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REVIEW ARTICLE

Review of the Role of Orphan Crops in Food Security

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Abstract: Ethiopia is one of the most populated countries in Africa. Agriculture employs over 70% of the population. It is dominated by small-scale farmers who practice rain-fed mixed farming by using traditional technology, adopting a low input and low output production system. As a result, it is vulnerable to adverse weather conditions. Cereal crops provide food for majority Ethiopians, so most agricultural transformation plans prioritize increasing cereal crop productivity. However, about five million people experience food insecurity each year and require support. Population growth, environmental degradation, conflict, and climate change are the most serious threats to nation's food security. In a time when the food supply cannot keep up with population expansion, there is a need for holistic solutions to development-related issues such as food insecurity, malnutrition, and poverty. Despite Ethiopia being a center of origin and diversity for several food crops, the potential benefits of underutilized indigenous crops are yet not exploited. However, they can play a significant part in human nutrition, income, and medicinal value. As a result, crop diversification may be the best choice for achieving household food security. One way to help nation's food systems diversify is to include more orphan crops. Even though a small portion of the country's land is dedicated to underused crops, more than 20% of the population relies on them for food. Orphan crops, such as enset, which can feed 100 million people, can help to attain food security in Ethiopia. As a result, promoting and researching these crops is the most sustainable strategy for lowering and managing poverty and food insecurity in Ethiopia.

Keywords: Agricultural policy; Cassava; *Ensete;* Food insecurity; Root crops

1. Introduction

Why did the country of human origin and ancient civilization become a symbol of poverty and famine? How can a nation where more than half of the population engages in farming suffer from food insecurity? How did poverty bring Ethiopia, the epitome of African independence, to its knees? These are the kinds of queries that all citizens have. We need to illustrate each agricultural growth barrier to provide accurate and practical solutions to such challenges. To manage the existing obstacles: it is necessary to look deep into the country's agricultural sector.

Agriculture is the foundation of Ethiopia's economy, and 82 percent of the country's population lives in rural areas that depend solely on it [1]. It is the economy's backbone, accounting for approximately 32.7% of total GDP [2],

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contributes 79 percent of foreign earnings, and is one of the most important sources of raw materials and capital for investment and market. It is also the most source of employment, accounting for roughly 73 percent of total jobs [1]. The sector is dominated by small-scale farmers who practice rain-fed mixed farming by employing traditional technology, adopting a low input and low output production system [3]. Despite various Ethiopian governments' efforts over the last half-century or more to turn the country from an agriculture-based economy to a manufacturing hub, agriculture continues to be the most key sector in terms of employment, revenue, and food security [4]. However, it is renowned for the recurrent food shortages caused by droughts, natural catastrophes, pests, a lack of rainfall, and a lack of technical developments. In addition, poor productivity resulted in an unbalance between population and production, resulting in the extension of the agricultural area through deforestation and rangelands.

The world's population is anticipated to reach 9.8 billion by 2050 [5]. According to Tilman *et al*. [6], to feed all those people by 2050, the world would need to produce 70% more food than it does today. However, the circumstances do not favor completing such a massive assignment. Currently, almost 800 million people are malnourished, 2 billion are micronutrient-deficient, and another 2 billion are overweight or obese. More than 50% of the African population is exposed to moderate or severe food insecurity. The highest level of food insecurity was recorded in East Africa (63% of the population, or 272 million) [7]. In Ethiopia, food insecurity is a significant challenge. Despite various efforts by the government and non-governmental organizations to support and improve the lives of millions of poor farmers, the majority of the population is food insecure, an estimated 20.4 million people currently require food assistance [8]. The nation's food security situation is inextricably tied to severe, periodic food shortages and famine caused by continuous drought. Ethiopia is particularly vulnerable to severe seasonal droughts, which have occurred every decade since 1953. The droughts have resulted in widespread crop loss and livestock fatalities. As a result, inflation and food prices have risen, increasing displacement and soaring malnutrition rates.

The FAO [9] highlighted three significant factors for the growth of food insecurity in East Africa: violent conflicts, climatic adversity, and the global economic environment. Climate change is making the world less suited for agriculture. A 2 °C increase in average temperatures is projected to create dramatic alterations in seasons and agricultural production [10]. Drought devastated 363 million people in Sub-Saharan Africa alone between 1980 and 2014 [11]. According to Pacillo *et al*. [12], climate also exacerbates existing household risks and vulnerabilities, increasing the likelihood and intensity of the conflict. Conflicts in Northern Ethiopia have made plowing extremely difficult since oxen needed to till farmlands have been looted and deliberately slaughtered. Furthermore, agricultural supplies such as seeds and fertilizer were scarce. Moreover, the conflict between Russia and Ukraine has already harmed global wheat prices. Ethiopia, which relies on wheat imports, is especially vulnerable to possible wheat price shocks since it is already suffering from internal socioeconomic and climatic shocks, both of which have resulted in high food prices.

To reduce the impact of climate change and increase/maintain world food production. There two potential approaches can be pursued. The first involves increasing yield per unit area of crops through genetic enhancement and improved agronomic practices [13]. Second, there should be breeding activities for stress tolerance and resource efficiency in marginal areas, and more research must work toward the introduction, assessment, and adaptation of underutilized crops for nutritional diversification. For example, Demeke [14] claims that 60 mature enset plants (Orphan crop) may offer adequate food for a household of five to six people over the course of a year when consumed with other dietary components.

Ethiopia is rich in biological resources. It had mentioned by several scientists that the country exhibit extraordinary genetic diversity in crops such as barley (Hordeum Vulgare), Wheat (Triticum spp.), sorghum (Sorghum bicolor), teff (Eragrostis tef), sesame (Sesame Indicum), Enset, Anchote, and other lesser-known but potential species of plants. Ethiopia is the center of diversity for eleven cultivated crop species that have been identified [15]. Despite being a center of food crop diversity and domestication, Ethiopia has been the largest receiver of targeted food aid [16]. It is ranked 174 out of 188 nations in the 2015 UN Human Development Index, and 104 out of 119 in the Global Hunger Index [17]. Rural poverty is also prevalent, with 30.4 percent of rural households living in poverty. According to the FAO [18], both chronic and transitory food insecurity persist at the family level, and millions of people remain susceptible as a result of various shocks and pressures. On average, 32% and 40% of Ethiopia's population are malnourished, and they consume less than the required daily calorie intake [19].

The country's rapidly growing population, low agricultural production, food insecurity, and reliance on food imports all highlight the importance of a comprehensive agricultural policy. Agricultural policies, in general, are the laws that govern agricultural activity as a whole and play a significant role in agricultural economic growth [20].

According to a large body of literature, governments define and decide on policies, commonly to achieve specific goals. Agricultural policy, for example, could be described as the maximization of agricultural output following consumer demand. Agricultural policy is critical for countries, particularly Ethiopia because it affects food security, water, the environment, jobs, and the economy. Since 1991, Ethiopia's government has implemented a variety of agricultural policies to eradicate poverty. The most visible and long-lasting economy-wide strategy to guide development efforts has been agricultural development-led industrialization [21].

According to some reports, food insecurity is a structural problem in many rural parts of Ethiopia. Even in years with abundant rainfall and pleasant weather, millions of Ethiopians have always been at risk of starvation. Approximately 10% of Ethiopians are chronically food insecure, 2.7 million people required emergency food assistance in 2014, and 238,761 children require treatment for severe and acute malnutrition [22]. As a result, short-term crisis response solutions cannot address the underlying source of the problem. It necessitates looking beyond the immediate stimuli, such as extreme weather events. As a result, an alternative food crop that can help to reduce climate change while also producing a reasonable yield in unpredictable weather should be available. Given the country's current food crop deficit, crop diversification can be a critical option. One opportunity to support food system diversification in Ethiopia is through the greater inclusion of orphan crops.

As a result, this review had been conducted to analyze the potential of some selected orphan or underutilized crops for enhanced food and nutrition security in Ethiopia, emphasizing the beneficial aspects of these crops as well as their relevance in Ethiopia's socioeconomics. Finally, it seeks to demonstrate how orphan crops might become a game-changer in Ethiopia's food crisis issue if government policies encourage the agricultural community to embrace these crops on a large scale.

2. Impediments to Ethiopian Agriculture Growth and Development

In Ethiopia, food security is the great challenge and most crucial constraint to further growth and development concerning agriculture. This condition has arisen a strong dependence on rain-fed agriculture. Ethiopian agriculture had characterized by cereal crop production, but productivity remains poor. A significant amount of money is invested in agricultural extension programs to boost cereal crop production and productivity. However, domestic demand for cereal crops is increasing, and the government has been importing cereal crops, especially wheat, to balance the domestic market for the past ten years. Despite the government's efforts to ensure the nation's food security, poverty affects a large population. According to Degefa and Anbessa [23], food insecurity is on the rise, with 55 percent of farmers unable to feed their families for more than six months. Every year, at least seven million people require food assistance because efforts to address the problem through grain-led approaches have failed to keep up with population growth. Furthermore, Ethiopian trade statistics show that the country imports nearly $2 billion in food products each year. In line with this, the additional impact of conflict, climate variability, and economic slowdowns and downturns raise the effect of food insecurity and threaten food safety.

Ethiopia's agricultural output is complex, with significant variation in crop types grown across various regions and ecosystems. Teff (local small grain), wheat, barley, corn, sorghum, and millet are the significant grain crops grown in the country. These crops are primarily rainfed and produced throughout the country. Despite the increased area of cereal crops production, most cereal crops in the country have seen an increase in demand and price. For instance, according to Anteneh & Asrat [24], wheat demand will increase by 90%, while supply will grow by 73%, implying that there will be a supply deficit in the future. This predicament has arisen in population growth, urbanization, and food habit changes. Maize production in Ethiopia is estimated to reach 8.63 million tonnes in 2021/2022. This increase in production was caused by the use of improved hybrid seed and increased demand as feed for both humans and livestock. Despite the production rise, the country expected to import 35,000 tonnes for food aid.

Ethiopia is currently dealing with a difficult situation in terms of foreign exchange earnings. It is due to unbalanced trade between foreign countries. Thus, the borrowing required to finance this trade deficit has resulted in a high foreign exchange shortage and debt burden. Ethiopia's public debt was 53,667 million dollars in 2020, a decrease of 29 million dollars since 2019. This amount means that the debt in 2020 will be 55.43 percent of Ethiopia's GDP, a 2.49 percentage point decrease from 2019 when it was 57.92 percent of GDP (ICIS, 2020). The current conflict in the country's north will exacerbate the situation. Aside from the population that requires annual food aid assistance due to natural disasters, millions more people have joined the food aid support list. Aside from the humanitarian crisis, the conflict has impacted agricultural production because it began during the cropping season. Moreover, the military expenses related to the conflict and the impact of the COVID-19 pandemic resulted in pro-

duction and export contractions, with an ensuing further degradation of the economic environment. The conflict also reduced sesame production, as 40 percent of production was in the conflict zone. The one thing we should remember is that oil crops are the country's second-largest export earner after coffee. As a result, the country's export earnings will be under pressure. It indicated that the country had in the wrong direction in terms of strategy. Thus, new developmental strategies are needed to restore economic growth and mitigate the consequence of human-made famine which, starts to knock on the country's door. Various findings indicate that emphasizing agriculture in Ethiopia necessitates political and economic commitment from all parties involved [25].

2.1 Agricultural Policy

The Ethiopian economy is heavily reliant on agriculture as the primary source of employment, foreign exchange earnings, and food security for the vast majority of the country's population. However, agricultural performance was unsatisfactory, as poverty remained a significant feature of the country in the world. In this regard, the lack of appropriate policies and strategies had viewed as the root cause of the sector's previous stagnation. As a result, to address this issue and promote agricultural growth as an engine for the industry and the overall economy, the government devised the Agricultural Development Led Industrialization national development strategy (ADLI) [26]. The policy prioritizes modernizing smallholder agriculture and increasing yield productivity through appropriate technology, certified seeds, fertilizers, rural credit facilities, and technical assistance. The policy made changes, particularly in the area of chronic poverty alleviation. It had, however, failed to fulfill its primary goal of expanding the industry's contribution to national GDP. Furthermore, the policy provided little attainment for pastoral development [27]. As a result, domestic supply shortages of agricultural and manufacturing commodities are significant causes of Ethiopia's current inflation, high food prices, which primarily affect the welfare of low-income households [20].

Despite the government's commitment and an admirable strong reputation of agricultural support, the sector has underperformed. Several findings suggest that to transform the nation's agricultural strategy, there must be a clear understanding of the complex issues involved, evidence-based analysis and policy recommendations, and consideration of alternative options [28]. In addition, the agricultural transformation is required to facilitate the transition of an economy from natural-based activities to manufacturing and services. Because as agricultural productivity increases to its full potential, it will be able to provide affordable food and other raw materials to support structural change while also allocating labor and capital for other sectors. However, Ethiopia's agricultural sector performs poorly. As a result, the government must commit to improving the performance of this critical sector of the economy.

2.2 Commitment and Prioritization

The government played a critical role in educating people about the importance of rural development and ensuring a stable rural economy. Governments must begin by establishing rural development as a national mission, and they must do so in consultation with the people. Farmers no longer had to be concerned about who would buy their products. They could concentrate their efforts on growing them as much as possible. The farmer was not in charge of the entire supply chain. However, in Ethiopia, the value chain of the majority of stable crops was semi-structured, and the government placed a special emphasis on cash crops such as coffee and sesame, which are the country's main export commodities. Maize is one of the most significant contributors to Ethiopia's economic and social development. In Ethiopia, maize is grown by more than 9 million smallholder households, more than any other crop. Maize productivity and output have more than doubled in the last two decades. The yield, 4.3 tons/ha in 2020, is the second-highest in Sub-Saharan Africa [29]. Several studies have found that if yield potentials are realized, maize can help to improve food security. However, several constraints exist throughout the maize value chain, including drawbacks in production, aggregation, and trading, as well as demand sinks or end markets [30].

Wheat is a significant stable and cash crop in Ethiopia, contributing to increased income, food security, employment, and national GDP growth [31]. Even though wheat productivity showed an increasing trend in the past two decades, there is still a 20% deficit that must be met through imports. When compared to maize, the wheat value chain is semi-structured and superior. However, a lack of market information leads to uncontrollable price increases [32]. As a result, the government took on significant responsibility in developing policies and programs to ensure that farmers received all of the assistance they required to succeed.

The government must also play a critical role in prioritizing the allocation of limited resources. It should consult with stakeholders over which crop products to invest in. Furthermore, crop selection should take into account both food security and imports. According to Yigezu [25], Ethiopia has a diverse range of climates and soil types, allowing it to cultivate a diverse range of horticultural crops. Furthermore, the country has a sizable labor force

as well as plentiful water resources. Its proximity to Middle Eastern markets benefits imports of fruits and vegetables. As a result, concentrating on agriculture in Ethiopia necessitates both political and economic commitment from all parties involved.

2.3 Agricultural Research and Development

Despite the availability of several improved agricultural technologies developed by Ethiopia's research system over the last four decades, smallholder farmers have adopted these innovations at a very low rate. As a result, agricultural productivity has stagnated and, crop yields have been low, exposing the country to recurring food shortages and national food insecurity [29]. Agricultural research in the country focused on developing new technologies, primarily through on-station research, to reach farmers through the public-sector extension system. Despite several research centers and more than 40 public universities in the country, the small-scale farmer still uses traditional production tools. The government put a large amount of money into agricultural research activities. However, most researches had done for the sake of benefiting researchers. As a result, scientists should assess how applicable their research findings are and how much they contribute to agricultural development. Furthermore, research activities should be directed toward farmer demand rather than quality.

Ethiopia's agricultural sector can be transformed if the government implements a triangle system that includes interactions between farmers, extension, and research. The government prioritized extension and committed funding. In 1994, the government implemented the Agricultural Development Led Industrialization Strategy (ADLI). In 1995, a new extension approach, Participatory Demonstration and Training Extension System (PADETES) had adopted within the framework of ADLI. The strategy enabled the establishment of nearly 12,500 farmer training centers across Ethiopia, and approximately 83,000 DAs had trained in total, with a reported 56,000 staffed on-site [33]. According to Berhane *et al.* [33], an extension system promotes modern inputs such as chemical fertilizers, improved seeds, herbicides, and irrigation. However, it has an indirect effect on increasing productivity levels. Furthermore, the authors argue that agricultural productivity increases in Ethiopia are not yet knowledge-driven. Therefore, the agricultural extension system should change to become more knowledge-driven and problem-solving.

The government also has a responsibility to enhance the number of extension workers. There are 21 development agents (DAs) per 10,000 farmers, with even more in high-potential areas [33]. A ratio of around one worker for every 476 farmers. Despite these efforts to improve the extension system's effectiveness and efficiency, the system is not yielding the desired results. Many technologies for increasing yield and quality have been developed in agriculture, but they are not reaching smallholder farmers. Similarly, the agricultural sector is underutilized in food self-sufficiency and poverty reduction. It is due to ineffective implementation and, lack of strategic intervention. Agricultural extension workers are frequently used as a political tool to deal with the nation's majority population. There will be a change in the sector if there is a genuine golden triangle model of interaction between research, extension, and farmers.

2.4 Food Safety and Food Security

Hunger and malnutrition are today's main concerns, with 960 million people either hungry or undernourished. Food insecurity is a persistent and significant issue in Ethiopia. Natural calamities such as severe drought, floods, instability, and conflict are the leading causes of food shortages in Ethiopia. These factors have deteriorated, resulting in large-scale displacement along the borders of Somalia, Oromia, and SNNPR [34]. Ethiopia's government is taking a significant leadership role in addressing the problem of food insecurity by implementing programs that serve the diverse needs of disadvantaged families. It is making substantial investments and achievements, notably through its productive safety net program [35].

Food insecurity has traditionally had regarded as an issue primarily impacting rural populations. As a result, most research on food insecurity excludes urban inhabitants. Recent findings indicate that, however, have begun to recognize the necessity to include food insecurity as a problem affecting the urban population [36]. Inflation had a significant factor in the rise of food insecurity in Ethiopia's cities. Since mid-2005, the country has been experiencing a spiral of price increases, with grain prices increasing by more than 100%. To address the issue, the Ethiopian government and humanitarian groups establish an initiative to assist urban poor food insecure families in improving their nutritional quality and addressing the underlying causes of food insecurity by giving them food and cash. However, it had a negative impact on the population as the trend made the people to wait for the aid and create dependency.

Food safety, public health, and sustainability must all be considered while developing instruments and strategies to attain food security because food chains are complicated and opaque [28]. Furthermore, the regulation of food fraud is a new issue that needs attention. Food security has been jeopardized when there are insufficient supplies

of healthy and safe foods or when customers' purchasing power is constrained [38]. Food safety and food security are unavoidably complementary goals in the pursuit of hunger abolition. One of the tenets is that unsafe food does not help food security issues. Food safety and quality controls, on the other hand, can occasionally restrict the amount of food available, exacerbating food scarcity [39].

The cultivation of biofuel crops is another issue concerning food security. Biofuel is gaining popularity in most regions of the world, particularly in developed nations, due to its sustainability. However, it has become a difficult topic because of rising commodity costs, a negative impact on food security, and, eventually, the issue of climate change. Biofuel consumption is predicted to rise in the coming years. However, there are significant worries about the impact of growing biofuel production on food security. Biofuel demand has the highest impact on food security by rising food costs and increasing import reliance [40]. Others argue that growing demand for sustainable biofuels would drive investment in agricultural production and that there may be synergies between biofuel and food production by bringing investment into relatively underdeveloped areas with limited access to input and output markets. According to Han *et al*. [41], the use of maize as a biofuel crop in China could lead to shortages of feed, growth in imports, and price increases. In addition, the price effects on maize have also been reflected in food grain prices through substitution effects and livestock prices.

Food safety is an umbrella phrase that incorporates various aspects of food handling, preparation, and storage to avoid disease and harm. Foods can become contaminated at any stage during the manufacturing process. The Food and Agriculture Organization (FAO) of the United Nations (UN) defines food security as "food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" [42]. Food security, on the other hand, is dependent not only on the availability of food but also on the ability of the home to prepare and store food, as well as the families' access to the available food. Climate change will also have an influence on people's capacity to use food successfully by raising the potential of water and food-related infections (Figure 1). Access to food refers to the capacity to access a sufficient amount and quality of food, whether through purchase or production. Climate change, food prices, COVID-19, productivity, and the value chain all have an impact on the food supply. Climate prediction models indicate that agricultural productivity will be greatly impacted in the future. The anticipated rise in average global temperature caused by increasing greenhouse gas (GHG) emissions into the atmosphere, as well as higher depletion of water resources owing to increased climatic variability, would pose a severe danger to global food security [43]. Aside from the effects of climate change, agricultural output is being limited by rising input costs such as labor and fertilizer. While the primary cause for increased fertilizer costs is the high cost of coal and natural gas, trade policies are also to blame. High fertilizer prices may impose inflationary pressures on food prices, exacerbating food security issues at a time when the COVID-19 epidemic and climate change are making food availability more difficult. The scarcity and high cost of fertilizers will impact African food systems shortly. Millions will face starvation as a result of low productivity. Reduced yields, followed by increasing food costs, will be a significant cause of inflation and a severe danger to food security and political stability in many Sub-Saharan African nations.

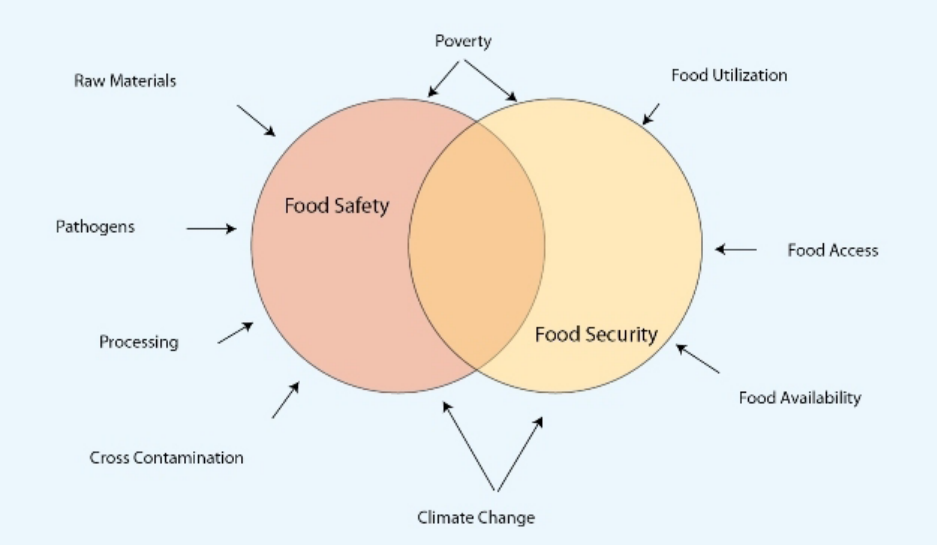

Figure 1. Overview of the Interrelationship Between Food Safety and Food Security [44]

3. Potential Benefits of Underutilized Root and Tuber Crops Production

Natural calamities had a significant impact on Ethiopian agricultural production. The agricultural sector's success or failure is heavily influenced by the country's topographic settings, degree of human interference, and underlying biophysical features. Farming practices in the country disrupted entire ecosystems, particularly soils, resulting in rapid nutrient depletion in the soil. In addition, environmental sustainability issue also becomes a serious agenda because of rapid industrialization, urbanization, and population growth. As a result, farmers would have better necessity accessibility to other crops that use new, environmentally sustainable technology to ensure food security and environmental sustainability. Crops that can withstand climate change and provide higher productivity are needed to address the food security problem. Reviews of crop susceptibility to climate change show that root crops like cassava may be best suited to withstand climatic variation than most major tropical staple crops, making it a crucial food security crop for the future [45].

Kusse [46] identifies four plausible reasons for increasing and encouraging root and tuber crop production and productivity in Ethiopia. They are one of the most and highly adaptable crops to harsh environments; they are nutritionally rich staple foods crops; they are suitable for double cropping to overcome food security issues; and they can be a year-round food source. The major root and tuber crops found entirely in Ethiopia include; enset, potato, taro, yams, cassava, and sweet potato [47]. Ethiopia has diverse agro-ecological zones that are suitable for the production of a wide range of food crops. However, the area allocated for root crop production is limited. The significant root and tuber crops contribute the most to the traditional food system of many Ethiopians [48].

Different findings reveal that the high yield gaps between potential and actual yield in rainfed agriculture in Africa show that there is still enormous potential for intensification. Along with cereals, highland banana, false banana, root and tuber crops (e.g., cassava, sweet potato, yam, and Irish potato), and aroids (e.g., taro and cocoyam) are important staple crops in Ethiopia. However, root crops such as potatoes, sweet potatoes, taro, and cassava accounted for 2% of Ethiopia's total cropping area [49]. For instance, cassava is among the most widely cultivated crops in some districts of the Wolaita zone, southern Ethiopia [50]. According to Tafesse *et al*. [51], cassava has the potential to yield 80 t/ha of the fresh root within a 12-month growing season, compared to averages of 22.4 t/ha in the main cassava producing area. It indicates that if the Ethiopian agriculture revolution considers neglected crops, they can contribute to attaining the food security of millions of small-scale farmers in Ethiopia.

Cassava is one of the most extensively produced carbohydrate crops in the globe. It can be a cash crop and a source of industrial raw material. It is the fourth most important food crop in the developing countries after rice, wheat and maize [52]. It is an important source of food calories in Sub-Saharan Africa, fulfilling a critical role as a food security crop [53]. Its roots are also one of the most important sources of commercial starch. In fact, the crop is the second most important source of starch worldwide after maize [54]. Despite the growing importance of cassava as a food security and income generating crop for smallholder farmers in Ethiopia, as well as for its potential to contribute to national economic, cassava production and productivity in Ethiopia are low compared to other crops [55].

However, taking a look at some of the possible benefits of cassava production in Ethiopia will show why the government should prioritize root and tuber crop cultivation.

3.1 Flour Production

Cereal prices have risen significantly in the last two decades as cereal production has leveled off [56,57]. Inflation has aggravated food insecurity in Ethiopian cities. Thus, the potential of root crops such as cassava to strengthen food security deserves attention. Several countries are interested in promoting local flour sources as a partial substitute for wheat flour in food products [58]. The use of cassava flour as a composite in various food products could reduce costs and increase local production [59]. Furthermore, gluten-free non-wheat flour made from root and tuber crops like cassava has helped to avoid the combined impact of growing food prices and wheat allergy.

3.2 Starch Production

According to Desta and Tigabu [60], starch production in Ethiopia is low, and only two private limited companies provide close to 40% of the total starch demand in the country. The remaining balance is filled dominantly from abroad with high foreign currency. Presently, maize, wheat, cassava, and potato are the dominant crops widely starch extraction.

Cassava crop will probably have the potential to be cultivated and valued over other root crops due to their low input requirements, pest resistance, and ability to mitigate the harmful effects of climate change [60]. Cassava starch is superior to other starch source crops such as maize, wheat, sweet potato, and rice because of its high grade, excellent thickening, neutral taste, desirable texture, and

relatively low cost. According to Nuwamanya *et al*. [61] findings the ash, fat and protein contents were high among cereal starches than root and tuber crops especially for cassava (Table 1). Low associated compounds compositions in cassava starch shows the high purity displayed and the ease of extraction. Cassava starch also characterizes by high amylose content which determine properties and uses of starch. In addition, high paste clarity observed for cassava makes it a better option for application in food and industry textile where high clarity is required. According to *Zhang et al*. [62] high past clarity is easily achieved with chemical modification, but starches such as cassava, such modification procedures may not necessarily make it cheaper and better than most other starches.

Cassava starch extraction is also a simple process that makes it suitable for developing countries like Ethiopia [63]. Furthermore, the market for starch products may grow as the demand for environmentally friendly products such as biodegradable packaging material grows as the globe becomes more concerned about the environment. Cassava is the most widely grown crop globally for producing a sustainable and affordable source of starch [64]. As a result, replacing non-biodegradable goods could be a big market in the world market, and cassava-producing countries could benefit from it.

3.3 Ethanol Production

Ethiopia is one of the fastest-growing nations in Africa and aims to reach lower-middle-income status in the coming few years. Maintaining the nation's energy stability is essential for the country's continuing development program [65]. Ethiopia additionally spends $billion on imported petroleum products each year, accounting for 20% of the country's foreign exchange earnings [66]. To address the issues and achieve energy sustainability, it is critical to expand the production and use of locally produced fuels such as bio-ethanol. Bioethanol production in Ethiopia is a realistic option; as well as supply expense and value will have a significant impact on its feasibility and competitiveness [65]. There are different potential crops for ethanol use in Ethiopia; these include sugar cane, maize, jatropha, castor, cassava, cottonseed, and sweet sorghum.

Cassava has an advantage over other potential biofuel crops in that it requires less input and is more resistant to harsh environmental conditions. Its roots are also less bulky than those of other biofuel crops like sugar cane and sorghum, making transportation cheaper [67]. Cassava has also proven to be the most cost-effective bio-crop [68]. According to Pérez *et al*. [69] findings production costs of fuel ethanol from cassava is lower than the sugar cane in Colombia (Table 2) and it is higher compared with other countries as Thailand (0.18 USD/L. This disparity may be related to the market price of cassava in countries such as Thailand, where productivity surpasses demand, allowing for a reduction in raw material prices while simultaneously decreasing the cost of fuel ethanol production. Geremew *et al*. [65] reported that 34 percent of the country's area land suitable for bioethanol crop cultivation. Hence, it can reduce the energy security burden by cultivating different potential feedstock crops.

Table 1. Comparison of physiochemical properties of starches from root, tuber and cereal crops

Crop	MC (%)	R.S.C (%)	Ash (%)	Protein (%)	Total amylose	SP80 (°C)	SOL80 (°C)	PC
cassava	16.50	0.255	0.31	0.52	0.476	8.575	1.230	50.55
Potato	13.67	0.200	0.26	1.82	0.355	8.440	0.770	42.16
Sweet potato	9.331	0.581	0.28	1.13	0.417	6.88	0.577	22.75
Maize	13.65	0.555	0.54	2.20	0.285	3.96	0.997	19.49
Wheat	10.0	0.246	0.60	6.44	0.468	6.31	0.247	13.47
Sorghum	9.20	0.563	0.63	4.14	0.306	5.25	0.803	21.90
Millet	9.30	0.178	0.70	4.98	0.383	5.16	0.205	5.03

MC: Moisture content; R.S.C.: reducing sugar content; SP: Swelling power; SOL: solubility; PC: paste clarity

Table 2. Fuel ethanol production cost from cassava and sugarcane bagasse case

Items	Cassava case		Sugarcane bagasse case	
	USD/L	Share of total cost (%)	USD/L	Share of total cost (%)
Raw materials	0.272	62.91	0.309	47.7
Utilities	0.027	6.34	0.178	27.4
Operating labor	0.008	1.80	0.008	1.2
Maintenance	0.005	1.13	0.007	1.0
Operating charge	0.002	0.45	0.002	0.3
Plant overhead	0.006	1.46	0.007	1.1
General and administrative	0.026	5.93	0.041	6.3
Depreciation of capital	0.086	19.99	0.097	15.0
Production cost (total)	0.432	100.00	0.649	100.00
Profit margin (%)	65.16		47.66	

4. The Potential Benefits of Orphan Crops

4.1 Enset

Enset (*Ensete ventricosum*) is a perennial herbaceous plant in the Musaceae family, which also includes bananas and plantain. It is a versatile crop in which all portions are used for a variety of applications [70]. Its production is mostly utilized for human food, animal feed, fiber, building materials, medicine, and cultural rituals. Kocho, bulla, and amicho are the most common foods obtained from Enset [71]. Furthermore, because of its high demands on soil fertility and soil structure, enset agriculture enhances soil through persistent soil tillage. The crop is well-known for its drought tolerance, high production, gender equity, and environmental sustainability [70].

In Ethiopia, E. *ventricosum* is perhaps the most significant crop, contributing to food security and rural livelihoods for around one-quarter (20 million people) [72]. According to research, "those who rely on enset have never suffered from hunger, even throughout Ethiopia's awful drought and famine-prone decades of the 1970s and 1980s" [73]. It is an indigenous food security plant that provides sustenance for over 15 million people in Southern and Central Ethiopia [70].

It is a vital economic and socio-cultural significant crop for a large spectrum of smallholder families in the country's population as a staple and co-staple food, and it is also utilized as traditional medicine. Because of its tolerance to variable rainfall patterns after establishment, Enset has been known to serve as a food shortfall barrier for humans and feed for animals during dry spells and recurring droughts. It possesses numerous essential food security characteristics. It thrives in a variety of settings, is drought-tolerant, and may be harvested at any time of year for several years. It is a significant source of dietary starch, textiles, pharmaceuticals, animal feed, roofing, and packaging. It has cultural significance and helps to stabilize soils and microclimates [74]. According to recent research, enset, an Ethiopian plant related to the banana, has the potential to feed more than 100 million people in warmer climates if its production has extended [75].

4.2 Ethiopian Potato (*Plectranthus edulis*)

Plectranthus edulis (Vatke) is an indigenous tuber crop distributed in Ethiopia as cultivated and wild species. It is a tuber-bearing member of the Labiatae family. It is a diploid, dicotyledonous plant that grows in the wild. It can be cultivated at mid to high altitudes in Ethiopia's south, north, and south-west. P. edulis is a high-energy food crop, and the tubers are rich in micro and macronutrients. In comparison to the Irish potato (*Solanum tuberosum*) [76]. It has more dietary energy and twice as much fat and calcium [77]. After cooking, it has roughly the same amount of protein as Irish potato and nearly doubles the amount of protein as sweet potato (*Ipomoea batatas*) [77]. The leaf is also prepared and consumed as a vegetable in some western regions of Ethiopia, notably in the Kaffa districts [78], and is used as a traditional medicine to treat a variety of diseases. Furthermore, farmers value P. edulis and believe it fills hunger better than other tuber crops. They feel that this tuber is vital because it gives them energy and encourages them to have more children [79]. Furthermore,

when wood is scarce, the dried stems of the crop are used as firewood. As a result, it may minimize the number of trees chopped down for firewood. Despite this promise, relatively little study has been conducted to boost P. edulis output [80].

Despite its importance in ensuring family food security, crop output has been dropping. Some of the major causes that have contributed to the decline include the introduction of new species of root crops, recurring droughts, and land scarcity, research focus of the country that mainly targets cereals and commercial crops, a long maturity time paired with a short shelf life [79]. The decline in cultivation of the crop may result in erosion of the genetic base preventing the use of distinctive useful traits that are used for crop adaptation and improvement [81]. As a result, increasing agro-biodiversity to improve food and nutrition security is a critical component of long-term development. As a result, the government and policymakers should prioritize such a spectacular but underutilized crop to be exploited and used to alleviate food poverty.

4.3 Anchote (*Coccinia abyssinica*)

Anchote (*Coccinia abyssinica*) (Lam.) Cogn.] is a tuber crop in the Cucurbitaceae family. The genus Coccinia has around 30 species, 10 of which are found in Ethiopia; however, only *Coccinia abyssinica* is cultivated for human consumption [83]. Despite being a key traditional food crop in the region, it is unknown in the rest of the globe. Anchote grows at elevations ranging from 1300 to 2800 meters above sea level, with annual rainfall ranging from 762 to 1016 mm. Anchote is widely grown in Ethiopia, particularly in the country's western and southwestern regions.

Its tubers are rich in macro-and micronutrients (for example, Ca = 7.78 mg, Fe = 5.23 mg, and Zn = 2.05 mg/100 g tuber). Anchote tubers and leaves have long been used in traditional medicine to treat a variety of diseases. It has a high concentration of nutrients such as crude fiber, protein, calcium, iron, zinc, and magnesium, which are uncommon in tuber crops. Local farmers claim that it aids in the rapid healing of fractured bones and misplaced joints. Anchote eating may also minimize the problem of vitamin A deficiency because of its high vitamin A content. Traditionally, breastfeeding moms are thought to be healthier and stronger when given anchote. The flour is also used as a supplement for newborns and young children. In addition, anchote tuber juice contains saponin, which is used to treat gonorrhea, tuberculosis, and malignancies [84].

Girma and Dereje reported that Anchote could be cultivated with minimal inputs and provide an acceptable yield under poor soil fertility, acidic soil, and drought conditions. The crop can be planted as a backup crop in case of crop failure. Although the crop has considerable value in achieving food security due to its drought resilience and capacity to stay in the soil for a longer period, there is insufficient agronomic knowledge. Despite its long history of cultivation and use, anchote has not been subjected to systematic study to comprehend the genetic architecture and manipulate it in an improvement program. Because of the lack of attention paid to anchote research and development, no variety has been produced or marketed thus far [85]. Although it has received little attention, genetic diversity in anchote may lead to the identification of new genes for combating agricultural production challenges. Anchote is suited to a variety of climates and provides a nutritious food supply if other crops fail. Anchote is a promising perspective crop for achieving household food security due to its varied feature.

5. Conclusions

The world's population is anticipated to reach 9.8 billion by 2050. However, the circumstances do not favor completing such a task. Climate change, population growth, a scarcity of farmland, and conflicts were the primary impediments to achieving food security. Chronic and transitory food insecurity has afflicted a considerable proportion of Ethiopia's population. The number of persons who are chronically food insecure is significant. Ethiopia's food security status had related to severe, repeated food shortages and famine, which have a direct relation to persistent drought. Currently, more than 17% of the overall population, the vast majority of whom live in rural regions, requires food assistance. As a result, farmers would have better necessity accessibility to other crops that use new, environmentally sustainable technology to ensure food security and environmental sustainability. Despite this, the current agricultural policies mainly focus on national or regionally significant crops without consideration for indigenous crop production. However, this does not seem realistic, especially for subsistence farmers in developing countries like Ethiopia, who prefer to increase their options by diversifying their small plots of land rather than homogenizing them with high external inputs and varieties. One opportunity to support food security is by employing crop diversification with greater inclusion of orphan crops. These crops could be utilized as a drought reserve crop since they give high productivity even in conditions that are generally considered unfavorable for other crops. These merits are paramount to meet food and nutrition security in these challenging climate change times. As a result, significant institutional and operational

reforms are necessary to improve the constraints and utilization of underutilized indigenous crops in Ethiopia.

Availability of Data and Material

Not applicable.

Author Contributions

The corresponding Author conceived of the paper, gathered the appropriate literature review articles, and wrote the first draft of the manuscript. Finally, the author read and approved the final manuscript.

Conflict of Interest

There is no conflict of interest associated with this publication.

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