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Review

Exploring banana production in Africa for food security and economic growth—A short review

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Abstract: Food insecurity is a critical global issue, but it is far more visible and challenging to address in Africa. Millions of Africans suffer from hunger and malnutrition. Food security programs are an essential part of human survival, and for that to happen, food that is nutritious and safe must be readily available to people. A society that will be well fed requires not only a strong policy framework but also institutional reforms that promote production and make agriculture more attractive to young people. In this context, sustainable production of banana crops could play a critical role in Africa's food security and advance economic growth. Bananas have an important position in human nutrition all over the world; they are a staple fruit consumed by many. A banana is a storehouse for minerals, vitamins, and carbohydrates and is regarded as a reserve of energy. It has a great prospect for foreign earnings through exports. The continuous growth in Africa's population, with its attendant increase in food demands, calls for a radical transformation in its agricultural production system. There are land and human capital resources that could be engaged. The estimated cultivable land mass in Africa for banana production is estimated to be around 50 million hectares, with over 60% of its population below the age of 25. Africa could achieve a decent society that is free from the burden of hunger and attain economic prosperity by leveraging on massive banana production for local needs and exports. Bananas have enormous potential as a recipe for food security and economic prosperity if well harnessed.

Keywords: banana; production; food security; Africa; European market

1. Introduction

Food insecurity is a serious global problem that is, however, more challenging to address in Africa, where several million people suffer from the burden of hunger and malnutrition. A large number of the citizens live in abject poverty and are thus vulnerable to diseases that are ordinarily preventable. This vulnerability is due to the poor management of Africa's agricultural production system to provide adequate food for its citizens. A food security development program is an indispensable prerequisite for the survival of mankind; it requires that safe and nutritious foods be sufficiently made available to people with the overall goal of having a healthy and productive society. However, Africa has failed in this regard because food insecurity is still a major threat in this economic region [1]. Available information suggests that at least one out of five people may go to bed hungry; the region appears to bear the heaviest burden of food insecurity and malnutrition compared with the rest of the world [2].

Africa has one of the fastest-growing populations globally, which consequently puts much pressure on its food supply. The region imports $35 billion worth of food annually, according to an Africa Development Bank report [3]. Thus, for the region to attain the goals of food security and economic growth in line with the Millennium Goal Agenda, there is a need for a very strong policy framework, as well as

institutional reforms, that will support sustainable production and make agriculture particularly attractive to youth.

In this context, continuous and sustainable production of banana crops, which have inherent nutrient and economic potential, could play a critical role in promoting food security and advancing economic growth in Africa. Bananas have an important position in human nutrition all over the world; they are a staple fruit consumed by many [2,4]. They offer several advantages that make them valuable for food security efforts. Bananas are highly nutritious: they are rich in critical nutrients, including potassium, vitamin C, vitamin B6, and dietary fiber. They also contain significant amounts of carbohydrates, which provide energy. Bananas are one of the most popular fruits on the world market, as they are relatively affordable, making them accessible to people with limited resources [5]. Bananas are easy to cultivate, can be grown in a wide range of climates, and are relatively resistant to pests and diseases under good agricultural practices.

Additionally, bananas can be stored for extended periods, which helps reduce post-harvest losses and ensure a steady supply to even beyond the region where they are not largely cultivated. Bananas can be consumed in various ways. They can be eaten fresh, used in making smoothies, baked into bread and cakes, or processed into other food products [6]. This versatility makes bananas a food source that can be easily incorporated into different diets. In a nutshell, the benefits of bananas for food security lie in their nutritional value, ease of cultivation, storability, and affordability. These factors contribute to bananas being a valuable crop for addressing food insecurity and improving the nutritional status of vulnerable populations in Africa.

Sustainable banana production, apart from promoting food security, can contribute to income generation for millions of small households, thereby improving their living conditions. In Africa, banana production could contribute to the economy through export earnings, tax revenues, and the creation of jobs for people along the banana value chain. The growth of the banana industry can lead to the development of agricultural infrastructure, technological innovations, and skill development among farmers, which in turn can increase overall agricultural productivity. The promotion of banana processing and the creation of value-added products can lead to the creation of new business opportunities and the diversification of a country's economy. Therefore, by supporting and promoting banana production through huge investments by clusters of individuals and governments, Africa can utilize its agricultural potential and make a significant contribution to the economic growth and development of their region.

The region is geostrategically positioned to massively produce bananas, which can significantly alleviate the problem of food insecurity and build a strong economic platform for future generations. There is abundant arable land that is highly fertile and human capital resources that could be productively engaged.

The estimated cultivable land mass in Africa for possible banana production is estimated to be about 50 million hectares, with the majority of this land located in West and Central Africa. However, only a small portion of this land is currently being utilized for banana cultivation, with the majority of bananas being produced on smallholder farms. Furthermore, Africa has the highest concentration of young people

around the world, with over 60% of its population below the age of 25, who can be productively engaged in the production of bananas for both export and local consumption. Addressing food insecurity in Africa could be achieved through huge investments in banana production.

The production of bananas must be seen beyond a small holding venture by rural farmers but as a big enterprise that could significantly contribute to food security and promote economic growth and development through local markets and exports. Several countries, as presented in **Table 1**, are making lots of economic fortune from banana exports. African countries can key into the opportunity. Institutions, such as the National Horticultural Research Institute (NIHORT) and the International Institute of Tropical Agriculture (IITA), both in the southwestern part of Nigeria, have made considerable progress in their areas of research in respect of good production practices (GPPs) and modern techniques for the production of plantain and banana rapid suckers. The outcome of this research can be utilized to develop farmers' capacity to have better production output than those of other countries in Latin America and the Caribbean.

Table 1. Top ten largest exporters of bananas in the world by worth [2].

No.	Country	Amount
1	Ecuador	US$3.5 billion
2	The Philippines	US$1.1 billion
3	Guatemala	US$1.07 billion
4	Costa Rica	US$1.02 billion
5	Netherland	US$795.5 million
6	Belgium	US$706.5 million
7	United States	US$507.7 million
8	Honduras	US$318.5 million
9	Vietnam	US$294.0 million
10	Cameroon	US$272.5 million

Although some African countries produce bananas, only very few of them participate in banana export trade [7]. Statistically, out of 19.7 million metric tons of bananas exported globally in 2022, Africa only contributed 700,000 (0.7 million) metric tons, while Asia contributed 3.9 million, and Latin America and the Caribbean traded 15.1 million metric tons, as shown in **Table 2**. The low volume of contribution to global banana exports from the African region could apparently be attributed to several factors, such as stiff competition from established countries with well-developed programs for banana production and export systems, a lack of infrastructure for efficient transport and storage systems, and lack of sufficient access to market information by small-scale farmers to participate in banana export trade. There is a need for government support to facilitate the development of strong export marketing channels among African countries to actively participate in international banana trade, which will eventually have a significant impact on regional economic growth.

Table 2. Global banana exports (in millions) between 2018–2022.

Region	2018	2019	2020	2021	2022
Latin America and Caribbean	15.5	15.9	16.4	15.9	15.1
Asian	3.5	5.9	5.2	3.9	3.9
Africa	0.7	0.7	0.6	0.6	0.7

The top ten banana-producing countries are shown in **Table 3,** while the method of packaging for export is shown in **Figure 1**.

Figure 1. Packaging of banana for export.

Table 3. Top 10 banana-producing countries in the world [8].

No.	Countries	Quantity (millions)
1	India	31,504
2	China	11,513
3	Indonesia	8182
4	Brazil	6637
5	Ecuador	6023
6	The Philippines	5955
7	Guatemala	4,115,03
8	Angola	4115
9	Tanzania	3419
10	Costa Rica	2528

1.1. Possible health benefits of banana consumption

Banana is a very delicious and nutritious fruit that is economically more affordable all over the world for all age groups. Banana has an active substance, polysaccharide, which is phytochemical and plays a beneficial role in human health [9]. It also has a rich amount of dietary fiber, which allows it to participate in a variety of nutraceutical and medicinal applications [10]. Bananas are easily digestible, have low fat, and contain sufficient amounts of minerals and vitamins; therefore, they can be used to promote health. Some of the possible health benefits of consuming bananas include lowering the risk of cancer, improving skin and anti-aging, and lowering blood pressure.

1.2. Banana protection against cancer

Cancer is a complex disease characterized by the uncontrolled growth and spread of abnormal cells in the body. Various factors, including genetics, lifestyle choices, and environmental exposures, can contribute to the development of cancer. While there is no single cause of cancer, certain dietary choices have been associated with a reduced risk of certain types of cancer [11]. However, bananas, as a common fruit, have been studied for their potential role in cancer prevention due to their nutritional content. Banana is a rich source of antioxidants and has an abundance of polyphenols [12]. The presence of naturally occurring antioxidants, which are found in fruits and vegetables and have pharmaceutical properties, can delay the progress of many chronic diseases by defending the human body from free radicals and preventing lipid oxidative stress [13]. Antioxidant components present in bananas are tocopherol, ascorbic acid, dopamine, phenolic groups, and beta-carotene [14]. Antioxidants are required to maintain good health. Damaged cells can be repaired by the utilization of natural antioxidants with the help of the reparative ability of the body [15]. However, it is important to note that consuming bananas alone cannot prevent cancer. A balanced diet that includes a variety of fruits, vegetables, whole grains, and lean proteins is essential for overall health and well-being. While bananas can be a part of a healthy diet, they should not be considered the sole means of cancer prevention.

1.3. Banana and cholesterol lowering effect

Cholesterol is a fat-like substance that is produced in the body and is also found in some foods. Too much cholesterol in the blood can stick and block the walls of the arteries, causing complications, such as high blood pressure. According to World Health Organization (WHO) data from 2013, an estimated 17 million people died every year from cardiovascular diseases and around 9.4 million people died every year due to complications of hypertension [16]. For the elderly, increased cholesterol is very dangerous to their health. Hypertension is a disease that occurs as the consequence of high blood pressure and leads to various complications and some other diseases, such as heart disease, stroke, and kidney failure [17].

However, according to Anindyah and Farmawati [18], consuming fruits and vegetables can help reduce blood pressure. Banana fruit can be processed to make a variety of culinary components and beverages, including juice. Juices' high water content helps lower cholesterol levels [19]. Because potassium in bananas lessens the effects of sodium, it helps regulate blood pressure in the body [20]. It was discovered

that giving older people bananas somewhat lowers their blood pressure [21]. Because bananas contain potassium, fiber, and vitamin C, eating them may help decrease blood pressure.

1.4. Banana anti-aging effect

Anti-aging refers to the process of preventing, slowing down, or reversing the effects of aging on the body. This can include various lifestyle choices, skincare products, and medical treatments aimed at maintaining a youthful appearance and promoting overall health. The human skin is the outer covering and the largest organ of the body. Although the skin fulfills numerous physiological functions, its composition changes with overexposure to environmental pollution and solar radiation [22]. The majority of sunburns and skin damage are believed to result from prolonged or excessive exposure to ultraviolet radiation, especially ultraviolet B. However, plant-based polyphenols with potential antioxidant properties can shield the skin from excessive or repeated exposure to ultraviolet irradiation [23].

Bananas are rich in several vitamins and minerals essential for healthy skin. Vitamin C, a powerful antioxidant, helps protect the skin from damage caused by free radicals, reducing signs of aging, and improving the overall complexion. Vitamin A, another key nutrient found in bananas, promotes cell regeneration, contributing to smoother and more youthful-looking skin. Furthermore, bananas contain potassium, which helps maintain the skin's moisture balance and prevents dryness.

1.5. Banana in kidney maintenance

Kidneys are a special filter system for the body. Kidneys remove waste products from the blood and produce urine. Kidneys control the levels of many substances in the blood. Kidneys help to control the blood pressure. When kidneys are not functioning properly, it can lead to various health problems. Conditions such as chronic kidney disease, kidney stones, urinary tract infections, and kidney failure can significantly impact overall health and well-being. For kidney health, bananas can help to maintain and build new healthy tissues, as they are abundant in calcium, nitrogen, and phosphorus and are a rich source of potassium intake [24]. Magnesium and potassium, two essential electrolytes that support kidney health, are rich in bananas. Potassium can diminish calcium excretion, which lowers the risk of kidney stones, if consumed in moderation [25].

2. Understanding process of banana ripening for proper management

Globally, large quantities of bananas are lost, with about one-fifth of harvested bananas wasted as a result of poor post-harvest management [26,27]. About 50% of post-harvest losses of bananas were reported in one fruit market in a particular province of South Africa [28]. Understanding the harvesting method and refining processes of bananas will help reduce post-harvest losses and waste always experienced in the banana production sector, therefore improving the rate of return for farmers and other people involved along the value chain.

Banana bunches attain maturity after 90–150 days of flowering, which differs depending on variety and weather conditions. A large bunch consists of multiple fruits (100–400 units) and may weigh between 50 and 200 kg. Thus, care should be taken while harvesting banana bunches; they could be collected in well-padded trays or baskets before being taken to the collection sites. The harvest is done with a sickle or sharp knife and transported to the desired destination. Banana fruits harvested at a lower stage of maturity have a longer life than fruit harvested at the peak of maturity. The banana, at its unripe stage, is easy to transport and has a longer shelf life [29].

The method of banana ripening for market handling involves stages to ensure that the fruits attain the desired stage of ripeness for supply to the market destination. Bananas are climacteric fruits that undergo rapid ripening after harvest. The rate of oxygen (O_2) consumption, carbon dioxide (CO_2) evolution, and ethylene production reach a peak value shortly after harvest, resulting in good ripeness and exceptional flavor and aroma at that particular time. After this stage, senescence occurs, during which the fruits steadily rot [30]. Ideally, bananas are harvested as mature green fruits and allowed to either ripen naturally or induced. After harvesting, the bananas are pre-cooled to put off the heat from the field. This is done by placing the bananas in a cooler or cold room for a specific time frame. Pre-cooling enables the ripening procedure to slow down to preserve the fruits.

After the ethylene treatment, the bananas are moved to a ripening room. The room is particularly designed to control temperature, humidity, and airflow to create the best conditions for ripening. The temperature is generally maintained between 18 ℃ and 20 ℃, and the humidity is kept high to prevent moisture loss [31]. Also, controlled atmospheres and modified atmospheres are used to extend the storage life of mature green bananas by reducing the metabolic rate, de-greening the peel, and limiting the fruits' decay [32]. Throughout the ripening process, the bananas are expected to be regularly monitored for color, texture, and ripeness to ensure that they reach the desired level of ripeness.

3. Banana export market and the need for more Africa participation

Bananas are among the most traded fruits in the world and one of the most important fresh fruits imported into Europe. In 2017, about 22.7 million metric tons of bananas were traded, and their value was put at $11 billion, which is higher than the export value of any other exported fruits. The region of Latin America and the Caribbean is the largest exporting region, responsible for approximately 80% of global exports, while the major importing regions are the EU, US, and Japan [8]. They account for about two-thirds of the world banana import markets, and the remaining one-third of the traded bananas are for the rest of the world.

In 2022, the combined value of all nations' banana exports worldwide was $12.5 billion. Sixty percent of all banana sales on international markets came from the top five exporters: Ecuador, the Philippines, Guatemala, Costa Rica, and the Netherlands. Africa accounted for four percent of all banana sales. Factors, such as supply chain logistics, demand, production levels, and trade policy, impact the worldwide banana trade [2].

The EU has a relatively open banana market, with tariffs on banana imports being relatively low compared to other agricultural products. This has allowed for a steady flow of bananas into the EU from various producing countries. However, the EU does have certain import regulations in place, such as quotas and quality standards, to ensure the quality and safety of imported bananas.

There are more than 1000 varieties of bananas produced and consumed around the world, but the most commercialized is Cavendish bananas. Approximately 50 billion metric tons of Cavendish bananas are produced globally every year, and significant quantities of these are supplied to the European and US markets. Cavendish is better suited to international trade than other varieties because it is more resilient to the effects of global travel. It is the major type of bananas produced and consumed in China and accounts for one-quarter of production and consumption in India.

Africa's participation in the global banana market supply is relatively low compared with other major players. There are vast opportunities for banana exports in Africa as a result of several favorable factors: many countries in Africa have a tropical climate, which is good for growing bananas. The temperature, rainfall, and sunlight levels are conducive to large-scale cultivation. Additionally, the region has vast amounts of arable land that can be utilized for banana plantations. This provides an opportunity for large-scale production and export. The demand for bananas is increasing due to population growth, urbanization, and changing dietary habits. This creates a golden advantage for domestic markets and neighboring countries, as well as an opportunity for exports to the Western world. African countries have a competitive advantage in banana production due to lower labor and production costs compared with those of other regions. This can make African bananas more price-competitive in the global market. Although, it is important to note that there may be challenges in terms of infrastructure, logistics, and market access that need to be addressed to fully make the most of the opportunity for banana export in Africa.

Table 4. Africa banana exports between 2021–2022 [2].

Countries	Total export for 2021 (thousands of tons)	Total export for 2022 (thousands of tons)
Cameroon	188	216
Côte d'Ivoire	339	322
Ghana	63	51

Côte d'Ivoire, Cameroon, and Ghana are major players in the production of dessert bananas for export in the African region (**Table 4**), while some countries with lower production volumes focus more on domestic markets. Côte d'Ivoire, which is the African leader in exports to the European market, exported 327,852 tons in 2020, followed by Cameroon and Ghana with 180,879 and 77,286 tons, respectively. The Middle East market is growing, supplied mainly by Egypt and Sudan. Countries such as Rwanda and Uganda have limited niche export markets (by airlifting) for fresh "finger" bananas [33]. The average banana export price stood at $1428 per ton in 2022, although actual banana export prices can vary depending on factors, such as quality, variety, market demand, and supply chain costs. Africa needs to produce more for export to boost foreign earnings for economic growth and development. This can be

achieved through government initiatives and support programs. Structures that will facilitate regional integration for banana production and trade among the African countries should be facilitated.

4. Prospects of bananas as value addition

Although there is a huge prospect for banana exports in Africa if massive investment could be deployed in sustainable production, the focus should not be exclusively on production for export; efforts towards the possible conversion of fresh produce into an added value for a good return on income for farmers should be part of policy framework work [34]. Bananas have a high potential for value addition, especially in producing products, such as banana chips, banana flour, banana wine, and banana puree. Strengthening such local value chains for bananas thus allows a greater number of people to participate, especially in rural areas. Some possible value-added products obtainable from bananas are highlighted, as follows.

4.1. Banana chips

Banana chips are family snacks in many societies that may be produced as described in Bornare et al. [35]. The production of banana chips entails the peeling of banana fingers treated with 0.1% potassium metabisulphite (KMS) for color retention and cut into slices of 1.2–0.8mm thickness for frying in suitable cooking oil. Upon frying, crisp yellow-colored chips are produced, which could be sprinkled with common salt and packed in polyethylene bags. The chips are usually savory, high in calories, and thus eaten as snacks. The storage life is about 30–35 days under ambient conditions. The oil used in frying could go rancid, and chip crispness becomes soft if the chips are not stored in airtight containers. Packing the chips in laminates with nitrogen gas can extend their shelf life by as much as four months.

4.2. Banana flour

The perishable nature of bananas, which are highly susceptible to damage, could result in significant postharvest loss and waste. Drying is extensively used to preserve the storage life of agricultural products, thereby allowing their whole-year availability. Drying and dehydration are two of the most important operations that are widely practiced because of the considerable savings in packaging, storage, and transportation.

Banana flour is produced from unripe, mature green fruits. The finger could be peeled using a knife or hand peeler and then sliced into 1–2mm thickness for effective, uniform drying. Before drying, the slices are immediately dipped into a citric acid solution (0.5%) for 30 min to avoid enzymatic browning. These slices are removed and put in a tray dryer at 55 ℃ for 6 h. The slices are then ground into flour, which is packaged in polyethylene pouches and stored at room temperature for further use [36,37].

4.3. Banana powder

Banana powder can be prepared from matured fruits by milling using a hydraulic shear to convert them into a paste. After that, sodium metabisulfite is added to enhance

the paste's yellow color. The paste is subsequently dried by spraying or drum drying, with the latter being more popular because no paste is wasted during the drying process. The flow sheet for banana powder preparation is shown in **Figure 2** below.

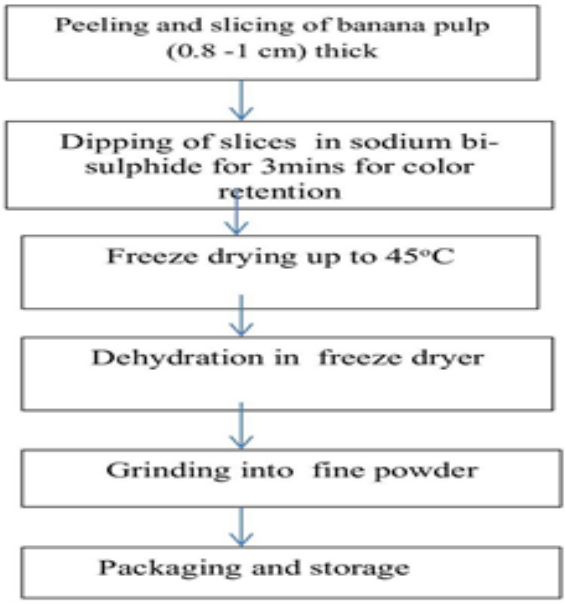

Figure 2. Flow chart fort production of banana flour.

Currently, banana powder is packaged in tetra-packing material (50–100 g in small pouches) for long-term preservation. Banana powder produced from dried green bananas may be kept for several months in airtight containers. The moisture content of the final product should be around 2%–4%. This product has a high market value, as it is extensively used in the confectionery industry, ice cream preparations, and baby food making. When suitably packed, it will have a shelf life of more than six months [35]. The powder could be fortified with milk, green gram, and sugar for baby food preparation. It can be adopted by food processing industries for the commercial manufacture of banana-based baby food. The product is likely rich in carbohydrates and energy. Baby food and health drinks are highly energetic and nutritious, which may be used for growing children [38].

4.4. Banana puree/juice

Bananas can be processed in various ways so that they may be stored for longer periods and utilized for other purposes. Puree is one of the processed products of bananas that could be commercialized. The puree can be used as an ingredient in dairy desserts, bakery items, drinks, processed foods, and sausages. The puree is made from fully mature bananas that are allowed to ripen at room temperature. The ripened bananas are washed and blanched unpeeled in hot water for 3 min and then in cold water. These are then peeled and dipped in 1% potassium metabisulfite. Pulping is done by adding 1 L of water to every 1 kg of banana pulp. Next, 0.1% citric acid, 10% sugar, and 200 ppm of potassium metabisulphite are added; the mixture is heated for 20 min, filled into a sterilized jar, sealed, and stored in a cool place. To obtain clear juice from a very thick puree, the mixture is treated with pectolytic enzymes and

filtered. After pasteurization and bottling, the juice can have a shelf life of a minimum of six months under ambient conditions [35]. Mechanically, juice preparation could also be done by mashing banana slices of approximately 3 cm thickness in a blender. A prolonged blending changes them into a homogeneous viscous puree, which is collected from the blender, wrapped in a cotton cloth, and hand-squeezed to get clear juice. The juice is pasteurized and bottled for a long shelf life.

4.5. Flavor bio-generation from banana

Flavors are sensory impressions we experience when consuming foods and beverages. According to food and beverage regulations, flavors are broken down into three main categories: artificial flavors, spices, and natural flavors. The US Food and Drug Administration ensures that food and beverage flavors in the market are safe for ingestion when consumed.

Flavors are formed through chemical reactions during food processing, and they involve mostly the reduction of carbon, nitrogen, and/or sulfur compounds, along with the generation of volatile organic compounds, such as aldehydes [39]. Biogeneration of aldehydes and alcohol used in the flavor industry can be achieved naturally through enzymatic pathways utilizing enzymes, such as lipase, alcohol dehydrogenase (ADH), lipooxygenase (LOX), and hydroperoxide lyase (HPLS) [40].

4.6. Yogurt fortification with banana puree

Yogurt is a type of dairy product produced from milk or milk products by lactic acid fermentation through the action of starter cultures (*Streptococcus salivarius subsp. thermophilus* and *Lactobacillus delbruekii sub-spp. bulgaricus*) [41]. It is one of the most famous fermented dairy products widely consumed in many countries. Yogurt is a healthy food for both adults and children [42].

For quality improvement, less-viscous banana puree could be added to yogurt production to enhance the pleasant taste, flavor, and nutrient density. Bananas are a rich source of vitamins and minerals, rich in fiber and carbohydrates, and low in fat. Bananas contain vital minerals, such as potassium, phosphorus, calcium, magnesium, sodium, iron, copper, zinc, and manganese. Bananas also contain dopamine, a powerful antioxidant, and all the B-group vitamins present in the plant kingdom. Thus, bananas contribute to the proper functioning of energy metabolism and the nervous system and maintain good digestive transit.

5. Conclusion

In conclusion, Africa can have a comparative advantage in the massive production of bananas as a fruit crop for food security. The potential of bananas as a recipe for food security and economic growth is immense. The fruit’s nutritional value and ease of production in a wide range of climates make it an ideal crop for providing access to safe and healthy food. However, a strategic plan that involves huge investment and a sustainable market structure to facilitate sales is needed to unlock the potential of the banana sector in Africa. Identifying and prioritizing the role of bananas for Africa’s food security and as a platform for wealth creation for economic growth is most welcome.

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