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The Economic Importance of Cowpea in Nigeria

Trends and Implications for Achieving Agri-Food System Transformation

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ABSTRACT

Nigeria is the largest producer of cowpea in the world and one of the highest consumers. This paper documents the challenges in cowpea production and consumption, export, and import trends in Nigeria. The critical and comparative review reveals several important insights. Cowpea is important for households and communities due to its substantial contributions to food security, nutrition, and revenue production. It plays a pivotal role in supporting various stakeholders involved in the value chain, including producers, processors, traders, and food vendors. Thus, cowpea is a crucial multipurpose crop. Although Nigeria is the largest producer of cowpea in the world, with a total production of 3.6 million tons in 2021, the demand for cowpea surpasses its supply due to factors such as the country's large population and low productivity. We describe the main challenges encountered in Nigeria's cowpea production, encompassing a range of issues such as high susceptibility to pests and diseases from planting to storage phases, low adoption of improved cowpea seed varieties, poor soil fertility, drought, and heat stress. The data suggest that low input use, low-yield varieties, and low productivity characterize the current level of cowpea production. Our findings suggest the need for tailored strategies to support the adoption of improved cowpea varieties in Nigeria to increase domestic production, adherence to quality standards, exploration of international markets for export opportunities, and ultimately, household income and improve nutritional outcomes.

Keywords: Cowpea, value chain, agri-food system, Nigeria, Sub-Saharan Africa

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1. Introduction

There is a growing concern about food security for the world's increasing population with the human population projected to reach nine billion by 2050 (Pawlak & Kołodziejczak, 2020). Nigeria, similar to other developing countries, faces persistent challenges related to food insecurity and malnutrition as a result of poverty, inadequate food production, displacements, and poor diets (such as inadequate protein consumption) (Adeagbo, 2012; FAO & ICRISAT, 2015). To boost the agricultural sector and improve food security, there is a growing prioritization of cowpea production, a domestically focused crop with a diverse role in Nigeria's agri-food systems (Manda *et al.,* 2019; Phillip *et al.,* 2019). The increased interest in agri-food systems over the last decade reflects concerns over the recent global food crisis and how to adequately provide for the growing population (Willett *et al.,* 2019) and in the context of climate change (Wudil *et al.*, 2022). Cowpea could be a significant contributor to the transformation of Nigeria's agri-food system in terms of food and nutrition, environmental sustainability and resilience, livelihoods and inclusiveness (Muñoz-Amatriaín *et al.,* 2017).

Cowpea is important for food security and the livelihoods of millions of smallholder farmers who rely on it for economic and nutritional well-being (Bolarinwa, 2022). Cowpea contributes to the general improvement of the farmers' standard of living since it is grown for food, vegetables, fodder, green manure, and cover crops (Osipitan *et al.,* 2021). It is a warm-season legume that provides many people with calories and protein, particularly in developing countries characterized by elevated poverty levels and malnutrition rates (Mekonnen *et al.*, 2022). This is because legumes are a nutrient-dense source of protein, particularly in regions where cereal-based diets are common and child malnutrition is a significant concern (Singh *et al.*, 2022). Cowpea offers a solution to the problem of declining protein intake, which is attributed to the scarcity and unaffordable prices of animal protein sources like milk, eggs, meat, and fish (Nordhagen *et al.,* 2023). Cowpea is a self-pollinated annual diploid and is regarded as a versatile crop due to its high tolerance to heat and drought, as well as its association with nitrogen-fixing bacteria (Ehlers & Hall, 1997, Moussa, 2011; Abebe & Alemayehu, 2022; Sindhu *et al.,* 2019).

Given the importance of cowpea in Nigeria’s agri-food system, this descriptive paper focuses on the trends and challenges in its production in Nigeria. It analyses the trends of import and export of cowpea in Nigeria, and the consumption patterns of local consumers, and then reflects on cowpea production implications for the transformation of agri-food systems. The remainder of this paper is organized as follows: section one analyses cowpea production trends at national and state levels and the factors hindering cowpea productivity in Nigeria. Section two explores the import and export of cowpea, while section three describes the consumption of cowpea in Nigeria. The implications of cowpea production for agri-food systems are presented in section four. Finally, conclusions are drawn in section five.

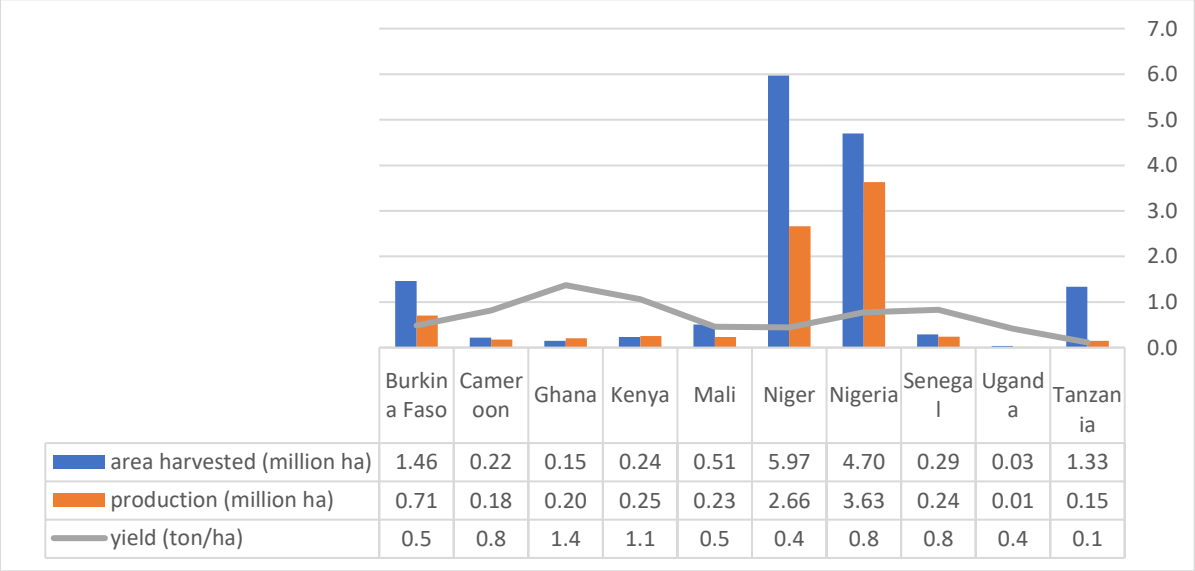
2. Cowpea Production and Productivity

2.1. Production and Productivity Trends in Nigeria

Cowpea, commonly called beans and black-eyed peas in Nigeria, is the world's most extensively grown, distributed, and traded legume (Horn *et al.,* 2022). It originated in Africa, and the main producing countries are in Africa (Phillip *et al.,* 2019). West Africa accounts for approximately 95% of global production, with Nigeria being the largest producer and consumer (Singh, 2002; Rivas *et al.,* 2016; Phillip *et al.,* 2019). While Nigeria and Niger are the major cowpea producers in Africa, other African countries produce cowpea, including Burkina Faso, Cameroon, Ghana, Kenya, Uganda, and Tanzania (Nkomo, 2021).

According to FAOSTAT, in 2021, Nigeria had the highest cowpea production of 3.63 million metric tons (MT) across an extensive area harvested of 4.7 million hectares. Niger followed closely with 2.66 million MT produced, with a larger area harvested of 5.97 million hectares. However, Ghana, Tanzania, and Kenya had a production of 0.14 million metric tons from 0.2 million hectares, 0.13 metric tons from 0.15 million hectares, and 0.23 million metric tons from 0.25 hectares, respectively. A notable disparity emerges in terms of cowpea production quantity between Nigeria and Niger when compared to other countries. For instance, when considering yield, in 2021, Ghana (1.4 tons/ha) and Kenya (1.1 tons/ha) outperformed Nigeria (0.8 tons/ha) and Niger (0.4 tons/ha), highlighting their greater efficiency in cowpea productivity (Figure 1). The low agricultural productivity in Nigeria is a result of its agricultural growth paradigm. Nigeria has relied on expanding agricultural land and enhancing fertilizer usage rather than achieving increases in productivity (USDA-ERS, 2019). In contrast, other nations have achieved higher productivity levels through strategic investments in research and development (R&D), development and adoption of innovative technologies such as improved cowpea varieties and genetically engineered varieties, and the implementation of modern irrigation techniques (Ruzzante et al., 2021).

Figure 1: Cowpea area harvested, production quantity, and yield in selected African countries, 2021.



	Burkina Faso	Cameroon	Ghana	Kenya	Mali	Niger	Nigeria	Senegal	Uganda	Tanzania
area harvested (million ha)	1.46	0.22	0.15	0.24	0.51	5.97	4.70	0.29	0.03	1.33
production (million ha)	0.71	0.18	0.20	0.25	0.23	2.66	3.63	0.24	0.01	0.15
yield (ton/ha)	0.5	0.8	1.4	1.1	0.5	0.4	0.8	0.8	0.4	0.1

Source: FAOSTAT, 2023

In Nigeria, the total area of cowpea harvested increased noticeably between 2000 and 2008, rising from 3.6 million hectares in 2000 to 4.2 million hectares in 2008 (Figure 2). Subsequently, there was a sharp fall to 2.3 million hectares in 2009, which could be attributed to the 2007/2008 global financial crisis, but it steadily increased to 2.9 million ha in 2010 as a result of the Nigerian Government's diversification to the non-oil sector, particularly agriculture (Njiforti, 2015). Nigeria also witnessed a decline in production quantity from 2.9 million MT in 2008 to 2.4 million MT in 2009.

Even with an increase in the total area harvested during the same period, cowpea production quantity further decreased to 1.6 tons in 2011 from a peak of 3.4 tons in 2010. While the reason for this decline is unknown, cowpea production peaked in 2012, reaching 5.1 tons; it dropped to 2.1 tons in 2014. However, due to growing commercialization in Nigeria, cowpea output has only seen a stable rise from 2018 to 2021. While it is known that cowpea production in Nigeria has advantages in terms of agri-food and nutrition, economies of scale, and environmental stability, its production output is restricted, and its status as an underutilized leguminous crop remains (Osipitan et al., 2021). Additionally, the lack of consistent production reflects the dominance of small-scale farming and the underuse of mechanized agriculture in cowpea production in Nigeria (Nkomo, 2021).

A large expanse of land is used for cowpea production in Nigeria, contributing to its rank as the leading global producer. Still, its productivity placed it 7th among other countries in the world (Osipitan et al., 2021). As seen in Figure 2, cowpea yield in Nigeria has remained consistently low through the years and resulted from severe epidemics and climatic changes and their adverse consequences on crop productivity (Amare and Balana, 2023; Amare et al., 2021). These include irregular and infrequent rainfall from drought and aridity problems, excessive use of synthetic chemicals, low-yielding seed varieties, and a decline in soil nutrients. This suggests the benefits of increasing breeding efforts towards climate-smart crops resistant to biotic and abiotic stresses (Amare et al., 2021).

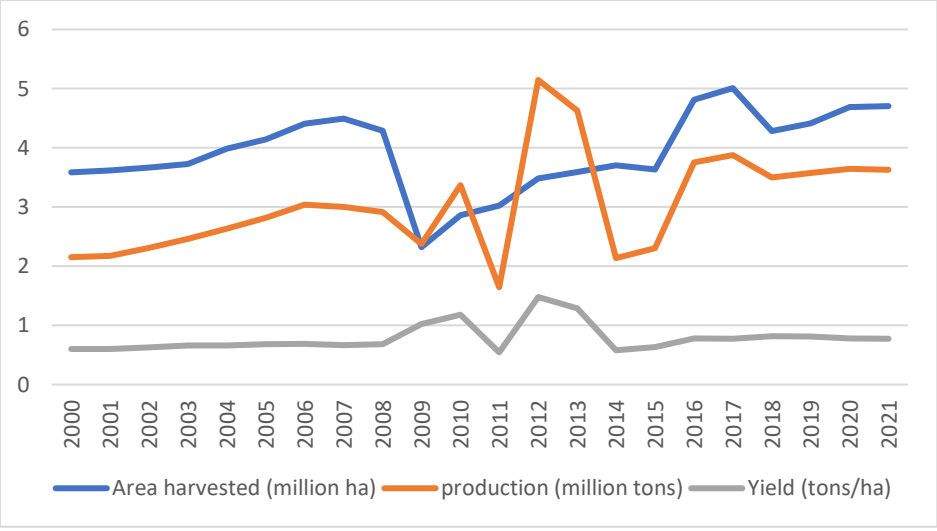


Figure 2***: Trends in Cowpea area harvested, production quantity, and yield in Nigeria.***

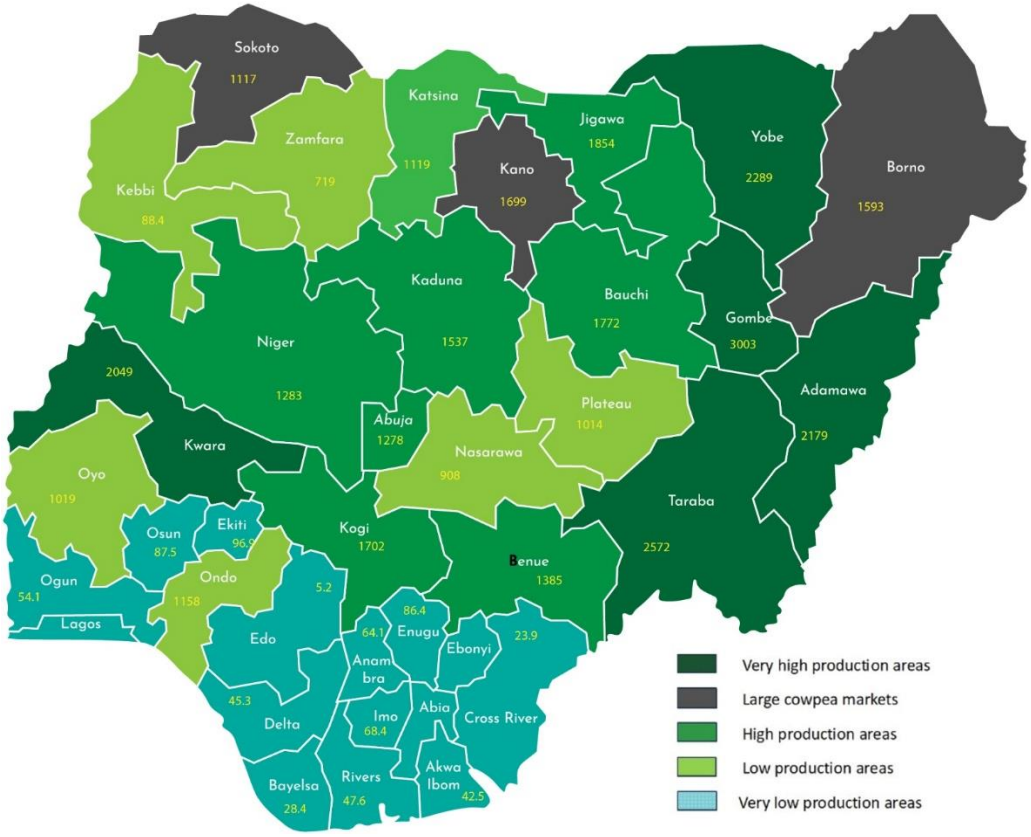
2.2. Cowpea Production and Productivity by States

Optimism surrounds the sustainability of plant protein for millions of Nigerians as the production of cowpeas is rising in the country (FAO 2020). The northeast contributes 25% to overall production, with the north-central zone producing 29% of all cowpeas (NAERLS, 2020). Phillip *et al.,* (2019)'s elaboration based on the General Household Survey 2015-2016 data revealed that the Sudan-Sahel savannah and the Guinea savannah located in the extreme northwest, northeast and north-central regions of the country have larger farm sizes, higher cowpea production and greater yields compared to any other agro-ecological or geographic zone. Notably, these three regions account for approximately 79 percent of the total cowpea production and 81 percent of the country's total land area in hectares. This can be attributed to cowpea's inherent drought tolerance and adaptability to poor soil conditions, resulting in the majority of cowpea output originating from the arid regions of the Guinea savanna and the Sudan-Sahel savanna.

There is a large market for cowpea grains and fodder in Nigeria, which has caused the demand for the crop to rise during the past few decades. Due to this, it is now grown as the sole crop in many parts of the country (Akpo *et al.,* 2020). Interestingly, cowpea is produced under three cropping systems: intercropping, monocropping, and rotational cropping. Productivity depends on environmental factors, cropping systems, and soil type. (Omoigui *et al.,* 2020). However, It has been observed that cowpea farmers in Nigeria often plant saved seeds, and recycled seed loses its viability over time and results in poor yield (Nkomo, 2021).

The planting season, which is influenced by the amount and distribution of rainfall, impacts the supply of cowpea seeds in Nigeria (Omoigui *et al.,* 2020 Amare and Balana, 2023). Under rain-fed production, the planting season starts in June or July, and the harvesting season is in September or October. However, farmers who use irrigation to produce cowpeas can plant twice a year: the first time from December to March/April and the second time from June to July (Bolarinwa *et al.,* 2022). When cowpea is planted between mid-July and mid-August, it produces better yields because the rain is fully established during the period, particularly in states in the Northern Guinea Savanna of Nigeria, such as Kano, Kaduna and Bauchi (Omoigui *et al.,* 2020). Similarly, in the southern parts of Nigeria, late-season planting, between late July and early August, is recommended as the most appropriate planting period based on distinct variations observed in the reproduction and growth of cowpea planted at various times. These seasonal variabilities affect cowpea market dynamics as cowpea products tend to be more expensive during the pre-harvest period when food is relatively scarce compared to other times of the year.

Figure 3: Map of Nigeria showing cowpea production and cowpea markets by state, 2021.



Source: Author's own illustration based on NAERLS (2021) data

According to NAERLS (2021), Gombe, Taraba, Yobe, Adamawa, and Kwara states have the highest cowpea production in 2021, with the total outputs of 300.26, 257.71, 228.9, 217.89, and 204.91 thousand tons, respectively (

Figure 3). These states are in the northeastern part of Nigeria, except for Kwara state, which is in the north-central part of Nigeria. This is because a substantial part of cowpea production comes from the drier regions of northern Nigeria (about four million hectares, with 1.7 million tonnes) (Phillip *et al.,* 2019). Furthermore, in 2021, Kogi state has the largest cowpea harvest area, amounting to 371.59 hectares, followed by Gombe, Taraba, Kwara, and Osun states. The lowest five states in a similar order of cowpea output volume were Abia, Bayelsa, Akwa Ibom, Cross Rivers, and Edo. Additionally, Yobe state had the highest yield, estimated at 2.08t/ha, followed by Jigawa, Nasarawa, Akwa Ibom, and Abia states.

Additionally, there was an increase in land area and production in Borno, Nasarawa, Lagos, Anambra, and Kwara states than in Edo, Niger, Bayelsa, Nasarawa, and Jigawa states in terms of the percentage rise for cowpea area harvested (Table 1). These results, which include northern and southern regions, show that cowpea production may be boosted in places where output is currently low, notably in the South, with purposeful initiatives like adopting improved varieties and irrigation techniques.

Table 1: Production output and land area for cowpea (in descending order by production)

State		Land Area ('000) Ha		Production ('000) MT			Yield (Ton/Ha)	
	2020	2021	% Change	2020	2021	% Change	2020	2021
Gombe	317.86	323.93	1.91	294.55	300.26	1.94	0.93	0.93
Taraba	261.17	266.39	2	251.91	257.71	2.3	0.97	0.97
Yobe	101.05	109.9	8.76	216.52	228.9	5.72	2.14	2.08
Adamawa	197.68	201.63	2	212.98	217.89	2.3	1.08	1.08
Kwara	226.82	233.48	2.94	202.73	204.91	1.07	0.89	0.88
Jigawa	117.85	117.99	0.12	181.88	185.37	1.92	1.54	1.57
Bauchi	192.59	198.39	3.01	175.59	177.19	0.91	0.91	0.89
Kogi	358.16	371.59	3.75	166.04	170.19	2.5	0.46	0.46
Kano	199.89	200.74	0.42	169.02	169.94	0.54	0.85	0.85
Borno	166.96	179.39	7.44	150.65	159.28	5.73	0.9	0.89
Kaduna	179.89	180.79	0.5	152.25	153.68	0.94	0.85	0.85
Benue	140.24	126.45	-9.83	133.46	138.51	3.79	0.95	1.1
FCT	137.97	144.92	5.04	124.45	127.81	2.7	0.9	0.88
Niger	119.93	97.62	-18.6	124.49	123.79	-0.56	1.04	1.27
Ondo	150.14	148.66	-0.99	115.06	115.81	0.65	0.77	0.78
Katsina	130.96	124.41	-5	120.15	111.85	-6.91	0.92	0.9
Sokoto	137.24	138.2	0.7	108.85	111.72	2.64	0.79	0.81
Oyo	118.75	127.31	7.21	101.42	101.87	0.45	0.85	0.8
Plateau	176.28	181.4	2.9	96.88	101.35	4.62	0.55	0.56
Ekiti	164.92	171.52	4	92.76	96.86	4.42	0.56	0.57
Nasarawa	59.9	64.93	8.39	85.8	90.77	5.79	1.43	1.4
Kebbi	108.81	108.35	-0.42	88.92	88.35	-0.64	0.82	0.82
Osun	207.81	211.99	2.01	80.82	87.45	8.21	0.39	0.41
Enugu	100.38	104.77	4.38	78.8	86.36	9.59	0.79	0.82
Zamfara	138.16	127.62	-7.63	79.84	71.9	-9.95	0.58	0.56
Imo	89.32	97.56	9.23	65.92	68.37	3.71	0.74	0.7
Anambra	119.58	120.25	0.56	64.01	64.13	0.18	0.54	0.53
Lagos	118.55	119.61	0.9	62.35	62.91	0.9	0.53	0.53
Ogun	88.2	85.98	-2.51	55.49	54.1	-2.5	0.63	0.63
Rivers	90.88	96.33	6	46.7	47.6	1.92	0.51	0.49
Abia	40.69	44.83	10.17	43.76	47.33	8.16	1.08	1.06
Delta	50.57	50.84	0.54	45.24	45.3	0.13	0.9	0.89
Ebonyi	71.56	71.56	0	43.59	43.59	0	0.61	0.61
Akwa-Ibom	30.16	30.3	0.45	42.45	42.5	0.12	1.41	1.4
Bayelsa	31.28	31.35	0.22	28.61	28.42	-0.65	0.92	0.91
C/Rivers	25.64	25.52	-0.46	24	23.92	-0.33	0.94	0.94
Edo	5.69	5.49	-3.58	4.91	5.21	6.19	0.86	0.95

Source: National Agricultural Extension and Research Liaison Services (NAERLS) (2021)

3. Factors Hindering Cowpea Productivity in Nigeria

Cowpea production in Nigeria faces challenges which can impact its overall productivity. Bolarinwa et al., (2022) revealed that the low productivity of cowpea is attributed to a variety of constraints that prevail in cowpea-growing areas. The factors hindering cowpea productivity in Nigeria include:

3.1. Insect and pest attacks

Cowpea is highly susceptible to pests and diseases from planting to storage phases. Insects and pests are the most biotic constraints to cowpea production, particularly under fluctuating weather patterns (Dugje *et al.,* 2009; Sangoyomi and Alabi, 2016; Baoua *et al., 2021*). The most perilous stage of insect attack in cowpea production is between pod development, flowering, and storage (Sanginga and Bergvinson, 2014). Post-flowering pests such as flower thrips, the legume pod borer (*Maruca vitrata*), and pod-sucking bugs (*Anoplocnemis curvipes*, *Riptortus dentipes*, and *Clavigralla tomentosicollis*) can lead to up to 90% yield losses in the absence of suitable control measures (Omoigui et al., 2020). Cowpea is attacked by pathogens such as bacteria, viruses, nematodes, and fungi. The most common diseases are Septoria, bacterial blight, and scab (Omoigui *et al.,* 2020). The Nigerian states with reported cases of these pests and diseases are Abia, Adamawa, Benue, Borno, Ekiti, Imo, Kastina, Kogi, Ondo, Oyo, Osun, and Yobe states, according to NAERLS (2020). In 2020, according to the Agricultural Performance Survey, Yobe experienced a 40% yield loss due to pod borers, Kogi experienced a 50% yield loss, Oyo experienced a 30% yield loss, and Ekiti state experienced a 25% yield loss. Abia, Borno, and Osun each recorded 10% losses (NAERLS 2020). Farmers' interest in cowpea production may be affected by losses incurred by pests and diseases during production, even though the cowpea has an advantage over other legume crops in that it can withstand drought and adapt well to drier areas of the tropics. These challenges can be effectively managed by planting improved cowpea varieties that are tolerant of or resistant to these pests and diseases (Omoigui *et al.,* 2020). Cowpea varieties that are resistant to weeds, pests, and diseases have been developed and should be promoted among smallholder farmers in Nigeria to improve adoption rate and productivity (Sanginga and Bergvinson, 2015).

3.2. Inappropriate application of pesticides and insecticides

In Nigeria, there are no precise or official estimates of pesticide use; however, the potential negative impacts of the application of pesticides and insecticides to the environment and human consumption have been long recognized as major health concerns (Sabo *et al.,* 2014). Concerns related to the use of pesticides in cowpea production include:

- **Inadequate handling procedures**: Farmers are the main users of pesticides to control insect pests, and it is important for them to learn how to manage and use them properly to get the intended outcome. Unfortunately, many farmers spray without knowing or following the proper pesticide handling, such as using necessary personal protective equipment (PPE), including gloves, long pants, boots, a face shield, a cap, and goggles, owing to ignorance and financial implications,

risking exposure to health-related problems. Additionally, farmers continue to reuse empty pesticide containers that ought to have been properly disposed of after use (Nwadike et al., 2021). Many also do not adequately clean up after spraying before they consume food items, including alcohol, food, or cigarettes (Rahman & Chima, 2018). This suggests that pesticide handling awareness should be strengthened, especially among smallholder farmers.

- **Excessive use of pesticides**: According to Omoigui (2020), successful cowpea production requires 2 – 3 applications of proper chemical insecticides, depending on the variety and the intensity of the insect attack. Late-maturing indeterminate varieties need more sprays than early-maturing varieties due to the staggered flowering phase. Pesticides can contaminate the soil, land, water, and environment if they are sprayed more than four times. Additionally, the overuse of pesticides on crops causes severe neurotoxicity in people. This issue is common among farmers in Nigeria and necessitated the European Commission to ban the import of cowpea from Nigeria (Hassan, Zamani, & Varshney, 2019). Lack of education among farmers, the prohibitive cost of pesticides and spraying equipment, and the large farm size are other issues that affect the usage of pesticides in the production of cowpeas (Sabo *et al.,* 2014).

3.3. Low adoption of improved cowpea seed varieties

In Nigeria and Sub-Saharan Africa (SSA), improved and certified seeds are available for purchase. However, many farming households believe improved/certified seeds are expensive and not readily available. Additionally, they believe they lack adequate information on the efficacy of improved/certified seeds. Thus, they decide to opt for their saved seeds without adequately considering the advantages of improved and certified seeds over their saved seeds (FAO and ICRISAT, 2015). The poor adoption of improved seeds partly resulted from the inadequate production of seeds, inadequate supply – quantity or a mismatch with farmers' preference, inability to distribute seeds to remote areas, and limited awareness of the characteristics of the improved seed (Alemu, Rashid, and Tripp, 2010; Takeshima *et al.,* 2010; Spielman and Mekonnen, 2013). According to research, a lot of the Nigeria commercial seeds available in the market are usually imported and marketed without any reliable guarantee of seed quality, which places farmers in a difficult position to trust the efficacy of such seeds (Takeshima *et al.*, 2022). Nevertheless, research has shown that many farming households still demand for improved seeds, particularly Irish potato, groundnut, and maize seed varieties (maize HV and Maize OPV) other than other crops such as cowpea (NASC, 2020).

3.4. High cost of fertilizers

Fertilizer is expensive in Nigeria because of the rising inflation, Naira depreciation and the crises between Russia and Ukraine that disrupted the raw materials used for fertilizer production (Balana & Fasoranti, 2022; Balana et al., 2023). However, cowpea is a leguminous crop that does not require too much nitrogen fertilizer because it fixes its own nitrogen from the air using the nodules in its roots. In locations where

the soils are deficient in nitrogen, it is necessary to apply a small amount of nitrogen, about 15kg, as a starter dose for successful production. Cowpea requires phosphorus fertilizers, but despite their importance in soil and in cowpea production, phosphorus fertilizers are expensive and not readily available in Nigeria to augment the soil nutrients, rather they are imported fertilizers (Oso, 2014). Consequently, an increase in fertilizer prices potentially results in intensified higher prices of cowpea produce.

3.5. Unsuitable cropping practices

It is a usual practice among farmers in West and Central Africa, including Nigeria, to intercrop cowpea with other crops such as millet, sorghum, and maize. This farming practice resulted in poor plant population and crowding of other crops on cowpea. These challenges, in addition to infertile soil, lack of access to recommended and improved seeds, contributed to extremely low cowpea yield (0.5t/ha). Even though Nigeria is the largest cowpea producer in the world, Nigeria still could not produce enough cowpea to meet the needs of its rising population because of these issues that affected productivity. However, improved strip cropping (four rows of densely sown cowpea and two rows of densely sown cereals) has proven to be more productive and offers over a 100% gross economic increase over the traditional intercropping systems (Singh and Ajeigbe, 2007).

3.6. Inadequate post-harvest and storage practices

The issue of post-harvest losses is prevalent among farmers in Nigeria. Most of the causes center around insect and pest infestation, a lack of storage facilities, and ineffective post-harvest practices that are accessible at the farm level, and limited farmers from benefitting from higher crop yields. Many farmers and traders in Nigeria adopted chemicals as preservative agents, posing health risks to the populace. The widespread use of storage chemicals technique is a great concern to the public and was among what prompted the European Commission to impose a restriction on the exportation of cowpea from Nigeria. Utilization of improved varieties that are less susceptible to infestation, adoption of facilities for practices such as double bagging, use of hermetic storage with PICS bags, and solar drying of cowpea grain provides farmers with the opportunity to store grain until later in the dry season when they can sell their crop for higher prices (Kotu *et al*., 2019).

3.7. Poor soil fertility, drought, and heat stress

Cowpea is known for its ability to grow in poor soils and withstand drought. However, it could be sensitive to severe droughts, especially during pod setting and grain-filling stages (Hall, 2004). Heat stress above a threshold temperature of 16 °C may cause a 4 to 14% loss in pod set and grain yield, depending on the variety (Hall, 2004). Early maturing improved cowpea varieties are recommended for cultivation to lessen the negative impacts of heat stress and drought (Daryanto et al. 2015).

A lot of farmers in SSA produce cowpea on poor soil because they believe that the crop does not require fertilization but will work well on any type of soil. This assumption is often reported because of the inflated cost of fertilizer (Mohammed *et al.,* 2020). Soils lose their fertility when they are used repeatedly for cultivation without adequate measures to replenish the fertility. This often occurs because of the prohibitive cost of fertilizer and results in low yields. However, instead of ignoring soil fertility completely, farmers may apply organic matter, such as manure, in place of chemical fertilizers to improve the soil fertility (Horn et al., 2015).

Nigeria's Import and Export of Cowpea

Nigeria is a leading exporter of cowpea (dry beans), soybeans, groundnut, cotton, garlic, rubber, and melon seeds. The European Union (EU) offers a stable market for exporting Nigerian dried beans, considering the reliable volumes that can be produced within the country (Hassan, Zamani, & Varshney, 2019). As reported by Phillip *et al.,* (2019), the United Nations COMTRADE database revealed that the combined imports by five European countries, plus Canada and South Africa, only amounted to approximately 4.2 million tons between 2012 and 2017.

Nigeria has not exported cowpea to European countries since 2013, when the European Commission suspended dried beans (cowpea) exports from Nigeria. This suspension was later extended until 2017 due to concerns related to phytosanitary measures, which encompass regulations and precautions aimed at preventing the spread of plant diseases, pests, and contaminants that can pose risks to agriculture, ecosystems, and human health. This resulted from the continuous presence of pesticides in the product (between 0.03mg/kg and 4.6mg/kg), which causes acute neurotoxicity (Hassan, Zamani, & Varshney, 2019). The European Commission's restriction resulted in significant losses for marketers, especially exporters. However, India has welcomed the import of pulses, including cowpeas from Nigeria, worth US$1 billion Phillip et al., 2019).

As seen in Figure 4, the quantity of dry cowpea exported from Nigeria was the lowest and recorded as 822 tons in 2017. However, the United Nations Industrial Development Organization (UNIDO) started a pilot export of dried beans from Nigeria to the EU, which may have caused the number to increase to 1,341 tons in 2018 (UNIDO, 2019). However, the export value of dry beans has declined since 2019, despite the most notable growth rate being recorded in 2018, with an estimated export value of 3.3 million USD (FAOSTAT, 2023). This could be due to the EU's continued restriction on the export of dry beans from Nigeria due to non-compliance with the minimum permissible residual level of 0.01 mg/kg observed for pesticides and other related substances (Hassan *et al.,* 2019). However, overall, Nigeria's dry bean export industry offers potential due to rising exports to other African nations and compliance with the EU's chemical minimum acceptable residual level.

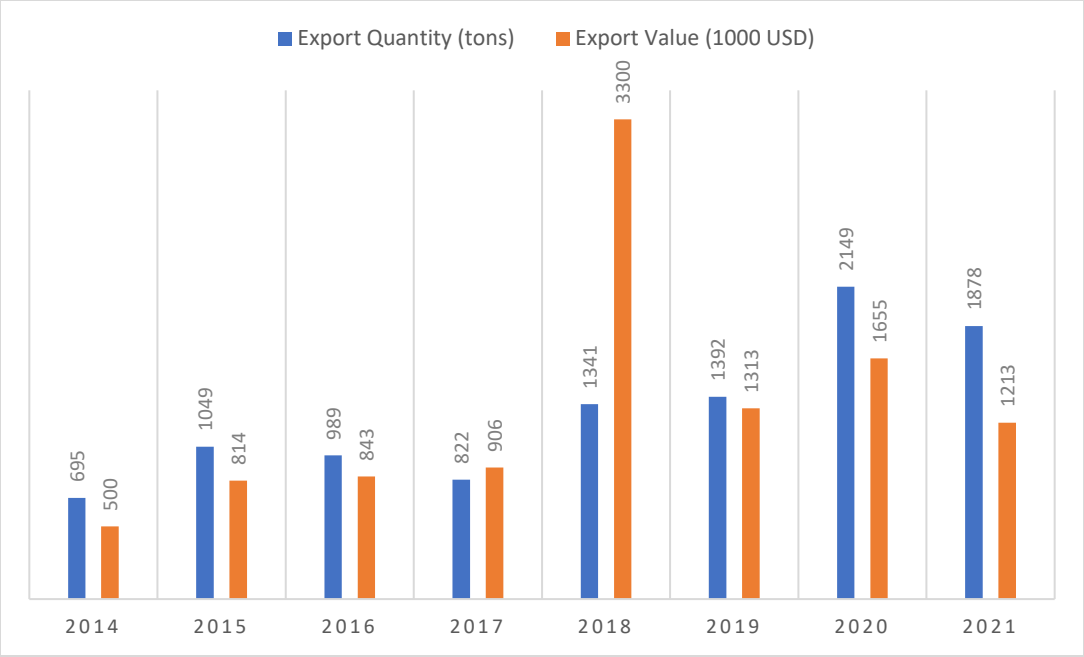


Figure 4: Export Quantity and Export Value of Beans (dry) in Nigeria (2014 – 2021)

Source: FAOSTAT, (2023)

With a population of 218.5 million, a 2.4 percent annual population growth rate, and a total fertility rate of 5.1 (PRB, 2022), Nigeria faces a demand for cowpea products that surpasses its production. This is driven by poverty, the need for affordable food options, and the versatile uses of cowpea, which encompasses both human and animal consumption and holds significant economic importance (Osipitan et al., 2021). According to Sanginga and Bergvinson's (2014) estimation, Nigeria's expenditure on cowpea imports exceeds US$628 million. Numerous studies have examined the evolution of cowpea consumption in Nigeria over the past two decades. These investigations have documented a noteworthy shift, with annual consumption rising from 6.9 kilograms per capita (Kormawa *et al.,* 2000), to eighteen kilograms per capita (Langyintuo *et al.,* 2003). The importing of cowpea is important to cushion the effect of higher demands. Phillip *et al.,* (2019) revealed that the excesses are imported from neighboring African countries, including Niger, Cameroon, and Burkina Faso. Langyituo *et al.,* (2005) estimated that about ninety-five percent of Nigeria's imports originated from Niger Republic.

Figure 5 confirms that in the years when cowpea production (see Figure 2) was high - between 2002 and 2013, the importation of cowpea was low. This was due to an increase in the domestic supply of Nigeria, which forced Niger, Nigeria's leading cowpea importer, to divert some of its exports intended for Nigeria to Ghana, Benin, and Togo. At the same time, Cameroon and Chad ceased to export cowpea to Nigeria. Additionally, this led to a decrease in import value and regional costs, which benefited consumers (Langyintuo & Lowenberg-DeBoer, 2006). Figure 5 also shows cowpea importation to Nigeria reached its peak in 2020, with an import quantity of over seven thousand tons, valued at 1.6 thousand USD, slightly exceeding the value of cowpeas exported in the same year.

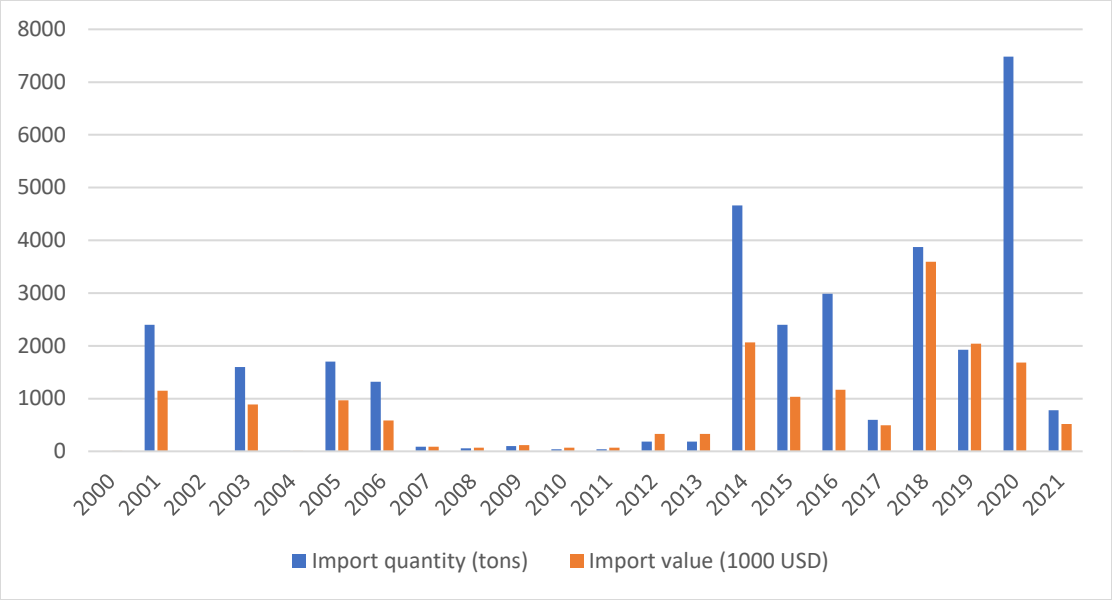


Figure 5: Import Quantity and Import Value of Beans (dry) in Nigeria (2000 – 2021)

Source: FAOSTAT, (2023)

4. Cowpea Consumption in Nigeria

About 52 percent of Africa's production of cowpeas is used for food, 16 percent is wasted, 13 percent is used as animal feed, 10 percent for seeds, and 9 percent for other uses (Nkomo, 2021). In 2016, the total annual cowpea production and consumption in Nigeria were 2,200 MT and 2,600 MT, respectively. However, of this total output, about 0.33MT accounts for post-harvest losses, seed, and animal feed (Phillip *et al.,* 2019). Given that cowpea is consumed often by almost every family, the demand-supply gap is likely to widen much more due to the increasing population (Manda et al., 2019). This anomaly would result in a persistent rise in the price of this commodity, among other staple crops. The consumption of cowpeas is influenced by several variables in Nigeria and West Africa, including consumer income, town population densities, taste, market prices for cowpeas and similar alternatives - such as soybeans, groundnuts, sorghum or millet. Additionally, cowpea prices are lower during harvest and in areas with higher production, such as Kaduna, Kano, Adamawa, and Kwara, because there is a surplus during this time (Mishili *et al.,* 2009).

In Nigeria, there are a variety of cowpea meals, each with regional variations. For instance, bean sauces/soups are not consumed in the southeast of Nigeria but are popular in some of the country's northern and southwestern areas. Cowpeas can be processed into several dishes, including bean soup (Gbegiri), bean cakes (Akara), bean puddings (Moin-moin and Okpa), and other well-known dishes. These foods are relatively affordable, easily accessible as street food, and essential in Nigeria.

The several cowpea varieties in Nigeria vary according to color, the texture of the skin, color of the eye, the size of the grain, and the amount of damage resulting from insect infestation. In terms of consumption, the white, milk, brown, and red-colored cowpea varieties are the common and popular types accepted by people in the northern region, while brown beans, commonly referred to as honey beans, are most preferred in the southern region (Omoigui *et al.,* 2020). Further studies by Ishikawa *et al.,* (2020) revealed that consumer preferences for cowpea grain size vary, with some consumers preferring medium-sized grains and others favoring large-sized grains. Bolarinwa *et al.,* (2022) recommended that developing varieties based on consumers' preferences with quality, such as high market acceptability, grain size, pest and disease resistance, and short cooking time, would go a long way in improving cowpea production and pleasing the consumers.

5. Transformation of the Cowpea Value Chain in Nigeria

This research on the trends of production, import and export of cowpea, and consumption patterns of local consumers shows that the cowpea value chain in Nigeria holds significant importance in the country's agricultural economy. The cowpea value chain originates with smallholder farmers that grow the crop. It then passes through various intermediaries that transport and handle the cowpea until they reach the urban markets. Research studies have highlighted the diverse influences that shape this value chain, including the evolving landscape of cowpea farming, the substantial involvement of women in production and processing, the role of market integration, and the impact of consumer preferences (Akpo et al, 2020).

In terms of inputs, the Tropical Legumes projects have increased cowpea seed production and supply of improved and farmers' preferred varieties, especially in Northern Nigeria (Akpo et al, 2020). Thus, the potential for cowpea production to transform Nigeria's economy first lies in the adoption of improved seed varieties, followed by an upgrade in production, processing, and marketing in the value chain (Barrett et al., 2022). Women, especially, are important in producing and processing cowpeas, and they are also part of systems where both crops and animals are taken care of together (Akpo, 2020). In addition, the cowpea fodder market has witnessed considerable success in Nigeria during the past years (Kamara et al., 2018).

During storage, cowpea is very susceptible to damage from weevils (bruchids), and the larvae of the bugs from the field, which quickly hatch and eat holes in the cowpeas. In the past, farmers had to sell their cowpeas quickly because they could not protect them from weevil damage due to poor storage facilities. But selling quickly meant they missed out on getting better prices later in the year. To address this issue, Purdue University, with its partners, initiated the PICS technology to enable farmers to preserve their dry crops at low cost. However, the level of adoption of PICS bags among Nigerian cowpea farmers, especially among men, is limited due to poor sack distribution networks (Ibro et al., 2014). Furthermore, adopting modern storage techniques, encouraging women's participation, and providing credit facilities to farmers is crucial to improving cowpea storage.

Transportation also emerges as a pivotal component in the value chain, especially the state of transportation infrastructure supporting the movement of cowpea from farm to market. This includes road networks, warehouses, and storage facilities. Using smart technology can also help reduce transit times and mitigate losses during transportation (Barrett et al, 2022).

The Dawanu market in Kano, Northern Nigeria, is the largest cowpea market in the world. Cowpea storage capacity in Dawanau Market exceeds 200,000 metric tons (Mishili et al., 2009). Merchants from the Dawanau Market finance a network of cowpea buyers who travel throughout Niger and the neighboring countries. Merchants from southern Nigerian cities come to Kano to purchase cowpea. Aside the Dawanau Market in Kano state, other important aggregation markets in Nigeria are found in Maiduguri and Sokoto in northern Nigeria. With the high volume of cowpea production and trade, these markets are indispensable to meeting global demand. Deepening market integration is crucial for ensuring the competitiveness of Nigerian cowpea in both local and international markets. The traditional marketing system for cowpeas in Nigeria effectively links surplus and deficit areas, with a high degree of organization and specialization among middlemen (Ejiga and Robinson, 1981).

Export trends and the role of market information systems in facilitating connections between producers and buyers are critical aspects of market integration, as explained by Langyintuo (2003) and Mishili et al., (2009). Langyintuo et al., (2003) found that grain traders in Nigeria and other West African countries formed community associations to facilitate cowpea marketing and pricing. These associations developed guidelines for storing, transporting, and grading cowpeas to add value along the supply chain. Additionally, Mishili et al., (2009) explain that traders process cowpeas in various ways, tailoring products to align with consumer preferences. Through coordinated efforts, the traders aimed to consistently meet local demands.

Another emerging opportunity for improving the cowpea value chain, specifically for smallholder farmers, lies in processing whole beans into various products, including cowpea flour, snacks, etc., compared to the primary product, thereby expanding the cowpea market, offering consumers a broader range of choices, and elevating the product's export value. Urban consumers increasingly prefer clean and packaged cowpea grains due to their busy lifestyles, thus presenting a market opportunity for value addition. To capitalize on this opportunity, it is crucial to standardize the processing and quality assessment of various cowpea varieties. This enables proper sorting and branding of cowpea products to sell in urban supermarkets or export to other countries (Barrett et al, 2022).

Through the provision of credit facilities, smallholder farmers can also invest in upgraded mechanized cowpea cleaning equipment as policymakers establish a quality assurance system to meet consistent quality standards expected in emerging markets beyond the traditional trade channels. Effectively tapping into the consumer preference for convenience and quality involves optimizing cowpea post-harvest handling and enabling more formalized retail packing formats aligned to urban customer needs and international standards. In a nutshell, a holistic approach to transforming the cowpea value chain in Nigeria is paramount, encompassing production, post-harvest processes, and creating market opportunities.

6. Implications of Cowpea Production for agri-food systems transformation

The key challenge of Nigeria's agri-food systems is the need to simultaneously provide sufficient food for all, improve incomes and productivity for small-scale producers, make diets healthier and more affordable, reduce greenhouse gas (GHG) emissions, and build capacities needed to adapt to climate change (Bizikova *et al.,* 2022; Amare *et al.,* 2023). Cowpea plays a significant role in Nigeria's agri-food-systems. The previous sections summarized the trends in cowpea production, consumption, and trade in Nigeria over the past few years. We reflect here on the implications for research and development (R&D); we do so by following the broad outcome categories of the agri-food systems framework, which are food & nutrition security, environmental sustainability & resilience, and livelihoods (SWAC/OECD, 2021).

6.1. Food and Nutrition Security

The United Nations Committee on World Food Security defines food security to mean that all people, at all times, have social, physical, and economic access to safe, sufficient, and nutritious food that meets their food preferences and dietary needs for an active and healthy life (McGuire, 2015). The problem of malnutrition is even more noticeable, particularly among children. The 2018 Nigeria Demographic and Health Survey revealed alarming statistics, indicating that about 17% of children in Nigeria were severely stunted, 37% were stunted, and 22% were underweight (National Population Commission (NPC) [Nigeria) & ICF, 2019). In addressing these challenges, cowpea is a viable value chain. One of the key implications of cowpea production in Nigeria is its contribution to nutrition.

Cowpea is a multipurpose legume that provides high-quality protein for human and animal consumption. Cowpea holds significant importance in the diets of individuals, especially those living in less developed tropical countries, where animal protein is not readily available for households. The crop offers a diverse range of nutritional components, including proteins (21-25%), carbohydrates (60-65%), fats (less than 2%), essential amino acids (such as lysine and tryptophan), vitamins (such as thiamine, folic acid, and riboflavin), minerals (such as zinc, iron, and calcium), water content (8-9%), and dietary fibers (less than 2%) (Huynh *et al.,* 2016; Horn *et al.,* 2022). Furthermore, a study by Moloto et al, (2022) stated that a 90g portion of cowpea leaves can meet more than 75% of the recommended dietary allowances (RDAs) for vitamin A and 25-50% of the RDAs for iron in children aged 4-8 years.

The immature pods and seeds are used as vegetables and for several main dishes and snacks (Agbogidi and Egho, 2012). Cowpea young leaves, pods, and seeds are increasingly used for animals, and its scorched seeds are occasionally used as a substitute for coffee (Ogbemudia *et al.,* 2010). Cowpea leaves are known to contain important vitamins and nutrients, including antioxidants, micronutrients, and nutraceuticals, which can improve the nutritional status of individuals and households and reduce food insecurity (Shetty, Magadum and Managanvi, 2013). Research has proven that cowpea products lower serum cholesterol levels with no side effects when combined with high-fibre diets (Pottorff *et al.,* 2012). Additionally, cowpeas are regarded as a useful source of dietary fiber, both soluble and insoluble, with numerous health advantages. The high nutritional value of cowpea grains makes them suitable for infant food and it is widely used in many African countries as weaning food (Souleymane, 2013). The entire aerial section of the cowpea plant is edible and is consumed regularly. While dry grain is mostly used, fresh grains are

frequently consumed during harvest season, and immature pods are consumed as vegetables. Furthermore, the tender leaves are used as a pot herb, and the dry hauls are harvested and sold as livestock fodder (Akpo *et al.,* 2020). Cowpea plants are used as green manure to form root nodules in collaboration with nitrogen-fixing bacteria as a legume (Sindhu *et al.,* 2019). As cover crops, spreading cowpea varieties are also utilized to prevent soil erosion and reduce the incidence of weeds (Osipitan et al., 2021).

These qualities make cowpea the perfect food to help families reach their nutritional objectives of consuming more starch and other complex carbs while consuming less fat (Hassan *et al.,* 2019). Among vulnerable households, cowpea can bridge the gap between food and nutrition insecurity and potentially reduce malnutrition (Jayathilake *et al.,* 2018). Since increased cowpea production will benefit households as well as the Nigerian economy by enhancing food security, addressing malnutrition and improving the overall well-being of individuals, especially those who are most vulnerable to nutrition deficiencies. It is crucial to enlighten farmers about the benefits of cowpea production and urge them to increase their participation in it (Dzanku *et al*., 2018).

However, challenges such as insect and pest attacks, inadequate pesticide use, post-harvest losses, and low adoption of improved seed varieties directly affect cowpea's ability to meet food security needs in Nigeria. Research and Development (R&D) efforts should, therefore, focus on developing and promoting resilient cowpea varieties that are resistant to pests and diseases. Research should also emphasize the development of sustainable pest management strategies, including the proper use of pesticides to ensure both crop protection, the development and dissemination of post-harvest technologies and practices that reduce losses and food safety. Furthermore, initiatives should aim to increase the adoption/affordable access of improved seed varieties among smallholder farmers through awareness campaigns. Promoting the use of safe storage techniques can help address health concerns associated with chemical preservatives.

6.2. Environment Sustainability

The evolving agri-food systems have raised concerns about their eco-friendly footprint and the need to stay within environmental boundaries (Willett *et al.,* 2019). Cowpea is useful in several ways for enhancing environmental sustainability and resilience outcomes, and it is an important crop to grow as the effects of global climate change become more pronounced. More extreme weather events, such as deeper and longer droughts and increased heat, are among the expected consequences. Cowpea is heat and drought-tolerant because it uses less water than other grown legume species and yields high results under situations of terminal drought. (Ehlers & Hall, 1997; Gomes *et al., 2020*).

Cowpea is essential in Nigeria for managing soil fertility in cereal-based rotational cropping and intercropping systems, as it improves nutrients in the soil and builds resistance to certain pests. In the cropping system, where little or no fertilizer is used, cowpea enhances soil fertility through symbiotic nitrogen fixation by fixing atmospheric nitrogen in the soil due to its high nitrogen content. The crop also performs well in poor soils with less than 0.2 organic matter, low levels of phosphorus, and more than eighty-five percent sand (Langyintuo *et al.,* 2003). It is produced all year round in Nigeria. It grows well

and attains good yield under irrigation when cultivated during the hot tropical dry season. Some cowpea varieties thrive well on the use of residual soil moisture in drier seasons (Ngalamu *et al.,* 2015). In addition, its early maturity, drought tolerance, and nitrogen fixation characteristics fit very well in humid soils where moisture, erosion, and low soil fertility are the major limiting factors in crop production (Hall, 2004).

Furthermore, Woghirena *et al.,* (2021) stated that cowpea is remarkably effective in weed control as it provides a good shade that denies the weed light for their survival. In organic cereal production, cowpea can be used as a living mulch to reduce the biomass of weeds. Thus, cowpea can be incorporated into weed management programs as an environmentally friendly and more cost-effective method to help save the environment, improve the yield of other crops, and improve soil fertility.

However, in relation to R&D, insect and pest attacks in cowpea production have negative environmental implications due to the overuse of pesticides and the risk of soil and water contamination. R&D should prioritize the development of integrated pest management (IPM) strategies that minimize the environmental impact of pest control. This might involve researching alternative pest control methods, promoting beneficial insects, and reducing pesticide usage. Furthermore, addressing the inflated cost of fertilizers and improving soil fertility is crucial for sustainable agriculture. Research can focus on developing affordable and locally sourced organic soil amendments to replace chemical fertilizers. This approach not only reduces the environmental footprint but also enhances soil health and long-term productivity.

6.3. Livelihoods

Based on Townsend's 2015 study, it is evident that economic growth rooted in agriculture has a greater impact on poverty reduction compared to growth stemming from other sectors, especially considering that a portion of the remaining poverty is concentrated in rural areas. This makes it imperative to enhance livelihood outcomes and inclusiveness of agri-food systems.

Cowpea is a multipurpose crop that generates income for producers, processors, traders, food vendors, and other actors across the value chain (Phillips *et al.,* 2003). It is regarded as a significant cash crop by most farmers in West and Central African states (Yusuf *et al.,* 2015). Farmers generate revenue from the stems and leaves as animal feed during the dry season to supplement their income (Timko *et al.,* 2008). R&D efforts should aim to increase cowpea yields and reduce production costs, thus improving farmers' income generation potential. This can be achieved through the development of drought-resistant and high-yielding cowpea varieties coupled with sustainable farming practices.

Urban and rural households, especially women, can earn money by trading fresh cowpea leaves, produce, and processed foods (Ngalamu *et al.,* 2015). Women mostly do the production, processing, and sale of cowpeas, and there is a growing understanding that the food produced and the money gained by women are distributed fairly among household members. For instance, the processing of cowpea is prevalent in Nigeria, Senegal, and Niger, and these tasks are virtually solely conducted by women who supply a variety of products that are marketed as street food (Sanginga, and Bergvinson, 2015). Although, data extracted from the General Household Survey 2015-2016 show that women play a minor role (about 5 percent) in

the processing and marketing of cowpea (Phillip *et al.,* 2019). According to estimates, Nigerian farmers who cut and stockpile cowpea fodder for sale at the height of the dry season experience a 25% markup in annual income (Dugje *et al.,* 2009).

In addition, Nigeria has the potential to become a significant exporter of cowpea and cowpea products. By expanding domestic production to meet its growing domestic demand, meeting quality international standards, establishing efficient supply chains, and exploiting opportunities in the international markets, Nigerian farmers and exporters can benefit from the growing global demand for cowpea. This opportunity can contribute to foreign exchange earnings and boost the country's agricultural export sector. Research and development (R&D) can focus on ensuring compliance with international quality standards, such as pesticide residue levels. Additionally, improving storage and processing technologies can enhance the export potential of Nigerian cowpea.

7. Conclusions and Implications

This research provides a comprehensive analysis of the trends in cowpea production, consumption, export, and import in Nigeria, shedding light on the challenges and implications for agri-food system transformation. Several points emerge from this analysis. For example, there is much room for improvement in the efficiency of cowpea production in Nigeria. Despite its status as the epicenter of cowpea production, Nigeria faces challenges in terms of productivity. The yield per hectare in Nigeria is low compared to some other African Countries like Ghana, Tanzania, and Kenya. Some of the factors that contribute to its low cowpea productivity include irregular and insufficient rainfall, geographic distribution, overreliance on synthetic chemicals and inappropriate pesticide use, use of low-yielding seed varieties and limited adoption of improved seed varieties, insect and pest attacks, high input costs, unsuitable cropping practices, inadequate post-harvest and storage techniques, and issues related to soil fertility. Effectively addressing these challenges and unlocking the potential of cowpea production in Nigeria necessitates a holistic approach involving policymakers, researchers, and stakeholders. Policymakers should prioritize the research, development, and promotion of pest-resistant cowpea varieties, climate-smart cowpea varieties, integrated pest management practices, sustainable farming practices, and explore cost-effective soil fertility management options. This approach can bolster cowpea productivity, increase farmers' income, and enhance food and nutrition security. Also, there is a potential for increasing cowpea production in other regions of the country, especially in the South, through initiatives like improved varieties and irrigation techniques.

Secondly, we find that the persistent consumption-production gap underscores the urgent need to boost local production to meet domestic demand effectively. We also find trade deficits due to heavy dependence on cowpea imports and bans on cowpea exports by the European Commission. However, the potential for export growth, particularly in African markets, exists, contingent on compliance with global quality standards and the adoption of advanced storage and processing technologies. Government policies and international quality standards wield substantial influence over cowpea trade, while seasonal variability and market dynamics impact prices and behavior. Addressing these trends and challenges is paramount for enhancing food and nutrition security, promoting environmental sustainability and resilience, strengthening economic resilience, and supporting livelihoods within Nigeria's agri-food systems.

Thirdly, in the context of environmental sustainability, we recommend that research efforts should focus on reducing pesticide use, enhancing soil health, and maintaining ecological balance. Additionally, promoting cowpea consumption and value addition through processing can contribute to improved nutrition and food security. Furthermore, strengthening education and capacity-building programs is imperative to equip farmers with the knowledge and skills required for proper pesticide handling, sustainable farming practices, and improved cultivation methods. By doing so, Nigeria can harness the full potential of cowpea production, fortify its agricultural sector, and actively participate in global trade, enhancing the well-being of its citizens.

Further research opportunities arise in exploring the nutritional value of cowpea leaves and pods, which have received limited attention compared to cowpea seeds. Properly processed cowpea leaves and pods

have the potential to serve as sustainable sources of protein and vitamins (Gonçalves et al., 2016). This presents an area for further exploration and utilization of these plant parts to enhance nutritional outcomes and contribute to broader food and nutrition security efforts.

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