

## Outlook of Plantain Production in Liberia

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### Abstract

This study provides an overview of plantain in Liberia. Plantain is an important crop in Liberia as it is a staple and the 3<sup>rd</sup> most consume crop in the country. Plantain is a very important fruit crop that is grown in the tropics. According to the World Plantain Council, Plantain is the 10<sup>th</sup> most important crop in the world. It is widely consumed across Africa, Asia and Latin America. Africa produces about 70% of the global output. Additionally, 5 out of the world top 10 producers of plantain are from Sub-Sahara Africa. Surprisingly, none of these African countries are among the top 5 highest exporters of plantain, because most of the produce are consumed domestically. Although the global trade of plantain is small, the global trend has been positive over the years as it gains traction from many countries such as the US and Saudi Arabia that has risen to be the 1<sup>st</sup> and 2<sup>nd</sup> largest importer of plantain in 2022. Laos is the world largest exporter of plantain. The goal of this study is to provide key statistics about the plantain sector in Liberia from 2005 to 2022, which include production, yield, area harvested, trade and the constraints encounter by actors within the supply chain.

The results shows that Liberia's plantain productivity has increase about 120% from 2005 to 2022. The area harvested has also seen a significant increase of 119% from 2005 to 2022. Additionally, despite the yield of plantain plummeting in 2012, there has been a significant recovery due to better agronomic practices. However, the sector still has significant challenges such as pests and diseases, poor road infrastructure and low adoption of innovative techniques which ultimately leads to the wastage of over-ripe plantain because value addition techniques is lacking. Based on these factors, it was recommended that farmers effort must be supplemented by subsidies from government and non-government institutions, viable social infrastructure such as better transport system and a better extension service that would aid farmers with the latest tools and techniques necessary to combat pest and diseases.

Additionally, farmers should form cooperatives to strengthen their bargaining power to lower input costs and gain access to larger markets.

**Key words:** *Yield, trade, marketing, constraints*

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## Introduction

Plantain (*Musa paradasica*) is a plant that grows in the tropic and its height range from 10 to 33ft high (plantain council). Plantain is the common name for the herbaceous plant of the genus *Musa*. Plantain (AAB) is a triploid, it has two genomes from *Musa acuminata* (AA) and one *genome Musa balbisiana* (B) (Lindsey Norgrove et al.). Plantains are further divided into four types of based on the morphological feature of the inflorescence: French, French horn, True horn and False horn (Swennen et al, 1995; Ortiz et al., 1998). The fruit, which is green, is typically larger than and closely related to the common banana (*Musa sapientum*). The edible fruit of the plantain has more starch than the banana and is not eaten raw unless it is very ripe. The raw plantain (*Musa spp.*) consists of nutrients, which includes proteins; carbohydrates; minerals, vitamins, monounsaturated and polyunsaturated fatty acid (Kwofie, M. et al., 2020). A daily intake of ripe (yellow) plantain of 250 g meets 7.6% and 71.8% DRI of Vitamin A of infants below (5) five years of age, whereas 500 g daily intakes of ripe plantain meet the Vitamin A DRI of 8.7% and 81% of women of childbearing ages respectively (Biome, G. et al., 2019). The plant is believed to have originated in Southeast Asia (Simmonds, 1966). Plantains are vegetatively propagated from Suckers (shoots that grow from a base at the base of a plant) or from Corms (an underground bulbs known as rhizome) (PlantVillage). Mostly, the use of small pieces of corms is preferred because the use of whole corm is laborious. Three types of suckers are produced by the mother plants: Maidenheads, Sword suckers and Water suckers. Maidenheads and Sword suckers are the two most preferred suckers (PlantVillage). Plantain is a staple in the tropics, ranking as the tenth most important crop in the world (The Plantain Council). Plantain is an all-season food that can fruit all year round which makes it an important crop for developing countries with inadequate food storage, preservation and transportation technologies. Plantain plant can produce for up to 100 years which make it a valuable crop. In Africa, plantain and banana provide more than 25% of food energy requirements for over 70 million people (IITA).

Plantain fruit may be consumed unripe (green) by cooking, and ripe or yellow. It is used to produce chips, fritters, flour, figs (dried slices of ripe plantain), powder (ground form of ripe plantain), flakes, juice and puree. Large quantities of beer are brewed from plantains in Africa and other parts of the world. Plantain can be used for jam, marmalade, juice and vinegar. Some other uses include handcrafts from the leaves and fiber, ropes, peels for animal feed, and leaves for wrapping foodstuff.

Beyond just consumption, the different part of the plant and fruits are used as traditional medicine in Sub-Sahara Africa: The coal obtain from the burnt skin is used to cure dysentery; The juice obtained after cooking the green fruit is recommended for urinary incontinence; The ashes of the burnt skin, after being mixed with some water and strained with a low fire, provide a potash which is used in medicines, soap works, and in sauces (FAO). Furthermore, conventional medicine has also been developed from plantains.

Idachaba, 1995; Due to its high nutrient, plantain is used in the production of Soymusa, which can be used in the treatment of Kwashiorkor. Studies have also found plantain to be effective in combating obesity. Nowadays, obesity is a major problem for both developed and developing countries. The number of overweight and obese adults is at a record high, with 39 and 40% of adults being overweight or obese, and the incidence of these conditions is increasing in adolescents (Ruiz et al., 2019; Thompson et al., 2022). According to Guo et al., (2021), being overweight or obese harms people's health, and consequently leads to numerous diseases, such as diabetes and cardiovascular diseases. Shiyun Tu et al. (2022) carried out a study on Unripe Plantain Flour (UPF) as a potential anti-obesity ingredient at the South China University of Technology, Guangzhou, China and found that UPF could be a potential food ingredient for the prevention of obesity-induced by a high-fat diet and the consumption of UPF could potentially aid in improving metabolic health.

Plantain also shows a promising prospect in combating climate change. In a study conducted by DairyNZ and the University of Waikato in New Zealand, the preliminary results found that by using plantain feed, Dairy cows produced the same or increase milk production. They also found that using alternative forage like plantain can reduce nitrogen concentration of urine by 25% and reduce nitrate leaching under urine patches by 30-60%. According to the scientists, Plantain may also be able to reduce another greenhouse gas – Methane. Methane is produced in the rumen of cows, and it is released by burping (sciencelearn.org). Because of these, plantain values continue to increase globally as the global output of plantain has increase more than +157%, from 2000 – 2022. Plantain can be fried. Cook In 2022, the world largest producer of plantain is Uganda, while the world second largest producer of plantain is DR Congo. Surprisingly, the world largest exporter of plantain is neither of these two countries in 2021, but Laos. That is because almost all the plantain produce in Sub-Sahara Africa are consumed domestically rather than exported. The largest importer of plantain is the USA. Only 15% of the global production is used in trade, the rest are domestically consumed in the countries where it is produced (plantain council).

### **Plantain in Liberia**

In Liberia, Plantain is also an important crop as it is a staple. It is the third most consume crop in Liberia after rice and cassava. Plantain is the most important crop grown by women and the third most important for men, after Cacao (*Theobroma cacao*), and Rubber (*Hevea brasiliensis*) (English, 2008). It is largely dominated by small-scale farmers, who mainly produce them in compound or home gardens. Additionally, it is also used in Agroforestry system, where it is commonly used as a shade crop for cacao saplings (English, 2008). Plantain serves as an important source of revenue for small-scale farmers in Liberia. The importance of this crop has been boosted with the high price of rice, which makes plantain a remedy for the population.

Despite its importance, it has numerous constraining factors especially for a sector led by small-scale farmers. Improving productivity and yield of plantain is crucial to society as it would improve food security, increase the agricultural component of the GDP, and improve the living standards of thousands of farmers that directly or indirectly rely on the sector by improving their level of incomes. The aim of this study is to present key statistic about plantain in Liberia which include production, yield, area harvest and trade from 2005. This study also highlights the constrains face by participant across the plantain supply chain in Liberia.

Plantain is one of the staple foods in the Liberian diet. Knowing the status of this product will give directions to the policies to be formulated regarding this product. For this purpose, it is important to know the status of the product. Therefore, the aim of this study is to present key statistic about plantain in Liberia which include production, yield, area harvest and trade from 2005 - 2022. This study also highlights the constrains face by participant across the plantain supply chain in Liberia.

## **Materials and Methods**

This study focuses on the plantain sector of Liberia. The data that was used in this study were obtained from the FAOSTAT database. Additional information was also collected from other secondary sources such as OurWorldInData etc.

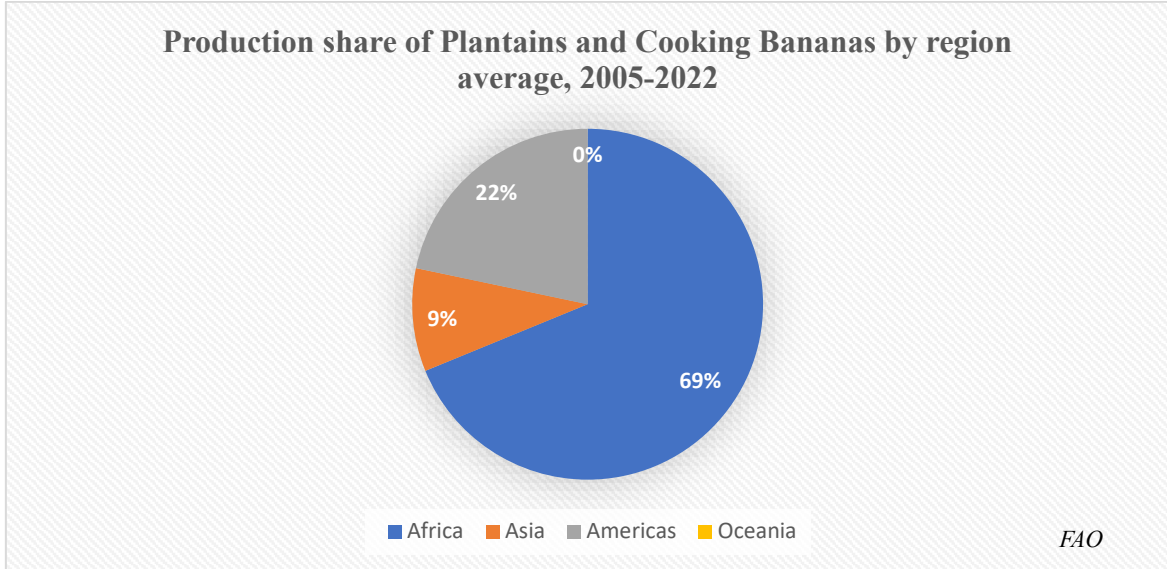
Data were collected on production, yield, area harvest and trade ranging from 2005 to 2022. The trade database includes Import value, import quantity, export value and export quantity. The unit of measurement used for the import and export value is the USD which is also a legal tender in Liberia. While the export and import quantities were in tons.

## **Methods**

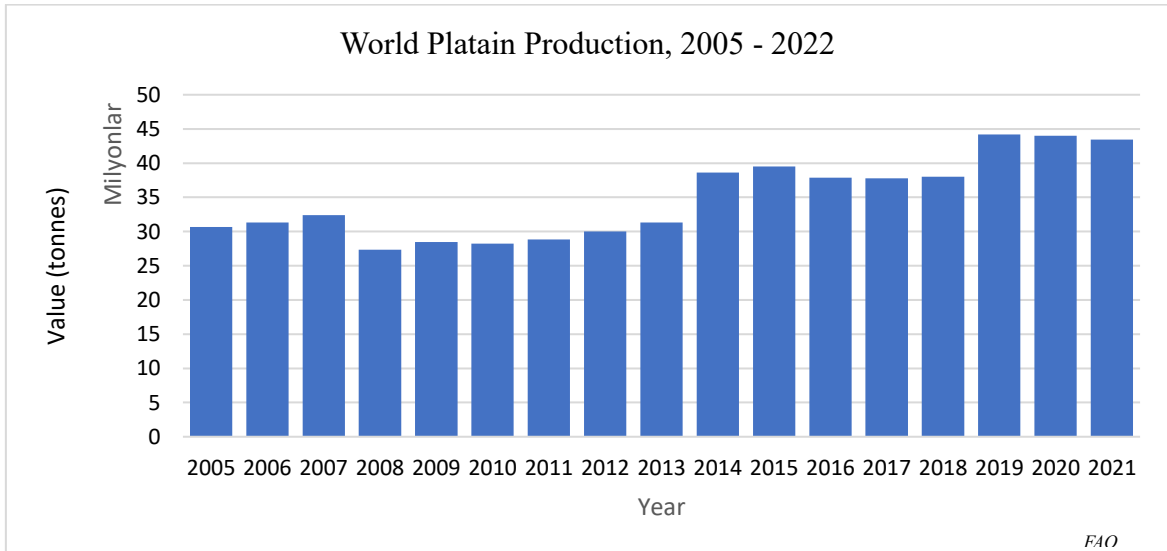
Relative Change = (Final Value – Initial Value)/ Initial Value \* 100

## **Results and Discussion**

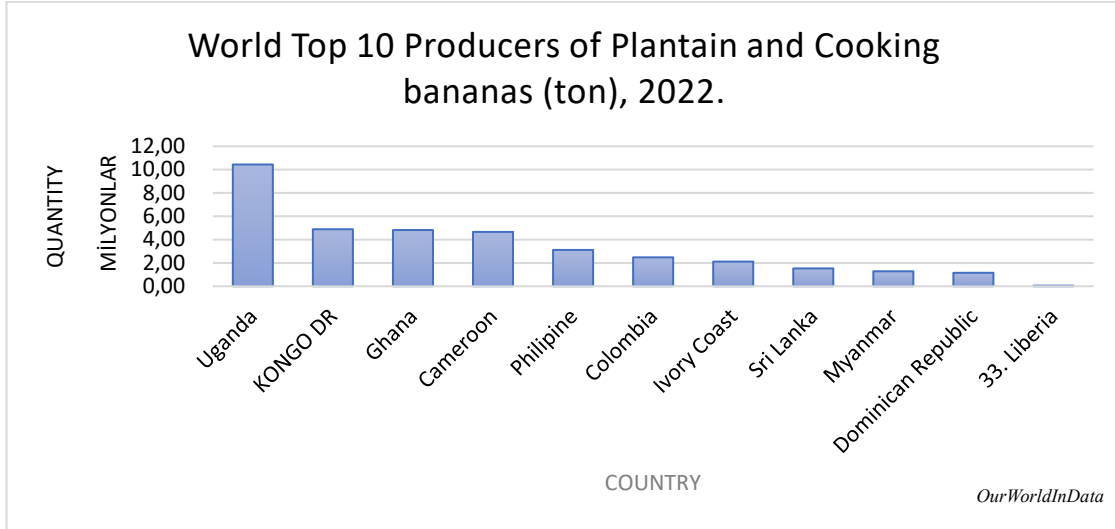
The global output of Plantain has risen significantly. So, between 2005 to 2022 there has been an absolute change of +13,473,961.52t and a relative change of 44%. According to FAOSTAT, Africa is ranked first in the global production of plantain which constitutes 69% per average aggregation, 2005-2022. The Americas, which include Latin America, North America and South America is second with a global production share of 22%, and Asia is third with 9% of global output share as indicated below.



Six of the top ten plantain producing countries are from Sub-Sahara Africa. In fact, the first four highest producing countries are from Sub-Sahara Africa.

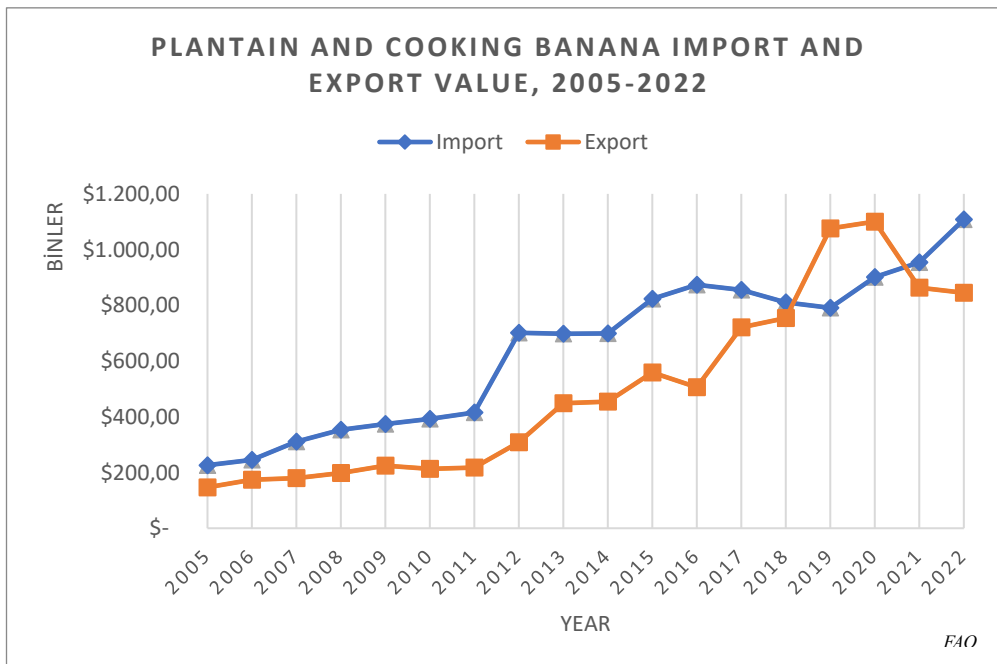


These countries include Uganda, Ghana, Cameroon, DR Congo, Nigeria and Ivory Coast. In 2022, five of the top ten plantain producing countries were from Sub-Sahara Africa. Nigeria was excluded because I could not find its 2022 production data. Uganda is the largest producer of plantain, accounting for 23.7% of the global output. DR Congo is the second largest producer of plantain, representing 11% of the global output, followed by Ghana and Cameroon in third and fourth place. Liberia is the 33rd largest producer of plantain globally with 51,275 ton. Uganda alone produces a combine total of the next two highest producers which is DR Congo and Ghana.

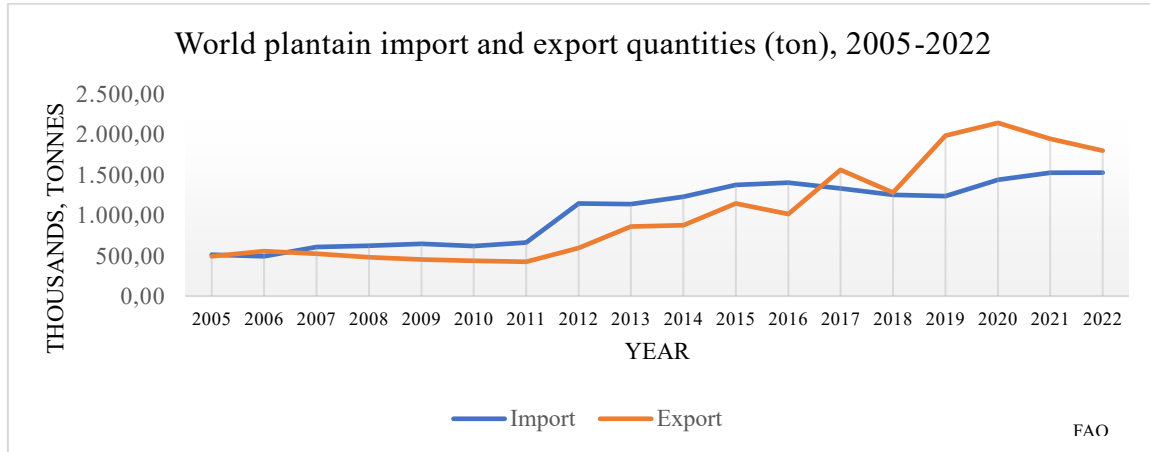


After the exclusion of Nigeria, Worldwide, 2 out of the top ten largest producers are from West Africa. Ghana is by far the largest producer of plantain in West Africa followed by Ivory Coast in 2022. Ghana produces a lot of plantain because it is also a staple in the country. According to global trade (2019), Ghana was the second highest per capital consumption of plantains (141kg per person) globally after Cameroon (197 kg per person). Another factor to the high production of plantain in Ghana can also be attributed to the cocoa sector. Ghana is the second largest producer of cocoa in the world, and plantain is a favorite crop among cocoa growers as a shade crop. The shading of cocoa beans is essential in maintaining the quality and its productive stability (Bastide P. et al., 2008).

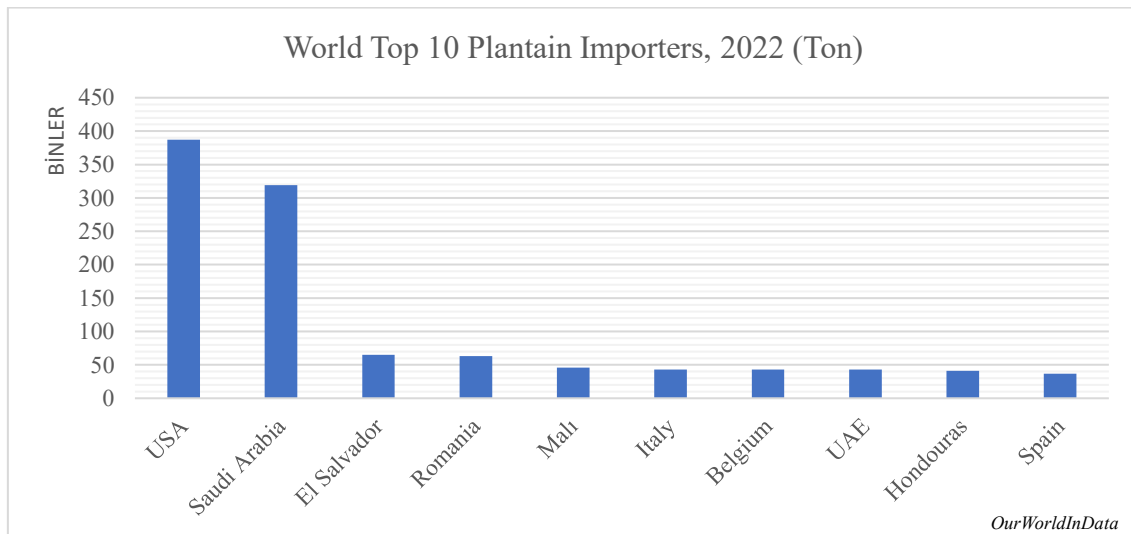
### Plantain and Cooking Banana Trade



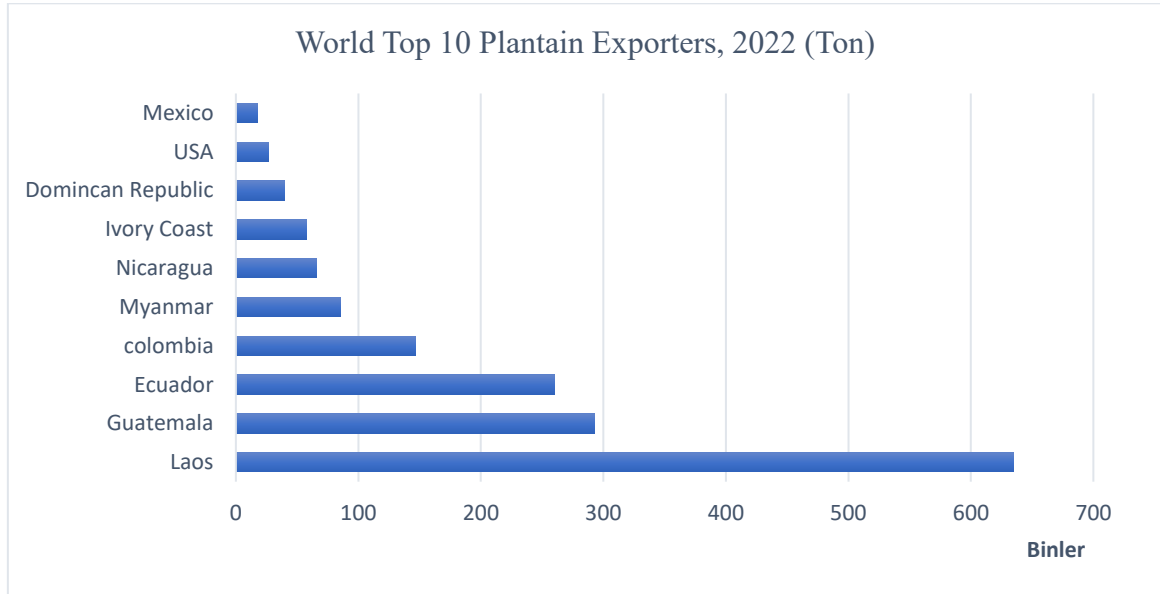
The import and export value of plantain has been on the increase since 2005 as shown on the trend line above. From 2005 to 2022, the global export value has risen to about 576%, while the global import value has peaked around 490%. The USA is the world largest importer of plantain per value, and Guatemala is its largest exporter of plantain with a value of \$125,265 in 2022 (FAOSTAT).



According to OURWORLDINDATA in 2022, the USA was the world largest importer of plantain with a volume of 387,000 tons despite importing less than 2021, followed by Saudi Arabia, El Salvado, Romania and Mali as the top 5 largest importers of plantain. Although consider a niche product in the USA, the import of plantain continues to strongly trend upward largely due to demographic shift. The growing African and Hispanic population in the US has massively contribute to this upward swing in demand. According to Fresh Plaza, 2025; approximately 85% of consumers of plantain in the US are from the Hispanic community. Saudi Arabia went from importing nothing in 2005 to being the second largest importer of plantain in 2022 with an import volume of 319,000 t.



This sudden rise is also attributed to the significant expatriate community residing within the country. Dietary diversity is also a factor, especially with the growth of the middle class seeking fresh fruit and -

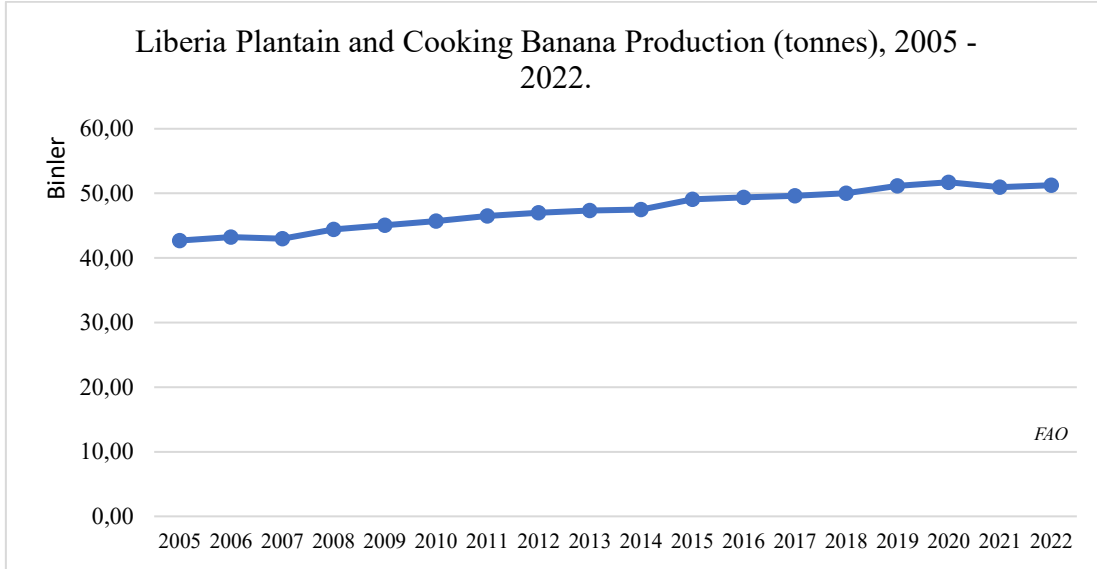


vegetables rich in dietary fiber and the essential nutrients that bananas can provide.

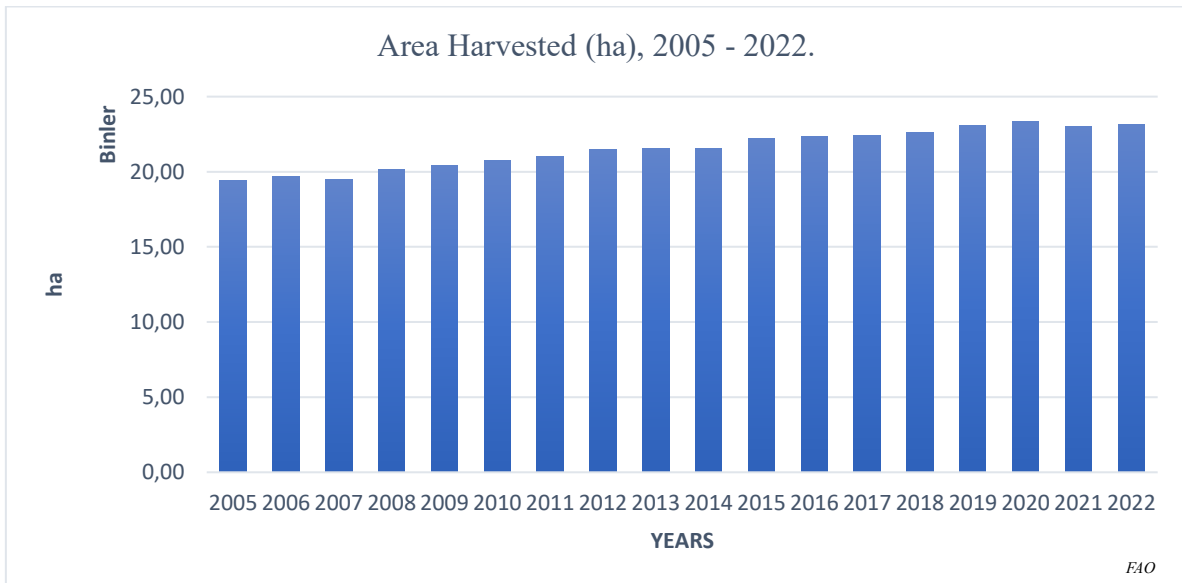
In 2022, Laos became the largest exporter of Plantain with a volume of about 635,000 t, followed by Guatemala, Ecuador, Colombia and Myanmar as the world top 5 largest exporters of plantain as shown on the graph above. As you have notice, not a single African country is found in the world top 5 exporters list despite the top 4 largest producers being from the continent. Moreover, there is only one African country among the world top 10 exporters, and that is Ivory Coast. You might have asked yourself, why? Well, the answer is obvious, most of the plantain produced by these countries are consumed domestically, because in most of these countries, it is a staple crop. Moreover, in most instances, domestic demand is higher than what is supply to the market. So, because the domestic demand is so high and the production capacity is not high enough to assuage domestic and international demand at the same time, the domestic market takes the day. Another reason is that the plantain sector in Africa is dominated by small-scale farmers, and these farmers lack the tools and the technical knowhow to mass produce on a commercial scale.

### **Importance of the plantain**

As stated in the introduction, Plantain is the third most consumed crop after rice and cassava. The sector is largely dominated by small-scale farmers. The sector productivity has increased tremendously over the years.



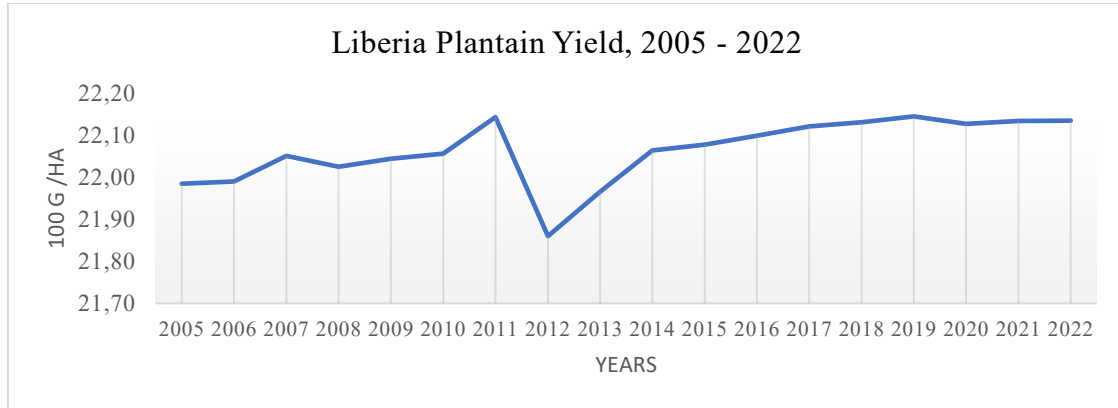
From 2005 to 2022, Liberia has experienced an absolute change of +8,574.85 and a relative change of 20.1%. This explains how significant the sector has expanded despite numerous challenges the country and its people have experienced over the years. In 2022, Liberia's plantain production output was 51,275.79 t, which represent 0.12% of the global output share. The area harvested has also significantly expanded over the years. The figure below gives a vivid description of how the plantain's area harvested has trend over the years in Liberia.



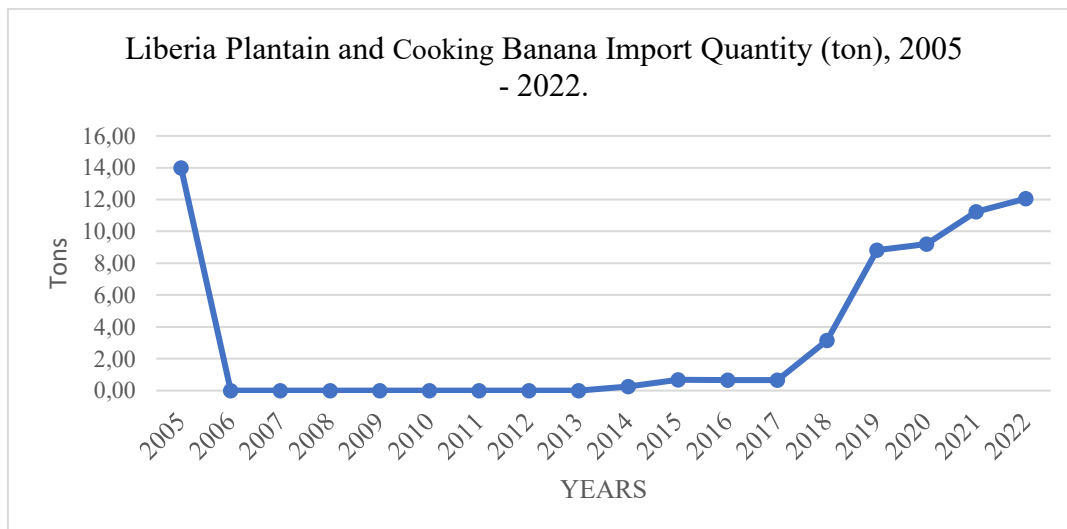
The area used in the cultivation peaked to its highest in 2020, felt slightly in 2021. Although area harvested fell in 2021, there was an increase in 2022. This also corresponds to the production output over the years, as land size of the cultivated area increases so does production output. When the area harvested and the yield of plantains were compared, it was found out that the yield did not correspond with the increased in area

harvested. Although they might not be aware, they are applying scale of change rather than intensity. That is, they see area expansion as a means to increase yield, a method that is more suitable for large scale enterprise with huge resources.

Unlike other charts that have shown less or no significant differences over the years, the yield of plantain has not been consistent over the years for Liberia.



As shown on the graph above, the yield of plantain rose in 2005, and fell slightly in 2008. After 2008, it rose consistently until 2011, and it was followed by a significant dip in 2012 and 2013. This was mainly caused by the disease Sigatoka which is a serious nuisance to farmers cultivating banana and plantains across the continent. Nematodes are also one of the factors which causes the destruction of primary roots. This often led to uprooting when there is a wind or rain especially when the plant is unstable at bearing age. However, it recovered in 2014 and trended upward until 2020. In 2020, yield experienced a slight decrease because of lockdown by the government caused by the Covid-19 pandemic. Because of the disease, farmers could not tend to their field as everyone focus shifted to battling the disease through isolation.



As shown above, Liberia imported its highest stock of plantain in 2005 which was just 2 years after the end of the civil war. In 2016, it fell to 0 and has been so until 2014 when Liberia started to import because of the Ebola outbreak that ravage the country entire supply chain. Since then, it has been on the increase until it peaked to its second highest in 2022 after 2005. This increase in imports only highlights the constraint underpinning the sector. Because domestic demand outweighs the supply potential of the small-scale farmers, the country must source from other markets to assuage demand. As a result, Liberia does not export plantain because all of it produce are consumed domestically. In this case, it negatively distorts the country balance of trade because imports are higher than exports. An economist can argue that imports are a good thing because they indicate a robust domestic market, however, it is arguably correct when the product that is imported is a productive asset such as equipment, because it will improve the country's economy over the long run. But when the product that is imported is a finished product, it does not positively reflect on the country's economy.

### **Distribution of Plantain in Liberia**

In Liberia, Montserrado County constitute the highest demand share of plantain in the country as it is the most populated county in Liberia. The plantain sector comprises of too many producers, but few wholesalers which complicate the supply chain. Movement and distribution to major cities and non-producing regions is usually undertaken by wholesalers. These wholesalers usually supply the market two days per week, which is on Saturdays and Sundays. As a retailer, you must be available on one of these two days otherwise you would have to wait for the following week. At times the retailers take the initiative upon themselves to source plantains from the producers. In Liberia, there are two marketing channels: Producer to wholesaler to retailer and producer to retailer.

### **Constraints**

Although the sector has shown some significant improvement, there are also a lot of factors impacting the sector from performing to its full potential. Beside diseases, Post Harvest Losses (PHL) is one the most important factor that affect farmers in Liberia and the continent at large. The World Bank report on 'Missing Food' recommends PHL reduction as an important response to food security (Zorya et al. 2011). According to Affognon et al., 2015; over the past decade, it is estimated that up to about 4 billion dollars in cereal value is lost to PHL in Sub-Sahara Africa, exceeding the value of food aid received in Sub-Sahara Africa. Unfortunately, there is no statical data on the losses of plantain due to post harvest losses (PHL) in Liberia, but these things are visible to the naked eyes especially in the highly concentrated market. However, mitigating PHL is a crucial step that must be taken in fighting food insecurity. Although the plantain sector is a very important sector to the country's fight against food insecurity, it is also gaining less traction from the younger generation as compared to other sectors that are deemed to be highly lucrative e.g. Cocoa, Rubber, Oil Palm etc. Of all its neighbors, Liberia is the least

in terms of plantain productivity. So, the constraints that harbor farmers' productivity and the factors observed to negatively affect the sector are listed below:

**Pest and Disease:** Nematode, Stemborers are the major pest, and Black Sigatoka is the major disease affecting plantain. Black sigatoka is a leafy spot that is the major disease attacking plantain in Africa. It is an airborne disease caused by the fungus *Mycosphaerella fijiensis* (Morelet). This disease was accidentally introduced into Africa, and it rapidly spread across the continent, first in Central and West Africa, and later in East Africa (IITA). This disease causes yellow spots on the leaves, later brown and then black which ultimately leads to the death of plant tissue after the leaf tissue becomes necrotic. Yield losses from this disease are estimated at between 30 and 50% (IITA). Though fungicide can control this disease, they are too expensive for the smallholder farmers and are also hazardous. There have been a lot of resources invested in developing disease resistance cultivars to mitigate or counter these diseases. Because of the introduction of the new resistance cultivar, production has improved drastically over the years.

The banana weevil (*Cosmopolites sordidus* Germar) is an important insect pest of banana and plantain in Africa that bore tunnel in the corm, causing the plant to weaken and lodge. Weevils and nematodes together interfere with nutrient uptake and transport, resulting in slower growth and reduced fruit filling (IITA). Banana weevils and nematode become extremely severe as the stand ages.

**Environmental factors:** Plantain is also affected by environmental factors such wind humidity and temperature. The major nuisance affecting plantain is wind. Wind speed above 40km/hr. can completely destroy a plant (Fonsah, EG. et al., 2011).

**Lack or Low adoption of technology:** In Liberia, the plantain sector is dominated by small-scale famers and most of these farmers lack the resources necessary to procure technologically advanced equipment to boost production. The adoption of technology is critical to maximizing yield and reducing post-harvest losses.

**Access of Inputs:** According to most surveys conducted in Liberia, one of the main constrain encounter by small-scale farmers across the entire sector is inputs. The inaccessibility of fertilizers, pesticides and machinery is troubling. At times, even if it is available, it is still inaccessible to farmers because the farmers do not have the capital to purchase it.

**Poor Infrastructure:** Plantain are vulnerable to postharvest deterioration owing to their short shelf-life of approximately 12 to 28 days under ambient condition (Gebremariam, 1999; Kikulwe et al., 2018). Lack of storage facilities is one of the major post-harvest constraints faced by farmers. Therefore, farmers' produce is often discarded because they cannot find buyers during the freshness period. Ripening increases the market value of plantain whereas over-ripening reduces the market value of plantain (Evelyn Serwah Ayeh et al., 2023). As mentioned throughout this research, the sector is

dominated by small-scale farmers who lack sufficient capital to procure cold storage facilities.

**Poor Transportation:** Poor road network is another post-harvest factor cited by farmers in Liberia as a major hindrance in the plantain sector. The lack of paved roads or roads marred by potholes often damage the plantain on the way to the market which leads to the spoilage of the produce. Poor road network also increases the malfunctioning of vehicles that transport plantain from other parts of the country, therefore, increasing the cost of transportation and prolonging the average time taken, only to be shunned by consumers for far better-quality produce. Another factor is that, because the commercial vehicle that is used to transport the plantain bunches to the market are usually open cargo without any cooling system, it aggravates the problem of poor road networks. These vehicles expose the plantain to both mechanical injuries and uncontrolled ripening conditions before reaching its destination (Evelyn Serwah Ayeh et al., 2023).

**Marketing:** This is another factor that affects farmers in the plantain sector. Farmers' inability to time the market leads to the oversupply of the market which in turn leads to seasonal price fluctuation. When the market is oversupplied, it gives consumers the bargaining leverage for a price that is more favorable towards them at the expense of the seller. The seller has no option but to give in to buyer requests after doing his cost and benefit analysis, because the longer the plantain stays the lower the quality, which means the lower the chances of the produce being sold. In the retail market, the bigger the size and greener/firmer the plantain, the better the chances of fetching premium prices. The degree of ripening is another indicator in determining plantain quality that is projected to influence prices (Evelyn Serwah Ayeh et al.).

## **Conclusion**

The plantain sector in Liberia has undergone a positively significant transformation over the years. The sector productivity has had a relative change of +20% from 2005 to 2022. The yield for plantain has also been able to recover from the depression in 2012, because of the adoption of pest and diseases cultivar and better agronomic practices. Having said that, the sector still needs significant support from the government and non-government institutions in supporting farmers to maximize their yield potential. The increase in imports and the constraints highlighted is an indicator that despite the progress thus far, more needs to be done to address the sector challenges. As the sector gains traction globally, there is a need for the country to tap on this growing window of opportunity by investing in processing facilities, providing subsidies and building the necessary infrastructure necessary for the development of the sector.

## Recommendation

Based on the research finding the following are recommended:

**Infrastructure:** Bad road networks must be addressed by the government. A better transportation system would be able to deliver the produce from the rural areas to urban areas in good condition by reducing the shaking and shortening the transport duration. Additionally, it will lead to a reduction in transportation costs, hence marketing costs.

**Handling Techniques:** Better handling techniques in loading and unloading of plantains in commercial vehicles must be taken into consideration while transporting the produce. Bad handling techniques like over-stocking bunches of plantains in commercial vehicles damages the produce resulting in lower market value. The use of plastic cages is recommended as it reduces mechanical damage and avoids reduction of fruit quality for transport, and it is also cost effective for farmers (FAO).

**Extension Services:** A better extension service is needed to educate these farmers about good agronomic practices and make sure that the farmers have access to the latest agricultural inputs necessary to achieve a bumper harvest. An extension worker serves as a bridge between the farmers and the research institution. So, to have a functional extension service the farmers must be incorporated in the decision-making process.

**Cooperatives:** Farmers should form cooperatives as it can lead to better bargaining power in the reduction of input costs which would eventually lead to an increase in profit for the members. Knowledge sharing is also another benefit where less skill farmers could be able hone their skills with the help of high skill farmers.

**Others:** Value addition is another step that must be taken to reduce PHL. Processing of plantain guarantees a longer shelf life, and it also creates an additional avenue for revenue creation. This is an untapped area that needs serious consideration as it also could boost employment in the country. Rather than throwing away over-ripe plantains, it can be used to produce juice, marmalade, puree etc.

## References

1. Norgrove, L., Hauser, S. Improving plantain (*Musa* spp. AAB) yields on smallholder farms in West and Central Africa. *Food Sec.* **6**, 501–514 (2014).  
<https://doi.org/10.1007/s12571-014-0365-1>
2. Christopher, Ariyo & Ariyo, M & Okelola, O & Akesode, H & Akanni, And. (2013). Profitability Analysis of Plantain Marketing in Kaduna Metropolis, Kaduna State Nigeria. 13. 21-30.
3. <https://plantvillage.psu.edu/topics/plantain/infos>
4. [https://www.fao.org/fileadmin/user\\_upload/inpho/docs/Post\\_Harvest\\_Compendium\\_-\\_Plantain.pdf](https://www.fao.org/fileadmin/user_upload/inpho/docs/Post_Harvest_Compendium_-_Plantain.pdf)
5. FAOSTAT

6. <https://cgspace.cgiar.org/server/api/core/bitstreams/d9fc03fa-3836-45a2-9d85-0ab1df79de8d/content> OUR WORLD IN DATA
7. Kwofie, M. , Sarpong, M. , Anima, F. , Bukari, N. and Adeboye, O. (2020) The Use of Ripe Plantain (*Musa spp.*) and Peppercorns for Beverage Processing as a Pro-Vitamin A Carotenoid and Nutrition Catalyst. *Food and Nutrition Sciences*, **11**, 1096-1106. doi: [10.4236/fns.2020.1112077](https://doi.org/10.4236/fns.2020.1112077).
8. <https://www.ajol.info/index.php/jard/article/view/66815>
9. <https://www.sciencelearn.org.nz/resources/3022-plantain-research>
10. Fu, J. , Xiao, J. , Tu, S. , Sheng, Q. , Yi, G. Wang, J. and Sheng, O. (2020) Plantain flour: A potential anti-obesity ingredient for intestinal flora regulation and improved hormone secretion. *Frontiers in Sustainable Food Systems*, **6**, 2571-581X. DOI:10.3389/fsufs.2022.1027762
11. Ayeh, E. S., Aryeetey, E., Quandoh, E., Boakye, A., Wireko-Manu, F. D., Osei Mensah, J., & Oduro, I. N. (2023). Economic Impact of Plantain Ripening: A Case Study Among Plantain Traders in Accra. *International Journal of Fruit Science*, **23**(1), 217–228. <https://doi.org/10.1080/15538362.2023.2271993>
12. <https://www.researchgate.net/publication/272507265> Plantain and banana research at the International Institute of Tropical Agriculture HortScience 2887 3-874 970-971
13. Olumba, Chukwudi & Onunka, Cynthia. (2020). Banana and plantain in West Africa: Production and marketing. *African Journal of Food, Agriculture, Nutrition and Development*. **20**. 15474-15489. 10.18697/ajfand.90.18365.
14. <https://www.sciencedirect.com/science/article/abs/pii/S0261219498800070#:~:text=The%20disease%20causes%20severe%20leaf,yield%20by%2030%20to%2050%25>.
15. Bastide P., Paulin D., Lachenaud P. Influence de la mortalité des cacaoyers sur la stabilité de la production dans une plantation industrielle. *Tropicultura* . 2008;26(1):33–38.
16. Fonsah, Esendugue Greg & Chidebelu, A.S.N.D.. (2011). Economics of banana production and marketing in the tropics: A case study of Cameroon. *Economics of Banana Production and Marketing in the Tropics: A Case Study of Cameroon*. 1-242.
17. <https://plantvillage.psu.edu/topics/plantain/infos>
18. <https://www.freshplaza.com/oceania/article/9052535/plantains-becoming-more-available-in-mainstream-us-supermarkets>