite accounting for 21 percent of Haiti's GDP and being the primary source of employment for 50 percent of the population, agriculture represents only 7 percent of Haiti's exports. The sector thus has the potential for greater export promotion, benefiting the country as a whole, but also poorer regions that strongly depend on this activity, such as the Nord-Ouest where it employs 62.7 percent of the workforce. This paper addresses the structural, economic, and policy barriers that have historically undermined the sector's productivity and export capabilities in this Department. Employing a combination of systems analysis, spatial value chain analysis, and quantitative crop ranking, the research identifies strategic interventions to enhance agricultural productivity and export potential. The analysis focuses on crops with high export potential, nutritional value, and climate change resilience. Findings suggest that increasing productivity and boosting exports requires a multipronged approach: improving infrastructure and food processing, combatting socioeconomic behaviors including charcoal production and deforestation, and restoring political stability.

Key Words: agriculture, Haiti, exports.
JEL Codes: Q17, O13, O19, Q18, R11

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Contents

Acronyms

BRH	Bank of the Republic of Haiti
CARICOM	Caribbean Community and Common Market
CET	Common External Tariff
EAEU	Eurasian Economic Union
EPI	Export Potential Index
FAO	Food and Agriculture Organization of the United Nations
FEWS NET	Famine Early Warning Systems Network
GDP	Gross Domestic Product
HOPE II	Hemispheric Opportunity through Partnership Encouragement II
IDB	Inter-American Development Bank
IFRC	International Federation of Red Cross and Red Crescent Societies
IPC	Integrated Food Security Phase Classification
LAC	Latin America and the Caribbean
MiCRO	Micro-insurance Catastrophe Risk Organisation
MSS	Multinational Security Support
N-O	Nord-Ouest
NTBs	Non-Tariff Barriers
PREPOC	Post-Covid Response Plan
RCA	Revealed Comparative Advantage
UN	United Nations
USDA	United States Department of Agriculture
WDI	World Development Indicators
WFP	World Food Programme

1. Introduction

Enhancing agricultural production is a key strategy for Haiti to tackle its dual challenges of low export levels and food insecurity. Agriculture is a crucial sector in Haiti, accounting for 21 percent of the Gross Domestic Product (GDP) and 50 percent of employment (BRH 2023). The agricultural sector is crucial for livelihoods, serving as a primary food source, with over 80% of arable land dedicated to subsistence farming (Oliveira 2021). Haiti faces substantial economic hurdles, evidenced by its GDP per capita which is the lowest in Latin America and the Caribbean (LAC) and has declined for five consecutive years. The country's reliance on imports, and low levels of exports, exacerbate the trade deficit and leave Haiti vulnerable to global price and supply chain fluctuations, both of which have become an increasing concern (Giles Alvarez et al. 2022).[1] This economic fragility is reflected in the food sector, where nearly five million Haitians, or 50 percent of the population, grapple with food insecurity, a figure that has tripled since 2016 (IPC 2024). Amid these challenges, agriculture, which has accounted for only 7 percent of Haitian exports since 2009, holds untapped potential as a pathway to ameliorate the trade balance and invigorate the economy with sustained revenue and international reserves.[2]

National agricultural policies aimed at boosting productivity and exports have been undermined by political turmoil. The Haitian government had already set ambitious objectives for agriculture through the Post-Covid Response Plan (PREPOC) 2021-2023 and the 2010-2025 Agricultural Development Policy, aiming to significantly enhance agricultural productivity for local consumption and export through import substitution and broadening the range of exportable agricultural products. However, the assassination of President Moïse in July 2021 and the ongoing absence of elected officials since January 2023 have severely debilitated the implementation of these policies, exacerbating political instability that has, in turn, increased crime, discouraged market activity, and further entrenched food insecurity. This instability has been particularly detrimental to the Ouest but also to regions like the Nord-Ouest, one of the poorest and most food-insecure regions in the country (FEWS NET 2023a).

The Nord-Ouest (N-O) Department is one of the regions that pays the highest price for limited local food availability, despite its potential for food production and export. The Department is one of the most vulnerable regions in the country, presenting high poverty rates, geographical isolation, and a large incidence of development gaps by national standards (Giles Alvarez et al. 2021). In this department, 62.7 percent of the workforce is employed in agriculture (RGA 2008). Specifically, agriculture in the Department is also affected by a complex system of problems, including climate change and unpredictable rainfall, limited job opportunities, and deeply entrenched social cycles. Despite this, the Department also has agricultural processing facilities and transportation infrastructure, including the airport of Port-de-Paix and the port of Port-de-Paix, all of which could support agricultural development to enhance food security and exports.

This study analyses strategies to foster greater production and export of food products in Haiti's Nord-Ouest Department. This is the fourth of a series of papers analyzing development

[1] For example, around 80 percent of the domestic demand for rice is met through imports (USDA, 2016).
[2] Calculated using the Free on Board (FOB) numbers derived from the Bank of the Republic of Haiti (BOH).

gaps in the country, food insecurity in the Nord-Ouest Department and the potential of supporting value chains for the commercialization and export of agricultural products in this Department.[3] Specifically, this analysis identifies the structural barriers which need to be addressed to ensure agricultural production and exports are successful, pinpoints the crops that should be the focus of an export-led strategy, and suggests where planting these crops would maximize the potential returns for production and exports. Section 2 provides context for economic and agricultural development in Haiti with a focus on the N-O. Section 3 lays out the methodology for the analysis. Section 4 uses a mix of literature and historical information to present a system analysis of the agriculture sector while Section 5 narrows down specific crops and geographies through a spatial value chain analysis. Section 6 then presents recommendations for improving the agricultural industry. Section 7 concludes.

2. Context

Economic & Political Landscape

Agriculture is one of the main drivers in a challenging economic landscape. Agriculture stands as an important sector in Haiti's economy, which, as of 2022, recorded a GDP per capita of $1,247.89.[4] This marked it as the least affluent in the LAC region and the Western Hemisphere. Accounting for 21 percent of the GDP, agriculture trails only behind the services sector in economic importance (BRH 2023). However, the economy contracted significantly over the past five years, with an average annual GDP decline of 2.1 percent from 2019 to 2023, with a further anticipated contraction of 3.0 percent in 2024 (WDI 2024). Inflation and exchange rate volatility have also been a significant challenge in the country. From 2012 to 2023, inflation averaged 15.9 percent while the Haitian Gourde weakened 70 percent against the U.S. dollar.[5]

Figure 1. GDP per Capita (Constant 2015 US$)

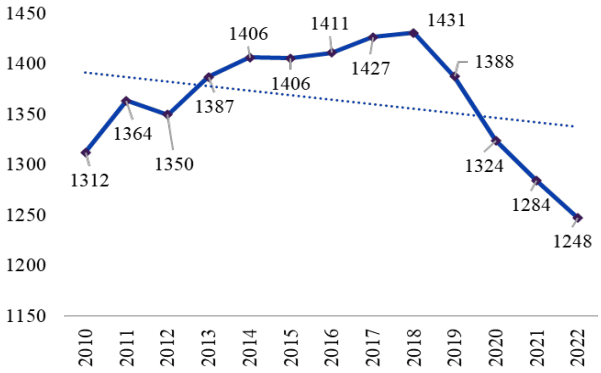
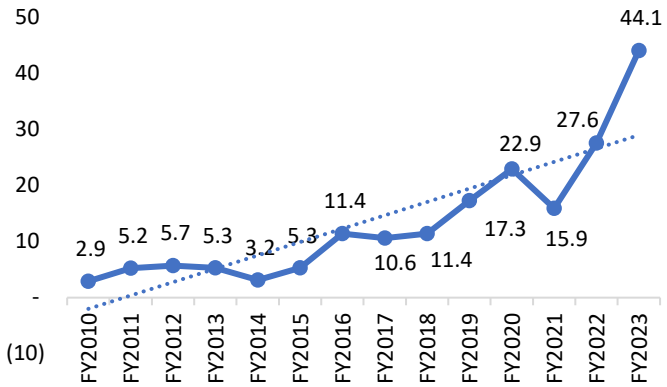


Figure 2. Inflation (Annual Percentage Change in average Consumer Price)



Source: FED St. Louis ; WEO April 2024

[3] The other papers are Giles Alvarez et al. 2021, Giles Alvarez et al. 2022a, and Giles Alvarez et al. 2022b.
[4] This is the current Nominal US$ GDP per capita. The chart shows the US$ Real GDP per Capita.
[5] Monthly inflation over the last two years has only worsened, averaging 34 percent.

Prolonged political instability has worsened crime, food insecurity, and natural disaster vulnerability. Following the assassination of President Jovenel Moïse in July 2021, the country's governance has quickly deteriorated. Since January 2023, there have been no elected officials, a situation that exacerbates governance challenges and hinders economic development (IRC 2024). The Prime Minister installed after the assassination, Ariel Henry, resigned in April 2024, with his replacement Gary Conille, chosen as the new Prime Minister by an appointed Transitional Presidential Council (Al Jazeera 2024). Meanwhile, Kenya stepped forward to lead a Multinational Security Support (MSS) mission in Haiti with the deployment of 1000 police officers, to help establish security. This instability has led to a massive increase in civil unrest and criminal activity, especially by gangs who exert control over parts of the country. As of March 2024, due to gang violence, 362,551 persons were internally displaced, 15% more than last year. According to the United Nations (UN), the number of people killed in armed violence in Haiti has risen by 120% in 2023 compared with 2022, reaching 4,789 homicides or 40.9 per 100,000 inhabitants. This has discouraged market activity and increased food insecurity as gangs have "taxed" farmers, stolen livestock, and displaced workers (UNHR 2023).[6] Moreover, inadequate governance has exacerbated vulnerability to disasters, such as hurricanes, floods, and earthquakes, which 96 percent of the population is exposed to, further increasing agricultural risks and decreasing productivity of the sector (World Bank 2024).

Haiti has increasingly become a net importer, exacerbating the trade deficit. On average, Haiti's imports accounted for US$4.6 billion annually (31.8 percent of GDP), between 2009 to 2022 (WDI 2024). This figure has seen an uptick from an average of 24.4 percent of GDP in the early 2000s, and well surpasses the LAC average for the period of 23.5 percent. Conversely, exports have remained significantly lower from 2009 to 2022, averaging US$1.4 billion (9.8 percent of GDP), significantly lower than the LAC average of 23 percent. The trade deficit has an average of 22 percent between 2009 and 2022, compared to Latin America and the Caribbean (LAC), which saw a slight trade deficit of 0.8 percent of GDP for the same period.

Agriculture & Agricultural Policy

Agricultural exports have steadily decreased over the last 15 years despite strong sectoral potential. From 2009 to 2023, Haiti's agricultural exports as a percentage of total exports have seen a declining trend, with fluctuations across various products. Starting at 8.4% in 2009, there was an initial increase peaking at approximately 9.8% in 2011, followed by a general decline to a low of 1.5% in 2023. Coffee exports experienced a significant peak in 2011 at roughly US$9.8 million, after a starting point of US$3.7 million in 2009, only to follow a declining path that steepened in the last three years, reducing to US$0.2 million by 2023. Cocoa reached its highest export value of US$14.2 million in 2014, and despite some fluctuations, ended up at US$3.4 million in 2023, showing a less drastic but still pronounced downward trend. Mango exports, which were the highest of the three at US$18.2 million in 2009, saw a relatively stable performance until a dramatic drop to virtually zero in 2023 after the United States imposed a ban on the importation from Haiti to prevent the spread of an invasive fruit fly.

[6] Gangs have forced farmers to pay fees to them or "taxes".

Figure 3. Exports and imports of goods and services (percent of GDP)

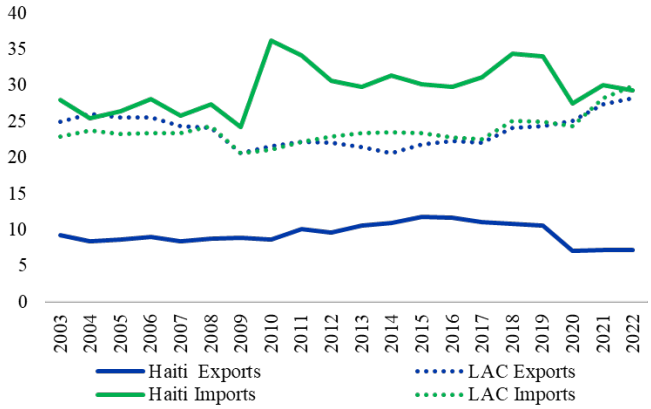
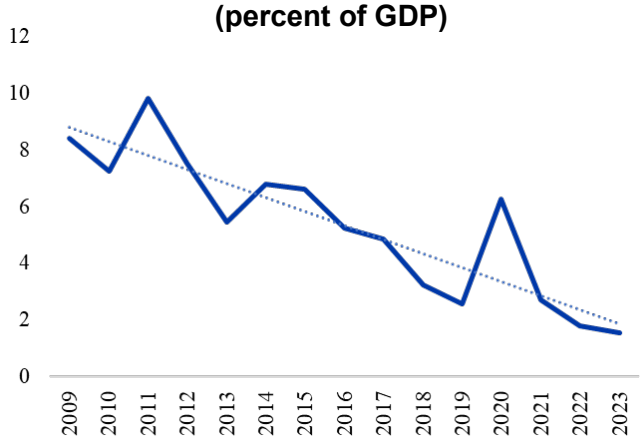


Figure 4. Haiti's Agricultural Exports (percent of GDP)



Source: WDI and BRH

The N-O suffers from many of the systemic issues which affect Haiti at large. The N-O, which is home to 762,507 people and makes up about eight percent of the country's land mass, suffers from a high poverty rate, food insecurity, and limited infrastructure. The N-O has an income poverty rate of 63 percent, which is higher than the national average of 57.1 percent (Pokhriyal, et al. 2020). The N-O is one of two Departments where more than half of the population is in urgent need of food support, and where begging, theft, and the sale of productive assets are observed as emergency strategies (FEWS NET 2023b). Moreover, the N-O is relatively isolated, and only connected to the rest of the country through three main roads. These factors have worsened in the last year, following the intertwining political, economic, and climate crises. Heightened crime and gang activity, inflation, alongside below-average rainfall and a severe drought, have decreased incomes, worsened food security and domestic crop production, as well as increased transport costs (FEWS NET 2023a).

Agricultural improvement can be an important strategy for sustainable development in the N-O. Agriculture is the most labor-intensive of the N-O employing 62.7 percent of the workforce (RGA 2008). The Department also has a growing labor force and young. It is home to the second largest city in Haiti (Port-de-Paix), and it benefits from access to a port which is Haiti's closest to the United States, the largest importer of several Haitian agricultural products including cocoa. It also hosts the airport of Port-de-Paix. The N-O is also one of the few Departments which has agricultural processing, with two facilities that are accessible via domestic primary roads. Overall, these strengths warrant an investigation into how the N-O's agricultural sector can be optimized to boost exports and food security.

3. Methodology

This paper employs a combination of methodologies to examine the potential of agriculture to support food production for consumption and export in the N-O. The analysis seeks to answer three main questions: 1) what are the structural barriers which need to be addressed to ensure agricultural production and exports are successful? 2) what crops should be the focus of an export-led strategy? and 3) where should planting these crops happen to maximize

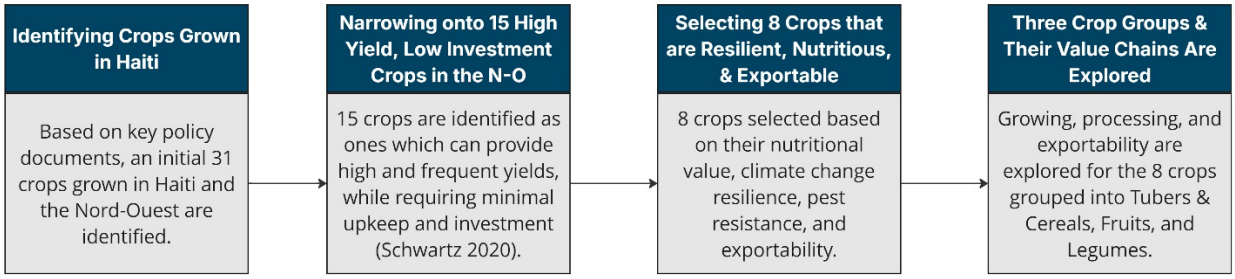
the potential returns for production and exports? To answer these questions, the paper leans on a variety of methods, including a systems analysis informed by a literature and historical review, a quantitative ranking of crops based on export potential, nutritional significance, and resistance to climate change and pests, alongside a georeferenced value chain analysis to determine hotspots for production. The combination of analyses is used to overcome the low data quality and availability which is inherent to countries affected by fragility, conflict and criminal violence.

A system analysis identifies barriers to agricultural production and exports based on existing literature and historical documentation. Sources for the literature review are systematically searched using academic databases such as Semantic Scholar and Google Scholar, utilizing keywords such as Haiti, N-O, Food, Agriculture, and Exports to ensure relevance. Additionally, the process includes backward and forward tracing from the initial articles identified, allowing for a more refined exploration of the topic. For insights from the field of international development, attention is given to major organizations, relying on their annual reports and country development briefings to enrich the understanding of the agricultural landscape and export dynamics in Haiti's Nord-Ouest region. This approach is also supplemented by anecdotal evidence, including from major websites and other sources, which provide a first-hand on-the-ground perspective that many papers cannot. The evidence gathered around the issues that afflict agriculture and exports is then organized into a systems analysis, pinpointing areas of cause and effect, recurrent loops and cycles, and potential interventions (explored later in the recommendations).

Crops grown in the Department are identified and ranked based on their resilience, nutritional value, and exportability (Figure 5). Based on key policy documents, 31 crops are identified (Appendix 1), out of which 15 are shortlisted for their potential to provide high and frequent yields while requiring minimal upkeep and investment.[7] This is in line with Schwartz (2020) who explains that Haitian farmers, to survive their high-risk environments, plant only crops which have near-zero risk and investment requirements. These 15 crops are evaluated using a 1-5 scale across four metrics: climate change vulnerability, pest vulnerability, nutritional properties, and theoretical export potential (Appendix 2 & 3).[8] The nutritional metric, given the need for food security, considers daily caloric needs and essential vitamins and minerals. Based on the cumulative scores across these metrics, a narrower list of eight crops is drawn, which are then assessed on the number of potential value-added products, female participation, local production facilities, and mechanization accessibility. An Export Potential Index (EPI) is considered, though this is undermined by the lack of data, with emphasis instead placed on theoretical justifications of the export potential.[9]

Figure 5 – Methodology & Process for Identifying Crops

[7] The selected products were contained in the "Economic Recovery Plan Post COVID-19 2020-2023 (PREPOC)", the "Produits Typiques d'Haiti", or the "National Agricultural Production Estimation Survey".
[8] The analyses eliminate any crops for which no evidence of growth in the N-O is found. Among these two crops, Avocadoes and Coconuts perform well on all other criteria.
[9] The EPI, detailed in Appendix 4, considers supply indicators including the export-import ratio and global tariff conditions, and demand variables like market share, target market tariffs, and distance. Additionally, existing bilateral trade, the exporter's expected GDP growth, and market growth relative to world growth are analyzed. Despite its theoretical robustness, data limitations significantly undermined the findings.



A spatial value chain analysis of the key products follows. To develop this analysis, four steps are taken. First, products are grouped in similar type, as crops within the same groups require similar production, collection and distribution facilities. Second, productive conditions and infrastructure (land, facilities, logistics solutions) of the value chain stages of products are georeferenced. Third, their geographic area of influence (chain catchments) are identified, and their enabling conditions are evaluated. Fourth, value-addition opportunities within the value chain crop groups are analyzed. The inclusion of the spatial component for the value chain analyses allows the key growing locations, processing facilities, and transport routes to be identified based on their geography.

Gaps in data availability limit the scope of the analysis. Every effort has been made to use the most accurate and up-to-date data sources available in the country. However, available data on Haiti is incredibly sparse, and most of this document draws on findings from before 2021, the point at which institutional capacity worsened significantly following the President's assassination in 2021.[10] Much of the data for the analysis is obtained from GeoAdaptive (2021), which used data science process such as remote sensing, document and data georeferencing and web2.0 extraction and mapping to build a representative geospatial database.

4. An Agricultural System Analysis

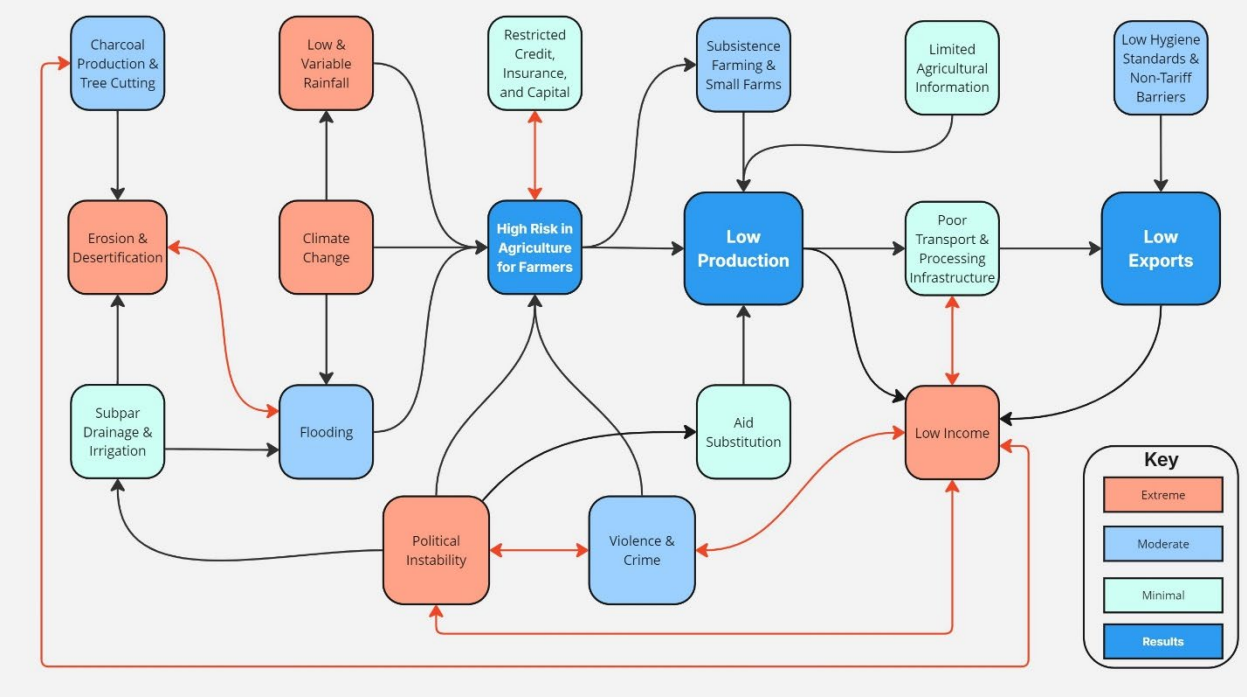
A mix of environmental, economic, and sociopolitical issues affects agricultural production and exports in Haiti and the N-O Department. This section analyzes the agricultural system and the factors affecting it, which have been identified through a review of the available literature, including academic papers, journal articles, policy papers, international organization publications, and news articles.[11] Substantial investments in Haiti's agricultural sector have consistently failed to promote agricultural production and exports for over 40 years, due to a myriad of self-reinforcing factors (Schwartz 2020). Though the lack of high-quality data and variability between regions means that this analysis focuses on qualitative methods, the research paints a complex system where entrenched reinforcing behaviors and cycles have consistently caused agricultural production and exports to suffer (Figure 6).[12]

[10] For example, it is difficult for the government and third parties to track farm locations due to land rights challenges. This limits the precision of data on where land is being cultivated.

[11] Papers from the literature were identified through searches conducted on major scholarly websites, including Google Scholar, Elicit, ResearchGate, and Semantic Scholar. Key words included "Haiti", "Nord-Ouest", "Northwest", "Agriculture", and "Exports". Once key papers were identified, a combination of backward and forward tracing was also used to identify related papers.

[12] Due to the underlying qualitative data, the degree of severity outlined in the diagram reflects the authors' subjective estimation based on prominence in the existing literature and the effects as depicted in the systems map.

Figure 6: Overview of the Complex System of Issues



Source: Author's Design Based on Existing Literature

Haiti's agricultural sector has suffered due to desertification and erosion, partially resulting from charcoal production. Low income and limited opportunities force Haitians to produce charcoal as a source of income. The process of producing charcoal requires cutting and burning trees, a process that leads to intense deforestation. Charcoal production in Haiti is a large industry, representing 5 percent of GDP (US$392 million) - over 6 times the value of Haiti's agricultural export market (World Bank 2018). This has left Haiti with only 4% of forest cover, contrasted with the Dominican Republic's 28% (Public Citizen 2017). The lack of trees has caused Haiti and the N-O to experience erosion and desertification, whereby nutritious topsoil is washed away by rain. Williams (2011) found that erosion and desertification have left a mere 20% of cultivated land as fit for agriculture, leading to the overuse of plots and significant degradation. Williams further details that this forced farmers to plant on small plots (less than 3 hectares), and on slopes with a 20% gradient, making farms extremely disaster-prone. Failed soil conservation efforts since the 1970s severely hamper agriculture and further highlight the need for sustainable reforestation (Zimmerman 1986).

Climate change threatens to further distort agricultural production. Climate change has increased the frequency and severity of natural disasters and has made rainfall in the barren N-O more unpredictable. Haiti is the most vulnerable country for natural disasters in the Caribbean, and the 8th most vulnerable worldwide (INFORM Risk Index 2024). The country registered 124 natural disasters from 2000 to 2023, which resulted in over 240,000 deaths and a significant reduction in GDP (EM-DAT 2024). As climate change continues to affect global temperature and rainfall, natural disasters like hurricanes will continue to affect crop production. Moreover, the N-

O, which is often extremely barren, is particularly susceptible.[13] In 2023, after a long period of drought meant farmers could not sow their crops, extreme rainfall damaged around 39,458 households, with 13,400 individuals displaced, including many from the N-O (IFRC 2023; FEWS NET 2023a).[14] Baro (2002) emphasizes that the risks are more severe in different localities, with some expecting a good harvest every four years due to localized climate, including the onset of rain, which is a strong determinant of yields.[15]

Political instability, violence, and crime have severely affected agriculture and its enabling infrastructure in the Nord-Ouest (N-O). As explored earlier in Section 2, Haiti's unstable political environment and ensuing crime and violence have significantly disrupted farming activities, reduced market access, and created barriers to accessing agricultural inputs and outputs. The country's unstable governance, stretching back over its 200-year history marked by frequent overthrows and assassinations of rulers, has also resulted in low-quality irrigation and drainage infrastructure that amplify the effects of unpredictable rainfall.[16] Baro (2002) identified limited infrastructure as a major barrier to agricultural production in his study, noting that irrigation channels suffer from heavy siltation. As the N-O has historically had highly unpredictable rainfall, including long periods of drought and contrastingly heavy rain, the lack of trees and poor infrastructure have meant rainfall washes away topsoil, floods crop yields, and distorts reaping seasons.[17] Robert and Harder (2017) also highlighted heat exposure and water management as significant issues, creating a recurrent loop where poor water management increases erosion and desertification, which worsens flooding and soil erosion.[18]

Limited access to finance, including microinsurance and microcredit schemes, as well as limited knowledge leaves agriculture as a high-risk activity. The combination of severe environmental and social factors means that agriculture in the N-O is a high-risk activity, skewing the risk-to-reward ratio against alternatives like charcoal production.[19] The limited access to insurance and credit further worsens this issue and creates a negative feedback loop in the industry which becomes perennially high risk. Though Haiti has innovative systems for disaster-related insurance through the Micro-insurance Catastrophe Risk Organisation (MiCRO) and the

[13] In the irrigated zone, the calendar is flexible, with planting spread throughout the year. The dry zones do not have a third season, whereas in the humid and irrigated zones, the third planting season is exclusively for bean cultivation.
[14] A noteworthy response comes from Roberts and Harder (2017) who quoted a survey respondent: "We are suffering a lot because we are living without water. If God would allow us to have a way to have water that would be best."
[15] The paper outlines that the Northwest has three growing seasons. In a normal year, the first begins in March/April, the second in September, and the last in November. The onset of the rains is a key factor in determining the seasons.
[16] Since its independence over 200 years ago, Haiti has had challenges with governance. Between 1843 and 1915 alone, 16 out of 20 rulers were either overthrown by revolution or assassinated, and at least five rulers, in total, have been assassinated while in power (Britannica 2024) (Celucian J. Joseph 2021).
[17] Political Champions Group (2013) explain: "Floods contribute considerably to the country's vulnerability. The most populated cities are all nestled in the valleys along the coast. When it rains, the steep, often barren hills around them flush rainwater towards the urban areas. Widespread deforestation in the upper reaches of these valleys, coupled of lacking drainage infrastructure, exacerbates the geographical propensity. Various Departments experience repeated droughts, from a combination of erratic rainfall patterns coupled with limited water management infrastructure. This has destroyed crops, reduced agricultural production, and decreased food security."
[18] Similarly, periods of long droughts expose nutritious topsoil which then becomes more likely to be washed away.
[19] From an individual perspective, coal production as an income source has numerous advantages to agriculture. Firstly, it requires far less resources (trees) than agriculture (land, seeds, tools, etc.). Secondly, it has a far shorter period between the time for investment and the payoff period than agriculture, with fewer external factors affecting the potential returns. Agriculture takes at least a few weeks between planting and reaping, and can be affected by a host of environmental factors and political factors (including rainfall, disasters, and crime). On the other hand, coal production usually only takes a few days and has very few factors which can affect its output.

Caribbean Catastrophe Insurance Facility (CCRIF), private sector insurance is generally underdeveloped. For instance, there is little use of agriculture index insurance, or insurance which can stabilize farmers' incomes by tying variations in yields to payoffs (Political Champions Group 2013).[20] In terms of access to finance, Baro (2002) and Roberts and Harder (2017) explain that as the inputs of seeds, fertilizer and water require purchasing power, limited credit prevents farmers from achieving the size needed for exportation.[21] They further state that the lack of knowledge about contemporary farming is a binding constraint. Zelaya, Harder, and Roberts (2016) reinforce this, stating farmers in the N-O suffer from a lack of quality information, and are undermined by the distrust of service providers. The lack of knowledge of agricultural practices suggests that farmers can benefit from human capital training and upskilling.

Subsistence farming minimizes risks but inhibits exports. To cope with the high risk of agriculture, farmers in Haiti have opted for subsistence farming, whereby they produce many crops in small quantities on small plots of land. Subsistence farming is a diversification strategy for reducing risk, whereby individual farmers can reduce the impact of any negative changes on a singular crop (for instance the effects of pests, changing weather, or trade barriers) from affecting their entire income. Moreover, it enables farmers, in the event of any negative shock affecting the country, to get a nutritious diet comprising a mix of produce, and not a singular input. Though subsistence farming is good for the individual farmer as a risk management approach, this strategy stifles exports. Monocropping or producing complementary crops is required to gain economies of scale for export by spreading the necessary physical and human capital for production to reduce per unit cost. Roberts and Harder (2017), for instance, suggest subsistence farming and small-scale production lead to food shortages and low exports.

Reliance on the imports of rice has created dependency and aid substitution that has discouraged local agricultural production. The country's low income and inherent political instability has caused widespread malnutrition which has historically been addressed through importing foods that compete with local products. Such is the case with rice, which after being pushed for decades by organizations like USAID not only contains dangerous levels of arsenic and cancer-inducing chemicals, it has also destabilized the agricultural industry (Reuters 2024). The import of rice as aid has undercut local prices and producers, who cannot compete with the highly subsidized grain (Dodds 2010). On the back of structural adjustment programmes from the IMF and World Bank, the tariff on rice in the 1990s in Haiti fell from 50 percent to 3 percent (McGuigan 2006; IMF 2001). Rice consumption surged, from supplying 7 percent of calories in the 1980s to 23 percent, with over 80 percent of the supply imported (Cochrane, Childs and Rosen 2016).[22] Former U.S. President Bill Clinton, who was instrumental in removing rice tariffs in Haiti, has said about the policies, "It may have been good for some of my farmers in Arkansas, but it has not worked. It was a mistake, I had to live every day with the consequences of the loss of

[20] Though the first instance of agricultural payout occurred in 2023 to 9,400 people through the support of the World Food Programme (WFP) Haiti, the pilot was only in the Grand Anse and South regions. The project aims to support agricultural communities against excess or insufficient rainfall, with a maximum compensation of US$900.

[21] Financial constraints also have a large effect on farmers' livelihoods and their family's well-being, in addition to affecting their ability to purchase essential assets.

[22] In 1985, FAO reported Haiti's per capita rice supply at a mere 13.1 kilograms per person, well below 31 kilograms for corn and 94 kilograms for starchy roots, historically the largest component of Haiti's food supply. By 2011, per capita rice consumption had risen to 48 kilograms, from 7 to 23 percent of the total caloric supply from starches. As of 2016, the country imported 10 percent of total US rice exports (Cochrane, Childs and Rosen 2016).

capacity to produce a rice crop in Haiti to feed those people because of what I did; nobody else" (Phillips and Watson 2011; Mullin 2024).

Even if farmers manage to overcome all the barriers to agricultural production mentioned above, there are many barriers which then inhibit the export of crops to foreign markets. One of the most severe factors is the poor transportation infrastructure. Most of the country's remaining arable land is scattered in rural areas away from the main cities. This means any food grown there will have to be transported a long distance to be processed or exported. However, as Haiti's road quality is poor - the country has the 6th worst roads in the world - transportation is difficult (World Population Review 2024). Despite government investments, the condition of roads remains subpar, with only 29 percent deemed to be in good condition in 2021 (IDB 2023). This is true for the Nord-Ouest as well, the main areas of which are connected by only a few paved roads, with the reliance on a network of unpaved roads. The low road quality is made worse by the country having only three main seaports for exports, Cap Haïtien in the North, and Port-au-Prince and Port Lafito in the South (Ahmed 2023; USAID 2017). Cap Haïtien, which is the closest to the Nord-Ouest, is still a 4.5-hour drive away from Port-de-Paix.

Trade barriers are a significant deterrent to agricultural exports. Though on paper Haiti benefits from many preferential trade agreements, including for agriculture, the country's trade is affected by Non-Tariff Barriers (NTBs) which discourage exports to large developed markets (Appendix 5). For instance, mango exports, Haiti's largest agricultural crop export in 2022, collapsed to near zero from US$12 million in 2020 after the U.S. Department of Agriculture (USDA) issued a ban against their import.[23] The barrier which was levied to prevent the spread of a potentially invasive fruit fly in unripen mangoes to the U.S., requires Haiti to treat mangos before exporting by immersing them in a hot water bath (115°F) for 60-90 minutes. Though Haiti had ten packing facilities with these systems in 2011, nine were in Port-au-Prince, and it is unclear whether these are operational (USDA 2022). Navarro, Currie, and Mercer (2020) also shed light on compliance with health regulations that influence the export potential of cocoa and coffee in Northern Haiti. Through their survey of 11 farms, they find low compliance with Good Agricultural Practices (GAPs) with significant challenges including poor infrastructure, inadequate sanitation, and a deficiency in technical training. Livestock and pets accessing production, inadequate control of agricultural chemicals, and unsafe water practices, also posed serious risks to contamination and exports.

5. Spatial Value Chain Analysis

The systematic representation of the locational distribution of value chain components, allows the evaluation of production activities as it relates to enabling factors and human conditions. A spatial approach improves value-chain analysis since it allows the integration of social gender and labor inclusion considerations as well as resilience dimensions since allows the investigation of correlation between production, population and climate characteristics. This permits a comprehensive evaluation that can better inform policy and action.

Haiti's agricultural sector, despite structural challenges, still holds substantial potential for growth and development, including in the Nord-Ouest Department. To capitalize on this

[23] Mangos were one of Haiti's most important exports, with the majority coming from backyard fruit trees, and their sale providing income to 150,000 - 200,000 small producers nationwide (Quixote Center 2022).

potential, this Section examines which crops can be effectively produced and exported and identifies where production and distribution can be concentrated. As mentioned in Section 3, out of 31 potential crops grown in Haiti (Appendix 1), the analysis narrows down eight key crops that have the highest potential for export (Appendix 2 & 3). The narrowing down is based on the crops' climate resilience, pest resistance, nutritional value, export potential (Appendix 4), high and frequent yields, and minimal upkeep and investment requirements. These eight crops are then categorized into three groups namely Tubers and Cereals (yam, sweet potato, cassava, and maize), Fruits (mangoes, guava, and breadfruit) and Legumes (peanuts) (Table 1). The grouping is based on the similarity of crop characteristics, know-how requirements, and production processes. The grouping also accounts for the possibility of shared crop production to promote a more efficient use of inputs, such as land and water.

Table 1: Table of Crops & Values Along Key Variables

Group	Crops	Nutritious Value	Climate Change Resilience	Resistance to Pests	Theoretical Export Potential	Number of Value Added Products	Export Potential Index (EPI)	Local Production Facilities	Mechanization Accessibility
Tubers	Sweet Potato	5	4	3	3	29	0	1	3
	Maize	4	3	2	1	29	0	2	3
	Yam	5	4	3	3	29	0	1	3
	Cassava	4	5	4	2	29	0	1	3
Fruits	Mangoes	4	2	3	5	14	30.1	0	2
	Guava	5	4	3	3	14	0	0	2
	Breadfruit	4	4	4	3	13	0	0	2
Legumes	Peanuts	5	3	3	3	15	0.2	0	4

Source: Nutritious Value, Climate Change Resilience, Resistance to Pests, and Theoretical Export Potential are scale variables with 1-5 ratings based on author's estimations. The Number of Value Added Products, Export Potential Index (EPI), Local Production Facilities, and Mechanization Accessibility are taken GeoAdaptive (2021).

Tubers & Cereals

Yam, sweet potato, cassava and maize grow extensively in the Nord-Ouest and contribute significantly to local dietary needs. The Department produced over 50,465 metric tons of these four crops in 2013 (7.6 percent of national production).[24] Maize production was the largest in the N-O, comprising 17,093 tons, with 75 percent of producers in the country growing the crop (FEWS NET 2018). Both maize and tubers are also mainstays in local Haitian diets, supplying 12 and 7 percent respectively of total daily caloric needs over 2019-2021 (FAOSTAT 2024). Though nearly the entire national consumption of tubers is from the domestic supply, a significant amount of maize is imported, 20 percent (57,000 tons) in 2021. The Nord-Ouest, however, is one of the few regions that has consistently registered a surplus.

These crops have high resilience and significant nutritional value. Tubers, especially cassava, are drought-resistant and grow well in a range of conditions, including low-quality soil. This makes them an ideal crop for the N-O, which will continue to suffer from variable rainfall and the other environmental effects of climate change. Maize on the other hand is a little more sensitive to water stress and can be affected by drought and flooding. Similarly, tubers are more resistant to pests than maize, which is vulnerable to corn earworms, borers, aphids, and a variety of diseases. Overall, these crops are nutrient-rich and are an important source of carbohydrates

[24] Figures for sweet potato export and production were not available, though several papers confirm that the crop is grown extensively in the Nord-Ouest (FEWS NET 2018).

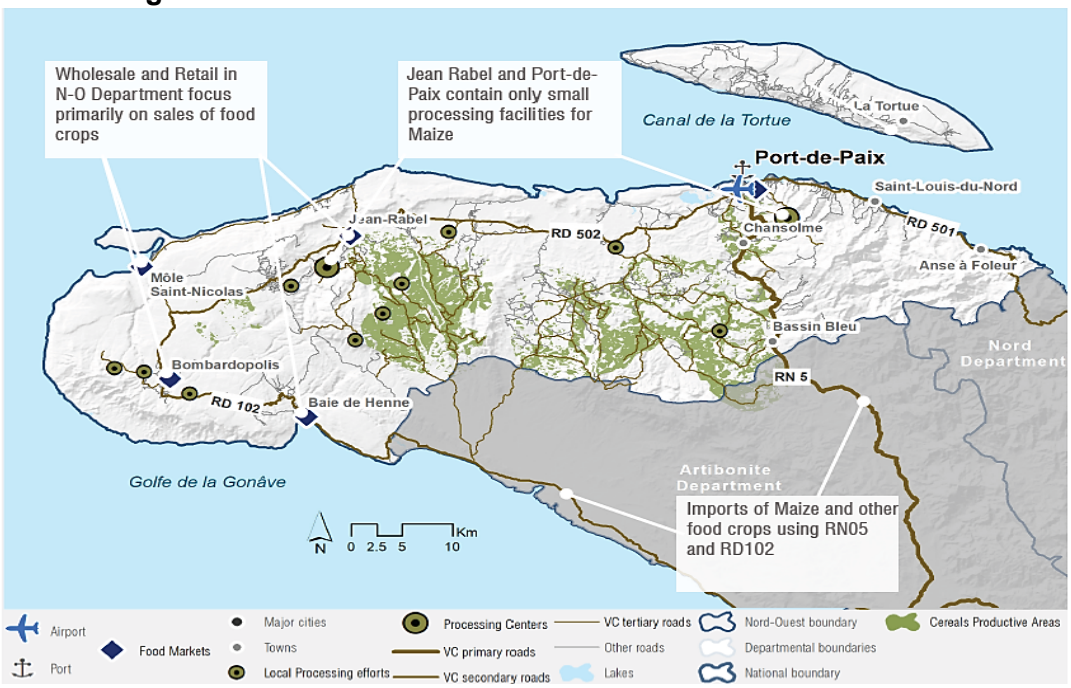
and fiber. Sweet potatoes are the most nutritious, filled with fiber and vitamins A and C. While maize, cassava, and yams offer essential carbohydrates and B vitamins, they need complementary protein. Cassava especially is less nutrient-dense overall than the others.

This crop group has a high potential for targeted exportation. Tubers have niche demand from the African and Caribbean diaspora living in the United States, Canada, the United Kingdom, and continental Europe. Generally, tubers, especially sweet potatoes, have also had an increase in global demand as their complex carbohydrate structure provides low-calorie sources of energy for increasingly health-conscious consumers. Though maize is demanded worldwide, the large suppliers in the United States and Canada make it difficult for small Haitian farmers to outcompete. This crop group, overall, also has a large number of potential value-added products, including meals, flour, bread, pastries, pasta, and even animal feed. Further, these crops are less susceptible to fermentation and rotting, and can be stored for weeks at room temperature, a vital quality given the lengthy processing and distribution times in the N-O.

Processing facilities tend to be spread out across the Department . Based on the geospatial mapping of the value-chain components for the three groups, both processing for tubers and to a lesser extent maize occurs close to production sites. As seen in Figures 7 & 8, for maize production, Bassin Bleu and Jean-Rabel feed into processing centers in Jean-Rabel and Port-de-Paix. Cassava has generally decentralized processing close to the production sites scattered throughout the Department with an estimated 428 household mills. These processing catchment areas are spread out across the Department, surrounding disaggregated production centers. However, the limited availability of infrastructure and material inputs like electricity and larger-scale processing facilities hinder greater production capacity. For example, only 13 percent of processing land catchment areas are supported by electrical mini-grids and lack of electricity makes milling rely on manual processing, reducing efficiency.

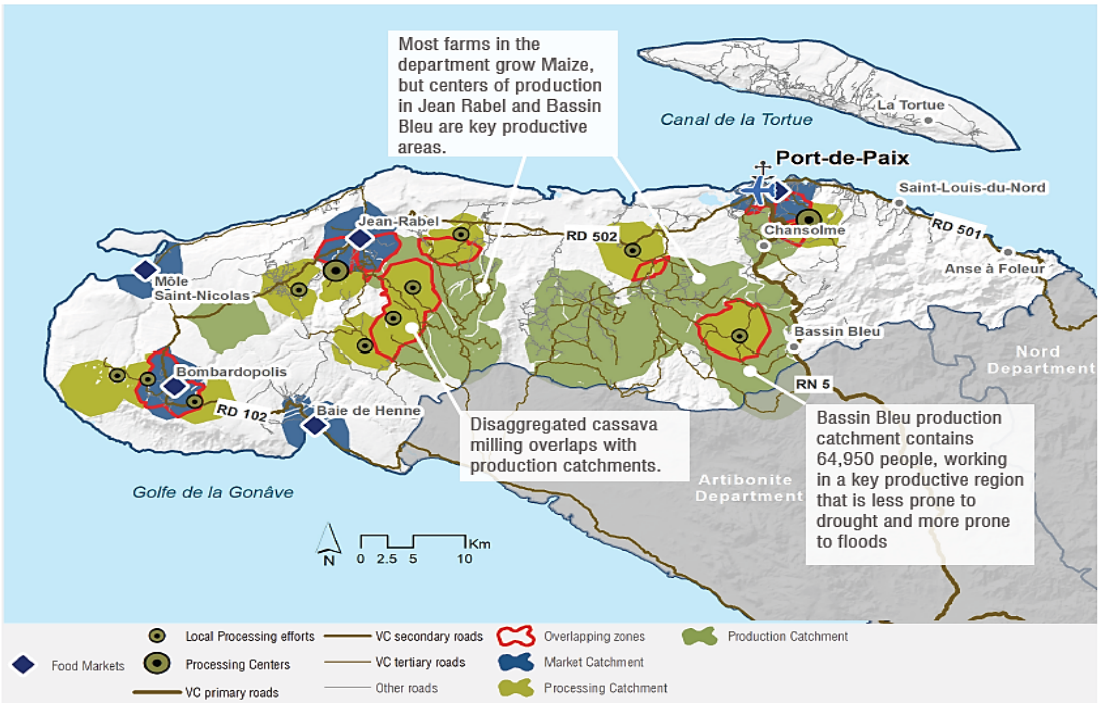
Distribution tends to take place across major roads or by air due to the limited port infrastructure. The Route Departementale (RD) 502 road connects crops to Port-de-Paix, whilst the RD 102 is significant for connecting processed cassava to the rest of the Department. Beyond the Department's main highways, the quality of the road network is poor, and 90 percent of roads are unpaved. Market catchment areas are located in urban centers, that are better connected between each other and to other Departments.

Figure 7. Georeferenced Value Chain of Tubers and Cereals



Source: GeoAdaptive (2021)

Figure 8. Catchment Areas and Enabling Conditions of Tubers and Cereals



Source: GeoAdaptive (2021)

Fruits

Fruits have great potential for export promotion. This group, which contains mangoes, guavas, and breadfruit, is widely produced in Haiti and the Nord-Ouest. Mangoes especially are prominent, with the country exporting over US$18.21 million at its peak in 2015, of which the Nord-Ouest produced 6.3 percent of national production (56,356 metric tons).[25] Though breadfruit is consumed by the local market, guava and mangoes are mostly exported.

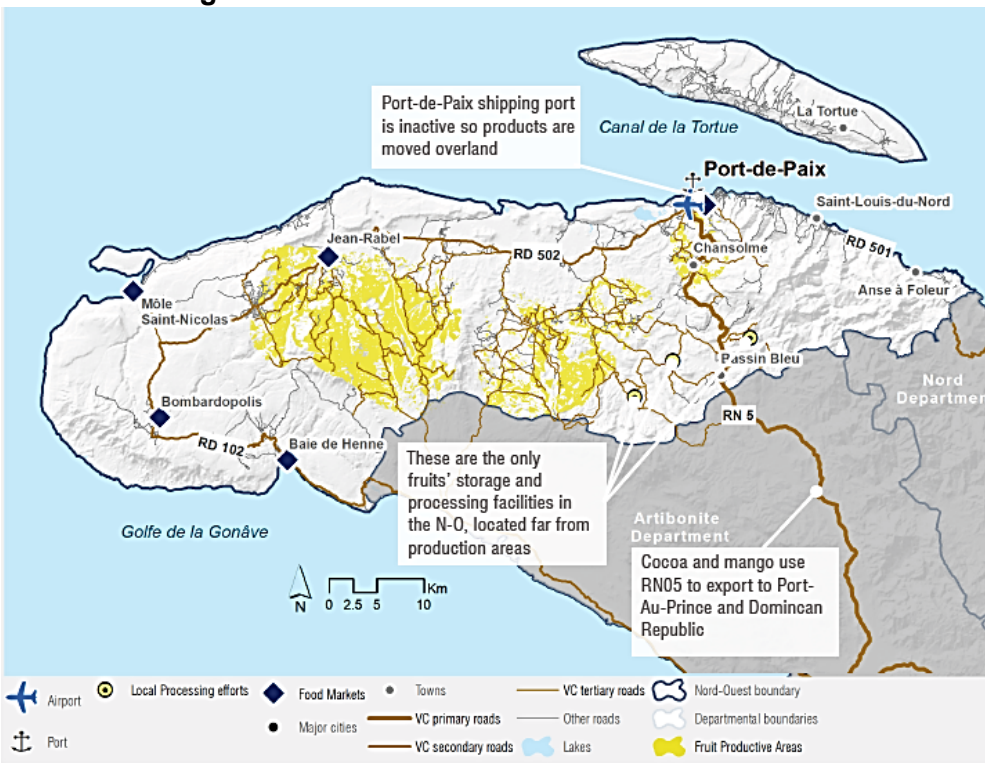
The crops in this group exhibit some resilience and are rich in vitamins, minerals, and fibers. These trees are quite resilient once mature, with guavas especially being extremely tolerant of droughts and floods and flourishing in imperfect soil types. Though mango trees are similar, they are more sensitive to temperature changes. Similarly, breadfruit is quite adaptable to moisture and dry conditions, though it often sustains damage during periods of high wind. In terms of pests, though breadfruit is primarily affected by mealybugs, guava and mangoes are affected by a range of conditions, including fruit flies and other fungal diseases. The fruit flies in particular have caused the USDA to issue a ban on Haitian mangoes. Despite this, these crops offer substantial nutritional benefits. Breadfruit provides a healthy source of energy through starchy carbohydrates and fiber, guavas boast extremely high levels of vitamin C, fiber, potassium, and antioxidants, and mangoes provide valuable vitamins A and C alongside fiber.

The export potential for breadfruit, guava, and mangoes from the N-O is bolstered by several strong factors. The growing diaspora from regions where these fruits are indigenous creates a steady demand in developed markets. This demand is supported by a trend towards eco-friendly and healthy eating, where breadfruit, guava, and mangoes are high-nutrient options that appeal to consumers. Furthermore, Haiti's mangoes, once imported by Whole Foods, already have a foothold in the United States. Favored for their unique taste, their EPI of 30.09 is unfulfilled following the ban on Haitian mango imports. Haitian producers can increase exports if they get access to facilities with the heating capabilities to kill the fruit flies. In addition, there is an increasing global demand for the potential value-added products fruits. A range of products, including juices, pastries, breads, preserved fruits, jams, and jellies have been identified, which could capture part of a global demand amounting to US$72 billion (GeoAdaptive 2021). Unlike maize, which faces stiff competition from North American suppliers, these value-added fruit products from the N-O can stand out due to their unique origins and flavors.

Production is costlier compared to other crop groups. The most active growers occupy the center of the Department, between Port-de-Paix and Jean-Rabel (Figures 9 & 10). Harvests for these products tend to be laborious and expensive compared to row crops, but they provide a larger income source than other types of crops.[26] Production catchment areas are concentrated in the center of the Department, between Port-de-Paix and Jean-Rabel. Moreover, there are only two fruit processing centers in the Department and two storage facilities located in Bassin Bleu; although disaggregated processing does exist, specifically for mango in Bassin Bleu. Processing catchment areas are also located around the area of Bassin Bleu.

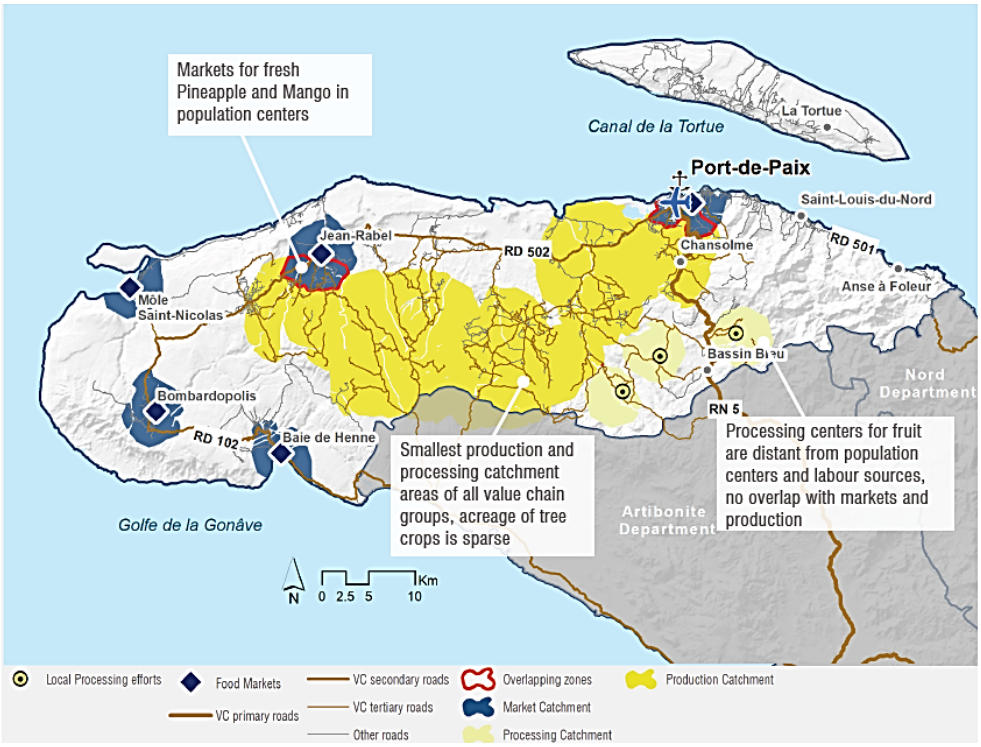
[25] Disaggregated data on the export and production of other fruits are difficult to find as they are lumped into “Fruits (Other)” on FAOSTAT and are not tracked by any major aid agency or the government.
[26] These crops are perennial fruits that establish deep roots, making soil easier to maintain and less prone to erosion.

Figure 9. Georeferenced Value Chain of Fruits



Source: GeoAdaptive (2021)

Figure 10. Catchment Areas and Enabling Conditions of Fruits



Source: GeoAdaptive (2021)

Low-quality infrastructure severely hinders distribution. The main markets are in Bombardopolis, Port-de-Paix, and Jean-Rabel. Flows of raw and processed crops exist along major roads for trade within the Department as well as for collection and processing in Gonaives and the Dominican Republic. Guava and mango are generally consumed fresh and within the Department or shipped elsewhere.[27] However, roads are susceptible to flooding and a lack of pavement slows travel, which limits transportation and makes fruits more vulnerable to spoilage due to long travel times. Market catchment areas are closely linked to good distribution capacity and communications and are thus located in urban centers across the Department.

Legumes

Peanuts can play an important role in improving nutrition in the N-O.[28] In 2013, the Nord-Ouest produced 717.91 metric tons of peanuts. Though national exports were relatively low at US$682,000, there is potential for increasing production. This, however, requires dealing with aflatoxin, a toxic substance produced by types of mold, commonly found on inadequately stored grains and nuts, which has anti-nutritive effects and can stunt growth, damage livers, and cause immuno-suppression. Though labs and testing facilities in Haiti are sparse, studies in the North and Northeast Departments are helping to identify value chain points for testing.

Peanuts have nutritional benefits and resilience to climatic stress, albeit with certain vulnerabilities. As a good source of protein, fats, fiber, and essential vitamins and minerals, they are a valuable addition to the diet, contributing to health and well-being. In terms of climate resilience, peanuts can endure moderate droughts, making them suitable for regions with variable rainfall. However, they are less resilient to extreme weather conditions, as both waterlogging and prolonged droughts can adversely affect their yield. When it comes to pests, peanut crops are challenged by beetles, thrips, and aphids, which can impact both the quality and quantity of the harvest. Despite these challenges, the peanut remains a robust crop choice due to its dietary significance and moderate tolerance to varying climatic conditions.

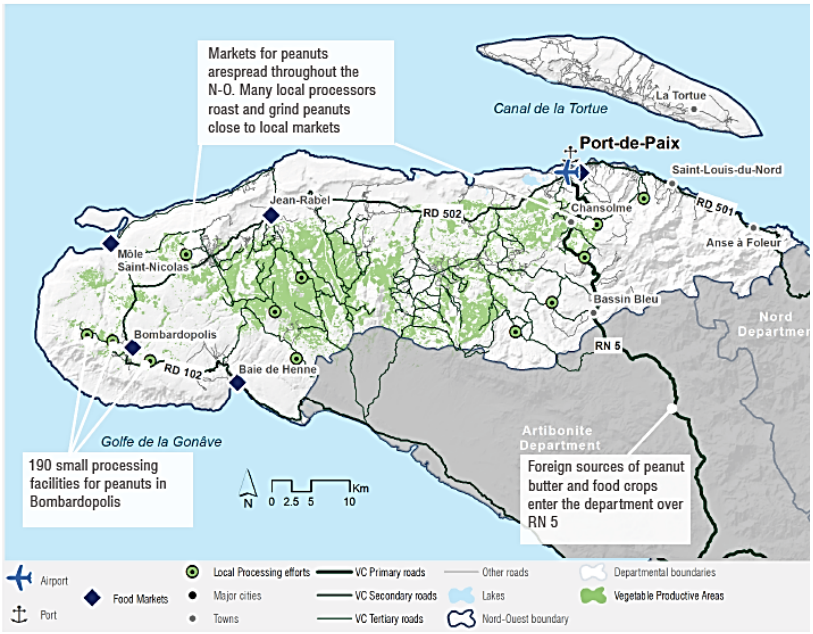
Peanuts can be exported but face significant global competition. The global popularity of peanuts creates a consistent demand in both developed and emerging markets, bolstered by the crop's versatility in various culinary and commercial applications. This demand is strengthened by the trend towards protein-rich and nutrient-dense foods, with peanuts serving as an excellent source of both. Peanuts also have an existing market recognition, being a staple in diets and food industries around the world, with the ability to penetrate markets as both raw nuts and value-added products including peanut butter, breads and pastries, or various dried forms. Further, unlike crops that are challenging to process and preserve, peanuts have a long shelf life and are relatively easy to store and transport, giving them a competitive edge.

Production is spread out across the N-O. Growth of these crops can occur in rows, as they are ground crops. This leads to high density and production potential compared to other crops. However, this also makes them very vulnerable to the effects of flooding and droughts. The main

[27] Mangoes and guavas are both consumed fresh, and can also be pressed for juice, dried, or made into preserves.
[28] Though peas are widely produced in Haiti, there is a notable difference between production capacity and total demand, so the majority of consumption has to be met from imports. Moreover, peas and beans are particularly vulnerable to the effects of climate change and the environment, which makes them less suitable to the N-O.

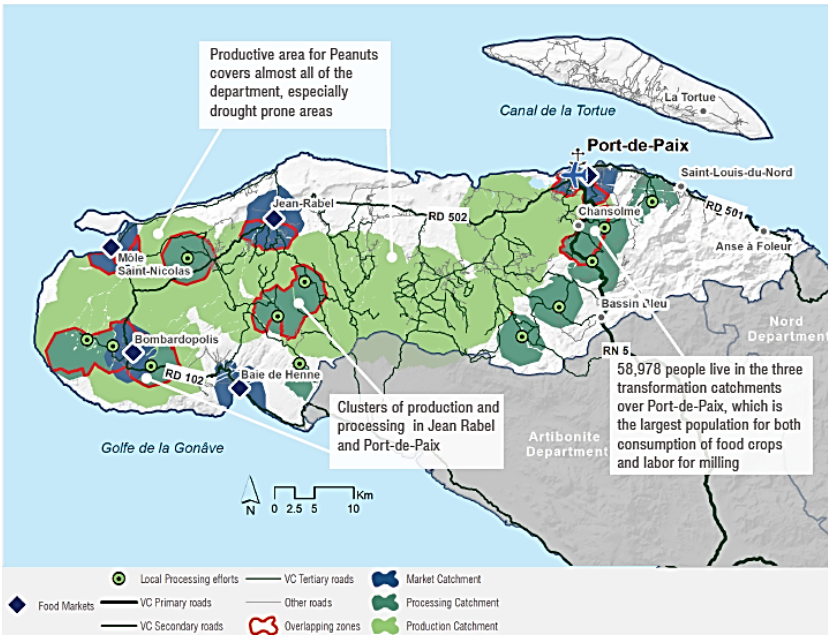
cities, Port-de-Paix and Jean-Rabel, are central nodes of production, though catchment areas, span across most of the interior of the Department. Still, 88 percent of productive land is threatened by drought, which makes production unstable and farm income less reliable. In addition to vulnerability to droughts, the productive area is also particularly vulnerable to floods.

Figure 11. Georeferenced Value Chain of Legumes



Source: GeoAdaptive (2021)

Figure 12. Catchment Areas and Enabling Conditions of Legumes



Source: GeoAdaptive (2021)

Processing facilities are spread out across the Department. There are over 500 mills located in Bombardopolis, Port-de-Paix, and Jean-Rabel (Figure 11). Processing tends to occur near production and market, and some yield does stay in the local community. Peanuts can be roasted but are most often consumed as peanut butter due to their increased shelf life and nutrient density. However, imported peanut butter tends to be consumed more, as it is safer from Aflatoxin, cheaper, and considered of higher quality. Processing facilities for legumes have a significant pool of labor to draw from, indicating a potential for expansion of skilled and unskilled labor for milling operations, which are most relevant for the peanut industry. Finally, processing catchment areas are spread across the Department (a large concentration in the east of the Department, in Port-de-Paix and south of the city), reaching Bassin Bleu and surrounding centers (Figure 12).

Distribution is hindered by low-quality infrastructure. Flows of raw and processed crops exist along major roads. Similar to cereals, starches, and sugars, imported products tend to flow from the Dominican Republic and Port-Au-Prince over the R5 national road due to the lack of port functionality. However, production and distribution infrastructure are lacking. Only 32 percent of processing catchment areas are supported by electrical mini-grids, hindering automated milling. As for the other food products, the fact that 90 percent of road coverage is unpaved slows down transporters and increases spoilage. As with the previous crop group, market catchment areas are linked to the capacity of distribution and tend to be in urban centers across the Department.

6. Recommendations[29]

This section presents specific strategies to foster greater production and exports of crops in the N-O. Based on the preceding analyses in Sections 4 & 5, it identifies the structural barriers that need addressing, pinpoints crops, and suggests optimal planting locations. Recommendations are divided into short-term solutions to immediately boost exports and food security, and long-term more capital-intensive investments.

Short-Term Solutions to Immediately Boost Exports and Food Security

Political stability and an elected government are required primarily to achieve any large-scale attempt at boosting agricultural production and exports. Without a government in place, violence, crime, and political instability will continue to affect all other aspects of life, including agricultural production. Improving the governance will be a prolonged process, requiring the ending of gang warfare in the capital and surrounding areas. Though the recent appointment of Prime Minister Garry Conille is welcome, the government has a long way to go to restore stability and order in the country. Until that occurs, it is advisable for international organizations, including the IDB, to continue to support production through the network of existing small-scale subsistence farmers.[30] As mentioned, the majority of farmers in Haiti are small and subsistence-based. For years these farmers have managed to export millions of dollars' worth of crops, including mangoes, by navigating the maze of political, environmental, and other risks through

[29] Though these recommendations were developed for the Nord-Ouest primarily, many areas within Haiti suffer from similar problems. As such, the recommendations themselves can broadly apply across the country.

[30] The IDB has supported smallholder farmers in several projects in the last 15 years, including - Acceso Haiti: A New Model to Add Value to Smallholder Farmer Production in Haiti; Agricultural and Agroforestry Technological Innovation Program – PITAG; Scaling Up the Smallholder Alliance for Sorghum in Haiti (SMASH); Technology Transfer to Small Farmers Program; and Competitiveness and Profitability of Fruit-processing Microenterprises.

their growing practices, in ways that no large-scale agricultural intervention can do without government and institutional support.

International organizations and the government need to support small-scale subsistence farmers. While the political and social crises in Haiti continue, small-scale farming should be supported. This form of farming has successfully enabled people to reduce their risks in the face of concurrent and intertwining crises that have ravaged Haiti since its independence. In the N-O especially, the environmental conditions mean that large-scale mono-cropping is extremely risky and requires a system of interventions, some of which are described below, to ensure commercial viability. This system can only be supported by institutions, one of which is a functional government, alongside extensive and targeted capital investment. In the meanwhile, though subsistence farming does not maximize Haiti's agricultural export potential, it has supported food security for individuals, and for certain crops like mangoes, subsistence farming over enough people has been sufficiently large to support international exports.

Tubers can provide a great deal of nutrients and have a high potential for exports. Tubers provide high amounts of complex carbohydrates and are already a mainstay in local diets and production. These crops have hundreds of disaggregated processing facilities across the Department and can be stored for longer than other crops including fruits. Moreover, Tubers have many potential secondary products which can be made in the long term to further enhance the value chain. Special attention should be paid to sweet potatoes, which are extremely nutritious, climate resilient, and have a high potential for export to major markets.

Fruits and peanut production though less resilient, are also promising for exports. These crops offer a nutrient-rich option for many of the residents of the Nord-Ouest. They also have the potential for export, especially the fruit groups, which can target niche markets and have a wide range of secondary products which can be made in the long term. A special focus should be placed on mangoes, which in previous years has shown its export viability.

Mango processing plants can help treat mangoes for U.S. export. The USDA banned the importation of mangoes from Haiti to eliminate the spread of an invasive fruit fly. The ban hurt thousands of subsistence Haitian farmers who grew mangoes in their land allotments. To bypass this ban, the country should develop processing capabilities in existing fruit production sites that can treat mangoes before export with a hot water bath (115^{o}F) for 60-90 minutes. This includes the production facilities of Bassin Bleu. Negotiations to remove the ban can also help, with participation from key members of the public sector and agriculture community, allies in international organizations, and the USDA and the U.S. government. An investment in creating the infrastructure needed to comply with the USDA regulations can boost Haitian exports by US$14 million (average export value from 2009-2020) (BRH 2023).

Target niche markets and health-conscious consumers. Many of the products Haiti produces appeal to members of the African and Caribbean diaspora, which make up a large population of developed countries including those in North America and Europe. To enable targeted export to these markets, Haiti could seek to establish strong relationships with organizations representing members of these communities, with a focus on areas that have a high density of diaspora. Moreover, producers can target large greengrocers, including Whole Foods in North America, as many crops appeal to a health-conscious consumer base.

Long-term and Heavy Investment to Boost Exports and Food Security

To improve agriculture production and food exports, the Department needs a holistic approach, including infrastructure development long-term in key hubs. The N-O can greatly benefit from upgrading and expanding infrastructure within key production and processing hubs like Port-de-Paix, Jean-Rabel, and Bassin Bleu. This includes improving road quality for better access and distribution channels, as well as enhancing electricity supply and storage facilities to support agricultural processing and preservation.

Promoting agroforestry and enhancing water management can help address some of the N-O's environmental challenges. Increasing the number of trees and enhancing water infrastructure, including for irrigation and rainfall, can help reduce the effects of desertification, erosion, and water scarcity exacerbated by climate change and deforestation. Subsidizing or offering microcredit loans for investments in tree fruit crops, combined with other crops, could help Haiti diversify its agricultural portfolio while restoring ecological balance. This approach may contribute to soil stabilization, improved water cycles, and offer farmers additional sources of income. Concurrently, upgrading water management and irrigation systems could help mitigate the impacts of drought and heavy rains, ensuring a more stable environment for crops.

The upgrade of processing facilities can enhance agricultural exports. Infrastructure is needed to enhance processing for all crop groups, including for peanuts to overcome the challenges of aflatoxins. Infrastructure enhancements can also include installing silos and dry storage facilities in key agricultural hotspots to bolster post-harvest storage capacity, alongside establishing a cold-chain network to minimize food spoilage and ensure product quality.

The geographic clustering of facilities and support infrastructure near population could result in gains of productivity, increase of labor market participation and enhance provision of infrastructure and services to human settlements. As evidence by the geospatial mapping, the production stage and catchment area experience the higher geographic overlap. Hotspots of production contain 26.7 percent of the population of the N-O (203,613 people), and 79.5% of land within the hotspots is drought-prone. This overlay results in a higher labor participation. Also, given this geographic correspondence, infrastructure solutions could be design to produce functions beyond production support, including provision of services to communities on dimensions such as energy, water, transport and digital connectivity.

Developing and reactivating the Port-de-Paix port, along with implementing warehousing and docking infrastructure, would enable easier exports. This port, situated at the northernmost point in Haiti, can ensure easier exports to the United States and other North American countries, and can also facilitate the internal transport of goods to major export points. However, achieving this would require a significant investment to upgrade the warehouse and docking infrastructure. Additionally, the port would need to overcome its reputation for drug shipments, which involves enhancing customs - a process being examined by the World Bank.

The paving and maintenance of rural roads can enhance connectivity.[31] This could facilitate access to food, markets, and services, improving the integration of rural areas within the Department and country, and positively impacting logistics and value chains. Connecting key production and catchment areas might be achieved through investments in the RD 502 road connecting to Jean-Rabel and the RN 5 which connects to Bassin Bleu. Additionally, investments could be directed towards RD 501, which connects Port-de-Paix to Cap Haïtien, the nearest port for exports in the country, and one of the only international airports.

Develop human capital through educational incentives and training programs. These programs should aim to enhance skills across the agricultural value chain, from crop and seedling production to processing, packaging, and distribution. Specifically, training can be directed towards improving knowledge in agroforestry and sustainable practices, as well as addressing specific challenges such as aflatoxin mitigation in processing facilities. Additionally, establishing programs for women's skill development in areas like food fortification, snack production, and kitchen gardening can significantly contribute to food security efforts (GeoAdaptive 2021). These initiatives not only elevate the technical capacity of the workforce but also ensure the integration of gender-sensitive approaches, empowering women-led SMEs and small-scale farmers through targeted technical assistance and finance solutions.

7. Conclusion

This study examined the potential of agriculture in the Nord-Ouest Department as a strategic avenue for addressing the challenges of food insecurity and low exports. The multi-pronged approach, which involved a systems analysis, quantitative crop ranking, and georeferenced value chain analysis**,** addressed three pivotal questions concerning the structural barriers to successful agricultural production and exports, the selection of crops for an export-led strategy, and optimal locations for their cultivation.

The systems analysis reveals a multifaceted array of challenges that have long affected Haiti's agricultural sector in the Nord-Ouest Department. Erosion and desertification, exacerbated by unsustainable charcoal production and deforestation, starkly contrast with the Dominican Republic's more substantial forest cover and underscore the environmental plight. The situation is further aggravated by inadequate infrastructure for drainage and irrigation, which, in combination with the erratic nature of rainfall, results in significant soil erosion and crop flooding. Political instability adds another layer of complexity, disrupting agricultural activities and infrastructure development. Additionally, the limited access to essential financial and informational resources renders agriculture a high-risk endeavor. This is compounded by a reliance on imports, which discourages local agricultural productivity and innovation.

The N-O has several crops which can penetrate international markets based on their resilience, exportability, nutritious value, and minimal upkeep and investment. Tubers and cereals such as sweet potatoes, yams, cassava and maize are particularly resilient, nutritious, and exportable, despite their primary role in subsistence farming. Sweet potatoes are especially resilient and nutritious, and have a niche market for exports. The fruit sector, including mangoes,

[31] This can be done through low-cost and low-maintenance solutions. One such is the "do-nou" method from Japan, which requires mixing local soil and a small amount of cement and then compacting it into a pothole or damaged road area. It's sustainable, cost-effective, easy to apply, and involves the community, making it a practical solution for emergency repairs.

guavas, and breadfruit, also presents significant export opportunities, driven by global demand and the nutritional benefits these crops offer. In this segment, Haiti can significantly restore mango exports through infrastructural investments, such as the reactivation of the Port-de-Paix port. Peanuts meanwhile emerge as a valuable crop for both domestic consumption and export potential, though they face challenges like aflatoxin contamination and market competition. The production and processing hubs for these aforementioned crops include Port-de-Paix, Jean-Rabel, and Bassin Bleu.

Support should be given in the N-O for subsistence farming in the short term. Political stability and an effective government are prerequisites for any significant advancements in agricultural production and exports. In the interim, supporting small-scale subsistence farmers, who have historically navigated a plethora of risks, remains a viable strategy. The potential for exports is notably high for tubers and fruits, including sweet potatoes and mangoes, which are not only nutritious and climate-resilient but also have a substantial demand in international markets. Overcoming barriers such as the USDA's ban on Haitian mangoes necessitates developing processing plants and diplomatic negotiations. Targeting niche markets, including the diaspora and health-conscious consumers, can also further boost agricultural exports.

To enhance agricultural production and exports in the Nord-Ouest Department, a holistic long-term approach is recommended. Key strategies include upgrading infrastructure such as roads, electricity, and storage facilities in hubs like Port-de-Paix, Jean-Rabel, and Bassin Bleu to improve access and distribution. Promoting agroforestry and improving water management through subsidies or microcredit loans can address environmental challenges like desertification and water scarcity while diversifying the agricultural portfolio. Enhancing processing facilities with silos and cold-chain networks can improve post-harvest storage and product quality. Reactivating the Port-de-Paix port with the necessary infrastructure can facilitate exports, though this requires significant investment and enhanced customs procedures. Finally, paving and maintaining rural roads can integrate rural areas and positively impact value chains, while developing human capital, including for the female workforce, can boost productivity.

Future research should expand the research scope and use more reliable data. Firstly, the scope of this study is limited, and the broader economic and political challenges in Haiti warrant a more comprehensive investigation. A holistic analysis of the national sectors could offer insights into effective strategies for addressing these issues beyond the agricultural focus presented here. Secondly, while this paper concentrates on the Nord-Ouest department, which is severely affected by Haiti's widespread challenges, it is essential to extend this focus to other equally impacted regions. Thirdly, the conclusions of this study are primarily based on older data, anecdotal evidence, or references from potentially outdated sources. Future studies should aim to incorporate more recent and robust data to strengthen the findings.

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Appendices

Appendix 1 – Curated List of the Crops Grown in Haiti

Product	Type of Crop
Breadfruit	Fruits
Cassava	Cereal, Starches, and Sugars
Coconut	Fruits
Mango	Fruits
Sweet Potato	Cereal, Starches, and Sugars
Yams	Cereal, Starches, and Sugars
Avocado	Fruits
Banana	Fruits
Beans	Legumes and Vegetables
Cocoa	Fruits
Coffee	Fruits
Ginger	Legumes and Vegetables
Guava	Fruits
Millet	Cereal, Starches, and Sugars
Peanut	Legumes and Vegetables
Plantain	Fruits
Eggplant	Legumes and Vegetables
Pineapple	Fruits
Rice	Cereal, Starches, and Sugars
Soursop	Fruits
Sugar Cane	Cereal, Starches, and Sugars
Apricot	Fruits
Broccoli	Legumes and Vegetables
Cherry	Fruits
Conga Bean	Legumes and Vegetables
Maize	Cereal, Starches, and Sugars
Onion	Legumes and Vegetables
Potato	Cereal, Starches, and Sugars
Shallot	Legumes and Vegetables
Tangerine	Fruits
Vetiver	Legumes and Vegetables

Appendix 2 – 15 Crop Shortlist

Crop	Grown in the Nord-Ouest	Climate Change Resilience	Resistance to Pests	Nutritious Value	Theoretical Export Potential	Sum
Coconut	0	4	4	4	4	16
Yam	1	4	3	5	3	15
Sweet Potato	1	4	3	5	3	15
Cassava	1	5	4	4	2	15
Guava	1	4	3	5	3	15
Breadfruit	0	4	4	4	3	15
Mangoes	1	2	3	4	5	14
Peanuts	1	3	3	5	3	14
Maize	1	4	4	4	1	14
Avocadoes	0	2	3	4	4	13
Banana	1	2	2	4	3	11
Plantain	1	2	2	4	3	11
Sugar Cane	1	3	3	2	2	10
Coffee	0	2	2	1	4	9
Cocoa	1	1	1	2	5	9

Source: Nutritious Value, Climate Change Resilience, Resistance to Pests, and Theoretical Export Potential are scale variables with 1-5 ratings based on author's estimations.

Appendix 3 – 15 Crop Shortlist Rationale

Crop	Nutritious Value	Climate Change Resilience	Resistance to Pests	Theoretical Export Potential
Breadfruit	High in carbohydrates, fiber, vitamin B and C.	Widerange of climates. Withstands drought and moisture but susceptible to high winds.	Most unaffected by pests, though can be targeted by mealybugs.	Niche market in the diaspora and for ecofriendly & healthy eating.
Guava	Very high in vitamin C, and a good source of fiber, potassium, and antioxidants.	Hardy, tolerates drought and imperfect soils.	Fruit flies and a few insects and diseases.	Potential in niche markets and among consumers seeking exotic fruits.
Mangoes	Good source of vitamin A, C, and fiber.	Establish trees are drought-tolerant, but young trees are flowering sensitive.	Fruit flies, scale insects, and fungal diseases.	Haiti's 'Francique' mangoes are valued in the U.S. for their unique flavor.
Maize	Provides good carbohydrates and vitamin Bs.	Fairily resilient but sensitive to water stress.	Vulnerable to borers, aphids, and some diseases.	Widely produced globally; Haiti may not have competitive advantage.
Yam	Good source of energy, vitamin C, and vitamin B.	Tolerant of poor soil and can handle periods of low water.	Nematodes, scale insects, some storage pests.	Potential niche market in areas with diaspora from regions where yams are a staple.
Sweet Potato	High in carbohydrates, fibers, vitamins A and C, and have better macros than other tubers.	Drought resistant and grows in marginal soils.	Sweet potato weevils, beetles, some diseases.	Growing market in the U.S.; potential for Haiti to capitalize on this trend.
Cassava	High in carbohydrates and some vitamins.	Highly tolerant of a wide-range of weather conditions, including poor soils and minimal rain.	Resistant to most pests, though affected by whiteflies and\ mealybugs.	Primarily for niche ethnic markets; less known in major markets.
Peanuts	Good source of protein, fats, fiber, and essential vitamins and minerals.	Can handle moderate drought but affected by waterlogging and prolonged droughts.	Susceptible to some beetles, thrips, and aphids.	Highly competitive global market; Haiti may face challenges in competing.
Sugar Cane	Just a source of sugar and calories.	Need ample water but tolerates some flooding.	Borers, scale insects, sugarcane mosaic virus.	Highly competitive market dominated by large-scale producers; difficult for Haiti to compete.
Banana	Carbohydrates, potassium, and fiber and vitamins.	Requires consistent moisture, damaged by high winds, very sensitive to temperature changes.	Nematodes, weevils, black sigatoka, and various viruses.	Steady market exists but Haiti competes with large, established producers in Latin America.
Plantain	Carbohydrates, potassium, and fiber and vitamins.	Requires consistent moisture, damaged by high winds, very sensitive to temperature changes.	Nematodes, weevils, black sigatoka, and various viruses.	Strong market in U.S. cities with large Latino and African populations.
Avocadoes	Heatlhy fats, fiber, vitamins, and minerals like potassium.	Intolerant of flooding, sensitive to drought and heat.	Mites, thrips, borers, and some diseases.	Growing U.S. market; opportunities exist if Haitian avocados meet quality standards.
Coconut	Healthy fats, and some minerals.	Tolerates salt spray, flooding, but prefers consisten moisture.	Rhinocerus beetles, some scale insects and diseases.	Moderate market for coconuts and related products, with existing competition from other tropical regions.
Coffee	Provides stimulants but little nutritional value.	Very sensitive to temperature and precipitation changes.	Coffee berry borers, coffee rust, and other diseases.	Haiti historically known for quality coffee; potential to re-enter specialty markets.
Cocoa	Offers some antioxidants, but mostly used in desserts.	Needs high humidity, consistent temperature, and ample moisture.	Extremely susceptible to pests mirids, pod borers, and diseases (witches' broom and cocoa pod borer).	Demand for high-quality, ethically produced cocoa in the global craft and premium chocolate market.

Appendix 4

The EPI methodology each food product (*k*) exported by Haiti (*i*) to each importing country (*j*): into a supply (revealed comparative advantage – RCA (Balassa's, 1965), a world demand component, and a bilateral trade component to inform about the general ease to export to a given market:

$$EPI_{ijk} = Exp.Mshare_{ik} x Easiness_{ij} x Exp.Demand_{jk} x MA_{ijk} \quad (1)$$

The multiplication of the supply, demand and bilateral components provides the EPI. The degree of unrealized potential is calculated by the gap between actual exports and current export potential.

The supply side $Exp.Mshare_{ik}$ is based on Balassa's Revealed Comparative Advantage and comprises:

a) **Growth of RCA:** the dynamic version of comparative advantage allows for predicting competitive export products in the future. This is computed through growth for each product as the ratio of comparative advantages during two periods of three years (2011–2013 and 2015–2017). An ITC empirical analysis has revealed that on average about one-third of moderate RCA growth passes through from one period to the next.
b) **Revealed Comparative Advantage (RCA):** compares the share of a product in a country's total exports with the share of this product in world exports. It shows whether the country has a relative advantage (RCA > 1) or disadvantage (RCA < 1) in exporting the goods.
c) **Export-Import ratio:** Declared exports often comprise re-exports that are not linked to any capacity of the country's production. RCAs are corrected by the ratio at which imports exceed exports. A product RCA will be downgraded if the country's trade balance of the product is negative while no correction factor will be applied if exports exceed imports.
d) **Global tariff disadvantage:** Products for which Haiti has large tariff advantages in the world market are likely to have more relevance in the country's current trade structure. Global tariff advantages therefore downgrade the RCA of the product. Global tariff disadvantages upgrade it.
e) **An adjustment:** incorporating the change in Haiti and World GDP:

$$Exp.Mshare_{ik} = f\left(\frac{x_{ik}}{x_k}, (\Delta RCA_{ik}), \left(\frac{\Delta GDP_i}{\Delta GDP_w}\right), \frac{x}{m} ratio, global\ tariff\ conditions\right) \quad (2)$$

The demand side $Exp.Demand_{jk} x MA_{ijk}$ accounts for the openness of the importing market to Haiti's food products. Indicators include:

a) **Share in market demand:** captures the relative importance of a product in the total imports of the target market.
b) **Growth of share in market demand:** shows which products have recently experienced a relative change in demand and allows for a projection of potential demand. The ratio of demand shares between the two periods of three years stated on the supply side is computed for each product. In line with ITC empirical findings, around one-fifth of this growth factor is combined with the static demand share.

c) **Tariff advantage in the target market:** If tariffs applied to the exporting country are lower than those applied to other suppliers, the exporter benefits from a tariff advantage in the market that will translate into higher export potential the opposite occurs when tariffs are higher for Haiti.
d) **Distance Factor:** Information embedded in the average distance over which a product is traded can help the best products to export to a given market. The closer the match (the lower the absolute difference) between the exporter's distance to the target market and the average distance over which the target market imports the product, the higher the export potential of the product to the market.
e) Finally, an adjustment is incorporated by considering the change in trade partners' GDP.

$$Exp.Demand_{jk}xMA_{ijk} = f\left(m_k\left(\Delta Dshare_{ijk}\right), \left(\Delta GDP_j\right), tariff\ conditions\ in\ the\ target\ market, distance\ factor\right) \quad (3)$$

The bilateral trade component ($Easiness_{ij}$) is captured by considering export growth accounted by GDP projections divided by the summed over all products of demand and supply components.

$$Easiness_{ij} = \frac{x_{ij}}{\sum_k MShare_{ik}xDemand_{jk}xMA_{ijk}} \quad (4)$$

Georeferencing value chain stages describes the stages of production, processing and distribution across the territory for each value chain. This step provides information on the spatial organization, and the geographic relationships between different processes, infrastructure, and people, within each value chain. It captures key actors, infrastructure and human capital needs, and investment opportunities and maps out the stages of production, distribution and processing across the territory.[32]

[32] For production and processing processes, spatial and census data is used. For distribution processes, markets and key routes for commercialization and export are mapped. This process considers traditional product flows, as well as the role of Madam Saras in the distribution of goods in rural areas.

Appendix 5

Haiti benefits from a large range of trade agreements and preferential schemes, that offer more competitive terms of trade. Haiti has been a World Trade Organization member since 1996 and a Caribbean Community and Common Market (CARICOM) member since 2002. It thus applies CARICOM's common external tariff (CET).[33] The country also has 33 trade agreements in force for exporting, highlighting a 10-year preferential access to USA markets through special tariff exemptions under the Hemispheric Opportunity through Partnership Encouragement (HOPE II)[34]. Additionally, as part of the Caribbean Forum (CARIFORUM), Haiti is a beneficiary of the CARIFORUM-EU Economic Partnership Agreement (EPA), enjoying preferential access to the European Union market. Many of these treaties offer preferential trade conditions by lowering tariff barriers for Haitian products and have supported important economic sectors in the country, such as the garments sector. Moreover, 12 of them have agricultural and apparel goods originating from Haiti as highlighted goods that could benefit from these treaties. Yet to do this, a first step is to identify what agricultural products would be prime candidates for this, given the country's national endowment and production and transport capacity. Then, potential demand in international markets can be explored to determine if there is potential for this production to grow. Finally, current trade treaties could be made the most of to maximize low export tariffs.

Trade treaties in force in Haiti

Trade agreement	Year
APP.A25TM 24: Caricom-Venezuela	1993
APP.A25TM 31: Caricom-Colombia	1997
Armenia for Least Development Countries	2015
Australia for GSP Countries	1966
Belarus (EAEU) for Least Developed Countries	2016
Canada for Least Developed Countries	1983
Caricom-Cuba	2005
Chile for Least Developed Countries	2014
Chinese Taipei for Least Developed Countries	2003
EPA, Cariforum-EU	2008
EU for Least Developed Countries	1971
FTA, Caricom-Costa Rica	2005
Global System of Trade Preferences	1989
Haitian Hemispheric Opportunity through Partnership Encouragement	2008
Iceland for Least Developed Countries	2002
India for Least Developed Countries	2008
Japan for Least Developed Countries	1971
Kazakhstan (EAEU) for Least Developed Countries	2016
Korea for Least Developed Countries	2000
Kyrgyzstan for Least Developed Countries	2006
Montenegro for Least Developed Countries	2016
New Zealand for Least Developed Countries	1972
Norway for Least Developed Countries	1971

[33] The CET consists of (i) a schedule of tariff rates, (ii) legal provisions for the temporary deviations from the schedule of tariff rates and; (iii) exemptions from duty arrangements based on the use of the imported goods.
[34] Additional benefits under CBTPA have been created through HOPE II.

Regional Group, CARICOM	1973
Russian Federation (EAEU) for Least Developed Countries	2016
Switzerland for Least Developed Countries	1972
Tajikistan for Least Developed Countries	2003
Thailand for Least Developed Countries	2015
Turkey for Least Developed Countries	2002
UK for Least Developed Countries	2021
United States for Caribbean Basin Economic Recovery Act	1984
United States for Caribbean Basi Trade Partnership Act	2000
United States for Least Developed Countries	1976

Source: Authors' elaboration