Report on the Horticulture Sector in West Africa

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CONTENTS

ACRONYM

AAGDS	Accelerated Agricultural Growth and Development Strategy
AfCFTA	African Continental Free Trade
AgSSIP	Agricultural Services Sub-Sector Investment Programme
CNRA	National Agricultural Research Department
CAADP	Comprehensive African Agricultural Development Programme
EC	European Commission
ECOWAP	Economic Community of West Africa Agricultural Policy
EMQAP	The Export Marketing and Quality Awareness Project
FAO	Food and Agriculture Organization
FASDEP	Food and Agriculture Sector Development Policy
FVO	Food and Veterinary Office
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
GoG	Government of Ghana
GEPA	Ghana Export Promotion Authority
GSC	Ghana Seed Company
GHPPP	Ghana Private-Public Partnership for Food Industry Development
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GSS	Ghana Statistical Service
IFPRI	International Food Policy Research Institute
ITA	International Trade Administration
METASIP	Medium Term Agriculture Sector Investment Plan
MiDA	Millennium Development Authority
MOAP	Market Oriented Agriculture Programme
MOFA	Ministry of Food and Agriculture
NTE	non-traditional export
NES	National Export Strategy
PERD	Planting for Export and Rural Development
PFJ	Planting for Food and Jobs
PPRSD	Plant Protection & Regulatory Services
SRID	Statistics, Research and Information Directorate
SSA	Sub Saharan Africa
TIPCEE	Ghana Trade and Investment Promotion for Competitive Export Economy
UNDESA	United Nations Department of Economic and Social Affairs
USAID	United State Agency for International Development
WA	West Africa

EXECUTIVE SUMMARY

INTRODUCTION

West Africa comprises six English-speaking countries (Ghana, Liberia, Nigeria, Sierra Leone, The Gambia, and the English-speaking part of Cameroon), eight French-speaking countries (Guinea, Togo, Burkina Faso, Cote D'Ivoire, Senegal, Mali, Niger, Benin), one Portuguese-speaking country (Guinea Bissau) and one Spanish-speaking country (Cape Verde). West Africa is largely agrarian, with agriculture accounting for about 30-50 percent of the region's GDP and up to 70-80 percent of total employment in Togo, The Gambia, and Burkina Faso. Horticulture also offers significant opportunities for economic development. For instance, in Togo, the sub-sector contributes more than 20% to the agricultural GDP and employs more than three workers per farm unit. Horticulture also occupies an important portion of farmers' income in Mali, ranging between 21.6% and 35.9%.

Horticultural products offer substantial prospects for export growth in West Africa due to the relative proximity to large and growing consumer markets in Europe and the Middle East. Indeed, fruit and vegetable imports into Europe are growing fast as consumers develop the taste for a wider variety of products such as tropical fruits which are not available in Europe and products that are 'off-season' in the European growing cycles but are available all year round from the tropical regions. International trade for horticulture products is growing at 7% per annum compared to 2% for staple food crops, providing an ever-increasing opportunity for West Africa (Labaste, 2005). Additionally, several international trends are growing in favour of West Africa including the expansion of EU membership, which will increase horticulture product demand in the medium to long term, and the rising strategy of European retailers to diversify their geographical sourcing from beyond Europe and also from their traditional over-sea growers.

ASSESSMENT METHODOLOGY

This review is focused on identifying priority areas determined by stakeholders in the horticulture sector. The methodology used in the assessment is a combination of (i) desk reviews, (ii) stakeholders' surveys, (iii) focus group discussions, and (iv) key informant interviews. Desk research included extensive searches on the websites of institutions for reports and documents of relevance. Organizations such as the Ministry of Food and Agriculture (MoFA), the Ghana Export Promotion Authority (GEPA), Ghana Statistical Services (GSS), the Institute of Rural Economy (IER), the National Institute of Agronomic Research (ITRA), the Ministry of Trade and Industry, and other relevant institutions from other countries were consulted for data. Published articles and reports on the horticulture sector were consulted.

Key informant interviews were conducted to gather information on challenges and opportunities for the horticulture sector. In the case of the research institutions and the universities, data was gathered on the research infrastructures, education, and training needs concerning the horticulture sector. The West African stakeholder inputs from ten (10) countries were considered. These key stakeholders included industry leaders, experts in horticulture production, crop handling between harvest and markets, gender equity, youth empowerment, nutrition, agri-policy, input suppliers, irrigation experts, value chain experts, climate experts, and farmer groups. After this review, a two-day regional conference (West Africa Regional Horticulture Conference: Horticulture for Food, Nutrition and Livelihood) was organized from 31st May to 1 June 2022. The workshop was designed to elicit equitable and active participation of all major stakeholders in the horticulture sector in West Africa.

SUMMARY OF FINDINGS

West Africa has experienced rapid growth in its horticulture sector in the last three decades.
A transformation that is mainly driven by (i) urbanization, (ii) an increase in per capita income, (iii) growth in supermarkets, and (iv) an increase in export market opportunities. However, the smallholder producers, processors, and exporters still face several structural challenges. Constraints in the sector are identified under eight (8) categories across the region: Biophysical; Natural Resources; Socio-Economics; Market and Consumption; Trade, and Standards; Engineering and Technology; Research, Education, and Training; and Regional and National Policy Environment

Biophysical

Biophysical challenges include input supply, productivity and production, improved varieties, and pests and disease infestation.

Inputs Supply

Inputs such as fertilizers, seeds, pesticides, land, and labour play an important role in fruit and vegetable production in West Africa. Fertilizer consumption among smallholder farmers, who make up the majority of farmers in the region has increased in the past decade but it is still far below what is needed as farmers face numerous challenges that limit their effective fertilizer demand. The majority of these farmers have little or no experience with fertilizers and its potential to enhance crop yields. Of the farmers who may be aware of this, the majority do not know the right types and application rates of fertilizers they should use for their soils and crops. These farmers have limited access to finance which further affects their demand for fertilizer and other inputs. Markets in the region are fragmented and intra-regional trade is weak. The supply of chemical inputs is largely dependent on imports. West Africa imports its chemical fertilizers and pesticides from Morocco, Asia, and Europe to meet farmers' demands. Improved seeds are also imported into West Africa. Only a few countries, including Ghana, have subsidies on inorganic fertilizers and improved seeds in the agricultural sector. Farmers source their inputs from multiple channels, including the use of their own saved seeds, neighbours, informal markets, commercial input dealers and seed-producing companies. The high price of fertilizer, lack of improved seeds, and inadequate knowledge of pesticides for usage and application pose a major challenge in the sub-region. These challenges are similar across the sub-region.

Production and Productivity of Horticultural Crops

Horticulture, especially fruit and vegetable production support social and economic development in West Africa. West Africa's vegetable production is dominated by tomato, onions, and chili pepper, while fruit production is dominated by pineapple, orange, mango, pawpaw, and banana. Nigeria is the leading producer of major fruits (pineapple, mango, and pawpaw) and vegetables (tomato, onion, and chili pepper) in West Africa. Ghana is the leading producer of oranges and has the highest orange yield in West Africa. Mango yields in Nigeria are the highest in West Africa, while pineapple yields in Ghana are the highest in West Africa. Banana yields in Cote d'Ivoire are highest in West Africa. Yields of tomatoes, chilies, and onions in Niger are the highest in West Africa. The total area under fruit and vegetable production has increased over the last three decades. Production of fruits and vegetables has more than doubled since 1990, but the region is not self-sufficient in fruit and vegetable production due to low yields.

Improved Varieties of Fruits and Vegetables

For vegetables and most fruits, farmers use local varieties and informal seed sources. The formal commercial seed sector serves only a small portion of vegetable producers, more often supplying commercial markets with quality seeds and improved varieties of crops, such as tomatoes, onions, and peppers. MD2, Smooth Cayenne, Sugar Loaf (Pan de Azucar), Red Spanish, Queen Victoria and Abacaxi

are the dominant improved varieties of pineapple grown by farmers. For orange, Washington Navel, Crimson Blood Orange, Hamlim, and Late Valencia are among the major improved varieties cultivated by farmers. Kent, Keitt, and Springfield are the major varieties of mango grown. The major improved varieties of bananas grown in West Africa include Cavendish, Mysore (Alata Kwadu, local variety), and Gros Michel varieties are the widely grown and preferred bananas in Ghana. The main varieties of pawpaw planted in Ghana are Solo Dwarf, Hortus Gold, and Bluestem. Green Chilies, Scotch Bonnet, and Bird's Eye are widely grown in Ghana and Nigeria. Recent improved varieties of tomatoes in Ghana include Kwabena Kwabena, Kopia, Adope Shite Adopte, Mako Ntose, Pectomech, Power Roma, Techiman, Eva F1, Padma F1, COBRA, Sultan, Raja, and Gigantico. Bawku Red and Galmi are the two main varieties of onions grown in Ghana.

Food Safety: Postharvest Losses and Management of Fresh Products

Food safety in the horticulture sector is necessary because it has adverse effects on nutrition and human health. Horticulture produce (fruits and vegetables) could be contaminated by physical, and biological hazards before harvesting, during the harvesting period, and cross-contamination during transportation, handling, and storage mainly due to poor agricultural and hygienic practices.

Good pre-harvest, harvest, and post-harvest practices are essential in preventing fruit and vegetable contamination. Microbial contamination of fruits and vegetables in the field is more likely in West Africa where growing conditions are unhygienic and protective practices such as the use of plastic mulch that prevents contamination by soil-borne microorganisms are lacking. Harvesting methods also predispose fruits and vegetables to microbial contamination. In addition, the transportation of fresh produce from the farm gate to the primary and secondary collection centers using head loads, farm animals, wheelbarrows, carts, bicycles, motorcycles, and motor vehicles can be sources of contamination. At the collection centers, fresh fruits and vegetables are often heaped together in piles in the open without any form of protection.

Food safety is a critical issue and promoting good practices in the production, harvesting and post-harvest handling of fresh produce reduces the risk of food contamination and helps maintain quality. Poor handling practices along the fresh produce supply chain from farm to market, poor infrastructure including transport and market infrastructure, and lack of refrigeration capacity in a tropical environment (within West Africa), promote the growth of pathogenic organisms with adverse consequences for food safety and human health.

Post-harvest losses for fruits and vegetables are very high in Ghana. In 2021, post-harvest losses for fruits and vegetables were 38% compared to other crops such as cereals (22%), roots and tubers (25%), and meat and fish (15%). Food losses are highest in sub-Saharan Africa, between 15 to 50 percent compared to East and South-eastern Asia (with a maximum of 13 percent) and even lower in Central and South Asia (with a maximum of 7 percent). The high post-harvest losses are mainly caused by (i) unsuitable harvest timing (ii) unexpected harsh climatic conditions and environment (iii) insect and pest infestations (iv) poor harvest and handling practices (v) infrastructure and marketing challenges and (vi) lack of storage facilities. The main postharvest management practices of fruits and vegetables identified in West Africa include precooling, washing and disinfecting, sorting and grading, packaging, storage, and transportation. These management practices help maintain the quality and increase the shelf life of fruits and vegetables. Precooling is done with the help of refrigerators while cleaning and disinfection are done by washing the product in clean water and disinfectants. Sorting and grading are done to eliminate unwanted products from the harvest, and also to determine prices.

Pests and Diseases

Pests and diseases are major problems in fruit and vegetable production in West Africa, causing significant crop losses for farmers. These include diseases such as anthracnose, powdery mildew, alternaria, stem-end rot, Fusarium and bacterial wilt, Pseudocercospora leaf and fruit leaf disease of citrus, Cape St Paul wilt

(CSPWD) for coconuts, bacteria black spots (BBS) on mango and pests (fruit fly, mealybug, termites and mango bugs).

Natural Resources

Water for fruit and vegetable production is mainly from irrigation, rainfall or wastewater. However, farmers depend mainly on rainwater for fruit and vegetable production. Water quality and availability are a challenge to the development of the horticulture sector. Most urban farmers use wastewater, which carries microbial and chemical hazards. In West Africa, less than 10 percent of the fertile land is under irrigation.
West Africa has a diverse agroecology and climate. The region has several climate zones suitable for fruit and vegetable production. Forest ecology is characterized by bimodal rainfall patterns, while savannah ecologies have monomodal rainfall patterns. However, there is a continuous decline and fluctuation in rainfall in West Africa due to climate change. Most savannah areas experience a long dry period. Yet, there is limited adoption of climate-smart practices by farmers in West Africa. The soils in West Africa are relatively less fertile, compared to other regions of the world. Most soils contain abundant coarse materials either gravel and stone, or concretionary materials which affect their physical properties. The coarse sand particles limit the water retention capacity of the soils, which compromises the resistance to drought for the crops. Ferralsols, strongly weathered reddish or yellowish soils are the well-known soil groups in West Africa.

Socioeconomics

Gender and Youth in Horticulture

The global population is projected to reach 9 billion by 2050. The number of young people (aged 15-24) is also expected to increase to 1.3 billion by 2050, accounting for almost 14 percent of the projected global population. While the youth of the world is expected to grow, employment and entrepreneurial opportunities for youth particularly those living in developing countries remain limited. According to the Food and Agriculture Organization (FAO), the unemployment rate for youth is currently three times that of adults in all regions of the world. Youth participation in agriculture is generally low in West Africa.
The horticultural sectors offer potential income-generating opportunities for women and youth.
In West Africa, women play a significant role in the horticulture industry, especially in the harvesting and post-production side of the vegetable value chains – such as processing and marketing/sales. They are more active in the production of mostly leafy and indigenous crops. Women account for more than 50 % of the workforce in the horticulture sector in West Africa. In The Gambia, women constitute over 60 % of the workforce in the horticultural sub-sector. In Nigeria, they account for 75% of the farming population. However, their ability to access land and other resources for production is dependent on their husbands or fathers. Women earn income from horticulture production for household upkeep and payment of school fees and health services.
They should be encouraged to participate in agricultural training, use machinery and adopt new advanced technologies, to enable them engage in improved agricultural practices. In addition, there is a need to improve women's access to education, land, and finance.

Innovation among the youth in the sector is necessary to adopt new technologies such as greenhouse production, artificial intelligence (AI), remote sensing, and drone technology. The youth require the adoption of block-chain (forecast, recording, and tracking) and decision-making technologies to better understand produce supply chains and make informed choices for improving crop yield, to get higher prices. In Ghana, for instance, the youth are being encouraged to go into agri-business along the horticulture value chain and greenhouse farming (Greenhouse Village Initiative-MoFA). The idea of the greenhouse village is to establish strong agribusinesses in the vegetable sector to attract both Ghanaian youth and international investors. The government of Ghana's objective is to position the country as a key competitor in the export of fresh vegetables and cut flowers. The project trained about 537 youths including Degree, Higher National Diploma (HND) and certificate holders. The three-month intensive training session covered all aspects of

greenhouse vegetable cultivation, starting from the nursery, crop production, fertigation, pest and disease management, handling, marketing, and branding.

Market and Consumption

Market Access

Fruits and vegetables produced in West Africa are destined for local and international markets. Locally, the marketing of fruits and vegetables is dominated by informal actors, operating largely in open markets. The local market comprises about 70 percent of the fresh fruit and vegetable market in Ghana and other West African countries. Farmers supply the fresh produce mainly to domestic bulk suppliers, itinerant suppliers, and other suppliers such as supermarkets, hotels, and restaurants. In addition to informal marketing outlets, which are smaller, street shops, hawkers, and well-built markets, formal retail outlets such as supermarkets and specialty stores also engage in selling fruits and vegetables.

Demand for nutritious fruits and vegetables

The demand for fruits and vegetables has grown steadily over the last decade in West Africa due to rising urbanization, population, and income coupled with the expansion of traditional markets, the hospitality industry, and fruit processing units. However, there are still disparities in the consumption of fruit and vegetables across West Africa and between income classes within countries. The consumption of fruit and vegetables is below the FAO/WHO daily recommendations of 400g/day. Ghana has the highest consumption of fruits (189kg/capita/yr), followed by Guinea (97kg/capita/yr), while Mali has the highest consumption of vegetables (97 kg/capita/yr), followed by Senegal (86kg/capita/yr). Vegetable consumption has increased for most countries in West Africa (Benin, Burkina Faso, Cote d'Ivoire, Ghana, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and The Gambia), compared to fruit consumption. Benin, Ghana, Senegal, and Mali have witnessed some growth in fruit consumption over the last decade.

Value-added Horticulture Products

Fruits and vegetables are mostly sold fresh, limiting value creation and value addition by producers and marketers. Producers and traders engage in primary activities such as cleaning, sorting and grading with poor storage, contributing to high post-harvest losses, food safety problems and low product shelf life.

Agribusiness Opportunities

This is an excellent opportunity for investors to help introduce disease-resistant varieties by using tissue culture technology. Greenhouse gardening, integrated pest management, and organic fertilizers also provide opportunities for farmers to produce safe fruits and vegetables in West Africa.

Trade and Standards

West Africa trades in a variety of fruits and vegetables. The major export markets for fruits and vegetables are Europe and North America. Exports of fruits and vegetables in West Africa have been unstable due to production and institutional challenges. In most cases, farmers are unable to meet food safety and sanitary standards set by foreign markets. Exports of pineapple, banana, and mango, especially in Ghana fell in 2020 due to restrictions imposed by COVID-19. However, exports of pineapple in Cote D'Ivoire have remained high in recent years. The volume of orange and pawpaw exports increased exponentially in Ghana. Nigeria exports just 10% of its fruits and vegetables. The main exported fruits and vegetables are the indigenous types consumed by Nigerians in the UK.

Engineering and Technology

There is minimal use of engineering and technology in horticulture production in West Africa. Most reviewers reported the low application of engineering and technology with regard to the production and supply of horticulture products. Nigeria, Mali, Liberia, Ivory Coast, Burkina Faso, Togo and Ghana provided no evidence to this effect. In recent years, however, drones have been used in pest, disease, and

weed surveillance, as well as water stress monitoring in agricultural production. However, most countries in West Africa are yet to adopt these new technologies.

Application of engineering and technology in postharvest packaging, cooling, storage and drying is low in West Africa. There is no evidence of post-harvest packaging, cooling, cold storage and drying of fruits and vegetables in Togo, Gambia, Liberia, and Sierra Leone. In Burkina Faso, only mango and cashew are processed. In Nigeria, although fruit and vegetable processing are at the infant stage, approximately nine (9) companies are involved in the processing of tomato, dried fruits, vegetable mix and dried spices. These factories are located in Kaduna, Kanu, Abuja, Legos, Ogun and Oyo states. Mali has a unit for storage of horticultural products (PLAZA). This is a modern refrigerated and packaging warehouse located in Bamako. Other infrastructures for fruit and vegetable processing are also located in the main producing regions such as Sikasso, Koulikoro, and Bougouni. Some private women's cooperatives also have postharvest packaging, cooling, cold storage, and drying equipment. In Ghana, for example, the major companies engaged in processing fruits such as mango, pineapple and coconut are Bomarts Ltd., Blue Skies and HPW Fresh and Dry Ltd. These companies apply engineering in fruits washing, peeling and cutting, removing and sorting and packaging. They also have PLC dryers for drying processed fruits. In addition, the construction of a refrigerated fruit export terminal (Shed 9 at Tema Harbor) also provides cold storage for pineapple and other horticultural produce.

Research, Education and Training

Horticulture is knowledge dependent and its success depends on research and development. A regional center for research and development in horticulture in West Africa does not exist. However, individual member states conduct research and training at public and private facilities available to them. In Ghana, there are three public universities and five agriculture colleges for teaching and training in agriculture and horticulture-related fields. The public universities are the University of Ghana (UG), the University for Development Studies (UDS), and Kwame Nkrumah University of Science and Technology (KNUST). In Sierra Leone, there are three institutions namely; Sierra Leone Agricultural Research Institute (SLARI), Njala University (NU) and the University of Sierra Leone (USL) that are mainly involved in horticultural research. Research and training in horticulture in Togo are carried out by Agriculture Schools (ESA/UL) and by National Institute of Agronomic Research (ITRA). The research conducted in these institutions are crop-specific. Similarly, several research institutions in Mali including (i) Rural Polytechnic Institute for Training and Applied Research (IPR/IFRA): considered one of the best agricultural engineering schools in the region (ii) Institute of Rural Economy (IER): agricultural research policies; approval and certification of agricultural inputs; and importation, testing and distribution of the latest crop varieties (iii) The DNA (National Directorate of Agriculture) Agricultural Learning Centers (CAA), University of Bamako (FSEG), (iv) Sahel Institute Permanent Interstate Committee for Drought Control in the Sahel (CILSS) CILSS): leads a common regional regulatory framework for pesticides as well as the approval process for new pesticides and (v) International Crops Research Institute for the Semi-Arid Tropics (ICRIS) (CGIAR network) International research institute actively conducting crop research in Mali and leading a world-class geographic information system (GIS) unit in partnership with IER are among few research institutions that undertake horticulture-related training. However, these public and private research institutions are confronted with challenges such as (i) lack of/or inadequate funding, (ii) lack of conducive research environment and infrastructure including laboratory space, basic laboratory instruments and chemicals, research gardens/stations/growth chambers, green houses, internet facility, unreliable electricity supply, (iii) lack of information due to poor access to electronic databases, e-journals, e-books, and lack of mentorship.

Role of Research for Horticultural Development

Several challenges confront the production and consumption of fruits and vegetables in West Africa. These include (i) low knowledge of good agricultural practices among producers (ii) high pests and diseases occurrence (iii) climate change (iv) poor soil quality (v) limited access to inputs and poor quality inputs

(vi) the perception of vegetables to be non-commercial crops (vii) poor postharvest handling practices (viii) limited knowledge/awareness on the benefits of fruit and vegetable consumption (ix) limited household income (x) high price and limited availability of fruits and vegetables and (xi) consumers preferences due to education, cultural beliefs, norms, etc.

Potential areas for intervention include both the demand and supply sides. On the supply side, there are diverse varieties of safe nutritious vegetables that require (i) improving on-farm productivity (improved vegetable varieties, safe and sustainable pest management, protected cultivation) and (ii) ensuring that vegetables are safe to eat, (iii) reduction of post-harvest losses and (iv) improve market access. The demand side entails increasing vegetable consumption to improve nutrition. This requires (i) increasing awareness of a balanced diet and concept of nutritional security (ii) behavioral change and better education on the importance of vegetable consumption (iii) popularization of home gardens, rural vegetable consumption, inclusion in school meals, and (iv) modifying food systems for better nutrition.

Research Priority Areas include (i) fruit and vegetable breeding research to improve variety performance (ii) raising peoples' interest in healthy eating through school and home gardens (iii) addressing access to fruits and vegetables through school meal provision (iv) analysis of seed policies affecting the fruit and vegetable seed sector; capacity strengthening of stakeholders (v) strengthening of business networks (vi) research on indigenous vegetables and popularization of their consumption (vii) education on the usage of local vegetables and recipes.

Regional and National Policy Environment

There is no regional policy for the horticulture sector in West Africa. Issues regarding horticulture in the sub-region are mainly addressed through the ECOWAP/CAADP. West Africa has unprecedented opportunities for growth in horticulture export. The review revealed that national agriculture policies are the main policies guiding the production, processing and export of horticulture products (fruits and vegetables). Various countries also implement programmes and projects in collaboration with donors to enhance the production, processing and export of horticulture products.

Horticultural Funding and Financing

Financing of horticultural production is attractive because horticultural products have a higher yield per acre compared to other value chains. This implies that the output per acre for most horticulture products is significantly higher than cereals and grains. In addition, the price per area for horticultural products is higher than in other value chains. Due to their high value, they may be cultivated year round under irrigation and greenhouse technology. The risk associated with cultivating horticulture products is mitigated by the use of modern technology and good agronomic practices. In order to access funds from a financial institution, agribusinesses have to go beyond identifying the market for their products and understanding the details of quality standards. Additionally, there must be a clear indication of the various activities to be undertaken as part of projects. Agribusiness firms requesting funding must determine how much is needed for activities planned for funds to be made available to them as and when it is needed. Transparency is necessary for acquiring funds for business activities. Funding sources for the sector include long-term funding from the Development Banks or equity investors, family, friends and private finance.

Challenges Faced by Smallholder Horticulture Farmers

The horticulture sector has been identified as the key driver for sustainable growth in West Africa. In recent years, there has been high demand for horticulture produce from domestic, export markets (the EU), and other emerging markets. However, horticulture crop production continues to be dominated by smallholders and farmer groups with about 80-95% of them having farm sizes less than 2 ha. The smallholder farmers in the sector are confronted with several challenges including (i) marketing challenges such as limited

market information, poor quality produce, inadequate knowledge of food safety standards (ii) inadequate credit facilities (iii) poor quality and high cost of inputs (iii) poor agronomic practices (iv) limited access to recommended fertilizer because of the high cost (v) inadequate extension services (vi) poor knowledge of harvesting and post-harvest handling practices (vii) high pest and diseases infestation leading to crop failures (viii) limited or non-availability of appropriate storage facilities and marketing centres.

To improve the challenges confronting the smallholders, the following strategies must be implemented:

(i) Improve accessibility to farms through the construction of farm roads
(ii) Private investment in nurseries in communities to sell good quality seedlings to farmers.
(iii) Provide continuous training in the nursery, Integrated Pest Management (IPM), and postharvest management to reduce pre-and post-harvest losses.
(iv) Motivate farmers to use certified planting materials through the provision of subsidies on agricultural inputs
(v) Harmonization and production of extension materials to be used by all trainers
(vi) Build the capacity of extension staff to provide efficient and effective extension services
(vii) Ensure ready markets for produce through contract farming arrangements
(viii) Provision of appropriate storage facilities and marketing centres and outlets

Research Priority Areas

Research and Development

- Conduct Food systems research across the West Africa sub-Region
- Comprehensive data collection and management on horticultural crops to enable forecasting and predictions of the sector
- Map and strengthen the horticultural value chains across the West Africa sub region
- Assess and develop the fruit and vegetable seed systems in various countries in West Africa
- Develop improved varieties adapted to local conditions and IPM systems against disease and pest problems
- Establish a West Africa Horticultural Research Center

Youth, Gender and Horticulture Development

- Empower youth and women in technology generation, transfer, adoption, and capacity building through participatory methods
- Emphasize research on youth and women's participation in horticultural export production
- Research should also focus on documenting women's constraints and opportunities in the horticulture sector.

Postharvest Technology and Food Safety

- Identify appropriate postharvest technologies to reduce losses in quantity and quality of produce
- Develop a postharvest system to meet market demand and food safety standards
- Develop detailed post-harvest handling and safety information for fruits and vegetables
- Develop and promote appropriate technologies for enhancing the shelf life and for processing horticultural produce (fruits, vegetables, spices and nuts).

Nutrition and Human Health

- Profile indigenous horticulture fruits and vegetables, develop agronomic and postharvest practices to improve yield and storage life and create awareness and increased consumer demand through product development.
- Promote research in nutritional value of indigenous fruits and vegetables

INTRODUCTION

The location, climate, and suitable soil conditions of West Africa (WA) make it ideal to become Europe's next largest supplier of horticulture products at a time when the EU imports large quantities of fruits and vegetables to meet growing demand and broadening taste for new, high quality, and ready-to-eat foods. Fruit and vegetable export growth has the potential to significantly boost economic growth in the West African countries, generate employment and income in rural areas, and create opportunities for smallholder inclusion into the value chain. In addition, the sector provides all-year-round sources of income in rural and urban areas for women, thus improving their standard of living. Women play an essential role in many aspects of the horticulture value chain.

Horticultural crops (fruits and vegetables) have a tremendous potential to contribute to food and nutrition security in West Africa by enhancing the nutritional quality of diets through, the provision of key minerals (zinc, iodine & iron), vitamins (A and C) and fibre. Micronutrient malnutrition as a result of the inadequate intake of fruits and vegetables has been known to cause serious disorders, especially in women and children. These nutrients are essential for pregnant and lactating women to ensure proper development of the brain of the unborn and breastfeeding child. They are also required for growing children to ensure normal growth. It is estimated that about 2 billion people globally who are mostly concentrated in developing countries suffer from micronutrient deficiency, referred to as hidden hunger[1]. Hidden hunger not only causes the lowering of a person's IQ but as well stunting and blindness, with children and women being especially vulnerable.

In WA, changing demographics, rising incomes and shifting consumer preferences have resulted in an ever-growing demand for food that is more varied, healthier and of higher quality. According to the IMF, by 2022, WA's per capita gross domestic product will increase from $1,753 in 2017 to about $2,122 in 2022. The region has an estimated population of 420.9 million people, with an annual growth rate of 2.63% percent, and it is projected to increase to 516.6 million in 2030 (World Bank, 2021). The region has become more urbanized with the urbanization rate being 44 percent in 2021, compared to 35 percent in 2000 (World Bank, 2021). The growing number of middle-class consumers in WA that are increasingly more affluent and educated will continue to shift their dietary preferences to include more protein, fruits, and vegetables. Additionally, market liberalization and a trend toward export diversification have played an important role in stimulating the exports of high-value horticulture crops in WA. Horticultural crops especially fruits and vegetables play a major role in food and nutrition security.

1.1 Global Performance of Fruits and Vegetables

Globally, fruit and vegetable production has increased exponentially over the past three decades. However, global production has been dominated by Asia which produced nearly 58.14% and 78.21% of fruits and vegetables in 2020 (Table 1.1). Africa produced nearly 13.51% and 7.41% of the world's fruits and vegetable output in 2020. Other major leading world producers of vegetables were Europe (7.36%), Latin America (3.66%), Northern America (3.08%), and Oceania (0.28%) (Table 1.1). Additional leading producers of fruits include Europe (9.34%), Latin America (15.31%), North America (2.78%) and Oceania (0.89%). West Africa's share of world production is relatively low accounting for 3.21% and 2.31% of global fruits and vegetable output in 2020 (Table 1.1).

[1] WHO (World Health Organization) and FAO (Food and Agriculture Organization of the United Nations), (2006). Guidelines on Food Fortification with Micronutrients. Geneva.

Table 1.1: Fruits and Vegetable Production Across Regions (2020)

Vegetables Production (MT)			Fruits Production (MT)		
Regions	**Quantity (MT)**	**Share (%)**	**Regions**	**Quantity (MT)**	**Share (%)**
Asia	898,151,797.00	78.21	Asia	515,770,210.00	58.14
Europe	84,577,939.00	7.36	Europe	82,853,809.00	9.34
Africa (excl. WA)	58,620,859.00	5.10	**Africa** (excl. WA)	91,368,938.00	10.30
West Africa	26,528,444.00	**2.31**	**West Africa**	28,514,991.00	**3.21**
Latin America	42,035,925.00	3.66	Latin America	135,864,415.00	15.31
North America	35,365,836.00	3.08	North America	24,673,541.00	2.78
Oceania	3,165,452.00	0.28	Oceania	7,981,472.00	0.89
TOTAL	1,148,446,252.00	100.00		**887,027,376.00**	100.00

Source: FAO, 2022

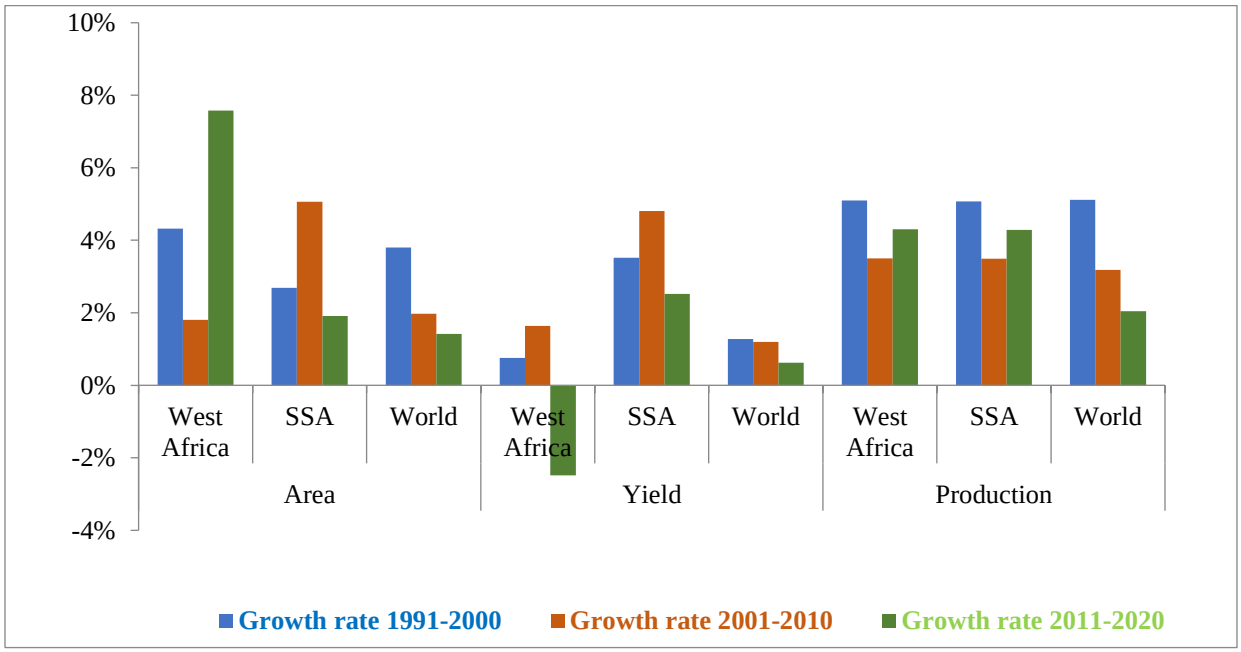


Figure 1.1: Fruit Production Across Regions
Source: FAO, 2022

Over the past three decades, the output of fruits and vegetables more than doubled. For instance, the global output of fruits increased from 420 million tons in 1990 to nearly 887 million tons in 2020. Similarly, vegetable output increased from 418 million tons in 1990 to 686.6 million tons in 2000. Production increased from 974.8 million tons in 2010 to over 1 million tons in 2020. The observed increase in global output is mainly driven by production from Asia. Production of fruits and vegetables remain relatively stable in other regions such as Africa, Europe, Latin America, North America and Oceania. The growth of fruits and vegetable production in West Africa declined over the past three decades. Estimated growth rates for fruits and vegetable were 5.11% between 1990-2000, 3.18% (2001-2010) and 2.04% (2011-2020) (Figure 1.1). Growth in production in WA is mainly driven by the expansion of land under cultivation (Figure 1.2).

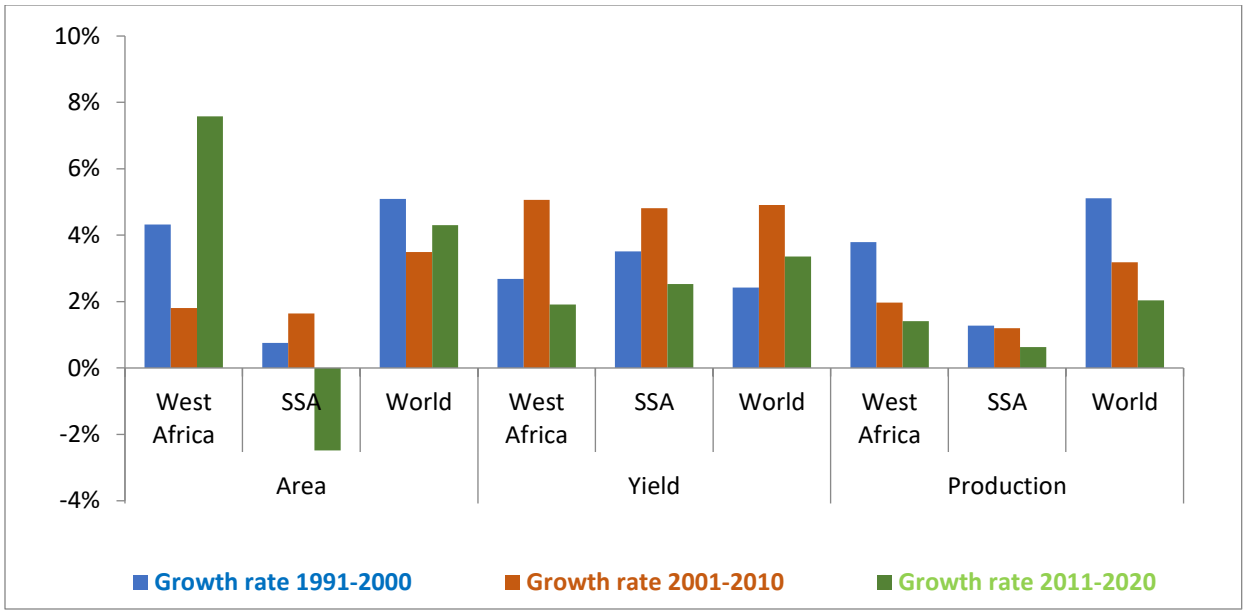


Figure 1.2: Vegetable Production Across Regions
Source: FAO, 2022

1.2 Regional Performance of Fruits and Vegetables

Pineapples are native to Central and South America, but they are also grown in Asia, North America, and Africa. In West Africa, Nigeria, Ghana, and Benin are the top three producers of pineapples. Nigeria accounted for around 44% of the total production in 2020. However, yields of pineapples are very high in Ghana (63.1 Mt/ha) compared to Benin (59.8 Mt/ha), and Nigeria (8.2 Mt/ha). West Africa accounts for 2.3% of global banana production. According to FAO data (2020), about 13 countries in West Africa produce bananas. After Cameroon, Cote d'Ivoire, and Guinea, Ghana is the fifth largest banana producer. Banana yields in Cote d'Ivoire (44.7 Mt/ha) are higher than in Cameroon (12.3 Mt/ha), Ghana (11.2 Mt/ha) and Guinea (11.2 Mt/ha).

Nigeria and Mali are the top producers of mango in WA. Mango yields are particularly high in Nigeria (89.4 Mt/ha), and Mali (79.3 Mt/ha). Ghana ranked seventh in West Africa in mango production in 2020, with an average yield of 9.9Mt/ha. Pawpaw (papaya) is a popular fruit cultivated for local use and export in many West African countries. Nigeria produced nearly 81.5% of the region's output in 2020. Ghana was placed fifth in 2020, with a total production of 5,661 Mt. Ghana is the leading orange producer in West Africa, producing 52.1% of the region's oranges in 2020. In comparison to Mali (13.4 Mt/ha), Cote D'Ivoire (12.6 Mt/ha), and Senegal (38.8 Mt/ha), Ghana also has the highest yield (38.8 Mt/ha).

In West Africa, chilies, onions, and tomatoes are among the most widely grown and consumed vegetable crops. Nigeria, Niger, Ghana, Cote D'Ivoire, and Sierra Leone are the leading chili producers in the subregion, with Nigeria accounting for 45.6% of total production in 2020. Niger, on the other hand, has the highest yield (14.0 Mt/ha), followed by Sierra Leone (12.8 Mt/ha), Ghana (7.9 Mt/ha), Cote D'Ivoire (6.0 Mt/ha), and Nigeria (4.6 Mt/ha). Nigeria produces nearly half of the region's tomatoes (49.6%), but has the lowest yield (4.4 Mt/ha), compared to Niger (27.0 Mt/ha), Cameroon (12.3 Mt/ha), and Ghana (7.8 Mt/ha). In 2020, Ghana ranked fourth in West Africa for tomato production, with about 144,328 tonnes produced. Similarly, Nigeria leads the other countries in onion production but has the lowest yield (2.1Mt/ha), compared to Niger (35.0 Mt/ha), Senegal (30.7 Mt/ha), Cameroon (12.3Mt/ha), and Ghana (35.0 Mt/ha).

1.3 Growing demand for fruits and vegetables in West Africa

Demand for fruits and vegetable have grown steadily over the last decade in West Africa. Table 1.2 shows the per capita consumption of fruits and vegetables between 2010 to 2019. During the period per capita consumption of fruits increased for the five countries-Benin, Cameroon, Ghana, Mali and Senegal. Fruit consumption in Ghana is the highest in West Africa with consumption levels of about 189 kg/year. Similarly, vegetable consumption increased in most countries in West Africa. However, consumption increased significantly for Benin, Niger, Senegal and Mali (Table 1.2). Consumption of vegetables increased in Ghana by about 0.5% per annum.

Table 1.2: Per Capita Consumption of Fruits and Vegetables in West Africa (2010-2019)

Country	Fruits		Vegetables	
	(kg/year)	CAGR	(kg/year)	CAGR
Benin	48	2.0%	49	6.5%
Burkina Faso	5	-0.6%	16	0.04%
Cote d'Ivoire	69	-0.01%	34	0.6%
Ghana	189	1.1%	30	0.5%
Guinea	97	-1.4%	52	-1.6%
Liberia	43	-1.5%	28	0.8%
Mali	70	1.0%	97	4.1%
Niger	26	-0.8%	86	11.8%
Nigeria	59	-1.4%	72	1.0%
Senegal	18	2.3%	78	9.9%
Sierra Leone	34	-0.1%	49	1.1%
Togo	8	-0.8%	21	-0.8%
Gambia	5	0.0%	33	4.3%

Source: FAO, 2021; CAGR – Compound Annual Growth Rate

However, high demand for food safety and quality from consumers and traders imposes standards on smallholder producers, processors and exporters of horticultural products to deliver competitive products. The emergence of more rigorous international food and safety standards over the past decades presents challenges and opportunities for horticulture exporters in WA. European markets differentiate themselves from their competitors by offering fresh fruits and vegetables and cannot afford to offer inferior products that do not meet food safety standards. These standards are not based on superficial preferences of retail shops but have become formalized as legal and commercial necessities of brands and food standard management. EurepGAP is a private sector body that sets the voluntary standard for the certification of agricultural products. In addition, governments of Europe, North America, and other importing regions set maximum residue levels (MRLs) for pesticides and other potentially harmful chemicals. These requirements are applied to imported food products and those grown domestically.

West African countries have signed the African Continental Free Trade Area (AfCFTA), as a major strategy for regional integration and trade facilitation. This presents opportunities for the export-oriented horticulture sector and also requires an urgent need to improve the competitiveness of smallholder farmers. Access to finance, suitable land, markets and market information, technical assistance, input providers, research services, production technologies and sustainable farming systems is needed to operate effectively and contribute to the competitiveness of smallholder farmers in the horticulture sector. In addition, improving opportunities for smallholder farmers to export horticultural crops and improving the value chain can benefit domestic markets and regional markets.

The current review is to provide a general overview of the horticulture sector and also identify challenges and opportunities (biophysical, natural resource, socio-economic. engineering and technology, policy, training and technical capability) that affect the horticultural value chain in West Africa; recognizing their

effects on productivity, product quality, profitability; and identifying what is required to achieve sustainable growth of the horticultural sector. Successful investments in programs aimed to enhance horticultural production in Ghana should be guided by the strategic assessment of the main constraints faced by small-scale farmers, who are the major players in the field.

Thus, the ultimate goal of the West Africa horticulture review is to identify challenges and opportunities in areas for research and capacity development in the sector. This report focuses on the opportunities and challenges of the horticulture sector (fruits and vegetables) in West Africa and the capacity of local and regional institutions to conduct horticultural research and training to address the challenges.

1.4 About West Africa

West Africa is approximately 5 million square miles and located in the westernmost region of the African continent. It has an estimated population of about 420.9 million people in 2022, and this is projected to increase to about 490 million by 2030 and 736 million people by 2050 (UNDESA, 2011). Though the region has an abundance of natural resources such as gold, diamond, land, and untapped water resources, it is still confronted with several social challenges. The World Bank posits that the total number of people living in extreme poverty (those living on less than US$1.90/day) at the end of 2019 was 138 million. This number is expected to increase by approximately 18 percent (or 25 million persons). This pushed the sub-regional poverty headcount to 41.1 percent, up from 34.8 percent in 2019, with varying country statistics. Additionally, the number of people at risk of hunger in West Africa is estimated to rise from 30.1 million in 2010 to 32.5 million in 2030 and 33.5 million in 2050 (IFPRI, 2017).

West Africa's population is rapidly urbanizing. between 1980 and 2010, urban populations grew 4.5% annually, against 1.8% in rural areas. This trend is expected to continue between 2011 and 2050, with urban population growth projected at 3.7% per annum compared to only 0.5% in rural areas (UNDESA, 2011). Already by 2020, half of the projected 388 million people residing in West Africa will live in urban areas, and urbanization it is expected to reach 65% by 2050 (UNFPA, 2010).

Development of the agriculture sector offers significant growth potential for the region. Agriculture remains a central part of the West African economy, providing 30–50% of GDP in most countries, the major source of income and livelihoods for 70–80% of the population, food supplies and revenue from the export of cash crops. In addition, investment in the sector is necessary for economic growth and the attainment of sustainable development goals (1, and 2). The production of horticulture crops especially fruits and vegetables offer promising opportunities for income and food production in WA. These crops are important because of their economic and nutritive value and can be an avenue for diversification for small-scale farmers who can produce them for local, regional and global markets.

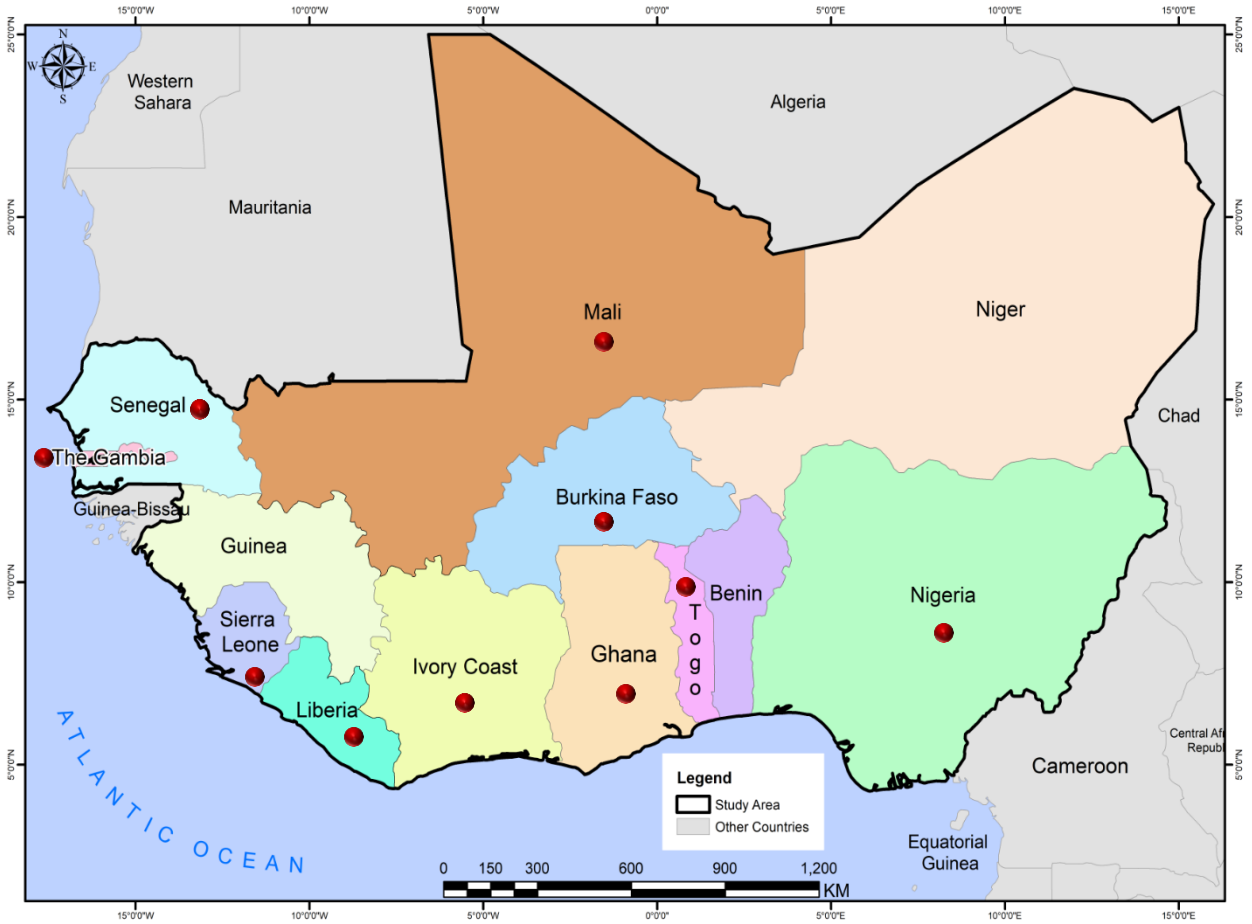


Figure 1.3: Study Area Map of West Africa Showing Participating Countries
Source: Authors Depiction

Increased production and consumption of fruits and vegetables are essential for achieving food and nutrition security in WA. Fruits and vegetables, due to their rich micronutrient content, play a key role in food and nutrition security. Recent statistics have shown that the prevalence of undernourishment has increased significantly over the past decades in WA (WHO, 2020). For instance, between 2005 and 2020, the prevalence of undernourishment increased from 14.2% to 18.7% while the number of people undernourished also increased from 38 million in 2005 to 75.2 million in 2020. Similarly, the level of food insecurity in WA has also increased exponentially within the same period. Severe food insecure levels increased from 8.6% in 2014 to 28.8% in 2020.

1.4 Methodology

West Africa Horticulture Sector Assessment is focused on priorities determined by stakeholders in the sector. Specific developments required in the sector, capacity building and recommendations will be proposed. The assessment process included desk reviews, stakeholders' surveys, focus group discussions, and key informant interviews.

Desk Research: Desk research included extensive searches on websites of institutions for reports and documents of relevance. Organisations such as the Ministry of Food and Agriculture (MOFA), the Ghana Export Promotion Authority (GEPA), Ghana Statistical Services (GSS), the Ministry of Trade and Industry

and the Peasant Farmers' Association were interviewed for relevant information and data. Published articles and reports on the horticulture sector were consulted. Other institutions in other West African countries were also consulted for relevant information.

Key Informant Interviews: One important qualitative method used in preparing this report involved key informant interviews with identifiable persons with relevant information on the subject. The interviews sought to gather information on challenges and opportunities for the horticulture sector. In the case of research institutions and the universities, data was gathered on the research infrastructures, education and training needs of the horticulture sector.

Expert Group Discussion: West Africa Stakeholders input from ten (10) countries were considered in this review. These key stakeholders include industry leaders, experts in horticulture production, crop handling between harvest and markets, gender equity, youth empowerment, nutrition, agri-policy, input suppliers, irrigation experts, value chain experts, climate experts and farmer associations.

The review of the horticulture sector is done within eight thematic areas namely: Biophysical, natural resources, socio-economics, markets and consumption, trade and standards, engineering and technology, research, education and training and policy environment for horticulture.

Subsequent to this review, a regional conference was organized between 31st May to 1 June 2022. The workshop was designed to elicit equitable and active participation of all major stakeholders in the horticulture sector in West Africa. The participating countries were Benin, Burkina Faso, Cote d'Ivoire, Ghana, Guinea, Mali, Nigeria, Senegal, Sierra Leone, Togo and Gambia. In addition to in-country coordinators from these participating countries, other stakeholders in all the countries were invited to join the conference online.

The horticulture innovation lab will focus its efforts in four regions with a country region serving as a hub. This includes West Africa (Ghana), Eastern Africa (Kenya), Asia (Nepal) and Central America (Honduras). It aims to implement a locally-led, globally supported programme that will lead to improvement in the horticulture sector.

REGIONAL REPORTS

GHANA

2.1 Introduction

In the last two decades, Ghana has achieved robust economic growth averaging 7.0 percent annually. However, this growth was not accompanied by a reduction in poverty, the creation of jobs, and socio-economic transformation. This situation is further worsened by the Covid-19 pandemic, causing a decline in economic growth. As a result, in 2020, gross domestic product (GDP) grew by 0.4%, a substantial decrease from the rate of 6.5% in 2019. Industry (3.6%) and services sector (1.5%) both grew at lower rates in 2020 than in 2019; however, the growth in the agriculture sector was substantially faster. The agriculture sector grew by 7.4% in 2020 which was mainly driven by the crop subsector (8.7%) (Ghana Statistical Service, GSS, 2021).

The horticulture sector offers great opportunities for economic growth due to strong export market potential and growing domestic demand. High-value horticulture crops are more profitable than the alternatives such as grains. For instance, fruits and vegetable producers in India earned eight times more profit than cereal farmers (Subramanian, Varadarajan, & Asokan, 2000). In Ghana, the gross margins of vegetable producers are significantly higher than maize and rice farmers (Van Asselt, DI Battista, Kolavalli, Udry, & Baker, 2018). They also noted that horticultural crops such as pineapple, tomatoes, onion, carrot, and Scotch Bonnet generate more income for farmers than cereals, providing good opportunities for poverty reduction. This implies that the export-based horticulture sector has the potential to increase farmer income and create jobs. However, it required improved technology, infrastructure, pre- and postharvest management, finance and technical knowledge.

According to data compiled by FAO Stats in 2020, banana, citrus, mango and coconut production have been growing progressively since 2010 (Figure 2.1).

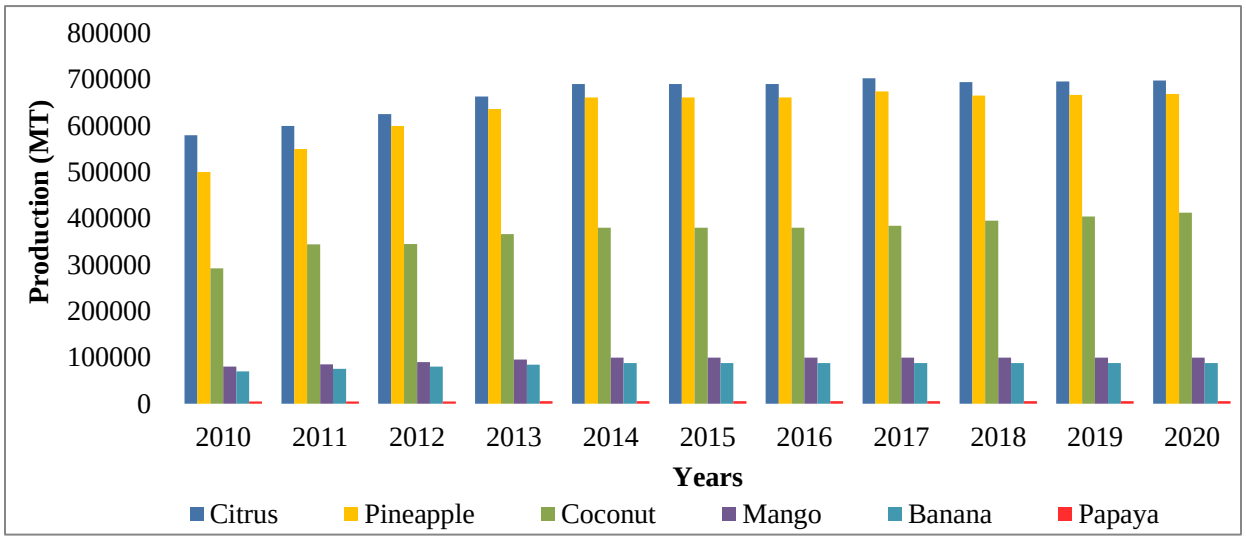


Figure 2.1: Production of Major Fruits in Ghana (Mt), (2010-2020)
Source: FAO, 2020

Pineapple production decreased drastically after the shift from the production of smooth cayenne to MD2. However, between 2010 to 2020, production increased from 500,000 Mt to 668,945 Mt (FAO, 2020). Production seems to be steady for the last five years with only a marginal increase within the period. Citrus production has also witnessed a significant increase. Production increased from 580,000 Mt in 2010 to

697,637 Mt in 2020 (FAO, 2020). Similar trends were also observed for coconut, mango and banana. Papaya production was on a smaller scale compared to other fruits.

Production of vegetables is widespread in Ghana. In 2020, tomato production was approximately 368,920 Mt, green chilies and peppers were 119,405 Mt, and onions were 144,328 Mt (Figure 2.2). In addition, together, these vegetables were planted on less than 1.5 percent of the estimated 4.7 million hectares of cultivated land (MoFA, 2020)

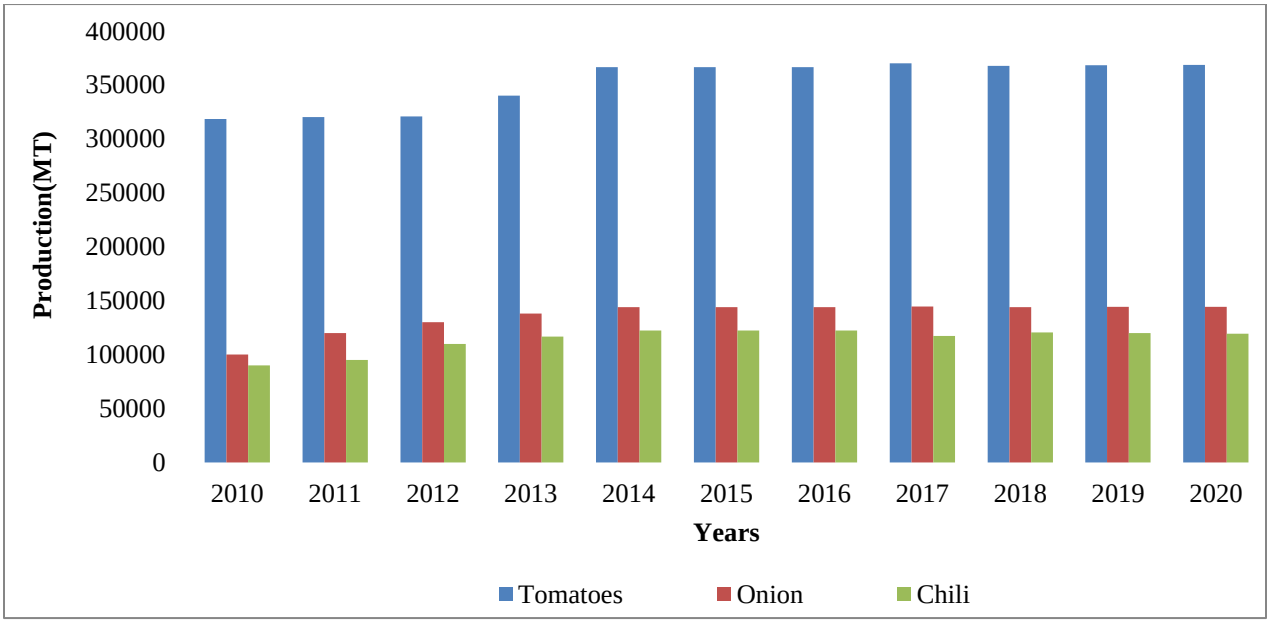


Figure 2.2: Production of Major Vegetables in Ghana (Mt), (2010-2020)

Source: FAO, 2020

In Ghana, fruit production is highly commercialized. More than 60% of farm produce is sold for both domestic and international consumption (Agyei-Sasu, Egyir, Osei-Asare, & Anaman, 2013; Asuming-Brempong, Anarfi, Arthur, & Asante, 2013), partly from pineapple, banana, and passion fruit, which are exported in greater quantities; about 35% of mango, citrus, and coconut are sold to buyers at the farm gate.

Data from FAO (2020) shows that the export of vegetables remained relatively stable over the past decade. Vegetable export values were 3,919Mt in 2010, however, decreased to 2,391Mt in 2012. Between 2015 to 2020, export remained relatively stable, amounted to 14,329Mt in 2020 (Figure 2.3).

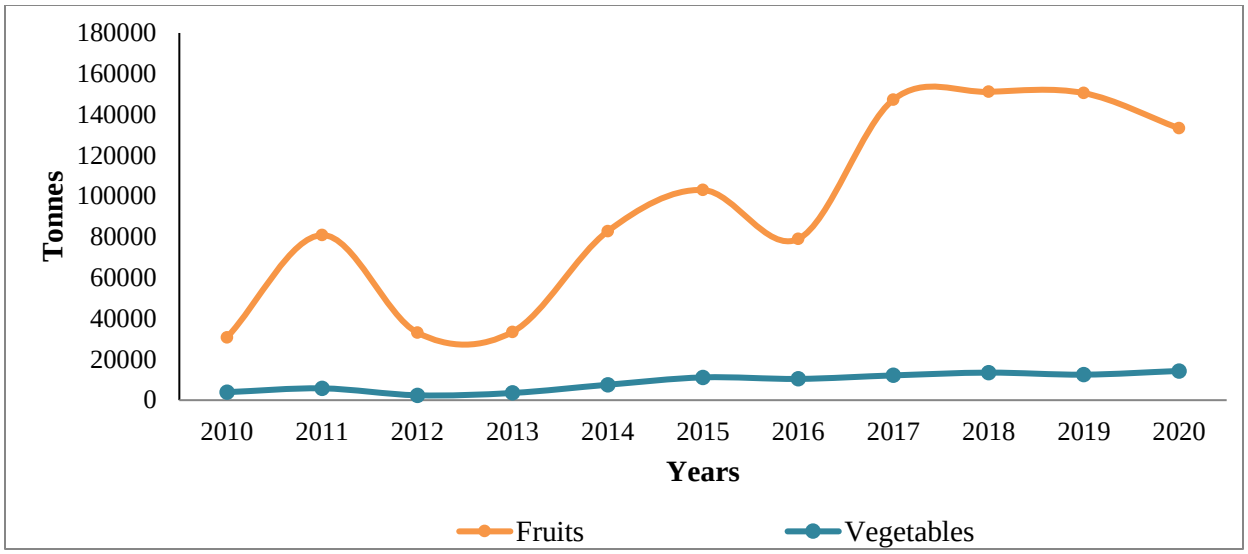


Figure 2.3: Export Volume of Fruits and Vegetables in Ghana (Mt)

Source: FAO, 2021

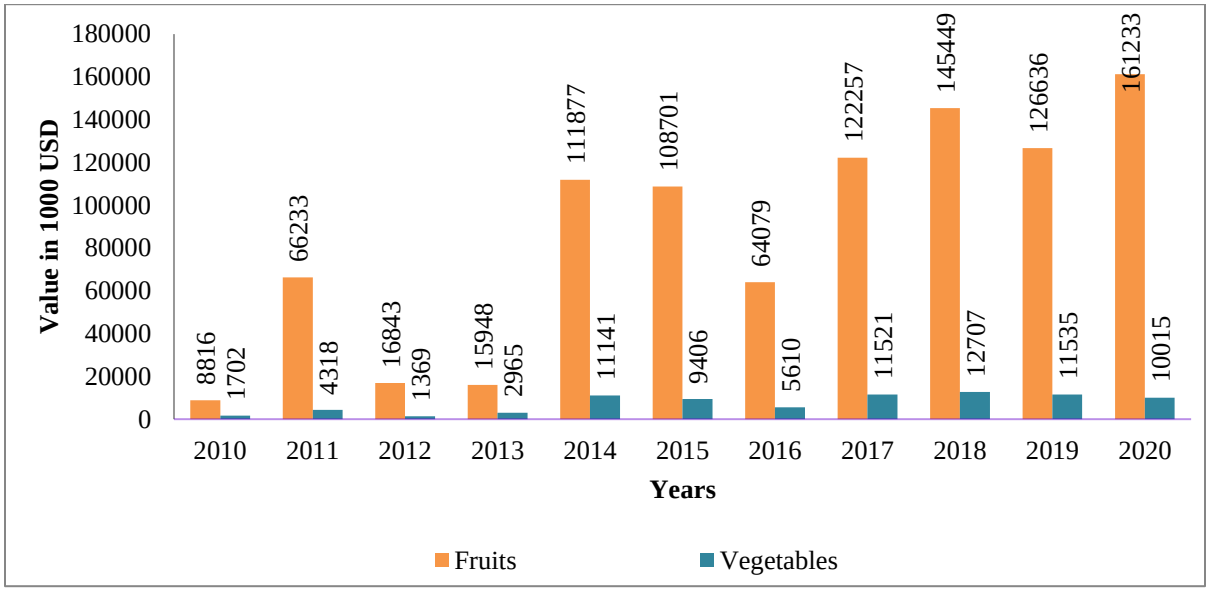


Figure 2.4: Export Value of Fruits and Vegetables in Ghana (in 1000 USD)

Source: FAO, 2021

Export of fruits fluctuated over the period. The average export volume of fruits in Ghana was 100,000 Mt for the period 2010-2020, with a yearly growth rate of about 4.14% (Figure 2.3). In 2010, the value of fruits was 31,000 Mt which increased to 80,911Mt in 2011 before declining to 33,427 Mt in 2013 (Figure 2.3). Export quantities increased to 82,812Mt in 2014 before reaching about 133, 263 Mt in 2020 (Figure 2.3). The export value for fruits and vegetables in Ghana is as indicated in Figure 2.4.

2.2 Geography and Markets

Ghana is located between latitudes (4° 44'N and 11° 11'N) and longitudes (3° 11' W and 1 ° 11'E) respectively. The closeness of Ghana to the EU is a major opportunity for horticulture exporters. Currently, most fruits and vegetable products are exported to the EU.

The agroecology of Ghana is conducive to the cultivation of horticultural crops. However, due to differences in rainfall patterns, Ghana's fruit and vegetable production systems vary by agroecological zones. Aside from mango, commercial fruit production is concentrated in eleven regions spanning the middle belt to the south. Tomatoes, onions, green chilies, and pepper are produced in the Upper East, Northern, Brong Ahafo, Ashanti, Eastern, and Volta regions (Robinson & Kolavalli, 2010; Saavedra et al., 2014). Barring irrigation, farmers in the forest savannah transition and coastal savannah zones have two production seasons because they enjoy bi-modal rainfall patterns (Table 2.1).

Table 2.1: Rainfall Distribution by Agro-Ecological Zones in Ghana

Agro-Ecological Zone	Mean Annual Rain (mm)	(Rainfall mode) Rainy Seasons	Growing Period (Days)		Dominant Horticultural Crops
			Major Season	Minor Season	
Rain Forest	2,200	**(Bimodal)** March-July Sept-October	150-160	100	Onions and shallots
Semi Deciduous Rain Forest	1,500	**(Bimodal)** March-July Sept-October	150-160	90	Onions and shallots
Transitional	1,300	**(Bimodal)** March-July Sept-October	200-220	60	cashew and vegetables
Coastal Savanna	800	**(Bimodal)** March-July Sept-October	100 - 110	50	Pineapple, mango, tomato, pepper, water melon
Northern Savana **Guinea Savanna** **Sudan Savanna**	 1,100 1,000	**(Monomodal) May-November**	 180 – 200 150 - 160	 * *	Shea, Mango, Tomato, Pepper, Dawadawa

Source: MOFA, 2021

Rainfall distribution is bimodal in the forest, transitional and coastal zones, giving major and minor growing seasons. Elsewhere (Guinea Savanna and Sudan Savanna), the unimodal distribution gives a single growing season. The Coastal Savanna belt covers the Coast - Winneba Plains, the Accra Plains and the Ho-Keta Plains. The Coastal Savanna is characterized by grassland, shrub and thicket. The major crops grown are cereal, fruit and vegetable crops. The Forest Agro-ecology is north of the Coastal Savanna. It is made up of evergreen rainforest and deciduous forest. The major horticultural crops grown are citrus, coconut, fruit and vegetable crops.

The Transitional Zone is a mixture of forest and grassland and is located to the north of the Forest Zone. The major crops grown are cashew and vegetables. The Guinea Savanna Zone is to the north of the Transition Zone. It is made up mainly of grassland with few trees. Major crops grown are vegetables and

shea. Sudan Savanna is further to the north of the Guinea Savanna zone and has less vegetation. The main crops grown are vegetables and shea.

Table 2.2: Major Fruits and Vegetable Production areas in Ghana
Source: MOFA, 2022

CROPS	REGION
FRUITS	
Pineapple	Ashanti, Western North, Central, Eastern, Greater Accra, Volta
Citrus	Ashanti, Central, Eastern, Bono, Oti, Volta, Western, Western North
Mango	Ashanti, Bono East, Central, Eastern, Northern, Savannah, Upper East, Upper West, Volta, Western, Western North
Pawpaw	Ashanti, Central, Eastern, Oti, Savannah, Upper East, Volta, Western North
VEGETABLES	
Tomato	Ashanti, Eastern, Greater Accra, Volta, Bono East, Bono, Ahafo Kasena Nankana, Ahafo Tano South, Techiman North, Wenchi, Techiman, Dormaa Central Berekum West, Offinso North, Asante Akim North Ada East, Ada West, Ga South, Anloga, Agortime, Akatsi North
Onion	Ashanti, Eastern, Greater Accra, Volta, Bono East, Bono, Ahafo, Western, Northern, Upper West
Pepper	Ashanti, Eastern, Greater Accra, Volta, Bono East, Bono, Ahafo, Upper West, Northern, Western

2.3 Notable Production System and Practices

Horticultural production systems in Ghana are dominated by crops such as pineapple, pawpaw and exotic vegetables, which are mainly grown for export. About 90% of farm holdings are less than two hectares in size. Vegetable production in Ghana is produced on smaller plots of land of less than one hectare (Van Asselt et al., 2018). The average farm size for tomatoes, onion, and Scotch Bonnet is 0.66 ha, 0.42 ha, and 0.36 ha, respectively. However, there are some large farms and plantations, particularly for bananas, coconuts and to a lesser extent, pineapples. The main system of farming is traditional where hoe and cutlass are the main farming tools.
There are two systems for fruits and vegetables based on sources of water for production:

Rain-Fed Cultivation: In Ghana, many small-scale farmers rely on rainfall to produce their vegetables. A bi-modal rainfall pattern in the south allows for a long farming season from May to November (van Asselt et al., 2018). In Ashanti and some parts of Bono regions, selected vegetables such as tomatoes and onions are produced mainly under rainfed conditions. Most fruits such as pineapple, papaw, mango, citrus and coconut are also mainly cultivated under a rain-fed system.

Irrigated Cultivation: Irrigated vegetable production is done in the North, Upper East and Volta whereas southern production is mainly rainfed. Farmers irrigate their plots using gravity-fed systems, whereas farmers in Upper East use irrigation pumps (Van Asselt et al., 2018). Tomato, onion and Scotch bonnet farmers in the Upper East have access to irrigation schemes. Other farmers also irrigate their vegetable plots using motorized pumps.

Seed Sources and Varieties: Farmers obtain their seeds and planting materials through either informal or formal seed systems. In informal systems, farmers save seeds and planting materials from their crops, collect seeds from neighbour's seed stands or high performing trees, and purchase seed and planting materials from non-regulated local seed producers and traders. Under the formal seed system, farmers obtain their seeds and planting materials, whose traits and quality have been certified through a rigorous

regulatory process. In Ghana, fruit and vegetable farmers use recycled seed or purchase seed from the local market for production (Van Asselt et al., 2018). About 42 percent and 64 percent of Scotch Bonnet seed and onion seed are purchased from the local market. However, 82 percent of carrot seed is purchased from private input dealers. Robinson and Kolavalli (2010), noted that about 20 percent of fruits and vegetable farmers in Ghana used recycled seeds.

Disease and Pest Control: Chemical application remains the most common means to control pests and diseases on fruits and vegetable farms in Ghana. The main chemical inputs for fruit and vegetable production in Ghana are fertilizer and pesticides, including insecticides, herbicides, and weedicides. Famers use pesticides to control weeds and protect their plants against pests and diseases. Research shows that more than seventy percent of vegetable farmers use insecticides for pest control and nearly all vegetable farmers used chemical fertilizer in vegetable production. The use of pesticides is excessive, especially in urban and peri-urban vegetable farming, posing health and environmental hazards (Nchanji et al., 2017).

Greenhouse Technology in Vegetable Production

Greenhouse cultivation is the production of high-value crops in controlled environments using the advantages of technology, water conservation and environmental protection techniques while increasing yields and productivity with substantial income to investors. The Government of Ghana, in a bid to open up more opportunities for increased production and export of vegetables introduced greenhouse technology in vegetable production in 2017. The crops produced under this technology include tomato, cherry tomato, cucumber, sweet pepper, and hot pepper (Habanero). Three greenhouse centres were built in Akumadan (14,440 m^2) in the Ashanti Region, Bawjiase (14,440 m^2) in the Central Region, and Dawhenya (38,260 m^2) in the Greater Accra Region. The centre trained 537 youths in greenhouse vegetable production.

2.4 Biophysical

Inputs Supply

Fertilizer, pesticide, seed, labour, land, and water for irrigation are the key inputs for fruit and vegetable production in Ghana. Although no specific data on the volume of imported fertilizers used for horticulture crops are available, several surveys reveal that most fruit and vegetable farmers in Ghana use inorganic fertilizers and plant protection inputs such as pesticides to control pests and diseases, as well as increase crop yields. Ghana currently does not produce inorganic fertilizers and pesticides because there are no pesticide manufacturing and formulation plants in the country (Onwona Kwakye, Mengistie, Ofosu-Anim, Nuer, & Van den Brink, 2019). What is available locally is imported from across the globe.

Availability of Fertilizer

According to FAO data, imports of certain types of inorganic fertilizers for agriculture have been rising in Ghana in recent years. Recent flagship programs of the government such as the Fertilizer Subsidy Program (2008-2018) and Planting for Food and Jobs (2017-Date) are among the primary drivers of rising fertilizer imports. Under these programs, the Government of Ghana (GoG) provided a 50% subsidy on fertilizer prices, which are regulated seasonally with the agreement of importers.

Between 2016 and 2017, the total volume of inorganic fertilizer imports grew from 440,826 MT to 499,566 MT (Table 2.3). Except for phosphates, the number of imports of NPK, urea, muriate of potash, ammonia sulphate, nitrates, and potassium sulphate grew dramatically between 2016 and 2020. The import of liquid fertilizers more than doubled, rising from 651,211 MT in 2016 to about 1.4 million MT in 2020 (Table 2.3). Fertilizers are imported into Ghana from some parts of Africa, Asia, and Europe. In 2018, the top ten sources of fertilizer imports into Ghana in 2018 were Morocco, Finland, Estonia, China, Italy, Latvia, Libya, Belgium, Turkey, and Germany (AfricanFertilizer.org, 2018). Despite increased imports, Ghana's fertilizer

application rates (8kg/ha) are lower than those of Malawi (22kg/ha) and Kenya (32kg/ha) (Fuentes, Bumb, & Johnson, 2012).

Table 2.3: Fertilizer Imports (2016-2020)

Fertilizer Type	Unit	2016	2017	2018	2019	2020
NPK	Mt	258,290	153,767	224,176	217,024	299,423
NPK (LIQUID)	Lt	127,565	14,351	-	99,334	734,325
Urea	Mt	16,353	78,591	42,005	77,011	90,025
Muriate of Potash	Mt	14,268	26,018	15,993	42,235	55,621
Sulphate of Ammonia	Mt	14,417	36,833	10,084	17,326	44,084
Phosphates	Mt	109,961	23,280	703	4,189	9,668
Nitrates	Mt	3,450	2,203	90,019	3,831	80,796
Potassium Sulphate	Mt	3,627	N. A	74	-	44,084
***Others: Solid**	Mt	20,459	178,875	-	63,494	119,326
Liquid	Lt	523,646	2,839,351	-	1,570,654	665,431
Total	Solid (Mt)	440,826	499,566	383,054	425,110	119,326
	Liquid (Lt)	651,211	2,853,702	-	1,669,988	1,399,756

Source: MOFA, 2021

The PFJ increased Ghana's fertilizer application rates to 20 kg/ha in 2019, but adoption remains low, particularly for millet, sorghum, yams, and cassava. But, according to FAO (2005), as cited in IFDC (2012), fertilizer application rates are higher for vegetables than those of maize and other cereals. The importation, distribution, and retailing of fertilizer goods are dominated by private enterprises. Chemico, Yara, AMG, Afcott, Omnifert, Macrofert, Macrofertil, Agricult Ghana, RMG, ETC Agro, and Jubaili Agrotech are also some of Ghana's major private fertilizer importers (MOFA, 2022). In 2020, Chemico, Yara, AMG, and Afcott alone accounted for 66% of total fertilizer imports in Ghana (MOFA, 2020). Fertilizer is purchased locally by farmers from these firms through their retail outlets which are located in all districts in Ghana.

Availability of Pesticides

The Environmental Protection Agency (EPA) and the Pesticides and Fertilizer Regulatory Division of the Ministry of Food and Agriculture (MoFA) are responsible for the registration and issuance of permits for pesticide use. The volume of pesticide imports decreased from 43,396 MT in 2016 to 37,611 MT in 2020 (Table 2.4). Pesticides are brought into Ghana from China, India, the United States, Germany, France, Belgium, Israel, Singapore, Switzerland, and Cyprus (Fuentes et al., 2012).

Table 2.4: Pesticide Imports (MT) (2016-2020)

Types of Pesticides	2016	2017	2018	2019	2020
Insecticide	5,742	1,620	1,295	1,247	6,351
Fungicide	4,707	4,482	1,770	4,069	1,105
Herbicide	32,947	19,113	6,975	8,063	30,154
Total	43,396	25,215	10,040	13,379	37,611

Source: MOFA, 2021

However, China alone accounts for more than half of Ghana's pesticide imports (Onwona Kwakye et al., 2019). In Ghana, private players are also heavily involved in the importation, distribution, and retailing of pesticides (Onwona Kwakye et al., 2019). Pesticides are widely used in fruit and vegetable production. According to Dinham (2003), 87% of Ghanaian vegetable producers use chemical pesticides to control pests and diseases. Most vegetable farmers are unduly reliant on pesticides due to perceived economic effects, but they are unmindful of which pesticides to use and how to apply them, putting the health of their

customers in danger (Onwona Kwakye et al., 2019). There is also limited government capacity for pesticide registration, testing, and regulation enforcement to guarantee that registered pesticides are used responsibly throughout the country (Saavedra et al., 2014).

2.5 Production and Productivity of Fruits and Vegetables

Fruit and vegetable production is a thriving agricultural activity in Ghana, providing social and economic support to both urban and rural households. Tomatoes, onions, and chilies are some of the most common vegetables grown in Ghana (Saavedra et al., 2014). Pineapples, oranges, mangoes, pawpaw, and banana are also popular fruits produced in Ghana (IFDC, 2012). There is a difference in crop mix and area cultivated across the major agroecological zones. Tomatoes, chilies, and mangoes are grown in all agroecological zones. Onions and shallots are mostly grown in the forest transition savannah zone (FTSZ) and guinea savannah zone (GSZ). Pineapple is mainly grown in the coastal savannah zone (CSZ), the Central, Eastern, Greater Accra, and Volta regions, where the climate is favourable for fruit production. Mangoes and oranges are grown in the Transitional and Forest zones respectively.

The total areas under fruits such as pineapples, mangoes, pawpaw, bananas, and oranges in 2019 and are 45,422 hectares and 45,498 hectares, respectively (FAOSTAT, 2020). Also, the total area under vegetable production such as chilies, onions and shallots, and tomatoes were 84,199 hectares and 84,207 in 2019 and 2020, respectively. According to Table 2.5, oranges have the largest land area and production in 2019 and 2020, followed by pineapples, tomatoes, chilies, onions and shallots. Mangoes, bananas, and pawpaw rank sixth, seventh, and eighth positions in both land area and production. Among the fruits, pineapples and oranges have the highest yields of 63.1 tonnes/ha and 38.8 tonnes/ha in 2020, respectively (Table 2.5). The yield of onions is higher (17.4 tonnes/ha) than tomatoes (7.8 tonnes/ha) and chilies (7.9 tonnes/ha).

Table 2.5: Total Production, and Yield of Horticultural Crops in Ghana (2019-2020)

	2019				2020			
Products	**Total Production (Mt)**	**Position**	**Land Size (ha)**	**Yield (Mt/ha)**	**Total Production (Mt)**	**Position**	**Land Size (ha)**	**Yield (Mt/ha)**
Fruits								
Pineapple	667,084	2nd	10,571	63.1	668,946	2nd	10,595	63.1
Mango	99,271	6th	7,586	13. 1	99,242	6th	7,590	13.1
Pawpaw	5,636	8th	1,612	3.5	5,661	8th	1,622	3.5
Banana	87,751	7th	7,813	11.2	87,832	7th	7,808	11.2
Orange	695,761	1st	17,840	39.0	697,637	1st	17,983	38.8
Vegetables								
Onions	144,242	5th	8,325	17.3	144,328	5th	8,294	17.4
Pepper	228,051	4th	28,874	7.9	227,636	4th	28,913	7.9
Tomatoes	368,383	3rd	47,000	7.8	368,920	3rd	47,000	7.8

Sources: FAO, 2021

Pineapple production grew by 10% in 2011, but growth has since remained stagnated in 2015 and 2016 (Figure 2.5). After increasing marginally in 2017 by 1.9%, production declined by -1.2% in 2018. Orange production also grew from 3.4% in 2011 to 6.1% in 2013 but stagnated in 2015 and 2016, as did mangoes, pawpaw, and bananas. The major fruits namely oranges, pawpaw, and bananas experienced negative growth in 2018, except for mangoes. Generally, the production of the selected fruits declined much faster from 2013 to 2016 and 2017 to 2020, except for mangoes.

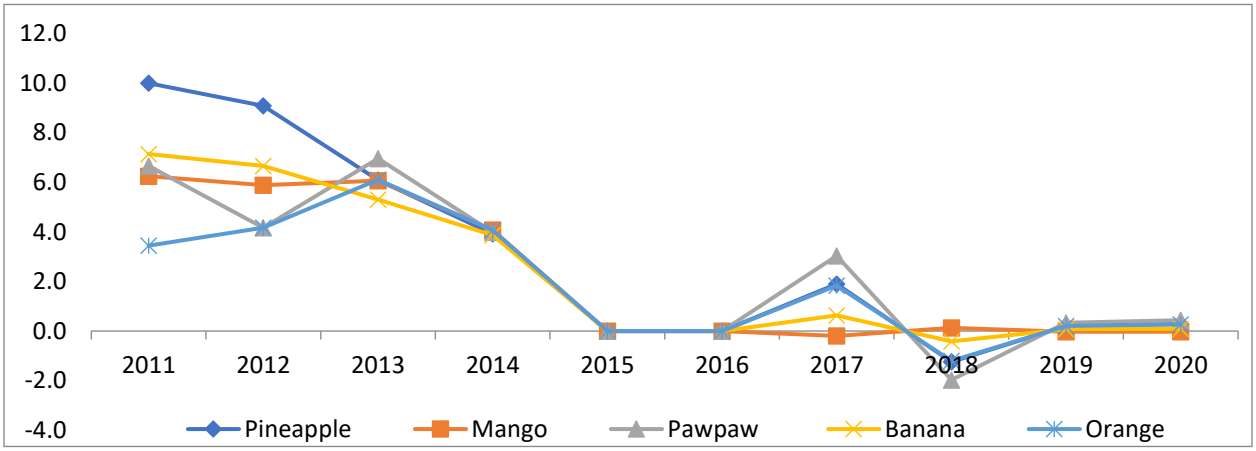


Figure 2.5: Growth rates of fruit production in Ghana (2011-2020)
Sources: FAO, 2021

In 2011, onion and shallot production grew by 20%, compared to 1.7% for chilies and 0.6 % for tomatoes (Figure 2.6). However, the increase in onion and shallot production has been low and declining since 2012. Chili production increased by 15% in 2012, but growth rates have remained low and falling since 2013. Chili production recorded negative growth in 2016, 2017, 2019, and 2020. Tomato production fell by 0.6-0.2 percent in 2012 but increased by 6.0% and 7.8% in 2013 and 2014.

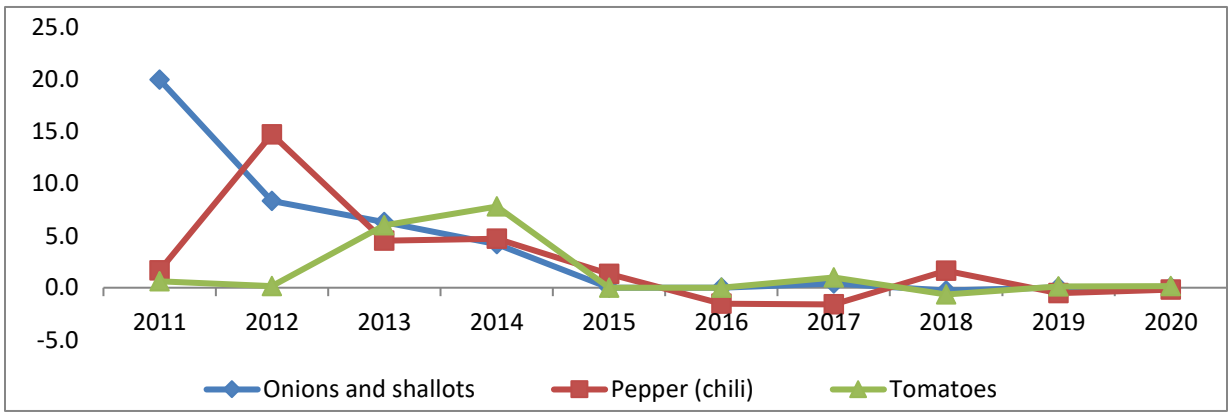


Figure 2.6: Growth rates of Vegetable Production in Ghana (2011-2020)
Sources: FAO, 2021

In 2003, the FAO and WHO launched the Global Initiative on the Promotion of Fruit and Vegetable for Health (PROFAV) to raise awareness, boost fruit and vegetable production and consumption for improving people's health and farmers' incomes. Despite increasing demand for fruits and vegetables in Ghana, production has been steadily declining in recent years. Demands for tomatoes and onions are met by massive imports, stifling production progress. Production shortfalls in fruits and vegetables are due to low yield and seasonality (Tsiboe, Asravor, & Osei, 2019; Van Asselt et al., 2018). Differences in soil fertility,

climatic factors like rainfall and temperature, access to water, improved technologies, and market access account for variation in harvested output (Robinson & Kolavalli, 2010). There is also a lack of public and private investment in productivity-enhancing technologies, which is stifling the production of fruits and vegetables in Ghana (Tsiboe et al., 2019).

Improved Varieties of Fruits and Vegetables in Ghana

Pineapples

There are over one hundred pineapple varieties, but only six (MD2, Smooth Cayenne, Sugar Loaf (Pan de Azucar), Red Spanish, Queen Victoria and Abacaxi) are known and traded on the international market (Kpare, 2016; MoFA, 2022). Pernambuco, Variegated, and Baby are some of the other cultivars. Smooth Cayenne is the most common variety worldwide, both for processing and consumption of fresh fruits. Smooth Cayenne and Sugarloaf are the most popular varieties in Ghana. However, MD2 is preferred for its sweet and savoury taste. It also has a higher vitamin C content and is less acidic (Danielou & Ravry, 2005). MD2 has excellent storage ability, making it ideal for shipment (Whitfield, 2010). However, MD2 adoption is low and farmers in Ghana have less preference for organic farming, compared to the traditional and robust varieties such as Sugar Loaf (Wuepper, Sauer, & Kleemann, 2014).

Oranges

Both local and exotic cultivars are grown in Ghana. Obuasi, Asuansi, Achiasi, Shama, Nkwanta, Anomabu, and Kwesi Nyarko oranges are among the popular local types of orange varieties grown in Ghana. The appearance and flavour of these local cultivars have changed over time due to considerable natural crossbreeding. Washington navel, crimson blood orange, hamlim, and late Valencia are among the exotic cultivars.

Mangoes

The Portuguese were the first to introduce mangoes to Africa. Some of the varieties cultivated in Ghana are Keitt, Kent, Francine, Tommy Atkins, Palmer, Haden, Springfield and Irvin. However, Kent and Keitt are the major varieties grown ((MoFA, 2022; Okorley, Acheampong, & Abenor, 2014). About 85% of the mangoes produced in Ghana are of the Keitt variety. Kent and Springfield's varieties have gained attention in recent years because of their export potential.

Pawpaw

Pawpaw (papaya), also known as *Carica papaya* (Family - Caricaceae) is a small tropical plant native to South America. Pawpaw is eaten fresh and ripe all around the country. The main varieties planted in Ghana are Solo dwarf, Hortus Gold, and Bluestem. These varieties were reintroduced in the 1990s, leading to commercial production (Akakpo, 2000). The Solo dwarf papaya, which is in high demand on the worldwide market, is the preferred Ghanaian export variety. Other varieties include Sunrise, Formosa, Amazon Red, Waimanalo, and Red Maradol (MoFA, 2022).

Bananas

There are over one hundred varieties of bananas growing around the world. However, Cavendish, Mysore (Alata kwadu, local variety), and Gros Michel varieties are the widely grown and preferred bananas in Ghana.

Chilies

Chili peppers (Capsicum spp.) are a common spice and condiment in Ghanaian cooking. Legon 18 is the most popular chili variety in Ghana (green chili). Other common varieties of chili are Scotch bonnet, Bird's eye, Demon, and CRI Shito Adope. According to (MoFA-IFPRI, 2020), Ghana's biggest export variety is green chili.

Tomatoes

In Ghana, the CSIR has played a key role in the development of novel tomato cultivars. Kwabena Kwabena, Kopia, Shito pepper var. Adope, and Mako pepper var. Ntose are some of the varieties released to farmers. Other varieties of tomatoes grown in Ghana are Pectomect, Power Roma and Techiman (Melomey et al., 2019), and Eva F1, Padma F1, COBRA, Sultan, Raja, and Gigantico (MoFA, 2022).

Onions

Bawku Red and Galmi are the two main varieties grown in Ghana (MoFA-IFPRI, 2020). Despite their important varietal traits, Dayo, Trophy, Red-Creole, and Orient are currently not widely grown in Ghana (MoFA, 2022; Mohamed, 2018).

Underutilized Neglected & Indigenous Crops

Ghana is endowed with a lot of indigenous fruits and vegetables. However, the majority of these products are neglected. Aboagye, Amoatey, Asante, Obiri-Opareh, and Ofosu (2010) provide a summary of underutilized, neglected and indigenous fruits and vegetables (UNIFV) in Ghana. The findings are presented in the Table 2.6.

Table 2.6: Underutilised and Neglected Vegetables in Ghana

Vegetables	Indigenous Leafy Vegetables	Edible Wild Fruits
Trichosanthes cucumerina, Colocynthis edulis, Sechium edulis, Telfairia occidentalis, Lagenaria siceraria, Cucumeropsis edulis, Solanum aethiopicum, Solanum macrocarpon, Solanum torvum, Solanum pimpinellifolium, Bird's eye chili	*Celosia argentea, Corchorus olitorius, Cleome gynandra, Talinum triangulare, Vernonia hybridus, Amaranthus cruentus, Basella alba, Amaranthus hybridus, Moringa oleifera, Vernonia amygdalina, Wild lettuce, Hibiscus sabdariffa*	*Morinda morindiodes, Salacasia pyriformis, Dacryodes klaineana, Diospyros vigneri, Chrysophyllum albidum, Heisteria parvifolia, Irvingia gabonensis, Drypetes chevalieri, Diospyros soubreana, Solocia cornifolia, Cola millenii, Atocarpus utilis, Annona muricata, Velvet tamarind*

Source: Adopted from (Aboagye et al., 2010)

Postharvest Management of Fresh Products

Fruits and vegetables belong to the category of perishable foods. The quality (safety) and shelf life of these fresh products are influenced by postharvest management and handling procedures and treatments. Harvesting, precooling, washing and disinfecting, sorting and grading, packaging, storage, and transportation, according to (Arah, Ahorbo, Anku, Kumah, & Amaglo, 2016), play a crucial role in maintaining the quality and increasing the shelf life of fruits and vegetables. Fruit and vegetable harvesting in Ghana is done by hand and requires a lot of effort. Precooling helps minimize the effect of microbial activity, metabolic activity such as, respiration rate, and ethylene production as well as quick ripening, dryness, decay, and water loss. Refrigeration are used for these. For tomatoes, however, many farmers in Ghana soak the fruits in cold water laced with disinfectants such as thiabendazole and sodium hypochlorite (Arah et al., 2016). Cleaning and disinfection are a challenge due to the unavailability of clean water and disinfectants. To minimize the microbial load before packaging and marketing, fruits and vegetables are frequently treated with chlorinated water, vinegar, and salt solution after washing before sales. Onions and chilies are, however, not washed or disinfected in Ghana. One of the most significant stages in the packaging and selling of fruits and vegetables is sorting and grading. Sellers sort and grade their produce to determine prices.

Processing and Packaging

Local processing of fruits and vegetables includes juicing and preparation of salads and fresh-cut products. However, there are just a few companies in Ghana that process fruits and vegetables. Table 2.7 is a list of Ghanaian fruit and vegetable processing companies, along with their year of operation, product category, and primary market destination.

Table 2.7: Companies Processing Fruits and Vegetables in Ghana

Company	Year of Operation	Type of Produce Processed	Main Market Destination
Blue skies Holding Ltd	1997	Pineapples, banana, passion, mango, pomegranate, orange	Local and international
Taitapic Agrofood and Services	2017	Pineapple fruits, ginger roots, mango, orange, ginger, watermelon	Local
Nestle Ghana Ltd	1957	Fruits	Local and international
Frutelli Ghana Ltd	2000	Fruits; mango, pineapple, orange, and cocktail flavour	Local and international
Quin Organics	1995	Fruits; pineapple, coconut and herbs	Local and international
Pinora Food Processing Company	2008	Fruits; pineapple, orange, lime	Local
Multi-Pac Ltd	2009	Fruits; orange, strawberry, pineapple, apple, passion fruits, red berries, watermelon	Local
Mandis Ltd		Pineapple, mango, orange	
HealthLife Beverage Ltd	2008	Orange, pineapples, banana, coconut, mango, ginger	Local and international
Vineyard Exotics	2010	Herbs, flowers and fruits	Local
Bomart Farms	-	Dried Mango, Dried Pineapple Dried Banana, Dried Coconut	Local and international
HPW FRESH AND DRY LTD.	-	Dried mango, coconut	Local and international

Source: Ghana Export Promotion Authority, 2022

Packaging of fruits and vegetables as a postharvest handling method is rare in Ghana except for exported produce. Local market produce is frequently exposed to direct sunlight and flies, resulting in severe losses and damages.

Pests and Diseases

Pests and diseases are major problems in fruit and vegetable production because they cause significant crop loss for farmers. This includes diseases such as anthracnose, powdery mildew, alternaria, stem-end rot, Pseudocercospora leaf and fruit leaf disease of citrus, Cape St Paul wilt for coconuts, bacteria black spots (BBS) on mango and pests (fruit fly, whitefly, mealybugs, aphids, termites, scale insects and mango bugs).

2.6 Natural Resources

Water

Water for fruits and vegetable production is mainly from irrigation, rainfall or wastewater. According to Van Asselt et al. (2018), access to water for irrigation was a major constraint for farmers in Upper East. Forty-five percent of tomato farmers, 85 percent of onion farmers and 29 percent of Scotch bonnet farmers in the Upper East region reported inadequate water for watering as the biggest hindrance to vegetable production. Vegetable farmers in urban areas such as Accra use wastewater for the production of carrot, lettuce, pepper etc. However, using such sources of water has been reported to have contaminants such as heavy metals or microbial pathogens in the water which come in contact with fresh produce during irrigation, application of pesticides or washing produce after harvest. This is a concern for human health and market opportunities.

Climate

Climate is an influential factor that affects the growth of fruits and vegetables in rain-fed environments in Ghana. Most importantly, having the right rainfall, temperature and right amount of sunlight during the growing season is essential (Jost et al., 2016). Changes in rainfall and temperatures are expected to have negative consequences on horticultural production (Adade, Nyarko, Aheto, & Osei, 2017). Untimely rains during drought stress periods or above normal temperatures during flowering and fruit growth reduce yields and can cause physiological disorders (FAO, 2013).

Guinea and Sudan Savannah (Northern savannah) make up 62% of the land area of Ghana with an average growing period of 172 days where rainfed and irrigated fruits and vegetables can be grown with flexibility in planting and harvesting times. Rainfall statistics obtained from MOFA revealed that the national average rainfall declined from 1,276 mm in 2008 to 937 mm in 2020. The continuous decline in the volume of rainfall could affect agronomic practices and yields of crops, especially fruits and vegetables (MoFA, 2020). The Savannah agro-ecological zones experience the lowest rainfall (<1000mm) amounts in a year in Ghana. There is only one growing season, referred to as mono-modal rainy season in this zone. The rainy season starts in May/June and ends in September/October, followed by a long dry period from November to April.

The Forest agro-ecological zones, on the other hand, experience relatively higher rainfall amounts (>15000mm per annum) with a bimodal pattern. In the major season rains occur between March and mid-July with a peak in May/June. There is a short dry spell from mid-July to mid-August. The minor rainy season starts from mid-August to about the end of October with a peak in September. There is a long dry period from November to February with possibilities of occasional rains. The rains are well distributed throughout the year, with amounts considered adequate for crop production occurring in the two peaks. Due to the reality of climate variability change and increasing capacity building in Climate Smart Agriculture, more farmers are now increasing their investments in alternative irrigation devices/equipment to supplement their plant-water provision to safeguard their investments.

Soil

The soils have predominantly light textured surface horizons in which sandy loams and loams are common. Lower soil horizons have slightly heavier textures varying from coarse sandy loams to clays. Heavier textured soils occur in many valley bottoms and in parts of the Accra Plains. Most soils contain abundant coarse materials; either gravel and stone, or concretionary materials which affect their physical properties. Tables 2.8 and 2.9 refer to the fertility status of soils in the Ecological zones and Regions of Ghana.

Table 2.8: Fertility Status of Soils in the Ecological Zones of Ghana

Ecological Zones	Soil pH	(%) Organic matter	(%) Total Nitrogen	Available Phosphorus (mg/kg soil)	Cation Exchange Capacity
Coastal Savanna	4.40-9.50	0.00-8.00	0.07-0.37	0.00-6.62	0.00-9.28
Deciduous Forest	4.40-9.50	0.00-13.83	0.00-0.52	0.00-3.48	0.00-9.62
Moist Evergreen	4.40-7.70	0.69-13.83	0.00-0.37	<0.02	0.00-1.21
Wet Evergreen	4.40-7.70	0.69-13.83	0.00-0.37	0.00-8.19	0.00-1.21
Transitional Zone	4.10-7.70	0.00-10.3	0.00-0.52	0.00-2.00	0.00-9.62
Guinea Savanna	4.10-7.40	0.00-6.74	0.00-0.14	0.00-7.60	0.00-7.85
Sudan Savanna	4.10-7.40	0.54-5.89	0.00-0.10	0.00-3.62	0.00-7.72

Source: Soil Research Institute, CSIR-Kumasi, 2018

Table 2.9: Fertility Status of Soils in the Regions of Ghana

Region	Soil pH	(%) Organic matter	(%) Total Nitrogen	Available Phosphorus (mg/kg soil)	Cation Exchange Capacity
Ashanti	4.10-7.30	0.00-13.83	0.00-0.52	0.00-6.98	0.00-9.62
Western	3.80-7.10	1.03-5.70	0.06-5.40	0.35-11.25	0.00-1.21
Brong Ahafo	3.50-6.70	0.34-1.69	0.2-0.28	0.00-0.41	0.00-9.62
Greater Accra	5.40-8.20	0.10-1.70	0.05-0.90	0.00-6.62	0.00-9.28
Upper East	5.10-6.80	1.10-2.50	0.06-0.14	1.75-14.75	0.00-7.72
Upper West	6.00-6.80	0.50-1.30	0.01-0.07	2.00-7.40	0.00-4.79
Northern	4.50-6.70	0.60-2.00	0.02-0.05	2.50-10.00	0.00-7.85
Volta Region	4.10-7.80	0.00-5.63	0.00-0.02	0.00-6.62	0.00-9.28
Eastern Region	4.10-7.80	0.00-8.19	0.00-0.37	0.00-3.48	0.00-9.62
Central Region	4.40-7.70	0.00-4.30	0.00-0.37	0.00-9.80	0.00-2.40

Source: Soil Research Institute, CSIR-Kumasi, 2018

2.7 Socioeconomic

Women in Horticulture

In Ghana, vegetable production is mainly undertaken by women. Cultivation of onions, tomato, pepper, and water melon are some few crops mostly cultivated by women. Women also tend to engage more in the post-production side of the vegetable value chain – such as processing and marketing/sales. They are more active in the production of mostly leafy and indigenous crops. However, in Ghana, women lack access to productive input and lack power regarding decision making in the community. Major challenges facing women in the horticulture sector include inadequate access to credit, markets and land.

Women in horticulture are confronted with barriers such as unimpeded access to markets and participation in large-scale and more remunerative value chains which require specialized vocational and technical skills in areas such as food safety, food processing, sanitation, food conservation, packaging and product certification. They lack knowledge about required trade standards particularly, in sanitary and phytosanitary measures which limit their involvement in other segments of the market. In Ghana, distribution, transportation, processing and export of horticultural products especially fruits are mainly dominated by men. The marketing of horticultural goods is predominated by women.

Land ownership among women is low limiting their ability to acquire financial assets. In addition, difficulty in securing funding for their production activities is also a major hindrance to women in the horticulture sector.

Horticulture production by the Indigenous People

Horticulture production in Ghana is mainly undertaken by indigenous people in most parts of Ghana. Cultivation of onions, shallots, pepper, water melon, and other leafy vegetable are done by indigenous people in parts of the Upper East Regions, Northern regions and Volta regions. Water for vegetable production is a major challenge, especially during the dry season. In addition, access to land can be limited resulting in low access to credit and stifling incentives for making improvements to increase production.

Youth and Horticulture

The Youth are being encouraged in agri-business along the horticulture value chain, and greenhouse farming (Greenhouse Village Initiative-MOFA). As part of the government's efforts to open opportunities for increased production and exports of vegetables after the 2015 European Union export ban on selected vegetables, the concept of greenhouse villages was introduced in 2017. The idea of the greenhouse village is to establish strong agribusiness in the vegetable sector to attract both Ghanaian youth and international investors. The goal is to place Ghana as a key competitor in the export of fresh vegetables and cut flowers. The project trained about 537 youths including Degree, HND and certificate holders. The three-month intensive training session covered all areas in greenhouse vegetable cultivation, starting from the nursery, crop production, fertigation, pest and disease management, handling, marketing, and branding.

Market and Consumption

Demand for nutritious fruits and vegetables

Demand for high-quality fruits and vegetables for home consumption and export is increasing rapidly due to increased consumer income and awareness of food nutritional needs and safety issues in Ghana and the expansion of traditional markets, the hospitality industry. The fruit processing units, which are fueling the market growth for fruits and vegetables have also played a major role in the expansion of demand for high quality fruits and vegetables. Based on the WHO and the Food and Agriculture Organization (FAO) recommendations, there should be minimum ingestion of 400 g of FVs daily, which is equivalent to five servings (Ungar, Sieverding, & Stadnitski, 2013). Tomatoes, peppers (both sweet and hot chilies), onions, and okra are consumed a lot in Ghana. The market for tomatoes and peppers has boomed recently (IFPRI, 2020). Overall vegetable consumption in Ghana falls short of WHO/FAO recommendations, in comparison with other African countries like Kenya (Saavedra et al., 2014). Despite the inexistence of local production, consumers have heightened interest in food safety in vegetables due to their susceptibility to chemical and microbial contamination (Cobbinah, Donkoh, & Ansah, 2018).

Market Access

The main market for fruits and vegetables is dominated by open markets, which include smaller street shops, hawkers, and well-built markets. The local market comprises of about 70 percent of the fresh fruits and vegetables market in Ghana. Farmers supply the fresh produce mainly to domestic bulk suppliers, itinerant suppliers, and other outlets such as supermarkets, hotels, and restaurants. Prices of pepper, onion, tomato and other fruits remained relatively stable in 2020 (Figure 2.7).

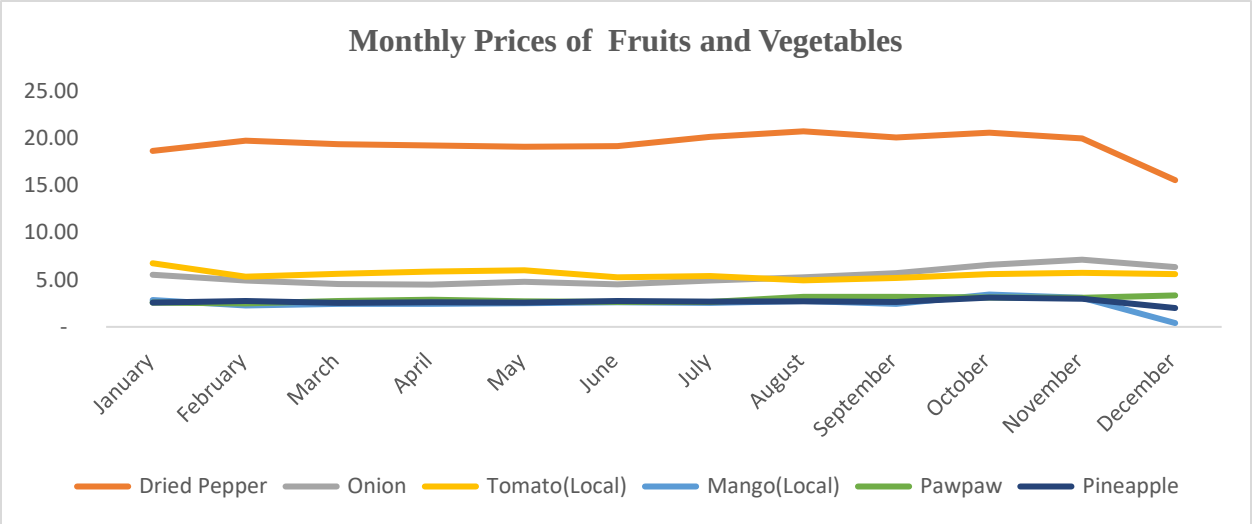


Figure 2.7: Monthly prices of fruits and Vegetables (2020*)*

Source: MOFA, 2022

Value-added Horticulture Products

Value creation and value addition in fruits and vegetables is minimal. Producers and marketers engage in primary activities such as cleaning, sorting, grading, and storage. However, local market centres encounter high post-harvest losses, food safety problems and a low product shelf life. Most fruit and vegetable products sold on the market are exposed to direct sunlight due to a lack of good storage and cooling systems. In some instances, vegetables are sold on the bare floor or tarpaulins. Good packaging is essential to maintain quality throughout the chain. In Ghana, suppliers use large sacks or wooden crates to store and carry huge amounts of produce. This method leads to significant market losses. Post-harvest losses in Ghana exceed 20% of the total value of the produce (Ridolfi, Hoffman, & Baral, 2018). Selling by weight is almost exclusively limited to the handful of super markets in Ghana.

2.8 Agribusiness Opportunities

Production Opportunities

Healthy Orchards and Planting Materials

This is an excellent opportunity for investors to help introduce disease-resistant varieties by using tissue culture technology. Tissue culture is a technology which helps in producing true to type planting materials which are also disease-free. There is also a business opportunity in exploring the development of early maturing varieties for farmers.

Mango

The current plantations have several pest and disease challenges. Infestation of Bacteria Black Spot Disease and Anthracnose are a major challenge in the sector leading to post-harvest losses. This offers opportunities for agro-input supply companies to identify effective management practices to ensure disease-free orchards.

Citrus

Majority (85–90%) of citrus orchards in Ghana are planted to the Late Valencia variety. This offers business opportunities for breeding and introducing other varieties into the sector. In addition, there is very high demand for citrus fruits in some West African countries for processing.

Improved Fruit Handling, Transport and Storage

Post-harvest losses in the fruit sector are high. Value chain actors who are into storage facilities operation and pack house activities can explore business opportunities to enhance the activities of the farmers, wholesalers and retailers of fresh produce.

Marketing Opportunities

Investment in value-added processing of fresh fruits to juices and concentrates will offer potential market as with production of food flavour, confectionary and industrial products.

2.9 Trade and Standards

Export and Import of Fresh Fruits and Vegetables

In the last two years, Ghana's total fresh fruit exports have decreased but overall fruit and vegetable exports increased. Between 2019 and 2020, the volume of orange and pawpaw exported increased by 211.8% and 149.7%, respectively (Table 2.10). Exports of pineapples, bananas, and mangoes, on the other hand, fell by 76.7%, 18.2%, and 96.1%, respectively (Table 2.10). Despite the impact of CoVID-19, the export of onions, chili and tomato increased respectively (Table 2.10).

Table 2.10: Export of Fresh Fruits and Vegetables in Ghana (2019-2021)

	Volume (Tonnes)			Value ($000)		
Commodity	**2019**	**2020**	**% Change (2019-2020)**	**2019**	**2020**	**% Change (2019-2020)**
Fruits						
Pineapples	18,992,351	4,427,318	-76.7	51,174,151	5,786,740	-88.7
Bananas	97,424	79,732	-18.2	32,582,000	67,296,00	106.5
Mangoes	20,013,322	778,273	-96.1	67, 217,484	4,140,802	-93.8
Pawpaw	1,453,589	3,629,581	149.7	5,130,300	3,515,119	-31.5
Oranges	1,660,975	94,200,000	211.8	10,122,513	3,222,077	-68.2
Vegetables						
Onions	568283.1	1,197,071	110.6	669,424.6	872,688	30.4
Pepper (Chili)	2	47	2250	2,000	105,000	5150
Tomato	10,356	11,013	6.3	6,657	6,656	0

Source: Ghana Statistical Service, GSS, 2021

The total volume and value of export of processed fruits (pineapples) in 2019 was 18, 992,351 tonnes and $51,174,151.00. The majority of Ghana's tomato paste is exported to West African countries including Niger, Mali, Togo, and Burkina Faso. Cameroon, South Africa and Zambia. Japan, the United States, the United Kingdom, and France are among the minor export destinations. Ghana's largest export market for processed pineapples is the United States.

Import of Fresh Fruits and Vegetables

Table 2.11: Imports of Fresh Fruits and Vegetables (2019-2020)

Commodity	2019 Volume (Mt)	2019 Value (Ghc)	2020 Volume (Mt)	2020 Value (Ghc)	Five Top Countries
Pineapples, fresh or dried	6,746.57	41,894.37	271	734	Spain, UK, The Netherlands, South Africa, United Sates
Mango	19525.75	38012.04	316.45	5,931.22	Togo, UK, The Netherlands, UAE
Pawpaws	5.33	35.52	2,790	42,012	Lebanon, The Netherlands
Oranges	92,066.84	207,606.13	358,772	797,270	Spain, Egypt, South Africa, Morocco, France
Onions and shallot	4,066,203.8	4,338,133.4	78,793,991.2	52,213,749.7	Niger, UK, Morocco, The Netherlands, UAE
Tomatoes	4,154,334.7	4,432,342.6	-	-	Burkina Faso, The Netherlands, Italy, Morocco, Luxembourg,

Source: GSS, 2022

Table 2.12: Import of Processed Horticulture Products (Tomatoes) in 2019

Top Ten Country	Volume (kg)	Value (GHS)
China	63,653,434.6	195,462,725.0
Italy	3,789,646.9	12,480,667.8
Cote D'Ivoire	461,668.2	1,429,830.9
Togo	465,519.0	1,381,215.1
USA	82,349.4	487,238.9
UAE	153,654.2	391,666.0
UK	103,789.7	362,819.6
Niger	55,786.4	173,371.8
South Africa	23,315.8	84,225.3
The Netherlands	21,806.3	69,329.3
Total Import	**68,895,939**	**212,556,611**

Source: GSS, 2022

The majority of Ghana's fresh fruits and vegetables, on the other hand, are exported to Asia, Europe, and Cote D'Ivoire. The top three importers of Ghanaian pineapples are France, Lebanon, and Switzerland (Table 2.12). The United Arab Emirates (UAE), the United Kingdom (UK), and Kuwait are the top importers of Ghanaian mangoes. Ghana's top three export destinations for pawpaw are Cote D'Ivoire, the United Kingdom, and the Netherlands. Cote D'Ivoire, the Netherlands, and Italy are the top three importers of Ghanaian oranges. The United Kingdom, the Netherlands, and Cote D'Ivoire are Ghana's top three onion importers (Table 2.13).

Table 2.13: Principal Export Destinations of Fresh Fruits and Vegetables from Ghana

	Major Export Country

Products	First Leading Country	Volume Exported in 2021	Second Leading Country	Volume Exported in 2021	Third Leading Country	Volume Exported in 2021
Pineapples	France	2,052,562 (3,698,553)	Lebanon	100,873 (158,632)	Switzerland	97,649 (145,150)
Mangoes	UAE	287,166 (871,260)	UK	5,572 (655,006)	Kuwait	96,935 (242,758)
Pawpaw	Cote D'Ivoire	788,101 (3,100,502)	UK	52,531 (143,846)	The Netherlands	20,937 (107,666)
Oranges	Cote D'Ivoire	6,502,700 (938,589,658)	The Netherlands	93,860 (1,587,641)	Italy	30,720 (411,765)
Onions and shallots	UK	140,638 (476,903)	The Netherlands	18,025 (94,302)	Cote D'Ivoire	9,866 (52,836)

Source: GEPA, 2022 **Note: Values of export in Ghana cedis are in parentheses**

Private Sector Participation in Horticulture Export

Private sector participation in the export of fruits and vegetables is increasing in Ghana. Companies and individuals like AB Farms Ltd, A.T. Mahli Farms Ltd, Agrigold Resource Development Ghana Limited, Akafad-Pa Company Limited, Albe Farms Limited, Albert Agbeko, Albert Mills Agbeko, Alexandr Atuobi, Alhaji Awudu Karim Enterprise Ltd, and Ayaawan Harrison are involved in the export of multiple products.

Engineering and Technology

Production Technology and Supplies

There is minimal use of engineering and technology in horticulture crop production in Ghana. Smallholder farmers employ basic farm implements under a rainfed system (Osei et al., 2022), which increases the vulnerability of production to climate change. At the nursery and early field establishing stages, supplemental irrigation is delivered using traditional tools such as watering cans, buckets, knapsack sprayers, and occasionally small powered pumps, or a mix of these methods. Manual labour dominates in seedbed preparation, fertilizer and pesticide application, weeding, and harvesting. This farming method is, however, labour intensive and time-consuming. Farmers have limited access to mechanization services such as tractors, planters and harvesters, posing a challenge to vegetable production (Nyo, 2016). In recent years, drones have been used elsewhere in pest, disease, and weed surveillance, as well as water stress monitoring in agricultural production (Osei et al., 2022). However, most developing countries such as Ghana have yet to adopt these new technologies.

Postharvest Packaging, Cooling, Cold Storage, Drying

Facilities such as harvesting and collection tools, containers and packing, rapid and cold chain transportation, and commercial storage are key to a successful vegetable postharvest value chain. The lack of appropriate storage conditions contributes to post-harvest losses in vegetable production. Apart from a few supermarkets that keep fruits and vegetables in under refrigeration temperatures, fruits and vegetables are sold in the open market, exposing the produce to harsh weather conditions. Most farmers and traders are obliged to sell their products at low rates due to a lack of cold storage facilities. There is dire need for the development of cold chain.

Processing of Horticultural Products

Processing of horticultural crops is important to add value to the products that are unsuitable for the fresh market, because of their size, shape, and superficial imperfections (Perera & Perera, 2019).

Some processing techniques for fruits and vegetables include:

- Preservation by removing moisture; e.g., drying and dehydration
- Preservation by concentration (e.g., Concentration by Freezing, Concentration by Vacuum Evaporation, Solar Concentration, or by the use of Flash Evaporators, Thin Film Evaporator, Ultrafiltration and Reverse Osmosis/Hyperfiltration)
- Preservation by Sugar
- Preservation by Fermentation
- Preservation by Food Additives
- Preservation by Chemicals (e.g., Sodium bicarbonate)
- Preservation by Heat Treatment (e.g., Pasteurisation, Sterilization)

Research, Education and Training

Education and Training Needs in Horticulture

Ghana has four public universities and four agriculture colleges, teaching agriculture and horticulture-related courses. The public universities include the University of Ghana (UG), the University for Development Studies (UDS), Kwame Nkrumah University of Science and Technology and the University of Cape Coast (UCC). These public Universities offer courses in BSc. Agriculture with specialization in horticulture, Masters and PhD Degree programmes in Agronomy, Horticulture and Crop Breeding. The four agriculture colleges include Ohawu, Kwadaso, Ejura, and Damango which offer courses leading to a Diploma and Certificate in Agriculture. Though these agriculture colleges do not specialize in horticulture, they offer courses in crop production. There are three farm institutes which are located in Adidome, Wenchi, and Asuansi and offer mainly certificate programmes in general agriculture.
There is a lack of connection between research conducted by the universities and agriculture colleges concerning on the ground agricultural issues affecting small-scale producers. This includes, among other things, a lack of operational capacity among small-scale producers which results in low-quality products, low productivity, inadequate production practices, and reduced access to formal markets. Fruits and vegetable farmers also lack training in well-accepted best practices for horticultural crop production and handling for export. Research in postharvest activities, such as postharvest handling, indigenous crops with export potential, and improved crop management to optimize postharvest quality and ensure food safety and standards are identified as priority areas for research.

Research Capacities of Universities and Research Institutions

Agricultural research is fundamental to enhancing Ghana's agricultural productivity in the horticulture sector. Ghana has a National Agricultural Research System (NARS) that includes research institutes, tertiary educational institutions, and other organizations. The main agency for agricultural research and development is the Council for Scientific and Industrial Research (CSIR) and its 13 research institutes, of which 10 are engaged in agricultural and related research activities. Research in the fruits and vegetable sector is mainly conducted at Food Research Institute (FRI), Crops Research Institute (CRI), Soil Research Institute (SRI), Plant Genetic Resources Research Institute (PGRRI), and Savanna Agricultural Research Institute (SARI). The public universities such as UDS, UG, KNUST and UCC also conduct research in the horticulture sector. The major challenge confronting these research institutions is the lack of facilities and funding.

Extension Capacity in Public and Private Sector

Extension service activities in the fruits and vegetable sector are mainly undertaken by the public sector. The extension agents who work under the Ministry of Food and Agriculture, train small-scale and commercial fruits and vegetable producers in good production practices, pest and disease control, post-harvest management practices (handling, washing, packaging, transportation etc.), and food safety standards. However, in recent years, there has been concern about private sector driven technical support in fruits and vegetable sector. GhanaVeg, conducted a survey to explore private sector driven technical support services in Ghana's vegetable sector. Below are the main technical support needs based on the value chain actors.

Commercial growers: (i) Production and investment planning (assessing qualitative and quantitative demands; financial planning and funding; dealing with uncertainties) (ii) Cultivation challenges (irrigation, pest and disease management, soil fertility) (iii) Product handling (quality preservation, sorting, grading, handling, packing) (iv) Quality assurance and traceability

Input suppliers (wholesale/large scale): Information on trends and opportunities in the sector, soil fertility management, and crop protection.

Handling agents and logistical service providers: (i) Quality management systems and traceability (ii) Handling of vegetables (sorting, grading, processing and packing fresh vegetables, storage).

This requires technical expertise such as Local GAP advisors for smallholder fruits and vegetables. Growers and fruits and vegetable business development coaches for large-scale commercial growers and wholesale traders/exporters.

2.10 National Policy and Regulatory Environment for Horticulture Sector in Ghana

National Level Horticulture Policies

The Ministry of Food and Agriculture (MOFA) is the main policy institution responsible for promoting agricultural development in Ghana through the creation of an enabling environment for sustainable growth in the agricultural sector. The horticulture sector falls directly under this ministry. The horticulture sector for decades lacked a single comprehensive policy framework for growth and development in Ghana. Policies aimed at promoting the sector were implemented through agriculture sector policies such as Food and Agriculture Sector Development Policy (FASDEP) 1 &2, Medium Term Agriculture Sector Investment Plan (METASIP) and other donor-funded programmes and projects. During the FASDEP period, the sector was expected to grow by between 6% to 8% per annum within four years, while the crop sector was expected to grow at 6% per annum. FASDEP was built essentially on the five key elements of the Accelerated Agricultural Growth and Development Strategy (AAGDS), with a focus on strengthening the private sector as the engine of growth.

The FASDEP I provided a framework for modernizing the agricultural sector and making it the catalyst for rural transformation. The objectives include (i) Ensuring Food Security (ii) Facilitating the Production of Agricultural Raw Materials for Industry (iii) Facilitating the Production of Agricultural Commodities for Export (iv) Facilitating Effective and Efficient Input Supply and Distribution Systems (v) Facilitating Effective and Efficient Output Marketing Systems (vi) Formulating and Coordinating Policies and Programmes for the Food and Agriculture Sector. Under FASDEP I, selected fruits and vegetables were targeted for food security, raw material for industry and export. MOFA supported the production and marketing of fruits and vegetables such as tomatoes, pepper, onions, mangoes, citrus, pawpaw and banana. The policy targeted service provisions such as market intelligence and communication, adequate financing,

efficient handling and transportation, good port facilities, grading, standardization and strong export marketing associations as strategies to promote the export of these selected horticulture crops.
FASDEP II was formulated based on six objectives: (i) food security and emergency preparedness; (ii) improved growth in incomes; (iii) increased competitiveness and enhanced integration into domestic and international markets; (iv) sustainable management of land and environment; (v) science and technology application in food and agriculture development; and (vi) improved institutional coordination. The key strategies include accelerating the provision of irrigation infrastructure, enhancing access to credit and inputs, promoting selective crop development, and increasing access to extension services. Horticulture crops such as mango, cashew, citrus and vegetables were targeted for production for domestic and international markets.

In 2008, the Tree crop policy was formulated based on the objectives of FASDEP II. The policy is to provide a comprehensive approach for the sustainable development of the tree crop sub-sector and for proper targeting of support to the tree crop value chains. It aimed to achieve the following objectives (i) support increased production and productivity (ii) promote investment and increase processing capacities (iii) improve marketing through value chain development (iv) promote sustainable practices for environmental protection (v) support research and development (vi) improve coordination and management of the policy. The policy also targeted some selected fruits for the different agro-ecological zones.
(i) Forest Zone: Citrus, Kola, Avocado
(ii) Transitional Zone: Cashew, Mango
(iii) Northern Zone: Cashew, Shea, Dawadawa, Baobab, Tamarind
(iv) Coastal Savanna: Coconut and Mango
The policy was to increase the share of locally processed products to generate added value to the sector, create jobs, and establish new marketing channels for farmers.

The National Seed Policy started on 1st August 2013. Quality seed is an essential input for increasing agricultural productivity and achieving food self-sufficiency. The National Seed Policy is to support the development and establishment of a well-coordinated, comprehensive and sustainable private sector-driven seed industry through systematic and strategic approaches which would continuously create and supply new and improved varieties for use by farmers. The Ghana seed industry started in 1958 with the establishment of a Hybrid Maize Seed Multiplication Unit within the then Ministry of Agriculture. The Unit produced only hybrid maize seed until 1961 when it was converted into a Seed Multiplication Unit (SMU) which included other crop seeds in its portfolio. The SMU eventually became the Ghana Seed Company (GSC) in 1979 with the mandate to produce all classes of seed except breeder seed which was under the mandate of research centres. The horticulture crops targeted by this policy included pineapple, plantain, papaya, banana, tomato, pepper, onion, okra and garden egg.

Ghana's Irrigation Policy (Lamptey, Nyamdi, & Minta, 2011), is designed to open up the investment space for intensified and diversified irrigated crop production in Ghana where there is a clear comparative advantage. The policy recognizes three main categories of irrigation in Ghana, namely (i) informal irrigation, (ii) formal irrigation, and (iii) large-scale commercial irrigation. Informal Irrigation comprises traditional and community-initiated schemes, which are typified by the cultivation of about 2,000 ha of shallots in the Southeastern coastline of Ghana, informal irrigation around the hundreds of small reservoirs in the North, and informal irrigators cultivation in inland valleys, groundwater irrigation e.g., near Bawku and irrigated urban and peri-urban agriculture. Formal irrigation may be defined as one that is reliant on some form of permanent irrigation infrastructure funded by the public sector. This includes Dawhenya, Afife, Weijah, Mankessim, Okyereko, Tono and Vea and Bontanga schemes. Large scale commercial irrigation is usually export-oriented and comprises farm sizes of between 25 ha and 1,000 ha or more. High-value fruits and vegetables are usually the main crops cultivated under these irrigation schemes.

Under the Planting for Food and Jobs (2017-2020), the GoG intends to enhance the productivity of crops of significance for food and feed in Ghana through integrated services in farming and marketing. The PFJ program provides a framework for engaging farmers through a private sector-led agricultural value chain development. The Program was implemented by the Ministry of Food and Agriculture (MoFA) in partnership with public and private stakeholders. The project aimed to achieve the following i)immediate and adequate availability of the selected crops in Ghana through improved productivity and intensification of food crop production, and extended support to private sector service providers ii) to provide job opportunities for the teeming unemployed youth in the agriculture and allied sectors, and iii) to create general awareness for all formal workers to either have farms and grow some cereals or vegetables or establish backyard gardens, when enough land is not available and accessible. The programme focused on the four thematic areas, namely fertilizer, seed, extension services, and e-agriculture. Some priority horticultural crops under the programme include tomato, onion and chili pepper.
Ghana's National Export Strategy (NES) is to develop the potential of the non-traditional export (NTE) sector to enable it make maximum contributions to GDP growth and national development to consolidate and enhance Ghana's middle-income status, create formal decent job opportunities and ensure high standards of living for the people. The NES is situated within the context of the Medium-Term Development Policy Framework, Ghana Shared Growth and Development Agenda (2010-2013), Trade Policy, and Industrial Policy which has identified the private sector as the main agent of change and a key actor in developing the non-traditional export sector. The strategy is to achieve a significant increase in the share of Non-Traditional Exports (NTEs) in total exports as a major step towards structural transformation of the export sector for spearheading growth and diversification of the economy. The horticultural crops targeted by the strategy including both fresh and processed fruits and vegetables were fresh pineapples, banana, mangoes, papaya, citrus, chilies, melons, cut fruit, and tomato paste. Other sector policies are the Crop Protection Policy in Ghana (2001), National Plant Protection Policy (2004) and Fertilizer Policy (2013).

International Support Projects and Programmes for Horticulture in Ghana

In the last three decades, the institutional support efforts for horticulture have expanded rapidly, and continue to grow. In 2003, a cooperative agricultural-development project led by MoFA, and funded by the World Bank, known by its acronym AgSSIP, identified horticulture as a sector of enormous potential for growth in Ghana. Thus, emerged the MoFA's Horticultural Export Industry Initiative **(**HEII) in the late 2004, funded by the World Bank.

HEII has been at the center of many rapid developments including product-specific efforts such as MD2 cultivar sourcing, development and distribution, and programs to support mango out-growers to coordinating the development of Ghana's cold-chains, developing and spreading planting materials, improving food and quality management; the establishment of a definitive pesticide list for all fresh produce export crops; international certification of the Ghana Standard Board laboratories as an ISO 17025 accredited laboratory; supporting the implementation of Good Agricultural Practices by small-scale farmers and strengthening the '*cluster dynamics'* among industries that support the horticulture sector.

Supporting these efforts has been a priority for donor partners especially U.S Agency for International Development (USAID). Funded by USAID and the GoG, (2005–2009) with a budget of $30 million, the Trade and Investment Programme for a Competitive Export Economy (TIPCEE) was implemented to achieve "exponential" growth in sales of agricultural exports by increasing the competitiveness of Ghana's private sector in international and regional markets. Other donor-funded initiatives like the German Technical Corporation's Market-Oriented Agricultural Programme (MOAP), and the EU's regional Pesticides Initiative have significantly contributed to the growth of the horticulture sector.

In August 2006, the government of Ghana signed a five-year Millenium Challenge Account pact with the U.S government. The Ghanaian government created Millennium Development Authority (MiDA) to implement the projects. A large portion of MiDA resources was devoted to developing the horticulture sector and its related infrastructure, such as roads. MiDA's approach was to look at the entire horticultural supply chain in an integrated way and target resources to the most promising geographical intervention areas and links in the production, transport, and processing chain. Additionally, MiDA devoted about $200 million to the construction of horticulture cold-chain system and spent $66 million on the development of farmers' commercial skills by engaging 1,200 Farmer Based Organizations (FBOs), 120 agribusinesses and 60,000 farmers.

In 2005, funded by the African Development Bank (AfDB), the implementation of the Export Marketing and Quality Awareness Project (EMQAP) started with an amount of $28.6 million. The five-year project established 'demonstration farms' for training in GAPs and the creation of manuals with GAP protocols and requirements for the international markets. Among other things, the project achieved the following: (i) trained Agricultural Extension Agents (AEAs) in post-harvest handling of pineapple and mango (ii) trained 400 farmers in post-harvest handling of mango (iii) trained 100 farmers and farm workers in GlobalGAP/Other International Standards (iv) a total of 114 Agriculture Extension Agents were trained in the post-harvest handling of vegetables (chili, garden egg/aubergine, okra and Asian vegetables). The project also built the capacity of farmer and agriculture extension agents.

The HortiFresh West Africa programme funded by the Embassy of the Kingdom of the Netherlands in Ghana is being implemented by a consortium of 5 partners: WUR (the lead), SNV, Resilience, Advance Consulting and SENSE. The programme seeks to achieve an overarching goal of "a sustainable and internationally competitive fruit and vegetable sector that contributes to inclusive economic growth, food and nutrition security''. The main results areas are aligned with the Dutch Development Policy and include: (i) A competitive and innovative high-value fruit and vegetable sector; (ii) An inclusive and sustainable fruit and vegetable sector; (iii) A conducive business climate that facilitates the development of the fruit and vegetable sector.
The programme employed instruments to engage the sector through enhancing the enabling environment, stakeholder business meetings, trade promotion activities, technical assistance in agronomy and business management and financial support services.

Other ongoing projects and programmes being implemented by the government and donors in the horticulture sector include:

i. Mainstreaming Market-Oriented Livelihood Improvement through the Smallholder Horticulture Empowerment and Promotion Approach (SHEP) for Horticulture Extension (MOFA-JICA 2022-2027).
ii. Ghana CARES "Obaatan Pa" Programme (Tomato Initiative). Seeks to boost local tomato production and support effective marketing and processing (2021-2023).
iii. Ghana Peri-Urban Vegetable Value Chains Projects: Sought to improve productivity and access to the market by the beneficiary vegetable farmers in selected peri-urban communities in Ghana (2016-2021).
iv. GhanaVeg
v. Ghana Green Label Scheme Initiative

These specific projects and programmes are meant to **(**i**)** ensure **s**ound implementation of sanitary and phytosanitary (SPS) measures (ii) investments in applied horticultural research (iii) maximize the state's horticultural potential and increase the production of all horticultural crops.

Policies, projects and programmes implemented in the Horticulture sector over the last two decades can be summarized in five thematic areas: production and export, access to improved seed, fertilizer access and water for crop production. Through these projects and programmes, the Government of Ghana seeks to expand international trade in high-value horticulture commodities, in which the country has a comparative advantage. The government has introduced major initiatives to enhance the competitiveness of the non-traditional export sub-sector, and the horticulture sector in particular is the country's focus on agricultural export diversification. This is being done in collaboration with local and international development partners.

The major horticultural crops that have been the focus of successive policies and programmes over the last three decades include pineapple, mango, papaya, banana, citrus, chili pepper, tomatoes, onion, okra, garden eggs, and Asian vegetables. Production of exotic (European) vegetables such as lettuce, cabbage, cauliflower, onion, spinach, tomato, carrot, French bean, turnip, cucumber, beet, and radish concentrated in and around the principal towns and cities of the country have been promoted alongside.

NIGERIA

3.1 Introduction

Nigeria is a multi-ethnic and culturally diverse federation of 36 autonomous states and the Federal Capital Territory (FCT). Agriculture is the mainstay of the economy, employs about 35% of the country's total workforce (WorldBank, 2020) and contributes approximately 24% to the country's gross domestic product (GDP) (NBS, 2020). In 2021, the sector experienced a growth of 3.4% and an inflation rate of 15.9% (NBS, 2020). The majority of the agricultural value is generated from arable crops.

Nigeria has an estimated population of 206 million people which is the largest in Africa and this is growing at a rate of about 2.6% annually (WorldBank, 2022). Nigeria is also the biggest oil exporter in Africa, with the continent's largest natural gas reserves. The oil and gas sector accounts for 86% of the total export revenue (Organization of the Petroleum Exporting Countries (OPEC), 2022). Despite its significant natural resources, poverty and unemployment remain widespread in Nigeria. According to the National Bureau of Statistics, an estimated 40 percent of Nigerians (83 million people) live below the poverty line of ₦198,000 (or US$360 per annum) (NBS, 2020) with an estimated 50 million youth unemployed.

There are two seasons in Nigeria, namely the rainy season and the dry season. Though Nigeria's climate varies across different regions, it is mostly tropical. More than 67% of its regions have an abundance of rainfall throughout the year. As a result of this favourable climatic condition, the country has the potential for increased agricultural productivity (Federal Ministry of Agriculture and Rural Development (FMARD, 2016).

Nigeria is the world's largest producer of cassava, yam and cowpea; yet it is a food deficit nation and depends on imports of grains, livestock products and fish. Of the total land size of 910,770 km^2, about 75% (70 million hectares) is considered agricultural land. Only half of this land is currently used for arable farming in 2018 (FAOSTAT., 2022). There is similar potential for an expansion of irrigation, which now only covers 7 percent of irrigable land with most farmers relying on rainfed production (Xie, You, & Takeshima, 2017). In 2017, the area equipped for irrigation was 331,200 ha. However, only 66% of the land equipped for irrigation was actually irrigated because of the need to rehabilitate most schemes (FAOSTAT., 2022).

Most of the rural population cultivate at a subsistence level, using small plots and depending on seasonal rainfall. Pressure from growing populations has resulted in diminished resources, further threatening food production. Over-farmed land, deforestation and overgrazing are severe in many parts of the country. Drought has become common in the north, while erosion and flooding are major problems in the south.

3.2 Geography and Markets

Nigeria has a range of climate zones that are relevant for horticulture crop production. International Köppen classification groups these into three; (i) the Sahelian climate in the northern part of the country, (ii) a tropical savannah/steppe climate in the middle and (iii) a tropical wet climate in the south. The mountainous areas of Jos and Adamawa, close to the Cameroon border, have a more temperate climate (Table 3.1, Figure 3.1). The various climates have the following key characteristics.

Kano, in northern Nigeria, has a dry semi-arid climate suitable for agriculture. The regional landscape is defined by semi-arid plains. The zone has several rivers, the most important being the Kaduna River flowing from the Jos plateau to Lake Chad. In Kano, there is also a major irrigation scheme, the Kano River Irrigation Scheme, which consists of 22,000 ha of irrigated land.

Table 3.1: International Köppen Classification of Nigeria's climate

Area	Climate type	Köppen classification	Designation
South	Tropical rainforest	**Af** – tropical wet – no dry season	Guinean
Central	Tropical Savannah/steppe	**Aw** – tropical and dry – winter dry season (Jos Plateau 1520 m is temperate, AwH Highland)	Sudanic or Savannah
North	Sahel Climate	**Bsh** – Subtropical dry semi-arid – evaporation exceeds precipitation on average	Sahelian

Source: Van der Waal (2015)

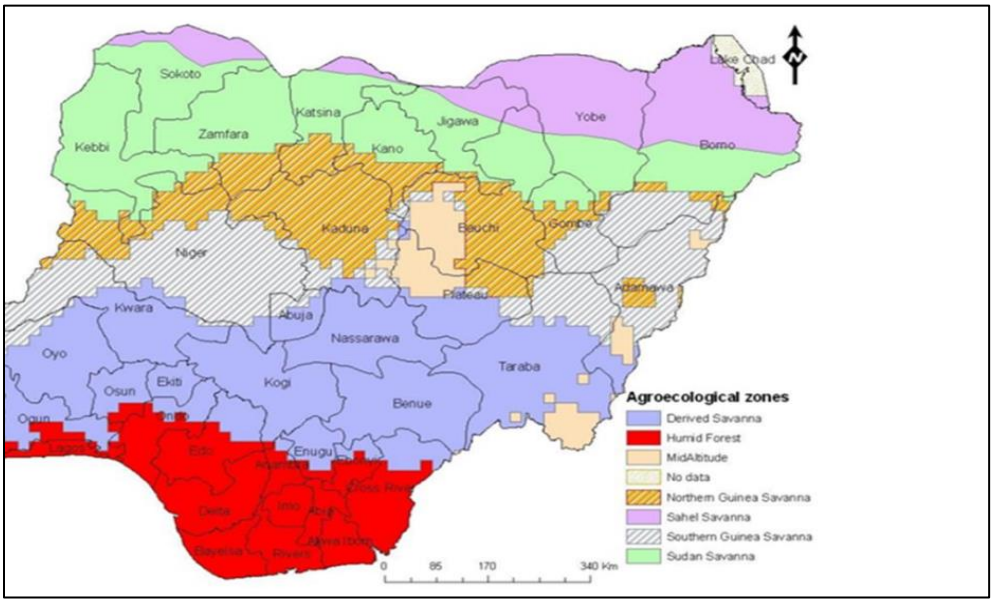


Figure 3.1: Map of Nigeria with different states and agroecological zones
Source:Alamu, A., Nwokedi, Oke, and Lawa (2013).

The main source of water for the irrigation scheme is provided by the Tiga Dam. Another major dam is the Challawa Gorge Dam in the northwest of Kano state (close to Makoda), which irrigates an estimated 10,000 ha (Van den Broek, Steemers, & Bagu, 2021).

Kaduna, in central Nigeria, is characterized by a tropical climate. The central area of the country is an interface between the dry and arid north and the tropical rainforest of the south. The climate is considered tropical wet and dry because a dry (in winter) and a wet season are distinguishable. Vegetation is divided into a variety of forests, steppes and savannahs: a tropical savannah or steppe, the Guinean savannah and the Sudan savannah.

The south is characterized by a tropical wet climate with relatively high temperatures. Vegetation is abundant as the region is divided between a tropical rainforest and a mangrove swamp. The southern part of the country is a delta region crossed by two important rivers namely the Benue River and Niger River.

3.3 Notable Production Practices

Production areas and main farming systems

In Nigeria, especially in the Middle Belt, the states of Kaduna, Kano and Jos Plateau, produce over half of the tomatoes, onions and potatoes. Figure 3.2 presents the share of production of some crops for each state. Data was collected by the National Agricultural Statistics Service in 2011 (NASS, 2011). The data presents the share of the total volume produced by the sample size of 18 million farmers. Despite the data being 10 years old, it still gives a representative overview of the relative differences between the states today.

For fruit production, there is no data available on the division per state. In the northern production zones of Nigeria, the main farming system is the smallholder mixed crops and livestock system, with seasonal irrigation. In Kaduna State, the average land size of irrigated dry season production is 0.7 ha (Van den Broek et al., 2021). Estimations for the typical farm size range between 1-3 ha Plaisier, Dijkxhoorn, van Rijn, Bonnand, and Talabi (2019), but there are also some larger-scale farmers, however, their share is limited (estimated at less than 5%). In the southern production zones, farmers rely more on rainfed production.

In addition to the mixed crops and home gardening, which provide an opportunity for people in different backgrounds to provide extra food for themselves and their families, these small-scale farming have a limited commercial outreach. However, the production of fruit and vegetable has been on the rise in Nigeria. Home gardening is also being increasingly recognized as a strong contributor to household food security.

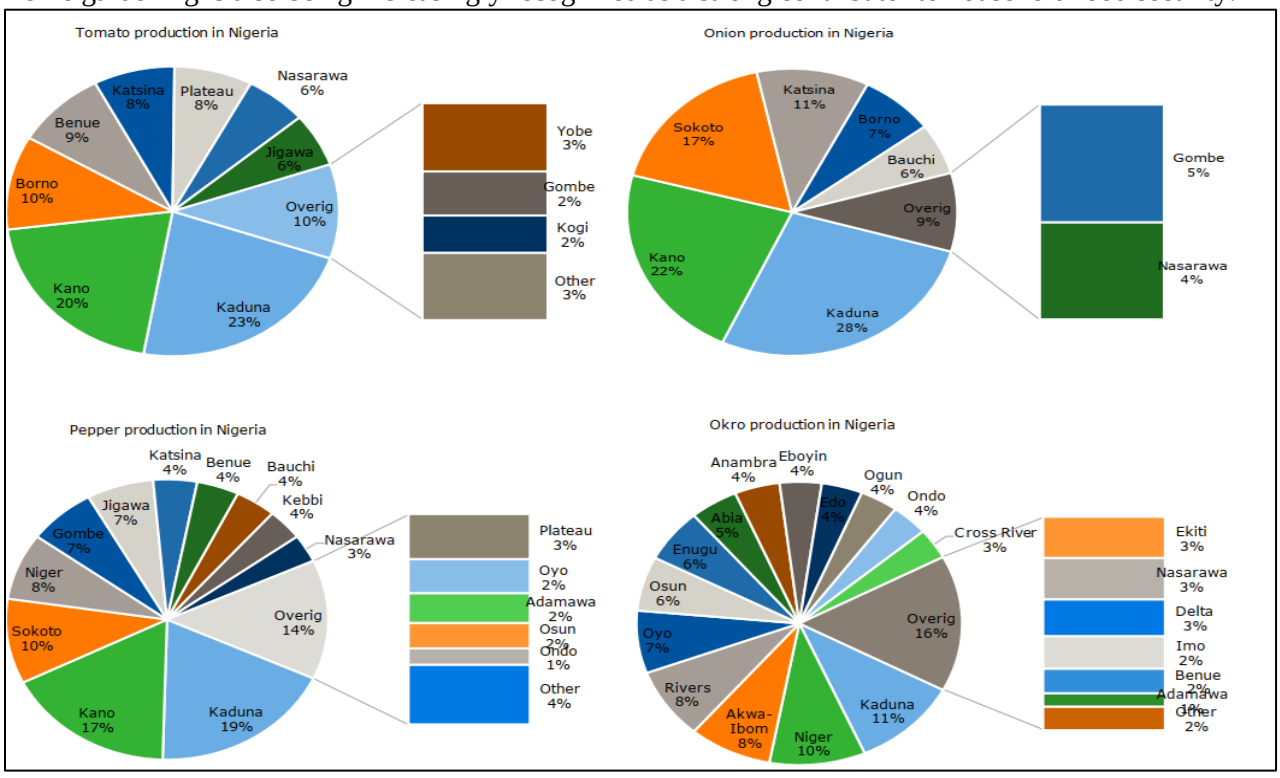


Figure 3.2: Division of different vegetables produced per state, in % of total tonnes
Source: NASS (2011)

Table 3.2: Overview of the different sub-groups for fruits and vegetables commonly consumed in Nigeria

Sub-Group	Sentinel Foods	Health and Nutritional Benefits
Green leafy vegetables	Jute leaves, pumpkin, bitter leaves, garden eggs, sweet potato, cowpea leaves	Contributes to iron, vitamin c, vitamin A and folate intake Reduce dietary risk for heart disease, stroke etc.
Orange and yellow vegetables	Carrots, pumpkin, squash	Contributes to iron, vitamin c, vitamin A and folate intake
Cruciferous vegetables	Cabbage	Reduce dietary risk for cancer
Other vegetables	Tomatoes, garden eggs, okra, cucumber, green pepper or green beans	Vitamin C and A, antioxidant, minerals, prevents cancer, reduces risk of heart disease, stroke etc.
Red, orange, yellow fruits	Mango, papaya, yellow melon	Vitamin C, vitamin A, and folate intake Vitamin E, high in antioxidants, reduces the risk of heart disease, alleviates constipation.
Apples, pears	Apples	Reduces dietary risk for cardiovascular disease, stroke
Fruits	Banana, guava, pineapple, and avocado	Several vitamins including vitamins C, B6, potassium, lowers blood pressure

Source: Dijkxhoorn, Talabi, and Eunice (2021)

Table 3.2 presents an overview of the different groups of fruits and vegetables that are consumed by a large share of the population in Nigeria.

Tomato

Tomato production in Nigeria is estimated to be about 3,816,000 tons/year and is a major food that is consumed in every household. It is an important part of the Nigerian daily diet (Plaisier et al., 2019) and used for stews or soups. Small-scale processing, packaging and retail of fresh and processed tomatoes are dominated by women.

Onion

Like tomato, onion is one of the most consumed vegetable crops in Nigeria. Retailers are also often women. The vegetable is available throughout the year, as farmers and upstream actors often use storage. There is also a strong regional and global export market for onions.

Amaranth

Amaranth is widely produced and consumed in Nigeria. It is consumed with most dishes such as pounded yam, amala and fufu(Akin-Idowu, Odunola, Gbadegesin, Oke, & Orkpeh, 2013). Amaranth is an adaptable crop, it resists various weather conditions, and the short production cycle present amaranth as a high potential vegetable of importance (Hoidal, Jacobsen, Odone, & Alandia, 2020). The amaranth value chain is largely dominated by women, especially the retail end. Amaranth is consumed mainly for health and nutritional benefits and it is the main source of iron, vitamin C, vitamin A and folate.

Pawpaw

Pawpaw production accounts for 855,581 tonnes per year. Women largely carry out the aggregation of pawpaw from rural communities and sell it to consumers. From a consumption perspective, pawpaw is high in fiber and an important source of vitamin A, vitamin C and folate intake. Consumption of papaya also decreases the risk of coronary heart disease.

Citrus

Various citrus fruits are produced in Nigeria, including oranges, lemons and grapefruits. Orange is a significant crop produced in Nigeria with an annual production of 4.2 million tonnes per year. The citrus value chain is equally dominated by both men and women.

Selected fruits and vegetable supply	Focus production area	Economic opportunities	Opportunities for women
Amaranth	Nation wide	Easy to cultivate	Women dominate supply chain
Tomato	North (Kano, Kaduna, Sokoto and Jos)	One of the most consumed vegetables	Women dominate retail
Onion	North (Kano, Kaduna, Sokoto and Kebbi)	One of the most consumed vegetables	Women dominate retail
Mango	North/South	Improved varieties; processing can make it more profitable	Women dominate retail
Pawpaw	Nation wide	Improved varieties; processing can make it more profitable	Women dominate trade and retail
Citrus	North/South	Improved varieties; processing can make it more profitable	Women dominate trade and retail

Table 3.3: Selected fruit and vegetable supply chains
Source:(Dijkxhoorn et al., 2021)

Table 3.3 presents an overview of some selected fruit and vegetable supply chains in Nigeria. The Middle Belt is the main production area for onion and tomato. Fruits are also widely grown in these northern production areas, although they are grown in more significant quantities elsewhere.

Mango

On average, about 946,695 tonnes of mangoes are produced every year. In the mango value chain, retail, processing and packaging are largely dominated by women. Mango is high in fiber and an important source of vitamin A, vitamin C and folate intake.

Major markets

The Nigerian food system is divided into two main market channels: the formal and informal markets. Figure 3.3 provides a simplified overview of the actors involved in both the formal and informal fruit and vegetable supply chain. In the following sections, the various actors will be discussed in more detail.

Farmers

Production of fruits and vegetables is mainly undertaken by smallholder farmers (Dijkxhoorn et al., 2021). Traditional mixed vegetable cropping systems are the most common production systems. Onions, tomatoes and amaranth are often produced in mixed crop and livestock farming systems. Tomatoes and onions are grown to a large scarlet in Fadama (seasonally irrigated flood plains) in the Northern savannah. Amaranth is produced across Nigeria and throughout the year.

Wholesale traders

Wholesale traders have a dominant position in connecting farmers to consumers. The majority of farmers sell to travelling collectors, with only a small minority taking their produce directly to the market. Traders provide an important intermediary service for both farmers and consumers. Exploitative behaviour, and high levels of informality, are significant challenges for the fruits and vegetables supply chains in Nigeria. This hinders marketing efficiency because they do not keep records of day-to-day financial activities, and this prevents traders from obtaining loans from formal financial institutions (Reardon, 2015).

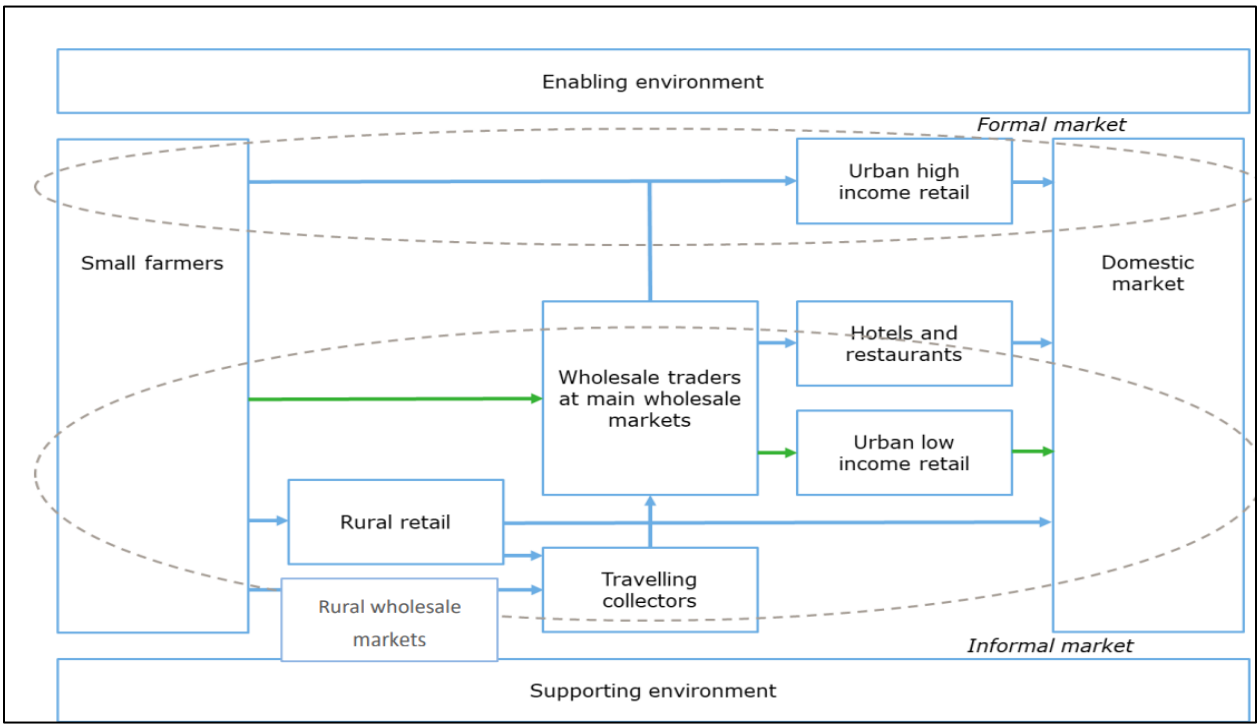


Figure 3.3: Vegetable and fruit supply chain, distinguishing the formal and informal chain
Source:(Dijkxhoorn et al., 2021)

Retailers

The Nigerian food retail sector is divided into two main market channels: the formal and informal markets. Two different types of urban market segments can be distinguished: urban high income and urban low income. Dijkxhoorn et al. (2021) noted that about 95% of the informal market mostly sells food. There is the emergence of supermarkets in Lagos and Ibadan that serve the higher-income classes and middle-class consumers. The lower-income classes purchase fruits and vegetables in informal wholesale and retail markets (corner shops).

In Lagos alone, there are more than 30 informal (wholesale) markets located in neighborhoods where fresh fruits and vegetables are sold. The markets are often private but are supported by the (local) government. However, the main wholesale market in Lagos is Mile 12. The market is located along the Ikorodu Road and serves as the main distribution center for vegetables and fruit arriving in Lagos.

Sourcing of fruits and vegetables often occurs at rural informal wholesale markets. Key markets for the different crops are:

- For tomato and onion, these are Kwanar Gafan tomato markets and Karfi yan Albasa respectively in Kano while notable markets in the south-west are Total market in Akure, Ondo State, Sasa/Akinyele and Bodija markets in Ibadan, Oyo State, Sabo market in Abeokuta in Ogun State, and Ilepo and Mile 12 in Lagos State
- Amaranth is picked up everywhere since it is an easy-to-produce crop and produced virtually in every region in substantial quantity.
- Citrus and mango are produced and traded in Benue State. For these crops the main markets are Makurdi market and Railway market both in Makurdi LGA, Wurukum market and Agidi market both in Konshisha LGA, and Austoma market in Gwer LGA in Benue.
- Pawpaw markets in the south-west can be found in all major fruit and vegetable markets. The notable urban markets are Oje market in Ibadan, Oyo State, and Ketu market in Lagos.

3.4 Horticulture Biophysical

Inputs

Seed Systems in Nigeria

The production of seeds is supervised by the National Agricultural Seed Council (NASC). However, there is a large presence of local government in seed production and distribution. As a Federal State, the NASC oversees the production of seeds. At the State level, Agricultural Development Projects produce foundation seeds and improved seeds to be sold to seed companies and farmers. Every State has its own Agricultural Development Projects that play a role in the development and production of seeds, especially for the staple crops. The National Agricultural Seed Council of Nigeria is a specialized agency overseeing the Nigerian seed industry to assure affordable access for farmers to improved quality seeds. The seed industry is organized into the seed association of Nigeria, with its office in Zaria.

For vegetables and fruits, farmers use local varieties and informal seed sources. There are many varieties of fruits and vegetable seeds often adapted to specific locations, and various farmer and customer demands. The formal commercial seed sector serves only a small portion of vegetable producers, more often supplying commercial markets with quality seeds and improved varieties, such as tomato, onion, and peppers. The informal sector remains particularly important for other vegetables (including especially African leafy vegetables) and fruits. The private sector now constitutes 13% of variety releases in the seed market, with the public seed sector constituting the remaining 87%.

There are several national and global seed companies in Nigeria. According to the NASC, there are 157 registered seed companies in Nigeria. Seed sector reform in Nigeria has led to the development of seed companies, but at a much slower pace than in Asia, and Eastern and Southern Africa.

Farmers growing fruits and vegetables use multiple seed sources. These sources include farmer-saved seed or planting material (fruit crops) from neighbours or informal markets or nurseries. Fruits and vegetable

seeds are mostly imported into Nigeria. Vegetable farmers purchase small packs of seed from regional or national companies, opting for quality seed that may be open-pollinated varieties (OPVs). There is low adoption of hybrid seed varieties among vegetable and fruit farmers. Smallholders currently prefer OPVs as they lend themselves to on-farm seed saving.

Most vegetable farmers in Osun, Ogun, and Oyo States use improved seed while about 60% use seed collected from previous harvests and 30% purchase from seed dealers. Improvement of cultivars with better storage and transport capability, better resistance to diseases and drought tolerance, presents an important business opportunity for seed enterprises. Seed companies can invest significantly in local research and demonstration facilities.

Premier, one of the leading seed companies produces its own inbred lines for hybrid maize. Premier also produces seeds of OPV maize, rice, soybeans, cowpeas, groundnuts, sorghum, pearl millet, cotton, okra and various local leafy vegetables, such as tete (*Amaranthus hybridus*), soko (*Celosia argentea*) and ewedu (*Corchorus olitorius*). Premier imports seeds of tomato, watermelon, cucumber, carrot, onion, sweet pepper, cabbage and lettuce. Other companies are Alheri Seed, Nagari Seed, Maslaha Seed (Van der Waal, 2015).

Fertilizer

These are external inputs used for soil fertility conservation in Nigeria. Improving soil fertility maintenance is therefore of the greatest importance. Farmers use organic and inorganic fertilizers in fruits and vegetable production. A major reason for the high soil nutrient deficiency is the low level of fertilizer use in Africa compared to the rest of the world.

Among the factors influencing the effectiveness of fertilizer usage are the poor road and transportation systems. This increases the farm gate prices of fertilizers (Liverpool-Tasie, Omonona, Sanou, & Ogunleye, 2017). Where rain-fed agriculture is dominant, and improved seeds are not present, farmers find it too risky to adopt fertilizer use (certainty to increasing cost price, uncertainty to have higher yield, hence higher risk of lower economic return). Additionally, the low level of education of farmers affects the proper use of fertilizers. Fertilizer application (type, dosage, timing) needs to be carefully adapted to the type of soil, type of crop and the condition of the soil.

Production

Horticultural products in Nigeria are mostly manually cultivated by subsistence farmers on a small scale. The production of horticulture crops is not done with irrigation systems, it is rather dependent s on the use of water from wells, boreholes and rainfall (FAO, 2016). Results from (Kainga & Johnson, 2012) established that small-scale farmers engage more in horticultural production. This limits their capacity to access the international market.

Poor control of insect pests and diseases was identified as a constraint to horticultural production (Ibeawuchi et al., 2015). Farmers still rely on traditional methods to control pest infestations, because these methods are cheaper. Farmers lack knowledge of pesticide usage in Nigeria. As indicated by Ugwu, Omoloye, Asogwa, and Aduloju (2015), many of the farmers need to be educated on appropriate pest control measures to improve the yield and quality of their products.

Processing and packaging

The fruit and vegetable processing industry is still in its infancy and is uncoordinated. A key processing challenge is the lack of tomato varieties suitable for processing. The import of raw materials from abroad also jeopardizes the competitiveness of the domestic processing sector. Another issue is the volatile supply and the high cost of raw materials.

Table 3.4 Processing companies of fruit and vegetable in Nigeria

Processor	Location	Classification
Tomato Jos	Kaduna	Large scale, tomato
Dangote	Kano	Large scale, tomato
Dangi foods	Abuja	Large scale, tomato
Nature's Bounty Health products	Legos	Medium, dried fruits
Dansa holdings limited	Legos	Large-scale, fruits and beverages
Gunni royals tomato paste and allied company	Oyo	Medium focused on tomato
Frutta juice and service limited	Legos	Large-scale, fruits juice
Mystrose limited	Abuja	Small scale, vegetable mix
AACE foods and processing	Ogun	Medium-scale, dried spices

Source: (Dijkxhoorn et al., 2021)

For example, processors need a constant supply of raw material at an affordable price to be able to offer a competitive product to consumers. Some studies (Plaisier et al., 2019; Ugonna, Jolaoso, & Onwualu, 2015) also confirmed some of these challenges faced by the Nigerian processing industry. To overcome some of these barriers, some large processing company have set up dedicated out-grower schemes and provided farmers with technical support and inputs.

Table 3.4 lists the key processing companies active in the fruit and vegetable supply chains. In recent years there has been a small increase observed in companies processing fruit juices on a small scale, possibly due to the ban on imported fruit juices and juice concentrates. Some processors, mostly at the downstream end, are focused on value addition using innovative approaches. One company is producing a pasteurized tomato, pepper and onion mix which is used as a ready-to-cook product for stew making. A big player like Dangote Tomato Processing also makes tomato concentrate and puree. For mango, there is a small and medium-sized enterprises (SME) making mango chips. Some SMEs also specialize in dry food mix packaging destined for retail markets in urban areas (e.g. ReelFruit in Lagos).

3.5 Natural Resources

Water

Water availability and quality are a challenge to the development of the horticulture sector in Nigeria. Although the northern parts of the country (Kano and Kaduna) have access to water through dams, water is a relatively scarce resource in Nigeria. Agricultural intensification will require good irrigation and water conservation methods to ensure its sustainability. Investments in improving the water system is required ((FMARD, 2016). In 2015, only half of the fertile land was used for farming activities and only 7% is grown under irrigation (Van der Waal, 2015).

Soil

The soils in Nigeria are comprised of various soil types, such as listed in Table 3.5. Ferralsols is the well-known, strongly weathered reddish or yellowish soil of the humid tropics. They have good soil physical

properties with a high percentage of clay minerals and are rich in iron and aluminium oxides, which cause the red colour, but have a poor nutrient holding capacity, especially phosphate. Their acidity requires frequent liming and fertilization.

Table 3.5: Major Soil Types in Nigeria

Agro-Ecological Zone	Major Soil Types
Humid forest	Ferralsols, Nitisols, Gleysols
Coastal Savannah	Ferralsols, Luvisols, Nitisols, Arenosol, Acrisols, Lithosols
Guinea savannah	Ferralsols, Luvisols, Acrisols, Lithosols
Central Savannah	Ferralsols, Nitisols,

Source: Salako (2004)

Nitisols are well-drained, weathered soils with high percentages of clay minerals. They have a good structure and a high cation exchange capacity, allowing them to keep nutrients. They are neutral to alkali and have favourable characteristics. They are considered to be the most fertile and productive soils in the tropics, especially when phosphorus is added. Acrisols are strongly weathered acidic soils with low fertility. Luvisols are heavy fertile soils, where water logging may be a problem. Lithosols are rock soils with very low fertility.

The quality of soils on the savannahs seems to be generally fragile, with shallow top soils, relatively acidic, and relatively coarse particles. The coarse sand particles limit the water retention capacity of the soils. This compromises the resistance to drought for the crops that are grown.

Climate

Climate change is an important factor affecting the mainly rain-fed agriculture in Nigeria. Ogungbenro and Morakinyo (2014), studied weather station data over a 90-year period and found that in the three climate zones, marked shifts in average rainfall could be observed. Figure 3.4 clearly shows how all the climate zones have become drier, with peaks in the curves shifting to the left, towards lower amounts of rainfall. Some of the curves also become wider, showing that the variability also increases. There are no climate-smart practices or effective resilience policies developed.

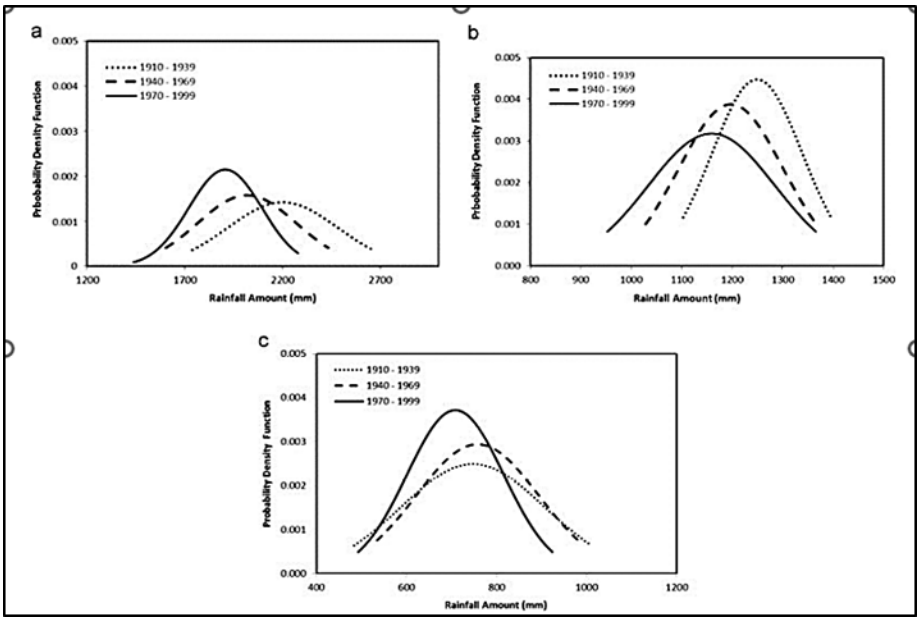


Figure 3.4 A shift in average annual rainfall in the main climate zones: a = Guinea zone, b = Sudanic zone, c = Sahelian zone from 1910-1999;
Source: Ogungbenro and Morakinyo (2014).

In conclusion, for the Sahelian zone, farmers need to adopt farming techniques that are resilient to poor rainfall patterns. Crops with short growing cycle, drought-tolerant crops and cultivars will be important to decrease the risk of failed harvests. Irrigation can also be an important strategy (to reduce dependence on rain) for sustainable crop production and high yields.

3.6 Socio-economic

Women in horticulture

Women account for 75% of Nigeria's farming population, yet, women's overall productivity and capacity in the different parts of the value chain remain low (Olakojo, 2017). Women farmers and entrepreneurs continue to face disadvantages, including lower mobility, less access to training, less access to market and information, and less access to productive resources such as credit, land and labour-saving processing technologies. Increasing access to food production provides opportunities for them to earn extra income that would enable women to spend more money on health care, nutrition, and education for their children – investments that could produce long-term, positive results for families that are dependent on the fruit and vegetable value chain(Gustavsson, Cederberg, Sonesson, Van Otterdijk, & Meybeck, 2011).

Women have more prominent roles in post-harvest activities and their ability to have access to land for production depends on their husbands or fathers. Vegetable production continues to be a profitable enterprise for women despite challenges that constrain them. Fruit and vegetable value chains provide women with economic opportunities as producers, and value-addition activities from production to marketing.

Traditional green leafy vegetables (GLVs) are important crops in Nigeria and are a major source of income for women entrepreneurs (Kelechi & Dorothy, 2015). The nutrient-rich and inexpensive amaranth vegetable

value chain is largely dominated by women, especially at the retail end of the value chain. Amaranth possesses tremendous potential for income generation among women because it is has very high consumer demand, easy to grow, highly affordable for the consumer, easily available, and requires minimum production inputs. Unlike staple crops like cassava and yams – which need large parcels of land, take a long time to mature and whose value chains are traditionally managed by men – amaranth can be produced on small parcels of land and is culturally acceptable for women to produce. Since women are likely to have access to less land than men, GLVs such as amaranth are an easier crop for women agri-preneurs to produce (Umar, Sadiq, & Suhasini, 2019). The fresh onion retail trade is dominated by men due to gender barriers at the production level that make it difficult for women to access land and other production resources (Kaka, Gindi, & Magaji, 2021). In the tomato sector, small-scale processing and packaging are often dominated by women.

In the fruit value chain, women are key actors in retail (Ocholi, Nyiatagher, & Ayila, 2020), and in processing activities. For example, mango processing and consumer-targeted trading is largely dominated by women. Similarly, for pawpaw, the downstream supply system is largely dominated by women. However, in the citrus value chain, both men and women are involved in retail activities. Agricultural development research needs to highlight the roles, contributions and gender-specific challenges that women in Nigeria face in different fruit and vegetable value chains. Addressing sociocultural factors such as cultural norms, that serve as barriers to women's agribusiness initiatives can also enhance their profits.

Marketing and consumption

Demand for nutritious fruits and vegetables

Many consumers in Nigeria are focused on consuming affordable sources of energy instead of nutrient-rich food. As a result, intake of fruits and vegetables remains below the daily recommendation of 400g. According to Olatona, Onabanjo, Ugbaja, Nnoaham, and Adelekan (2018) only about 27% of respondents reported adequate daily intake of fruits and vegetables as recommended. Other studies in Nigeria reported much lower percentages such as 5.5% among Junior Secondary School students in Surulere, Lagos, 12% among adolescents in Ibadan, Nigeria (Ilesanmi, Ilesanmi, & Ijarotimi, 2014). However, reliable data on food intake in developing countries (including Nigeria) are scarce and limited.

The available information on expenditure reveals that the consumption of fruit and vegetables remains insufficient to meet daily recommendations. The Global Burden of Disease Murray et al. (2020) provided estimates of daily per capita consumption of 238 g vegetables and 84 g for fruits per day per person. Six disparities are observed in the consumption of fruits and vegetables across the country and between income classes. As a result, this study specifically differentiates between different consumer groups: urban high-income classes, the middle classes, and low-income classes.

Trade

In Nigeria, horticulture export is almost non-existent (EuropeanCommission, 2015; FAOSTAT, 2016a ; UNCTAD, 2016) unlike in Egypt and Kenya. Nigeria is the main African country producing mangoes in large quantities and one of the top mango producing countries in the world.

According to Thomas (2012), several horticultural crops such as lettuce, cucumbers, spring onions, amaranth and eggplants are produced in Nigeria.

Major constraints affecting the development of the horticulture sector are a lack of policy, absence of institutional support, absence of agricultural extension practices, poor technological and marketing infrastructure, a lack of credit facilities, a lack of land (in urban areas) and water (Thomas, 2012). Food safety and health certification issues, low economies of scale, a lack of knowledge of organic farming techniques, infrastructure and an enabling national regulatory framework are the constraints that have prevented Nigeria from accessing international markets.

Import and export trade

According to the Federal Ministry of Agriculture and Rural Development FMARD (2016), there are serious annual demand gaps for vegetables, including tomatoes (1.4 million tonnes). This is a result of low yields, high post-harvest losses and increasing demand (FMARD, 2016). In addition, vegetable production has not been able to keep pace with Nigeria's increasing population; the high demand is met by import. Food imports have more than quadrupled in the past decades, from a value of US$ 964 million in 1995 to US$ 4,566 million in 2016 FAO (2019), resulting in a substantial trade deficit for the agri-food sector.

3.7 Research, Education and Training

Education and training needs in horticulture

Farmers have very limited knowledge of plant diseases and pests. The extension services are not able to accurately advice farmers. Advice is usually given by chemical sellers, but that advice may not be appropriate. This leads to frequent overdosage of pesticides and the application of the wrong pesticides. Training of farmers, training of extensionists and intensifying land use leading to higher yields can help develop the fruit and vegetable industry and mitigate social tensions and pressure on the land.

Research capacity of technical vocational institutes, universities and research institutes

National Agricultural Research Institutes (NARIs) play a significant role in the agriculture sector. NARIs, among others, produce foundation seeds. Nigeria has a large national agricultural research and extension service; however, their research has traditionally not been focused on fruits and vegetables, but mainly on other crops such as cereals. Public agricultural research institutes are critical for varietal development, however public investment in the development of vegetable and fruit varieties is inadequate. NARIs are made up of 17 commodity-based research institutes, a specialized national agricultural extension institute, 18 faculties of agriculture in regular federal universities, and three specialized agriculture universities (Van der Waal, 2015). Moreover, the Consultative Group on International Agricultural Research (CGIAR) is an important player in Nigeria, with ongoing activities, particularly through the International Institute of Tropical Agriculture (IITA) in Ibadan.

Most of the States have universities which in many cases have an agricultural faculty. They provide research for development. The study by Van der Waal (2015) shows that much useful research is done at these institutions, in many cases with limited means, but often of high relevance. The trick will be to turn the research into policy and practice, so that research leads to development.

The National Horticultural Research Institute is located in Ibadan and is part of the Agricultural Research Council of Nigeria. Ibadan hosts the International Institute for Tropical Agriculture (IITA), a CGIAR

branch, focusing mainly on food staples, such as maize, rice, yam and cassava, but also on plantain and banana. Table 21 lists the most important universities with agricultural colleges and schools, as well as the major research institutes on Nigeria.

An important agenda for research could be the further study of the relationships between different interventions or strategies for improved production, yields, quality and hence food security. While there are ample studies into the effect of single improvement strategies, such as fertilizer application, there are limited studies where the relation between more than one is taken into account, like e.g., fertilizer and irrigation, or irrigation and improved seeds use. Horticulture is a multi-factorial production system, where inputs are complimentary. The absence of one factor may render useless the increase of another factor (Takeshima, 2011).

Table 3.6: Nigerian Universities with Agricultural Colleges and Research Institutes

University/College	Location	State
Federal College of Horticulture	Dadin Kowa	Gombe
Landmark University	Omu-Aran	Kwara
Ahmadu Bello University	Zaria	Kaduna
Federal College of Animal Health and Production Technology	Moor Plantation	Ibadan
Feral college of agricultural Produce and Technology	Kano	Kano
Federal College of Agriculture	Ibadan	Ibadan
Federal College of Agriculture	Ishiagu	Ebonyi
Kwara State University	Ilorin	Kwara
Ladoke Akintola University of Technology	Ogbomosho	Oyo
Feral University of Technology Oweri	Owerri	Imo
Michael Okpara University of Agriculture	Umudike	Abia
Obafemi Awolowo University	Yola	Adamawa
Federal University of Agriculture	Ile-Ife	Osun
University of Agriculture	Abeokuta	Ogun
University of Ibadan	Makundi	Benue
University of Nigeria	Nsukka	Enugu
National Horticulture Research Institute	Ibadan	Oyo
Agricultural Research Council of Nigeria	Abuja	FCT
International Institute for Tropical Agriculture	Ibadan	Oyo

Extension Capacity in Public and Private Sector

Extension activities are important for the development of the horticulture sector. All the States have Agricultural Development Projects, which provide agricultural infrastructure and serve as the main vehicle for agricultural extension. It has already been mentioned how important extension services are to improve the quality and productivity of horticultural production.

3.8 Policy and Horticulture

The enabling environment for agriculture development in Nigeria is improving but is still very challenging. The Agriculture Transformation Agenda in Nigeria is and has been, the key to agricultural development. Food security, import substitution, job creation and economic diversification are priorities of the new agricultural promotion policy.

The Federal Government concentrates on supporting the development of a conducive enabling environment. Policy emphasis is on providing a conducive legislative and agricultural knowledge framework, macro policies, security, enhancing physical infrastructure and institutional mechanisms for coordination and enhancing access to adequate inputs, finance, information on innovation, agricultural services and markets. However, in general, policies are considered to be ineffective, and lack enforcement.

The formal seed sector is run by FMARD, and the National Agricultural Seeds Council (NASC), which works under FMARD, and is a member of the Crop Varieties Registration and Release Committee (CVRRC). The CVRRC is responsible for varietal evaluation, release and registration in the national catalogue of registered and released varieties. NASC is a statutory government agency with the responsibility of coordinating and regulating the seed industry. It advises the government on seed-related programs and is responsible for quality control through certification procedures and enforcement of quality standards. Before varieties are officially released, NASC forms part of the committee that evaluates the technical procedures and parameters.

CÔTE D'IVOIRE

4.1 Introduction

The horticulture sector in Côte d'Ivoire is characterized by fruits and vegetables both for local consumption and export. The local market constitutes of a multitude of smallholder farmers growing fruits and vegetables with low application of modern technology. Old varieties and extensive techniques are used. The markets are scattered, and no independent cool chain is employed, other than supermarkets. The quality of the products is generally low, which compel the supermarkets to import high-quality fruits and vegetables, mainly from Morocco and France. The fruit export consists mainly of banana, mango, pineapple, and papaya. The banana sector is dominated by two companies who control the sector by vertical integration. Little opportunities exist in this banana sector for other players. The mango exports are done by independent exporters from mostly medium-sized farms. Only a few bigger ones exist. The main export destination for mango is Rotterdam.

Opportunities for improvement of the horticulture sector in Côte d'Ivoire exist. High-quality seeds, soil analysis services, plant protection products, and good quality fertilizers are needed. Intensification of production practices can improve quality and yields per ha enormously and enhance the income of the farmers. For the export crop specifically, the main challenge is the high number of notifications of phytosanitary interceptions in Europe of Quarantine organisms that can ultimately lead to an embargo for export into the (whole) European Union. Opportunities exist for the adoption of best practices in phytosanitary and the establishment of highly specialized companies active in biocontrol of those organisms. The establishment of independent cold chains for individual and smallholders' fruit and vegetable could as well reduce post-harvest losses and improve the quality of fruit and vegetable.

4.2 Landscape Challenges and Opportunities of Fruits and Vegetables

Diagnostic

The production and area cultivated increased between 2000–2020, sometimes even by 100%, with extraordinary growth in the case of dry chilies and peppers. Although the income of farmers has improved over the past two decades, there are still poor and vulnerable groups, living mainly around big cities. Those people are the cheap labour reservoir for the urban economies. They often don't own land but a lot of them produce vegetables on very small plots and sell them at the urban market via middlemen. The money earned is mainly used to buy staple foods and pay their children's school fees. To maximize profits, a very intensive production is needed with multiple harvests per year. Around Abidjan, we see a high percentage of immigrants from Burkina Faso, or the north of Côte d'Ivoire involved in vegetable production on small plots of land.

Table 4.1: Fruit and vegetable production and cultivated area in Côte d'Ivoire

	Year 2000		Year 2010		Year 2020	
Item	Cultivated Area (ha)	Production (tonnes)	Cultivated Area (ha)	Production (tonnes)	Cultivated Area (ha)	Production (tonnes)
Avocados	4770	20032	4878	30077	5332	35415
Bananas	7800	305300	7760	314270	13990	625981
Beans, dry	22988	20689	38725	33102	44300	37849
Beans, green	970	3269	1500	4436	1674	4969
Chilies and peppers, dry	14285	18000	21000	95000	25045	127642
Chilies and peppers, green	4015	23283	4200	25000	3857	26522
Coconuts	35000	230000	30000	150816	41154	105660
Cucumbers and gherkins	3874	16245	4500	19607	4272	20721
Eggplants (aubergines)	4914	63667	11881	83983	20879	109052
Fruit, citrus nes	2633	31074	3000	37754	3412	43251
Fruit, fresh nes	1550	9000	3500	18000	3986	20947
Fruit, tropical fresh nes	30789	44105	35579	46240	39555	49857
Mangoes	50331	23655	84000	45206	169921	103420
Okra	39644	92685	47000	125748	67285	188736
Onions, shallots, green	717	5130	850	7300	845	7980
Oranges	2619	29248	2900	35797	3208	40558
Papayas	2095	3981	4958	11626	5662	13992
Pepper (piper spp.)	977	1079	588	480	124	63
Pineapples	7663	238000	1194	68212	800	50893
Pumpkins, squash, gourds	1753	16030	2050	19635	1978	19297
Tomatoes	2331	23026	3300	31241	4550	47283
Vegetables, fresh nes	11772	95891	16577	136222	17858	147241

Source: FAO, 2020

Production Areas

Fruit and vegetable producers are mindful of the distance to the market and the climate. Nearly everywhere in West Africa, highly perishable vegetables like lettuce and other leafy vegetables are grown in urban areas. For instance, at the end of runways of airports, you will always find them and Abidjan is no exception. The logic is that the land is close to the market, but forbidden for building structures, so perfect for vegetables. Further away, less perishable vegetables and often fruits are grown. Being close to a highway speed up the development of these production areas. Highways such Abidjan–Yamoussoukro-Bouake have boosted the production of fruits and vegetables as transport prices have reduced significantly. Storable and transportable crops like onions mostly come from Sahelian countries like Niger, Mali, Burkina Faso etc. The onions can be stored for a while when dried properly. A big part of the harvest is transported to the coastal urban areas of the richer, neighbouring countries like Ghana.

Climate Zones

Côte d'Ivoire has several climate zones suitable for vegetable growing:

- A narrow coastal zone is suited for 'European' vegetable growing during the dry seasons because of the temperate influence of the sea.
- More inland temperatures are higher and more suitable for tropical fruits and vegetables. During the rainy season, vegetable growing can become difficult because of too heavy showers and high relative humidity, causing bacterial and fungus diseases. Fewer insect problems occur in this season.

- In the north with less rainfall, irrigation is needed. The relative humidity is lower and gives fewer problems with diseases, but pests can become a nuisance. In the cooler 'winter' period, onions and other 'European' vegetables can be grown.

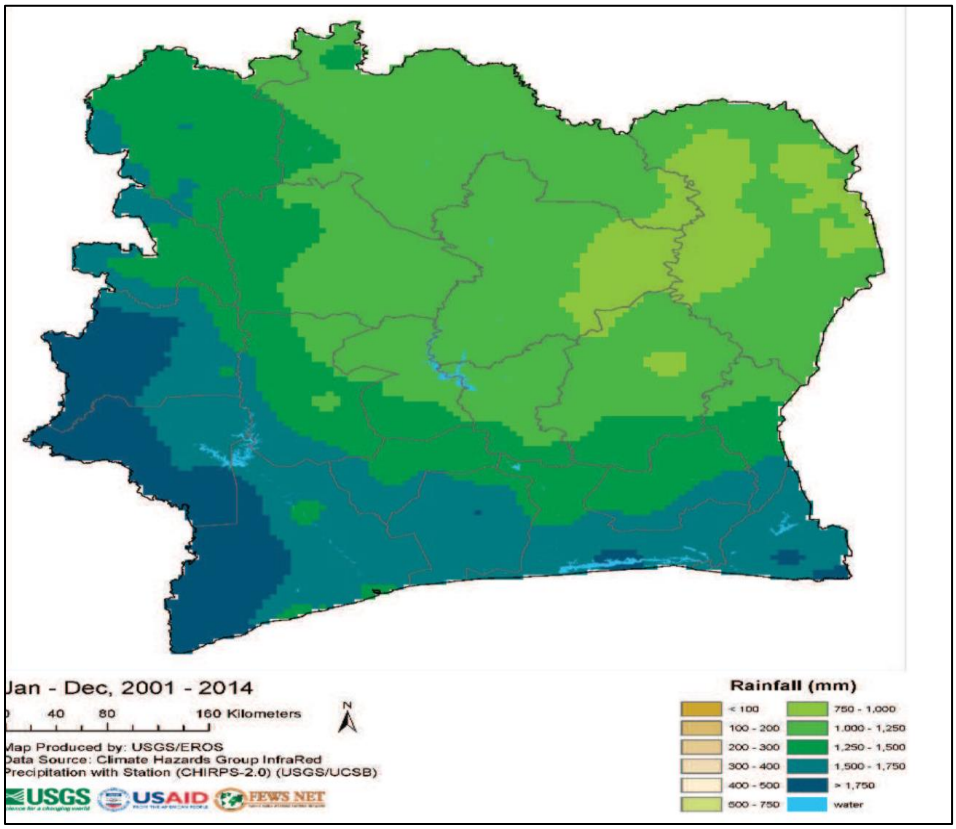


Figure 4.1: Historical Average Rainfall (mm/year) in Côte d'Ivoire

Vegetables produced can be divided into exotic or European types including lettuce, onion, garlic, tomato, cabbage, carrot, string bean, cucumber, bell pepper, European eggplant etc.) which are grown in Africa at lower temperatures during 'winter' time and tropical vegetables which require higher temperatures (African eggplant, chili pepper, okra, bitter leaf, jute leaf, cowpea leaf, amaranth, hibiscus leaf etc.). Growing the 'European' vegetables in the hot season ('off season'), will consequently lead to problems related to temperature (too high); rain (too little, too much, not well distributed, too high relative humidity etc.); pests and diseases (as a result of non-adapted varieties and adverse climatic conditions); non-adapted genetics.

Markets

The main markets for fruits and vegetables are the traditional open markets in the urban centers of Côte d'Ivoire. The customers have some purchasing power and are mindful of their diet. It is estimated that 90% of the fruits and vegetables produced for the local market are sold at the farm gate by the farmer to the middlemen (or women), transported to towns and sold to wholesalers at certain large wholesale markets, mostly in the outskirts of towns.
In Côte d'Ivoire, the retail market women buy their supply for their daily sales in smaller markets. These markets are highly seasonal. When products become rare and thus expensive, they disappear from the

market. The middle- and higher-class customers purchase their fruits and vegetables in specialized shops and supermarkets. This sector is growing fast.
Companies in Côte d'Ivoire, like Prosuma, buy fruits and vegetables from local farmers and sell them to supermarkets (Casino excluded). Prosuma's main problem is to ensure constant availability of the same vegetables all year round, regardless of the season. Buying fruits and vegetables from Morocco, South Africa or Europe is much easier as most products are available the all year round. In supermarkets in Côte d'Ivoire, we do see a lot of products from abroad at huge prices differences. Adoption of technology such as irrigation might contribute to reducing the seasonality variability in the supply of fruit and vegetable in Côte d'Ivoire. The features of fruits and vegetables growing in Côte d'Ivoire as a whole can be summarized in table 23 below.

Table 4.2: SWOT Analysis of markets in the Horticulture Sector in Côte d'Ivoire

Strengths	Weakness
• Good climatic conditions for commercial fruit and vegetable production. • Profitable activity for growers • Employment for young and old along the whole value chain • Motivated growers and entrepreneurs available • Good access to urban markets • Growing need for fruits and vegetables in the urban areas • Ongoing research and practical trials to improve and intensify the existing production • Systems are already carried out on a small scale	• Scarcity of land in and near urban areas • Climate change can give rise to unpredictable heavy showers or dry spells • Poor soils • Lack of access to soil laboratories • Lack of more efficient irrigation and drainage systems • Lack of affordable loans for investment • Inadequate technical know-how and education • Lack of cheap labour close to the consumption areas • Lack of mechanization • Handling and transport are suboptimal • Road network is not yet optimal but improving a lot!
Opportunity	**Threats**
• Intensification: the use of improved seeds, specialized fertilizer, biocides, better techniques etc. on a smaller area is already being practiced and can be improved further on • All-year-round production of vegetables • Organic fruits and vegetable niche market • Commercial vegetable growing is lucrative and creates employment • Offers opportunities for enterprising young people.	• Wrong and excessive use of biocides giving the local product a bad image

Fruit export sector

The fruit export sector in Côte d'Ivoire is important as it generates foreign currency and employment. In general, this sector has experienced some challenges in recent years, but it is starting up strongly again. The world market for exotic fruits is growing fast. Côte d'Ivoire has an advantage in the European market over Latin America because of its shorter distance to Europe.

Table 4.3: Main features of the fruit export sector in Côte d'Ivoire

Main features of the fruit export sector in Côte d'Ivoire					
	Banana	**Mango**	**Pineapple**	**Papaya**	**Others**
Area of production in Côte d'Ivoire	South and Central	North	South and Central	South	Anywhere
Production scale of companies	Large	Medium Small	Medium Small	Small	Small
Ranking main export destination countries	1. France 2. Belgium 3. UK	1. Netherlands 2. Belgium 3. France 4. UK	1. France 2. Belgium 3. Netherlands 4. UK	France	Hardly any export yet

a. Banana

The banana production and export are the main fruit business of Côte d'Ivoire. Banana is grown mainly in the coastal and central areas of Côte d'Ivoire. After the eighteen years of 'Banana wars' between Europe (with preferential customs tariffs for African bananas) and the Americas via the WTO, the production and market has changed considerably. Latin America is the main competitor for the Côte d'Ivoire banana sector. Some changes that are observed lately is that the north American buyers try to protect their position in Latin America against European buyers. This makes the Côte d'Ivoire banana production more important for Europe. The export crop is grown on large plantations, owned by two French companies: i) SCB: mother company in France: 'Compagnie Fruitière', covers 4000 ha ii) SCAB: mother company in France: Canavese; exploits 1900 ha. Both companies have a large number of expat personnel and control the whole value chain: growing, packing, transport to port, loading on specialized vessels for transport to Europe.

Table 4.4: Exports of bananas into the EU countries from Côte d'Ivoire in tons

Exports of bananas into EU (tons)				
Country	2017	2016	**2015**	**2014**
France	166828	136468	120234	126861
Belgium	82709	99745	88794	81052
UK	74969	43247	40893	37724
Netherlands	0	40	0	0
Total EU	324507	279500	249921	245637

Over-dependence on a single crop is risky, and the large French companies are trying to diversify. Large trials with sweet corn (for the Dutch market) have been undertaken by SCB. Attempts of SCB to diversify with pineapple were also not very successful. SCB has become involved in mango export from the north which has turned out to be more profitable.

Table 4.5: SWOT Analysis of the Banana fruit sector

Strengths	Weakness
• Vertical, top-down, organized value chain (from farm to arrival port in Europe) assuring good quality and profitability. • Access to European and Latin America markets. Côte d'Ivoire is 2000 km from Europe. Latin America is at least 5000 km from Europe.	• The civil war in Côte d'Ivoire has negatively influenced the production, economy, investment and export of bananas since 2009. • Inland transport is difficult because of poor road networks. • Lack of processing industry for bananas. However, there is a growing market for banana powder and banana chips in the EU and USA. • Phytosanitary inspections at the port of Abidjan can take a long time (up to 72 hours instead of the stipulated 24 hours) and are not necessarily effective. • Congestion in the Port of Abidjan.
Opportunity	**Threats**
• The Eastern European and Russian markets for bananas are growing fast with tariff advantages for both. • Bananas can be grown year-round in Côte d'Ivoire which is an advantage compared to countries where traditionally it can only be grown during the rainy season. • Drip irrigation can help banana plantations to overcome drought periods which appear to occur more frequently with climate change. It requires very high investments. • Companies are looking into the installation of plantations more to the northern region of Côte d'Ivoire where the rainfall is less, less drainage is needed and there are fewer problems with harmful fungal diseases. • Growing bananas up north creates a possibility for organically certified banana production since fewer fungus attacks can be expected. This is a niche market where other parties than the traditional ones, might come in. • New highways are under construction. Together with the new bridge in Abidjan this is improving the logistic situation a lot. However, there is still a lot to be done.	• With the apparent climate change, rains are less regular. Periods of drought are alternated by heavy rains. Both phenomena come with problems. • The occurrence of pests and diseases forms a threat to banana production in Côte d'Ivoire. • Production and transport costs need to be decreased. Otherwise, in time Côte d'Ivoire will not be competitive in the EU-market. • Being dependent on one crop is a financial hazard.

b. Mango

Mango production is highly seasonal. This is why there is no real competition between the Asian, West African and Latin American mango growing areas. Large international fruit companies buy mangoes year-round, switching between different countries and continents depending on the period of the year. Having all-year-round mangoes production will help serve the supermarkets. The main production is in Asia. Mango crops prefer drier areas than banana and pineapple. The Ivorian mango area is part of a greater growing area consisting of the north of Côte d'Ivoire, the south of Mali and south of Burkina Faso and the

north of Ghana and north and south of Nigeria. The nature of the borders between those countries makes all statistics on production difficult. The 'pisteurs', small businessmen buy and harvest the mangoes from medium-size farmers (mostly between 5 and 20 ha per farmer) sell them to exporters at packing houses. The exact origin of those mangoes may be unknown, although the certification mentions a distinct place.
A few larger growers like 'Nembel Invest' with 340 ha, also export fruits themselves. They often buy extra mangoes from surrounding smaller farmers. This can be a lucrative business to have higher efficiency in the packing house, etc., but it can easily turn into a headache when the situation in the port turns out into a disaster like in 2017, when reefer containers with mangoes were delayed for long periods in the Port of Abidjan.
Mangoes are prone to pests and diseases. Some have Quarantine-status and are forbidden to enter the EU. Interceptions made by phytosanitary services when these mangoes are entering the EU led to a direct loss for the owner of the container (Soro, Amao, Adjiri, & Soro, 2019). When it happens too often, an embargo on Ivorian fruits into the EU is a possibility. There are 3 Quarantine-organisms in mango that are not allowed to enter the EU: specific fruit flies, mango stone weevil and a fungus, commonly called 'anthracnose'.

Table 4.6: Exports of mangoes into the EU countries from Côte d'Ivoire in tons

Exports of Mangoes into the EU countries (in tons)				
Country	2017	2016	2015	2014
France	6222	2959	1638	1483
Belgium	6495	4704	4051	5424
UK	4407	7135	2980	1889
Netherlands	10860	13283	11896	10322
Total EU	27984	28081	20565	19118

Little is done with second and third-grade mangoes. The second-grade mangoes are sold at local and regional markets. Opportunities to export second-grade mangoes to Morocco and Algeria should be investigated, possibly together with second-grade banana and pineapple. Moroccan orange exporters bring their first-grade products to Europe but decided, with success, to penetrate the markets of Senegal, Mali, Burkina Faso and also Côte d'Ivoire for second-grade oranges.

Processing: Mango drying is still often done at an artisanal scale with small solar dryers at the village or cooperative level or at a semi-industrial scale. In recent years, new initiatives for mango processing have started producing ultra-frozen chunks, juices and concentrates. Two major exporters investing in processing equipment and training. In this way, they hope to stay in business and keep their trained personnel employed within the company throughout the embargo period.

Table 4.7: SWOT Analysis of the Mango Fruit Sector

Strengths	Weakness
• The climate is perfect for the production of mangoes. • There are larger farms and existing trees with a very high production capacity. • According to professionals, the taste of the West African mango is the best. • Farmers are open-minded to adopting new varieties when market demands it. • Harvest occurs right into a time slot with less other suppliers on the world market. • If all systems work, the shipping time is short so more mature mangoes can be picked without spoiling. This results in a better taste at the destination. • Two factories produce packaging material locally.	• Lack of affordable loans for investment for producers leading to low yields and low quality. • The mango season is very short due to lack of early varieties. Additionally, the problems with fruit flies and anthracnose are limiting the growing season. • The control of pests and diseases is not yet effective, resulting in notifications by the EU phytosanitary authorities at arrival in Europe. • Very little is done with second and third grade mangoes. • Processing of mangoes (dried strips) is done but often still on an artisanal or semi-industrial scale.
Opportunity	Threats
• The use of growth hormones or early varieties (e.g., Tommy Atkins) can increase the season by 1,5 months. • Faster transport means could bring back the better tasting varieties into the market in Europe. • Biological control of the pests and diseases of the crop (especially of the 3 EU Quarantine organisms) should be priority number one, to avoid an embargo for export to the EU. • There is more international demand than supply in the specific months that Côte d'Ivoire is on the market. Local and regional markets are also emerging, providing opportunities for increased export. • Côte d'Ivoire is relatively close to Europe. • There is a lack of cold storage facilities offering opportunities for investors. • The processing of mangoes is still at an artisanal or semi-industrial scale. There is a growing demand for dried mango in the EU and its production pays off.	• The inadequate control of pests and diseases in mango-production, resulting in notifications by the EU phytosanitary authorities might lead to an embargo. • The inadequate logistics in the congested port.

c. Pineapple

The climate in the south of Côte d'Ivoire is very favourable for pineapple growing. It is grown all year around. Even small farmers have good yields and a low amount of second and third grades. The production is close to the port which makes inland transport costs relatively low. Transport for export however is expensive and not reliable. Pineapple exports reached 200,000 tons per year in the year 2000. Production and export dropped dramatically because of the introduction of the MD2 variety in Latin America (Table 4.8). Currently, only 22,000 tons is exported. From importers in Europe, MD2 fruit quality from Costa Rica

is superior to the MD2 from Côte d'Ivoire. This can be attributed to the professionalism of the growers and/or better climatic factors.

Table 4.8: Exports of pineapple into the EU countries from Côte d'Ivoire in tons

Exports of pineapples into EU countries (in tons)				
	2017	2016	2015	2014
France	12747	8474	10784	9635
Belgium	9109	8664	9995	11119
UK	2035	1365	1501	961
Netherlands	3528	2235	1438	736
Total EU	27419	20738	23718	22451

Apart from mango and banana, the pineapple value chain has a juice company in Côte d'Ivoire. In an attempt to diversify, this company has also brought other juices and mixtures onto the market but with little success yet. In a marketing study, especially the packaging was criticized by the respondents. Only one size cans are available which get them only one place on the supermarket's shelves. In recent years, imported juices have had several stands because of different bottle and/or can sizes. A small factory has started in Grand Bassam, processing organic pineapple into fresh-cut pieces, frozen 'carpaccio', 'kebab' and chunks. The product is exported to France. Sustainability is very important to the owners and management: only organic fruits are used. Regeneration of heat and bio-generation of the produced waste materials to generate electricity is part of the factory design. They are also expanding now into coconuts and other fruits for processing.

Table 4.9: SWOT Analysis of Pineapple Fruit Sector

Strengths	Weakness
• The climate in the south is very good for pineapple production. • Year around production is possible. • Producers have adopted the MD2-variety with its cultivation practices. It also seems to be more adapted to climate change. • There are no important pests and diseases. • Production is close to the port. • Prices on the national and regional markets for second and third grades are good. • The activity is profitable for all involved in the value chain.	• Farm gate prices are high compared to other production areas. There is room for negotiation with the farmers. Currently, farmers make some 50% margin (Van den Broek et all, 2016). • Small farmers have left the pineapple cultivation during the political crisis. • Availability of quality planting material is still limited. • Irrigation facilities are poor on small farms. • Cold storage is lacking in the packing stations. • Export is dominated by many smaller, less professional exporters. Their working capital is also often limited. • Airfreight is expensive and is therefore prohibitive for the pineapple export by air.
Opportunity	**Threats**
• Good possibilities for growth on the European market especially with the MD2-variety. • The crop is very profitable when managed by well-trained, commercial farmers. • If producers accept lower sales prices, the organic market could become a more important niche market. • Processing of second and third-grade pineapples into juice, frozen, cut or dried pineapple can be extended, both for the West African market as well as for the export to Europe.	• International competition on the world market on production and logistics efficiency • Climate change forms a challenge. The majority of farms still rely on rainfall only. • Alternative crops like rubber and oil palm are competitive on land use.

d. Papaya

It is difficult to find figures on the papaya export from Côte d'Ivoire, but considerable quantities were shipped in the 80s and 90s of the last century. The main commercial variety is 'Solo Sunrise' developed in Latin America. In 2010, heavy infestations of the Papaya Ring Spot Virus (PRSV) were observed in the main production area around Azaguié. These days, papaya is only produced for the Abidjan market but on a low level. Small quantities are exported to Mali, mainly from the north of Côte d'Ivoire. Until some 8 years ago, the European market only wanted this small 'Solo Sunrise' variety, but lately, there is a movement toward larger papayas in Europe. This opens the way to replace the 'Solo Sunrise', which is very susceptible to this PRSV, with bigger fruited modern hybrids. The latter varieties often produce 10 times more kg per ha, have a better shelf life, good taste and larger fruits.

Table 4.10: SWOT Analysis of Papaya Fruit Sector

Strengths	Weakness
• The climate in Côte d'Ivoire is ideal for papaya. • The growing market for papaya in the EU • Distance to the European market is relatively short. • Strong demand for good-tasting papayas in the urban areas of Côte d'Ivoire itself.	• Still 100% old varieties in use. • Papaya is a fragile fruit which has to be handled with care. • The shelf life of papaya is short, so international transport has to be by air.
Opportunity	**Threats**
• The introduction of new PRSV-resistant or -tolerant hybrids can revitalize the sector. • The international papain market is growing fast. Papain is a natural meat tenderizer. There exist special varieties for papain production.	• Climate change: most papaya is grown rain-fed. With irregular rain patterns, drip irrigation will become necessary making production more expensive. • PRSV is spreading all over the country. Local varieties are highly susceptible.

There was a reduction in demand for exported fruit, leading to a reduction in income for both exporters and producers. Challenges are mainly related to exports to Europe. There are three main areas of concern when it comes to exporting to Europe; (i) contractual difficulties due to travel restrictions, (ii) cash flow difficulties due to the decline in prepayments and the closure of the main French markets (namely, Rungis) during the peak of the COVID-19 pandemic. The pandemic exposed the inherent risks regarding supplying a region. There were staff reductions (for example, in treatment and cooling centres). It is difficult to comply with all measures for combatting COVID-19, such as reducing the number of employees per packaging facility, social distancing and curfew.

4.3 The organizational overview of fruit and vegetable production in Côte d'Ivoire

In Côte d'Ivoire there are many organizations (international, governmental and non-governmental including cooperatives) that stimulate fruit and vegetable production. The most important are mentioned in this chapter with their main activities and fields of intervention in the horticultural sector. Also, cooperative organizations of producers are mentioned.

International organizations

PARFACI *(French Development Cooperation)*
Mainly irrigation activities in rural areas. These irrigated plots can also offer ownership titles which are normally not available in rural areas. The association of farmers organizations ADCVI installs drip irrigation on-demand for individual farmers or groups of farmers to intensify agriculture. Nearly all projects are in the vegetable sector.

FAO
The FAO is also active in Côte d'Ivoire. The representative is in dire need of reliable figures on horticultural production in Côte d'Ivoire. These figures which form the basis of decision-making by governments and companies are either not available or, if available they are, extrapolations of earlier extrapolations. He explains the absence of these figures as being caused by the unrest of the last years and is hopeful that new, reliable figures will be published.
Agricultural programs financed by FAO include:

- HORTIVAR, the CNRA program on Horticulture
- SNDCV (mainly on manioc)

- PND (National Development Program)
- Agricultural production on wetlands

GIZ
This German development organization is active in Côte d'Ivoire on various subjects. It started as a development organization of the German Government. Nowadays, it is also open to collaboration with companies to improve the situation of the local population. Training 'out-grower' farmers is part of their business. In the north (Ferkesedougou) a program to include small mango farmers the Export Value Chain of a large company is ongoing.

IFDC *(International Fertilizer Development Center)*
IFDC originated in the USA as a development organization for fertilizers. Today it executes agricultural development projects all over the world. In Côte d'Ivoire, the organization was absent during the past period of political instability.

Governmental organizations

CNRA *(National Agricultural Research Department)*
Apart from agricultural research, CNRA also develops, produces and commercializes new varieties of vegetables and other crops. This was done in other countries by governmental organizations as well but this activity has been abandoned a long time ago. Modern breeding techniques take huge investments in equipment and laboratories. Governments are rarely willing to make these investments. These activities are now left to the commercial sector instead of being performed by state or parastatal organizations. In the 'Plan Directeur,' these activities are planned to be transferred to the private sector. Useful research on the hydroponics method of growing vegetables by Dr Lassina Fondio are available at the Bouake branch of CNRA.

ANADER
This governmental organization is coordinating activities of donor organizations that aim to develop agricultural production by small farmers. On the horticultural side, ANADER is supporting several ongoing projects.

Non-governmental organizations and cooperatives
In general, cooperatives have been misused in West Africa for political reasons. Mismanagement of funds has further weakened the image of a cooperative in the perception of the farmers. Fruit and vegetable growers are often more individualists. The central pumping installations, canalizations and filtration systems need maintenance daily and renewal at the end of their economic life. Watering schemes have to be respected by the farmers. Without efficient association and management of these irrigated schemes, it can collapse.

Some recently started organizations of producers are;
- 'Interprofession de l'Oignon': An organization where members of the whole Value Chain of onion are represented: producers, input dealers, buyers, retailers, importers etc.
- 'Interprofession de la Mangue': An organization where all actors in the Value Chain of mango are represented. This association was set up recently.
- OBAMCI (Organisation des producteurs-exportateurs de Bananes, d'Ananas, de Mangues et autres fruits de Côte d'Ivoire) : This is a lobbying organization. Only the budget for lobbying at the EU in Brussels is considered to be more a EUR 300.000 annually. The biggest member of OBAMCI (by far) is SCB, market leader in banana production in Côte d'Ivoire. SCB is a company of the multinational.

- OCAB (Organisation Centrale des producteurs exportateurs d'Ananas et Bananes de Côte d'Ivoire). This also a lobbying organization like OBAMCI. The other big banana producer of Côte d'Ivoire, Canavese, is member of OCAB.
- SCOPACI-SCOOPS is a successful organic pineapple export cooperative of small farmers around Bonoua. Pineapple exports from Côte d'Ivoire have been in decline in the last decades. This group of pineapple farmers joined forces with a (Dutch) importer to export certified organic pineapple to The Netherlands. Without the cooperative, this would not have been possible.
- ADCVI (Association pour le Développement des Cultures Vivrières Intensives). This association was started as a Swiss-financed NGO. The main activity is conceiving and constructing irrigation systems for small and medium scale farmers (mainly vegetable producers), and organizing the farmers into a more intensified production system. The association has installed irrigated schemes all over Côte d'Ivoire.

4.4 Research Priority Areas

Adoption of improved seeds

There is an urgent need to adopt new varieties of seeds that are resistant to local diseases and climate. The Ivorian horticultural sector needs better varieties to develop the sector and solve some of its problems. About 90% of the varieties are traditional. These varieties are low-yielding and lack resistance to pests and diseases. They are mostly Open Pollinated Varieties (OPV) which the farmers grow often from self-saved seeds. These varieties have low potential and prevent farmers from obtaining good income even when weeding, fertilizing, and watering is done. Hybrid varieties are rarely found in Côte d'Ivoire.

Adoption of irrigation

Less than 1% of the land in Côte d'Ivoire is irrigated which tremendously affects the productivity of fruits and vegetable productions. There is a need for irrigation and drainage to cope with climate change.

Increase use of greenhouse and netting

Greenhouse structures and netting material might become an interesting market for smallholder farmers in fruits and vegetable production. Small net houses are very useful as nurseries because the plants are already infected by viruses at a young stage, so there is little chance for a good yield. However, when plants are attacked at an older age there still is yield reduction, though much less than when attacked early. In Senegal, a lot of farmers, including small ones have a 'net house nursery'. Plastic-covered greenhouses have been tried a lot (all over West Africa) but are seldom successful. It may be possible to adapt these greenhouse structures to provide shadow or insect netting.

Greenhouse structures and netting material might become an interesting market but now will still be small because of the high investment costs involved. When intensification increases, these innovative techniques will come within reach of a larger number of farmers. The adoption of greenhouse and netting is constrained by limitations in scale and the cost.

Improved access to credit

Small farmers have no access to credit facilities to invest in their farms. Financial institutions do not accept land as collateral. This has to do with the non-transparent land tenure system in rural areas, and as a result, production for the local and export markets suffer. The use of credit guarantee could be a useful instrument to leverage much financing to the sector.

Adoption of post-harvest technologies and packing material

After harvest, produce has to be collected and transported to the urban areas. They are packaged in bags or wooden boxes, resulting in high losses and quality reduction. Provision of better, smaller boxes and other packing material to maintain the quality of the products could help reduce losses.

Cooling and storage

With the extra efforts of the government improving road transport, the need is higher for more and better packaging and cooling equipments. However, as we see in other emerging countries, some extra cooling at wholesale markets in urban centers could be profitable. In Abidjan, this is not yet a reality, but developments might go fast with the current spirit of rebuilding the nation.

Processing

In most West African countries, development agencies and governments have tried to start up tomato paste factories. Except for Senegal, where the conditions are positive for this industrial tomato crop, it has failed nearly everywhere.

Functioning markets

A non-functional market can make the financial result of a nice crop turn to nothing. Direct links between farmers and supermarket suppliers might lead to a win-win situation. The quality of the product and a reliable supply chain will be an advantage for the supermarkets while a guaranteed sale of products against fixed prices is advantageous to the farmers. Marketing strategies will help to make sales a success.

Logistics

The Ivorian government is very active in building roads and bridges. The new highway between Abidjan and Yamoussoukro (at the moment extended to Bouake) is a very positive contribution to the vegetable sector. Products can be transported on longer stretches at lower prices.

Intensification of the production system

The need for high production levels on small fields becomes evident to keep down investment costs per unit of product. This brings us to the main theme of improving this sector, which is intensification. The development of intensive farming will give much more profitability. Weed suppression becomes expensive and crop protection becomes difficult. Investments in irrigation and drainage systems have become very expensive on large fields with low yields. Some research and practical improvements have already been tried out in Côte d'Ivoire to intensify the production system.

THE GAMBIA

5.1 Introduction

Agriculture is the most important sector in the Gambian economy, accounting for roughly 20 percent of GDP in 2017 (International Trade Administration (ITA), 2020). Agriculture accounts for approximately one-quarter of GDP and employs 75 percent of the labour force (Fatty, Ode, & Ogbe, 2017). Horticulture has long been recognized as a means of diversifying the production and export base of the Gambian economy and improving self-sufficiency and improving the food security situation of the country. The sub-sector makes up 65% of the agricultural labour force in the Gambia (FAO, 2021). The sub-sector contributed 4% of the country's GDP in 2009 (Sanyang, Kao, & Huang, 2009). Since 2000, fruit and vegetable output has been continuously growing (Figure 5.1). Fruit production increased from 5,866 tonnes to 9,503 tonnes between 2000 and 2020. Vegetable production also increased from 9,000 tonnes in 2000 to 12,828 tonnes in 2020. Fruit production has however remained lower than vegetable production.

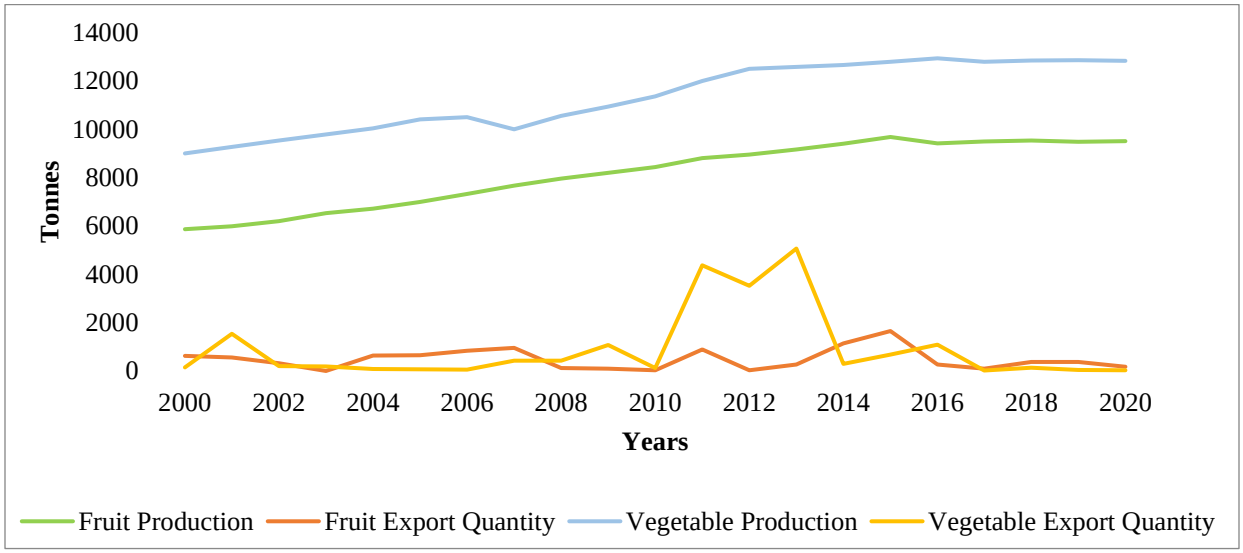


Figure 5.1: Production and export of fruit and vegetable production in The Gambia
Source: FAO (2022)

Furthermore, the country's annual fruit and vegetable exports have averaged less than 1000 tonnes. Fruit and vegetable exports have been fluctuating during the last two decades. Vegetable exports increased exponentially in 2011 and 2013 but then fell drastically in 2014 and subsequent years.

The Gambia's proximity to Europe (approximately 6 hours flight to the UK) and its ability to produce during the off-season winter months when demand and prices for fresh produce are relatively high in Europe holds promise for the country. Horticulture production is concentrated in the West Coast region of the country (Fatty et al., 2017). The West Coast region has a favourable climate for horticulture production. Production in this region is based on community gardens organized and managed by smallholder farmers and women's groups. Smallholder horticulture offers considerable potential to increase women's income-earning capabilities, promote food security, alleviate poverty, generate employment and diversify export markets. In the Gambia, the horticulture sector primarily consists of fruits and vegetables. Production is largely confined to the dry season when plant growth can only be sustained through reliable irrigation. For the most part, gardens depend for their water on relatively shallow, hand-dug wells, and therefore sites are located in low-lying areas where the water table is near the surface and borehole drill with reservoir displayed in all four corners of the garden. ,Chicken wire attached on metal poles and stock-proof fencing is another essential for successful crop production in the country. The women gardeners have become skilled in growing horticultural crops but post-harvest handling, distribution, and marketing activities are less well

developed. Produce that is surplus to domestic needs finds an outlet through tourist hotels and local markets, but gluts frequently occur and attempts are being made to overcome this problem. One approach has been to stagger production by advancing planting dates, although this has often proved difficult as women are not usually available to start work on their gardens until the completion of the rice harvest. A spread in production could also be achieved by planting a suitable range of early and late cultivars, but this depends heavily on a timely supply of high-quality seeds. Overall, the gardens make a useful contribution to the country's economy and the health of its people and represent an important focus for development (Fatty et al., 2017).

5.2 Geography and Markets

Fruit and vegetable production covers a small land area in The Gambia. Consequently, individual farmers' and community farms' average fruit and vegetable farm sizes are 1 hectare and 5 hectares, respectively. The area dedicated to vegetable cultivation is greater than that dedicated to fruit production. However, the area under fruit and vegetable production is increasing gradually both for domestic consumption and export (Fatty et al., 2017).

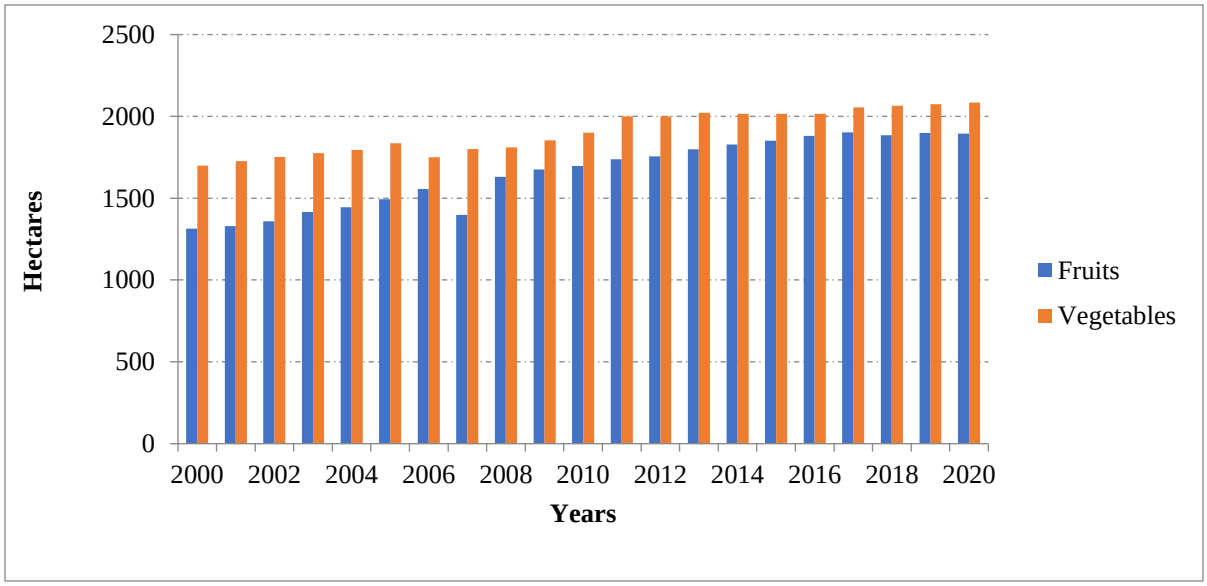


Figure 5.2: Area under fruit and vegetable production in The Gambia
Source: FAO (2022)

Between 2000 and 2020, the area under fruit production increased from 1,314 hectares to 1,895 hectares, while the area under vegetable production increased from 1,700 hectares to 2,085 hectares (Figure 5.2).

It is estimated that 23% of the total arable land in the Gambia, which is about 117,329 hectares is suitable for horticulture, however only 3,519.9 ha (i.e. less than 3% is currently under production). The Gambia is divided into seven agricultural regions namely, West Coast Region (WCR), North Bank Region (NBR), Central River Region North (CRR/N), Central River Region South (CRR/S), Lower River Region (LRR), Upper River Region (URR), and URBAN agriculture.

West Coast Region is the region that plays a major role in horticultural production and trade. The region is the largest and most populated. According to the Gambia Bureau of Statistics (2013), it has a population of 699,704 people and a total land size of 1764 SQ KM. Mean temperatures range between 21^0-30^OC (Department of water resources, 2012). Rainfall is seasonal. It has a minimum temperature of 14.3^0C

recorded in January and a maximum temperature of 41.7^{0}C and April is usually the hottest month (Department of Water Resources, 2012).

Women dominate the production of vegetables (Fatty et al., 2017). The soil type of the region is sandy loamy. Major sources of water for vegetable production in the region are rivers, wells, and boreholes. The main socio-economic activities of the region include crops and livestock production with vegetable production largely dominant. The region holds the largest commercial fishing activities and serves as a business center for both agricultural and non-agricultural products.

The sector is favoured by reasonably good growing conditions and contributes highly to the economy of the country. If the potential of the river Gambia is tapped, this would allow for the spread of horticultural production throughout the year and in all parts of the country. Improved marketing opportunities are required to spur production. The Serekunda market in KMC, Divisional Administrative Headquarters Brikama, Farafenni, and Basse market are where the majority of the vegetable farmers sell their products at wholesale price to retailers who in turn sell them to consumers within the various regions and municipalities. The pricing of the vegetable products depends on the availability of the products in the various markets' when vegetables are scarce prices soar and when a glut occurs, the prices drop.

5.3 Biophysical

Input Supply: Fertilizer and Improved Seed

Limited agricultural inputs such as fertilizers, pesticides, improved seedlings, and insecticides are a major challenge to the productivity of the sector. Both organic and inorganic fertilizer is available in the market for farmers. Nationally, about 47% of small-scale farmers use fertilizer in the Gambia. Only 13% of farmers use pesticides while 21% have access to irrigation. The supply of input is mainly done by the private sector.

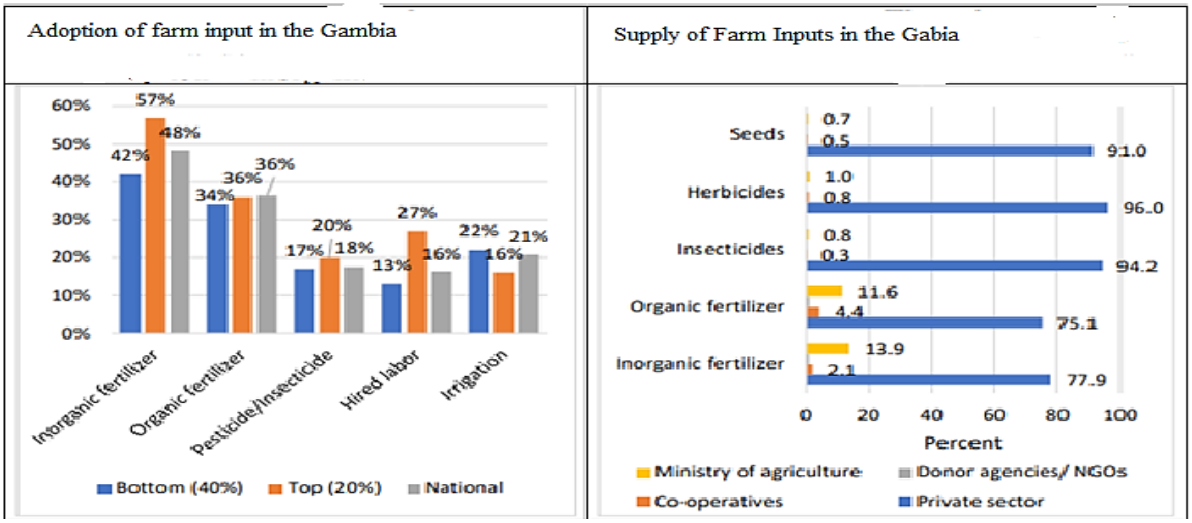


Figure 5.3 Adoption and Supply of Farm Inputs in the Gambia
Source: World Bank, 2019

Production and Productivity of Horticulture Crops

The Gambia is not self-sufficient in fruit and vegetable production. Throughout the country, mango and onions are the most predominant horticultural crops grown by farmers. Mango production has increased in the last three decades. The area under mango production and yield of mangoes have also increased.

However, the area under mango production witnessed the highest growth from 1991 to 2000, then from 2001 to 2010, and from 2011 to 2020.

Table 5.1: Production and Productivity of Mangoes in The Gambia

Year	Area (ha)	Yield (tonnes/ha)	Production (tonnes)	The growth rate of Area	The growth rate of Yield	The growth rate of Production
1991-2000	114.4	4.7	536.0	22.2%	-10.0%	24.0%
2001-2010	177.0	4.9	876.6	5.6%	1.6%	7.2%
2011-2020	253.9	5.4	1380.8	1.8%	0.0%	1.7%

Source: FAO, 2022

Fruits and Vegetable Producer associations like National Women Farmers Association (NAWFA) can serve as an important center that provides a guaranteed and fair price market for the women's produce and takes the risk off the women producers. It can also purchase inputs in wholesale quantities thus bringing down the cost of inputs which can enhance women's access to inputs. The association is also better positioned than individual growers to negotiate credit arrangements with development banks and other credit institutions. Projects also support their interventions sites with inputs and the non-intervention areas purchase their inputs from the inputs dealers within the country. Small scale farmers who cannot afford to purchase their inputs from the right source (dealer) visit the weekly market and purchase from retailers. These dealers usually re-package the vegetable seeds in smaller plastic bags and that can reduce the viability of the seeds and cause poor germination rates.

Improved Varieties

The Gambia has numerous varieties of fruits and vegetables. Table 5.2 below shows the improved varieties of major fruits and vegetables.

Table 5.2: Improved Fruit and Vegetable Varieties in Gambia

Crop	Variety
Onions	1. Texas Grano, 2. Red creole 3. Violet de galmy 4. Red Bombay
Tomatoes	1. Moneymaker 2. Roma 3. Tropics 4. Manmade 5. xina 6. Mongal 7. Nadira

Indigenous and Neglected Species

Indigenous and underutilized crops include fruits and vegetables with high nutritional, economic and market value which include, beetroots, radish, carrot, and Irish potato.

Postharvest Management Practices

Postharvest management of fresh products includes; sorting, grading, cooling, and cleaning (washing). Some losses occur during handling at the farm gate and final destination at the market, with the majority of the post-harvest losses occurring during storage. There are no standard storage facilities for fresh products which lead to a lot of losses or selling the products at giveaway prices and there are no standard vehicles for transporting harvested produce from farm gate to the final destination (market).

Processing and Packaging of Fruits and Vegetables

Processing and packaging are done locally in the Gambia by using locally available materials. For packaging vegetables, farmers normally used locally made bamboo baskets and plastic containers, and for processing, processors use cooking pots, blenders, wooden spoons etc.

5.4 Natural Resources

Physical Resource: Climate and Soils

Fruit and vegetable production is dependent on natural processes and resources, including rainfall and soils. Fruit and vegetable production is largely rain-fed and suffers the brunt of climate change. Farmers do not have access to irrigation systems but depend on waterlogged areas to produce vegetables. Soils in The Gambia are generally infertile. Farmers rely on crop residue or animal waste to increase soil fertility. Farmers adopt the following climate-smart varieties and practices to increase productivity:

- Heat tolerant varieties, Flood tolerant plant varieties, fast-maturing varieties, etc.
- Intercropping, crop diversity, container gardening, micro gardening, rainwater harvesting, efficient irrigation, mulching, composting, water management, shade house, and boundary trees.

Human resource: Women in horticulture

The Gambia is dominated by women. Women occupy a good stand in the country's horticulture. Women constitute over 60% of the workforce in the horticultural sub-sector (Fatty et al., 2017). Women are largely involved in production and marketing activities. Youth participation in horticulture is minimal (Fatty et al., 2017). Presently, youth are venturing into horticultural production but in the form of individual gardens.

Market and consumption

Demand for fruits and vegetables are very high in the Gambia, yet farmers are unable to meet this demand. Scarcity does occur and the motive behind it is that vegetable farmers are not active during the rainy season.

Market access for horticultural products is an issue, as fruits and vegetables are perishable. Farmers need to have a ready market or standard cool stores for storage of the harvested products which is inadequate in the Gambia.

Value-added horticulture products are done through the processing of fruits and vegetables into finished products and that will help to increase the shelf-life of the products and the market prices as well.

Agribusiness Opportunities in The Gambia are through cooperatives, farmer groups come together and form cooperatives. The different groups contribute (depending on what they agreed based on agreed rates either monthly, quarterly, or yearly). The money generated is used to purchase inputs and resell the inputs among members at a cheaper price or give it out to members on credit payable after harvest. Cooperatives help members to sell their products in bulk.

Horticultural farmers use available local materials for packaging such as bamboo baskets, plastic containers, and recycled bags to package their harvested products. The cooling process is conducted either in the garden or at home before packaging, cooling immediately after harvest will remove the heat. Storage is done at home using locally available stores which are not up to standard for storing fruits and vegetables and that leads to a lot of losses. Processing of horticultural products in the Gambia is done on a small-scale, hence there are no processing plants for farmers to process on large scale. They use the available local materials to process on small scale.

5.5 Trade and Standards

The Gambia exports few vegetables. The volume of export of fruits and vegetables is small. According to FAO data, mangoes are the dominant export product, followed by tomatoes, chilies, and onions.

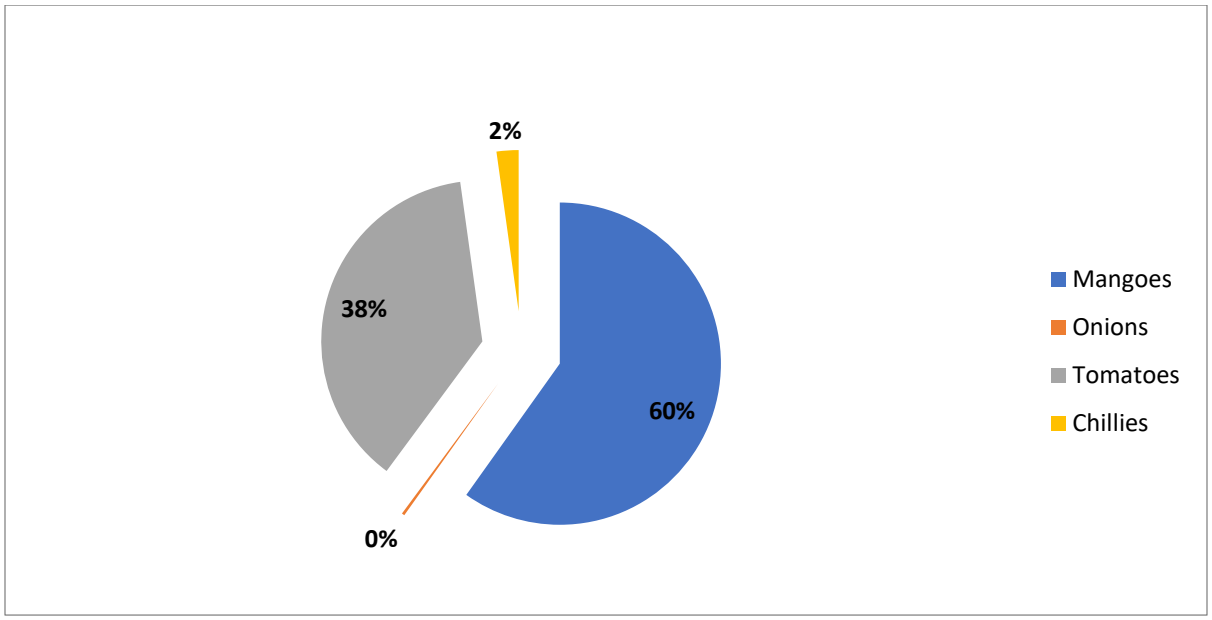


Figure 5.4: Percentage Fruit and Vegetable Exported from The Gambia

Source: FAO, 2020

Inputs such as fertilizers, seeds, pesticides, and fungicides are key to enhanced productivity. In the Gambia, there are four categories of inputs suppliers for horticulture, namely:

- Commercial suppliers such as GHE: One-stop shop for all agricultural inputs for farmers (seeds, farming implements, garden equipment, milling machines, irrigation equipment, fencing materials);
- Small scale suppliers in urban centers, vegetable seeds (tomato, cabbage, onion, cucumber, etc.); fertilizers (N.P.K & Urea); chemicals (pesticides, fungicides, nematicides, insecticides, herbicides, etc.), and garden equipment (watering can, spade, hand fork, knapsack sprayer etc.);
- Village shops: often stock a limited range of pesticides and other garden materials; and

- Loumos: weekly markets in various locations throughout the country and neighbouring regions in Senegal where farmers can also access inputs.

There are 480 communal gardens country-wide –Table 5.3 for distribution. They are mostly sponsored by government and development partners through projects such as FASDEP, NEMA/CHOSSO, GCAV, FAO, LHDP, GALDEP, RED CROSS, United Purpose, etc. It is important to stress that horticulture is often only one component of these projects, and there is as yet no major project entirely dedicated to the horticulture sector. As reported in the national horticulture master plan.
Membership in these groups ranges between 100 and 300 persons, with each allocated an average of twenty or more beds. They benefit from government or donor support that takes the form of technical advice, training, grants of seeds and fertilizer, fencing material, concrete-lined wells, or boreholes.

Table 5.3: Distribution of Communal Garden Schemes[2]

Region	Total Number of Communal Garden Schemes	Area (Ha)	Membership		
			Male	Female	Total
West Coast	116	508.9	353	13,550	13,903
North Bank	84	114.9	1043	14,537	15,580
Lower River	82	112.4	592	11,963	12,555
Central River/South	38	25	231	3,610	3,841
Central River/North	48	52.5	242	3,658	3,900
Upper River	86	54.4	277	9,337	9,614
Total	454	868.2	2738	56,655	59,393

Commercial Farms

These are medium-sized to large farms, with farm sizes between 40 to over 100ha. Although only a limited number of enterprises are under this category - Radville Farms, GHE, Kharafi, Kura's Garden, they are responsible for supplying over 90% of total horticultural exports. Vegetable crops grown include Hot pepper (Chilies); Green French beans, Okra, Baby corn, Squash; Butternut, and Eggplant.
Typically, they employ capital-intensive means of production with modern farming tools, machinery, and equipment as the farm sizes are relatively large and have sprinkler or drip irrigation systems. These farms are distinguished by the following features[3]:

- They are often vertically integrated with their customers and are close to the market, react to market demand, and can organize production accordingly.
- Have a high level of professionalism in production by the mastering of the agronomy and post-harvest handling of all crops of interest
- Outsource from smaller growers through contract farming for export purposes
- Make substantial investment and fund further developments
- Have good leadership and business management skills.

Small Scale Horticulture Producers' Organizations

With the support of partners, communal garden producers have organized themselves into six marketing federations (one in each agricultural region) and an apex body:

i. Fangsoto (West Coast Region)
ii. Khewal (Central River Region – North)
iii. Nematulai (Upper River Region)
iv. Sofaniama (Lower River Region)
v. Fangkaso (Central River Region – South)
vi. Solicita (North Bank Region)
vii. Sosolaso (National Apex Body)

These federations can potentially play many useful roles such as:

i. Generally representing the voice of horticulture farmers in policy circles;
ii. Assisting farmers to collectively bargain to purchase critical inputs such as fertilizers, pesticides, seeds, etc, and collectively market their produce;
iii. Conducting training, especially on good agronomic practices, and business development;
iv. Advocating to improve access to finance; and
v. Linking producers with exporters and other buyers.

These organizations can also be building blocks for the setting of agriculture cluster models as a way to modernize and catalyze production.

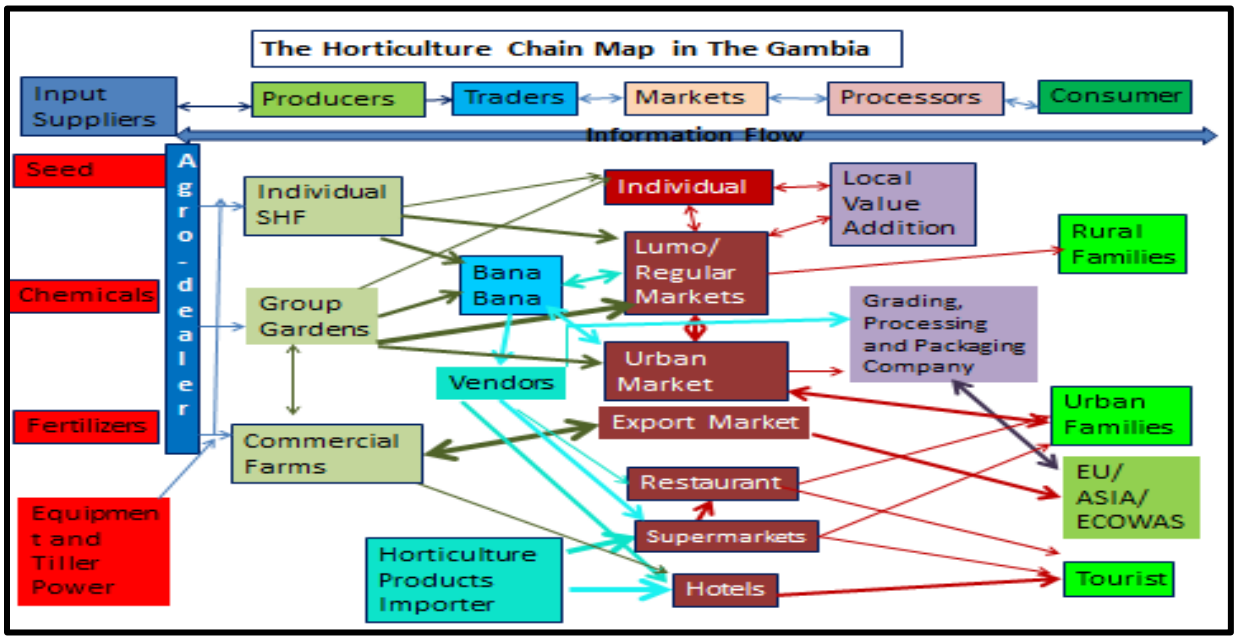


Figure 5.5: The inter-linkages between the various actors and processes

MALI

6.1 Introduction

In Mali, cereals such as millet, sorghum, corn, and rice constitute the staple food. However, for more than a decade, horticultural crops have become one of the spearheads of the policy of diversifying income sources for farmers and the country. Horticulture occupies an important portion of farmers' income, ranging between 21.6% and 35.9% (INSTAT, 2020). The government has demonstrated interest in horticultural crops since the unprecedented drought. The development of the horticultural sector can improve the food security of the population because of their nutritional quality. Food security remains a positive impact of fruit and vegetable crops in the diet and nutrition of urban and rural populations. Fruit and vegetable consumption in Bamako has increased from 15 to 70 kg/inhabitant/year and 20 to 97 kg/inhabitant/year between 2000 and 2020 (FAO, 2020). Horticultural production, especially market gardening, is a remunerative activity undertaken largely by women. Women are present at all points of the horticulture value chain. Horticulture remains a significant source of income for women, who invest in the education and health of their families (Diakité, Dramé, & Sidibé, 2014).

The horticultural sector is dominated by informal activities. Horticultural production is geographically dispersed across Sikasso, Koulikoro, Mopti, Ségou, Kayes, and Bamako (Diakité et al., 2014). Mali's horticultural products are mainly fruit trees, vegetables/leaves, vegetables/fruits, bulbs, and tuber vegetables (CPS/SDR, 2019).

Mali is one of the largest producers of fruits and vegetables in West Africa. Fruit and vegetable production in the country has seen tremendous growth over the last three decades. Between 1990 and 2000, fruit production increased from 351,008 tonnes to 534,481 tonnes. In 2020, fruit production was 2,350,297 tonnes, which is an increment of more than 300%, when compared to what was achieved in 2000.

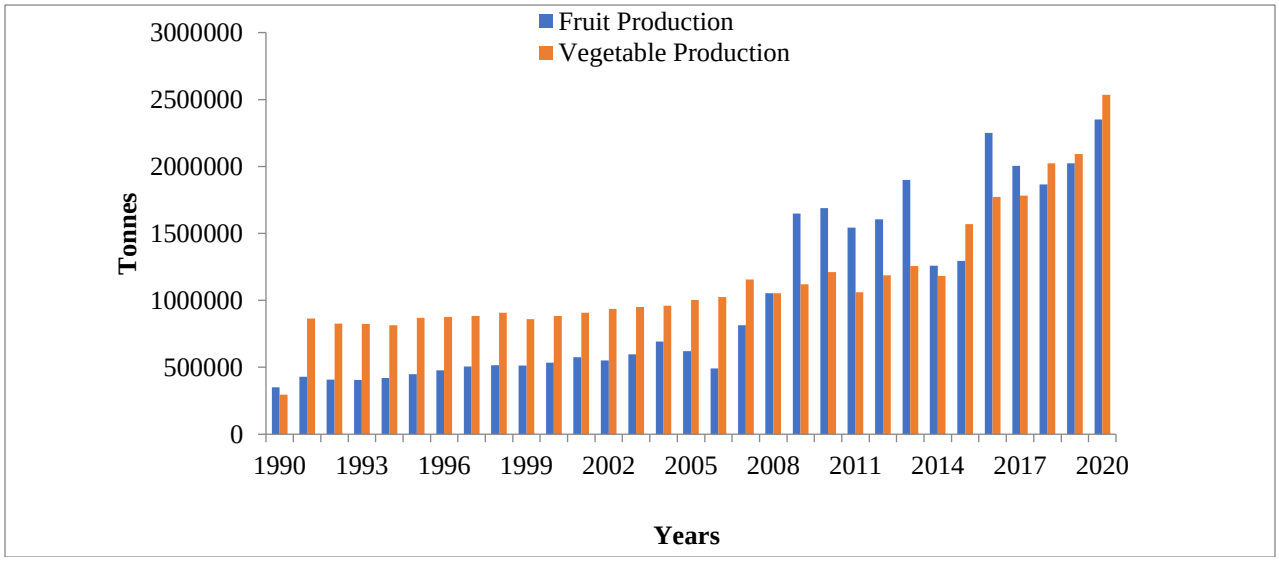


Figure 6.1: Fruit and vegetable production in Mali (1990-2020)
Source: FAO (2020)

Vegetable production increased more than fruit production (Figure 6.1). Production increased from 296,290 tonnes in 1990 to 2,535,287 tonnes in 2020. However, major fluctuations persist. Vegetable production declined in 2008, 2011, and 2014. Production has increased steadily since 2015.

Export of vegetables has been relatively stable. However, vegetable export increased significantly in 2017. Just like vegetables, fruit export increased drastically to 21, 060 tonnes in 2012, but fell to 8,034 tonnes in 2013. This trend was also observed in 2014-2015, 2017-2018, and 2019-2020.

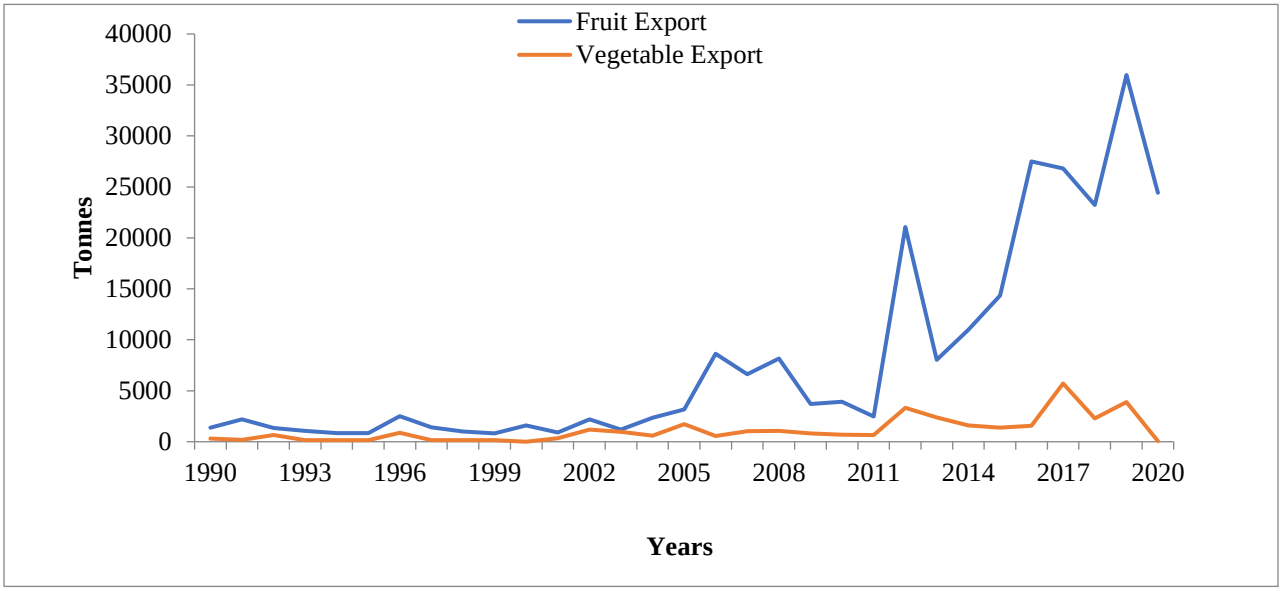


Figure 6.2: Fruit and vegetable Export in Mali (1990-2020)
Source: FAO (2020)

Mali's horticultural products are intended for local, sub-regional (UEMOA countries), and European Union (EU) markets (Key informant survey, 2022). According to Diakité et al. (2014), the analysis of exports of Malian horticultural products in the WAEMU countries reveals that (i) before the crises (financial and food), most of the trade-in products takes place within the community area (78% in 2007); (ii) exports fell in 2008 (-63.2%) and 2009 (41.2%) before growing again in 2010 (63.2%). This can be explained by the combined effects of the financial and food crises observed during this period; (iii) despite the crises, trade-in horticultural products represent half, if not more, of all agricultural product exports in WAEMU; (iv) the challenges to be met by Mali to exploit these sub-regional niches are: a better knowledge of the characteristics of these markets and the creation of efficient distribution mechanisms. New EU regulations, Brazilian competition, and the proliferation of private standards limit access to EU markets for horticultural products from Mali. The problems of reciprocity also constitute a challenge to the export of horticultural products from Mali.
In general, there is a problem with the organization and management of horticultural sub-sectors in Mali, limiting their access to short- and medium-term financing. Specifically, there are constraints at all the stages of the horticulture value chains in Mali. Production techniques are obsolete and unsustainable (Key informant survey, 2022).

6.2 Landscape challenges and opportunities

Horticulture – Biophysical

Inputs (including seed supply)
Horticultural crop producers source their inputs (fertilizer, seed, and agrochemicals) on the market or use self-supply seeds and fertilizers (organic fertilizers). Through programs and projects, farmers can benefit from small subsidies to produce horticultural products. However, there are no subsidies for the horticultural sector.

Production

The horticultural sector in Mali is mainly dominated by the following sub-sectors: fruit trees, vegetables/leaves, vegetables/fruits, and bulb and tuber vegetables(CPS/SDR, 2019). For the sub-sector of fruit trees, the production of mango occupies the first place (754892 MT) followed by that of orange, banana, and cashew with 487794 MT, 191228 MT, and 119,761 MT, respectively (Table 6.1). However, the region of Sikasso occupies the first place in terms of production (74.8%) followed by the region of Koulikoro, the district of Bamako, and the region of Segou with 11.54%, 7.67%, and 3.54% respectively.

Table 6.1: Production of fruit trees by region

Products		Kayes	Koulikoro	Sikasso	Segou	Mopti	Tombouctou	Goa	Kidal	Bamako	Total
Cashew	Production (mt)	213	25384	93695	469	0	0	0	0	0	119761
Orange tree	Production (mt)	3167	14524	463462	5008	2	69	0	0	1562	487794
Mandarin	Production (mt)	1305	3638	6002	1027	0	14	0	0	1200	13186
Lemon	Production (mt)	1762	4797	25342	2895	460	144	33	0	98	35531
Grapefruit	Production (mt)	5	278	533	153	0	0	0	0	0	969
Mango	Production (mt)	8597	71385	527716	22240	9210	244	0	0	115500	754892
Papaya	Production (mt)	1919	15767	25563	18720	2088	18	0	0	3816	67891
Guava	Production (mt)	780	2545	2796	1608	6900	15	0	0	280	14924
Banana tree	Production (mt)	2357	55099	118208	6790	1769	5	0	0	7000	191228
Grafted jujube	Production (mt)	0	820	0	225	30	0	0	0	0	1075
Date palm	Production (mt)	0	0	0	620	30	2	0	6	0	658
Apple Cinnamon	Production (mt)	215	653	27	88	0	0	0	0	128	1111
Total Production (mt)		20320	194890	1263344	59843	20489	511	33	6	129584	1689020
Percentage Production (%)		1.2	11.54	74.8	3.54	1.2	0.03	0.002	0.0004	7.67	100

Source: Author calculation from CPS/CDR data

For the vegetables/leaves sub-sector, cabbage production ranks first (69,072 MT), followed by lettuce, and cowpea leaves 64,395 MT, and cowpea leaf 6,722 MT, respectively (Table 6.2). However, the district of Bamako ranks first in terms of production (31.44%) followed by the region of Sikasso, the region of Koulikoro, and the region of Segou with 25.13%, 21.67%, and 7.88%, respectively.

Table 6.2: Production and yield of vegetables/leaves by region

Products		Kayes	Koulikoro	Sikasso	Segou	Mopti	Tombouctou	Goa	Kidal	Bamako	Total
Lettuce	Production (mt)	1509 (10480)	11505 (8960)	5277 (5555)	5739 (14593)	5407 (12782)	1547 (11050)	881 (9904)	180 (15000)	32350 (16015)	64395 (11804)
Cabbage	Production (mt)	3691 (17011)	17800 (15936)	29636 (18171)	5254 (18698)	2986 (15635)	504 (14410)	580 (10733)	200 (20000)	8420 (29034)	69072 (18053)
Parsley	Production (mt)	104 (7990)	1271 (5450)	61 (2329)	46.8 (18700)	5.3 (10568)	0 (0)	0 (0)	2 (2000)	201 (8040)	1691 (5612)
Cowpea leaf	Production (mt)	2208 (6835)	214 (3057)	576 (4202)	248 (8267)	29 (699)	30 (4250)	0 (0)	8 (8000)	3410 (11000)	6722 (7307)
Potato leaf	Production (mt)	0 (0)	259 (2698)	451 (5858)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	660 (13200)	1370 (6144)
Total Production (mt)		7512	31049	36001	11288	8427	2081	1461	390	45041	143250
Percentage Production (%)		5.24	21.67	25.13	7.88	5.88	1.45	1.02	0.27	31.44	100

NB: () represents the Yield measured kg/ha
Source: Author calculation from CPS/CDR data

For the vegetables/fruits sub-sector, the production of Okra occupies the first place (254545 MT), followed by Tomato, Eggplant, and squash 175577 MT, 96943 MT, and 67 921 MT, respectively (Table 6.3). However, the Koulikoro region ranks first in terms of production (48.84%) followed by the Sikasso region, the Segou region, and the Kayes region with 27.24%, 12.26%, and 4.15% respectively.

Table 6.3: Production and yield of vegetables/fruits by region

Products		Kayes	Koulikoro	Sikasso	Segou	Mopti	Tombouctou	Goa	Kidal	Bamako	Total
Squash	Production (mt)	5242 (9496)	21972 (15695)	19314 (18625)	16122 (16203)	891 (17479)	630 (14000)	119 (6635)	0 (0)	3630 (22975)	67921 (15959)
Green bean	Production (mt)	0 (0)	262 (5574)	719 (5789)	371 (8433)	0 (0)	70 (5000)	0 (0)	0 (0)	475 (9500)	1897 (6794)
Melon	Production (mt)	7053 (29760)	9926 (10639)	8898 (13380)	13085 (22599)	2461 (12494)	185 (10250)	207 (9202)	0 (0)	5556 (17363)	47371 (15942)
Eggplant	Production (mt)	3910 (11637)	22834 (14017)	52811 (28953)	5742 (12760)	8166 (17448)	117 (11720)	490 (10000)	0 (0)	2874 (21605)	96943 (19788)
Jaxatu	Production (mt)	949 (14598)	17830 (11943)	8103 (15464)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	26882 (12912)
Tomato	Production (mt)	6191 (11380)	53784 (15451)	48467 (14268)	49520 (22550)	10671 (20760)	2794 (15350)	698 (12243)	252 (18000)	3200 (19162)	175577 (16639
Pepper	Production (mt)	842 (8000)	5637 (11382)	4664 (13065)	344 (10104)	0 (0)	32 (8000)	114 (7500)	0 (0)	495 (16500)	12128 (11653)
Okra	Production (mt)	8497 (7635)	98030 (11578)	93313 (11635)	32996 (12990)	9533 (5928)	8186 (11812)	221 (3803)	80 (5000)	3690 (11903)	254545 (11152)
Pepper	Production (mt)	482 (4189)	2999 (3447)	14092 (2742)	9812 (5610)	1766 (3463)	42 (5250)	44 (3167)	0 (0)	299 (9328)	29536 (3501)
Cucumber	Production (mt)	2690 (8706)	30909 (15562)	20933 (15224)	7712 (14550	2344 (14744)	469 (10668)	193 (8283)	56 (7000)	3576 (28381)	68882 (15104)
Watermelon	Production (mt)	10276 (26830)	278483 (24237)	31349 (18205)	477 (25107)	6918 (10627)	931 (19000)	237 (11167)	0 (0)	722 (27500)	329413 (22934)
Total Production (mt)		46132	542666	302663	136181	42750	13456	2323	388	24517	1111076
Percentage Production (%)		4.15	48.84	27.24	12.26	3.85	1.21	0.21	0.03	2.21	100

NB: () represents the Yield measured kg/ha
Source: Author calculation from CPS/CDR data

For the vegetables/bulbs and tubers/roots sub-sector, the production of Shallot occupies the first place (401,285 MT) followed by the potato, Onion, and Carrot 251,558 MT, 111,385 MT, and 15,790 MT, respectively (Table 6.4). However, the region of Ségou occupies the first place in terms of production (39.71%) followed by the region of Koulikoro, the region of Sikasso, and the region of Mopti with 21.37%, 18.11%, and 10.43% respectively.

Table 6.4: Production and yield of bulbs and roots/tubers vegetables by region

Produits		Régions									Total
		Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Goa	Kidal	Bamako	
Pomme de terre	Production (mt)	759 (14588)	91866 (20111)	106329 (19930)	40631 (32847)	3560 (20000)	3420 (20000)	4698 (23609)	0 (0)	295 (29500)	251558 (21409)
Carotte	Production (mt)	167 (7275)	3257 (9840)	1763 (16177)	1100 (12083)	861 (10125)	100 (11090)	239 (9207)	0 (0)	8303 (25546)	15790 (15805)
Betterave	Production (mt)	257 (1190)	1595 (13749)	864 (13190)	269 (10596)	526 (11442)	134 (11200)	363 (11346)	0 (0)	2640 (17600)	6649 (14150)
Navet	Production (mt)	0 (0)	38 (1924)	114 (8127)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1428 (21962)	1580 (15938)
Oignon	Production (mt)	2921 (12020)	40059 (17609)	14299 (19642)	10856 (24956)	3851 (20057)	26263 (17370)	10706 (21939)	0 (0)	2428 (22391)	111385 (18622)
Echalote	Production (mt)	2601 (15124)	34056 (14859)	21201 (18812)	257361 (28105)	70697 (30778)	14395 (16192)	684 (10529)	0 (0)	290 (19300)	401285 (25058)
Ail	Production (mt)	0 (0)	393 (4471)	544 (12952)	8079 (17756)	4099 (13754)	0 (0)	0 (0)	0 (0)	84 (7000)	13199 (14748)
Total Production (mt)		6705	171264	145114	318296	83594	44312	16690	0	15468	801443
Percentage Production (%)		0.84	21.37	18.11	39.71	10.43	5.53	2.08	0	1.93	100

Postharvest management of fresh products

With regard to the phytosanitary requirements for the marketing (local and export) of agro-food products, particularly horticultural products, the survey reveals that there are a certain number of services (public and private) involved: Central Veterinary Laboratory (LCV), National Health Laboratory (LNS), National Food Safety Agency (ANSSA), Malian Agency for Standardization and Quality Promotion (AMANORM), and PROSLABS.

Central Veterinary Laboratory (LCV) is involved in phytosanitary requirements through the Toxicology, Control and Environmental Quality Laboratory (LTCQE) which is equipped and adapted for the analysis of pesticide residues in water, soil, fruits and vegetables, and other foodstuffs. It analyzes fruits and vegetables for national exporters.

National Health Laboratory (LNS) was created to preserve the well-being of the population. The LNS's mission is to control the quality of food, drugs, and drinks. The LNS is responsible for taking and analyzing samples in any unit producing, importing, distributing, or storing food products (Mali, 2017).

The National Food Safety Agency (ANSSA) is responsible for ensuring food safety. As such, it is responsible for: coordinating all actions related to food safety; providing technical and scientific support to control structures; providing the technical and scientific support necessary for the development of food safety regulations; assessing the health risks that food intended for humans and animals may present; water intended for human and animal consumption; the processes and conditions for the production, processing, preservation, transport, storage and distribution of foodstuffs; food additives; residues of veterinary and phytosanitary products and other contaminants; residues of fertilizing materials and crop supports; the

packaging and materials intended to be in contact with the elements mentioned above; support the activities of surveillance systems and epidemiological networks; ensure risk communication.
Agence Malienne de Normalisation et de Promotion de la Qualité (AMANORM) is the national standards body of Mali. AMANORM coordinates and carries out work, studies, and research related to standards, promotion of quality, certification, and accreditation. Its main functions are: assist companies with production and product certification; provide assistance to laboratories, inspection and certification bodies with accreditation; manage and distribute documentation on standardization and quality promotion; provide information, assistance, and advice to companies and laboratories on standardization, quality assurance, management quality, and quality tools, certification and accreditation; training and development related to standards, promotion of quality, certification and accreditation; creation and management of the national logo of conformity to standards. AMANORM is a member of ISO, ECOSHAM (program for harmonization of standards of ECOWAS[4]), ECOQUAL (quality policy of ECOWAS and UEMOA[5]).
PROSLABS is a private laboratory that does a lot of analysis, in particular, agro-food analyzes for the marketing authorization of agri-food products, and their periodic monitoring.

b. Natural resources: This is both in terms of natural resources as a resource and as a limiting factor (climate change) for horticulture production.

Water– availability, quality, accessibility

Market gardening, which is one of the major components of horticultural production in Mali, is an off-season activity that mainly uses irrigation (key informant survey, 2022). Wells and boreholes are the main sources of irrigation water. Water availability is limited from April to June because the water table is getting deeper and deeper (key informant survey, 2022). This problem is linked to the proliferation of boreholes which are multiplying in an anarchic way without regulation. Added to this problem is also the problem of lack of monitoring and quality control of drilling equipment, limited depth of drilling, lack of geophysical study when drilling, and lack of qualified personnel to repair the water pumps (key informant survey, 2022).

Soil – fertility (fertile areas for crop production)
More and more mineral fertilizers are used because the soils are less fertile. The vegetables and fruits sectors were the sectors that used fewer fertilizers but because of the production intensity, their yields are very low without fertilizers and agrochemicals (key informing survey, 2022).

Climate – rainfall patterns, climate-smart crops, climate-smart agricultural practices in place

The data from the meteorological service of Mali shows that the rainfall trend has been unstable from 1991 to 2021 (Figure 6.3). The environment and natural resources continue to deteriorate under the effects of increasing pressures related to climate change, socio-economic development, and population growth. The key informing surveys also revealed that farmers are using resilient and improved seeds in vegetable and fruit production.

[4]Economic Community of West African States
[5]West African Economic and Monetary Union

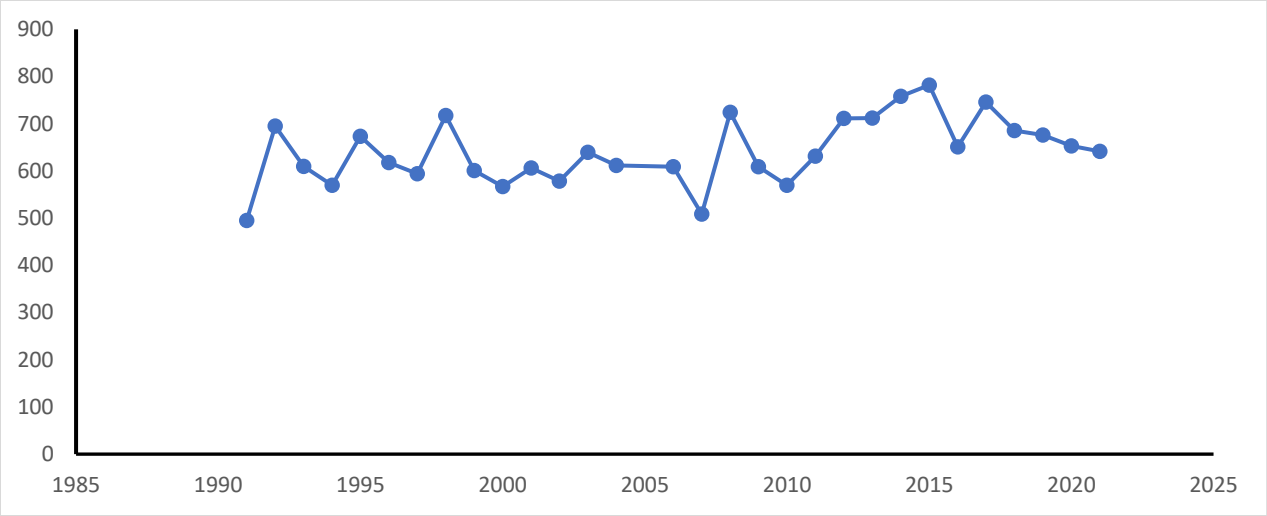


Figure 6.3: Rainfall patterns in Mali from 1991 to 2021

6.3 Socioeconomic

Women and youth in horticulture

Often seen as women's crops, horticultural products offer considerable economic opportunities for women and young people (Key informant Survey, 2022). First, access to plots for dry season production is easier than for the rainfall crops, such as cereals and cotton, crops typically grown by men. In addition, the size of the farms of horticultural products are very small, on average 0.1 ha per farm. The rental of irrigated plots in developed areas such as the Office du Niger benefits tenants and those who rent. Given the small plot sizes, the high demand for labor, and the high value of yields, many women and young people see the production and marketing of horticultural products as a means of achieving economic independence from the head of household (Key informing Survey, 2022). According to different studies, women account for 40% to 80% of the horticulture production labor and around 80% of traders in horticultural products (Drame, Moumouni, & Traore, 2018).

Market and Consumption

Demand for Nutritious Fruits and Vegetables

In Mali, according to FAO data 2019, fruit and vegetable consumption was estimated at 74.89 kg/inhabitant/year and that of vegetables at 93.3 kg/capita/year (Figure 6.4). In 2019, fruit consumption fell to 66.26 kg/capita/year, but vegetable consumption increased to 115.81 kg/capita/year.

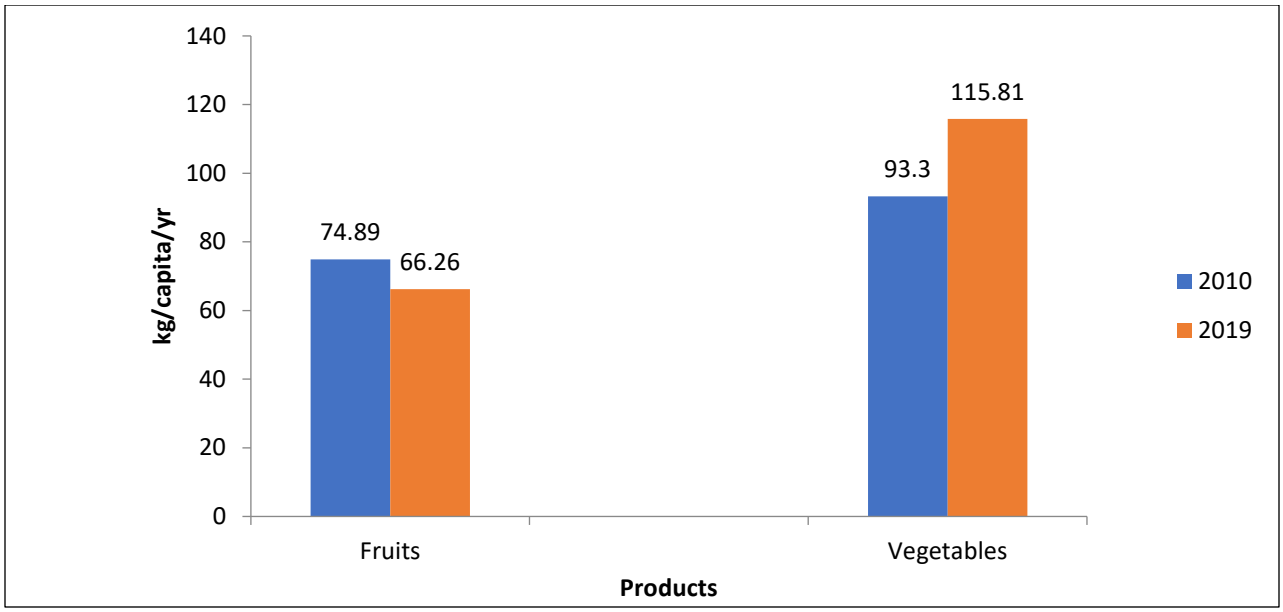


Figure 6.4: Fruit and Vegetable Consumption in Mali
Source: FAO (2019)

The Household Food Diversity Score (SDAM) shows households in Mali consume fruits, vegetables, and leaves in the respective order of 11.8%, and 65.2% (ENSAN, 2018). These statistics show that there is a potential domestic demand for fruits and vegetables. From a nutritional point of view, horticultural products provide considerable benefits. With high nutritional intensity, they offer farming households as well as urban consumers an important source of vitamins, fiber, and micronutrients (Key informing Survey, 2022).

Market Access

Most of the horticultural production is intended for sale. The main customers are women resellers, processors, exporters, etc. Transactions take place either in the field or at the market (Key informing survey, 2022).

In most cases, the sale is made by the number or the heap except in the case of bananas, potatoes, onions, and shallots which are sold by the kilogram. According to a study carried out by the FAO in 2000 in Mali, in the market gardening sector, 31% of small producers declare that they market their products themselves. This percentage decreased to 7 and 2% respectively for medium and large producers. Direct marketing is carried out by the farmers' wives who are in charge of the retail sale in the markets. Most of the production is sold on the farm (from 69% for small producers to 98% for large ones). Seasonal commodity price fluctuations reflect agronomic and climatic constraints as well as underdeveloped marketing infrastructure (Diakité et al., 2014).

Value-added horticulture products

Horticultural products are mostly sold fresh for domestic consumption and export (CPS/SDR, 2019). There are few processed and semi-processed products from these specific value chains, which are geared toward export.

Trade

Imports are mainly vegetable seeds, bananas, plantains, yams, onions, potatoes, garlic, and processed products. The cooperatives of planters and market gardeners organize the marketing of their members' produce both for the internal market and for the external market. Some exporters have organized themselves

to create associations while others work independently. Generally, all these exporters collaborate with development structures to organize production. According to Diakité et al. (2014), the products are generally exported to neighboring countries such as Burkina, the Ivory Coast (potatoes, onions, fresh and dry peppers), Mauritania (watermelon, squash, mango), Senegal (dry peppers, mango, watermelon) and Europe (mainly mango and green beans but also eggplant, fresh and powdered okra).

6.4 Engineering and Technology

Production technology and supplies
Faced with the depletion of the soil and the intensification of production, more and more producers are turning to Microdosing and the use of chemical fertilizers and biological fertilizers such as fertinova (Key Informant Survey, 2022).

Postharvest packaging, cooling, cold storage, drying
Units specializing in the storage of horticultural products (PLAZA: Modern refrigerated and packaging warehouse located in the Bamako area, other logistical infrastructures in the main producing regions Sikasso, Koulikoro, Bougouni), exporters, processing units such as Large Cereal Distributor in Mali (GDCM), and some women's cooperatives have postharvest packaging, cooling, cold storage, and drying equipment (Key Informing Survey, 2022).

Processing of horticultural products
Most of the processing of horticultural products is dominated by women's cooperatives, which are generally semi-industrial or artisanal units. Alongside these cooperatives, there are a few very well-equipped industrial units with a large capacity for processing, packaging, and sales at the national and sub-regional levels (Key Informant Survey, 2022). These horticultural product processing and marketing units are found in all regions of the country (Key Informing Survey, 2022). One of these agri-food processing units is the Laboratory of Agro-food Technology (LTA) of IER.

Research, education, and training
Education and training needs in horticulture
Education and training needs in horticulture are done along the value chain from the production techniques, storage techniques, processing, management technique, and marketing technique (Key informing survey, 2022).

Research capacity of technical vocational institutes, universities, and research institutes
According to the key informant survey (2022), the institutions of education, research, and technical assistance existing in Mali are:

- Rural Polytechnic Institute for Training and Applied Research (IPR/IFRA): considered one of the best agricultural engineering schools in the region
- Institute of Rural Economy (IER): agricultural research policies; approval and certification of agricultural inputs; and importation, testing, and distribution of the latest crop varieties
- The DNA (National Directorate of Agriculture) Agricultural Learning Centers (CAA),
- University of Bamako (FSEG)
- Sahel Institute Permanent Interstate Committee for Drought Control in the Sahel (CILSS) CILSS): leads a common regional regulatory framework for pesticides as well as the approval process for new pesticides
- International Crops Research Institute for the Semi-Arid Tropics (ICRIS) (CGIAR network) International research institute actively conducting crop research in Mali and leading a world-class geographic information system (GIS) unit in partnership with IER

- Laboratories: several laboratories are equipped to conduct quality research and analyzes (SEP, IPR IFRA, LCV, etc.)
- PLAZA: Modern refrigerated and packaging warehouse located in the Bamako area, other logistics infrastructure in the main producing regions (Sikasso, Koulikoro, Bougouni).

Extension capacity in the public and private sector

Extension service are undertaken by public institutions such as DNA and NGOs such as European Cooperative for Rural Development (EUCORD), Association Malienne d'Eveil Au Développement Durable (AMEDD), Association Malienne pour le Développement Durable (AMDD), FASO JIGI, Association Malienne pour la Sécurité et la Souveraineté Alimentaires (AMASSA), Mali Agricultural Market Development Trust (MALIMARK), etc. (Key Informant Survey, 2022).

6.5 The National Policy Environment for the Horticulture Sector

The state intervenes in the horticulture sector through development projects and programs, including the West African Agricultural Productivity Program (WAPP), the Proximity Irrigation Program, and the Strengthening of Irrigated Agriculture -Strengthening of Irrigated Agriculture (IPRO-REAGIR), a Support program for the local irrigation sub-sector – Strengthening of Irrigated Agriculture (PASSIP-REAGIR), GIZ projects, World Vegetable Center projects, DARWIN INITIATIVE, the JEKE NI JABA Project, USAID horticulture scaling project to improve nutrition and hygiene in Mali, etc. (Key Informant Survey, 2022). The policies, legislation, and strategies supporting the development of horticulture in Mali include the strategic framework for growth and poverty reduction (CSCRP 2012-2017), the agricultural orientation law (N° 06-40 /AN-RM), the Master plan for the Rural Development sector, and trade policy (key informant survey, 2022).

BURKINA FASO

7.1 Introduction

Agriculture is an important sector in Burkina Faso, contributing about 80% of the country's labour force and 16-30% of gross domestic product (Carrico et al., 2021). Agriculture also contributes significantly to food security and the income of agricultural households. Fruits and vegetables play a crucial role in food security and income generation for the rural population. In West Africa, horticultural production is particularly important in the Sahel countries (Burkina Faso, Niger, and Mali). Indeed, these countries are subject to climatic variability (drought, flooding) which means that horticultural production, particularly fruit and vegetables, is a way out for rural and peri-urban populations. The fruit and vegetable sector occupies a prominent place among sectors selected by the Burkinabe authorities. According to the Ministry of Agriculture (2018), there were approximately 698,682 market garden producers in Burkina Faso in 2018, of which 445,091 (65%) were managed by men and 244,592 (35%) were women. The largest market gardening regions are Centre-West (19%), Boucle du Mouhoun (14%), Centre-North (14%), North (10%), Centre-East (10%), Hauts-Bassins (8%), Centre (5%), Cascades (5%), and South-West (2%). The total area sown under market gardening in 2019 is 54,678.4 hectares.

The average area per region is 4,206 hectares. The major production regions in terms of area are Boucle du Mouhoun (9,759.0 ha), Hauts-Bassins (7,762.5 ha), Centre-North (7,558.5 ha), Centre-South (5,909.9 ha), and North (5,904.2 ha). The regions where market gardening is less practised are the South-West (480.9 ha), the Sahel (563.8 ha), and the East (1,623.7 ha). The sources of water mostly used by farmers are dams (30%) of market gardeners) and traditional wells (26% of market gardeners). After these sources come market garden wells (18%) and rivers (17%). Boreholes are the least used by farmers, with 5% of market gardeners using them.

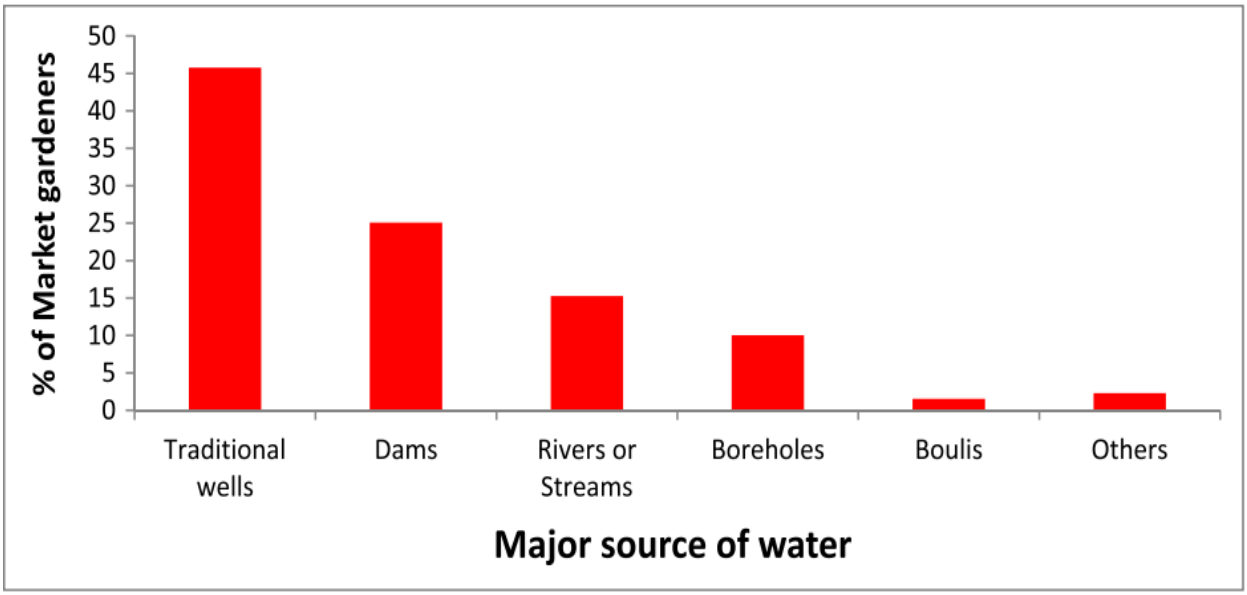


Figure 7.1: Number of market gardeners (%) by a major source of water
Source: (Sanfo, Barbier, & Zangre, 2017)

According to the FAO (2022), the volumes exported by Burkina Faso from 2016 to 2020 are more than 33, 000 Mt. Shea nuts, sesame seed, mangoes, and cashew were the dominant exported commodities (see Table 7.1).

Table 7.1: Volume of Commodities Exported by Burkina Faso (2016-2020)

Commodities	2016	2017	2018	2019	2020	Grand Total
Cashew nuts shelled	3676	2185	2032	2368	2514	2555
Cashew nuts, with shell	90360	98127	127011	96554	59669	94344.2
Eggplants (aubergines)	71	40	102	69	100	76.4
Shea nuts		135002	114933	150482	104740	126289.25
Mangoes, mangosteens, guavas	10334	7329	8941	8931		8883.75
Onions, shallots, green	8163	5345	5700	5486	12990	7536.8
Sesame seed	159837	110490	163559	72210	60770	113373.2
Soybeans	383	1159	2959	8790	15377	5733.6
Tomatoes	12610	8678	19160		0	10112
Vegetables, fresh nes	600	3000	3000	2200	5000	2760
Grand Total	**28603.5**	**37135.5**	**44739.7**	**31553.81818**	**26116.6**	**33589.11765**

Source: FAO, 2022

The revenue from this export is about $27.9 million. Cashew nuts, sesame seeds, shea nuts, and mangoes provide more revenue to Burkina Faso (Table 7.2).

Table 7.2: Value of Commodities Exported by Burkina Faso (2016-2020)

Commodities	2016	2017	2018	2019	2020	Grand Total
Cashew nuts shelled	9,362	10,497	13,086	14,247	14,961	12,431
Cashew nuts, with shell	103,209	144,759	198,732	81,028	53,262	116,198
Eggplants (aubergines)	36	9	14	8	9	15
Shea nuts		27,692	41,447	66,334	45,727	45,300
Mangoes, mangosteens, guavas	14,053	15,052	24,097	23,352		19,139
Onions, shallots, green	620	442	595	651	693	600
Sesame seed	113,363	96,774	128,540	70,589	64,468	94,747
Soybeans	230	699	1,777	4,196	6,399	2,660
Tomatoes	1,272	928	1,754		-	989
Grand Total	**24,217**	**29,696**	**41,024**	**26,049**	**18,576**	**27,912**

Source: FAO, 2022

7.2 Geography and Markets

According to MAAH (2018), there were an estimated 698,682 market garden producers in 2018 in Burkina Faso, comprising about 445,091(65%) men and 244,592 (35%) women. The largest market gardening regions are respectively Centre-West (19% of producers), Boucle du Mouhoun (14%), Centre-North (14%), North (10%), Centre-East (10%), Hauts-Bassins (8%), Centre (5%) and Cascades (5%). The other regions accounted for less than 5% of market gardeners each, notably the South-West (2%). Similar spatial distribution is also found by (Sanfo et al., 2017) by type of commodities (Figure 7.2).

According to the Ministry of Trade (2020), the main destinations of horticultural commodities from Burkina Faso are Cote d'Ivoire, Ghana, Togo, Benin, Senegal, and other countries such as Nigeria, Morocco, South Africa, and Egypt. Indeed, Sesame seeds, shea nuts, and cashew are mainly exported to Asia (China, Singapore, and India). Also, dried and fresh mangoes are exported to Germany, France, and the UK. For vegetables such as tomatoes and onions, are exported to Ghana and Cote d'Ivoire. The domestic market is

also growing with the installation of medium and large[6] factories, especially for mango processing (juice and dried).

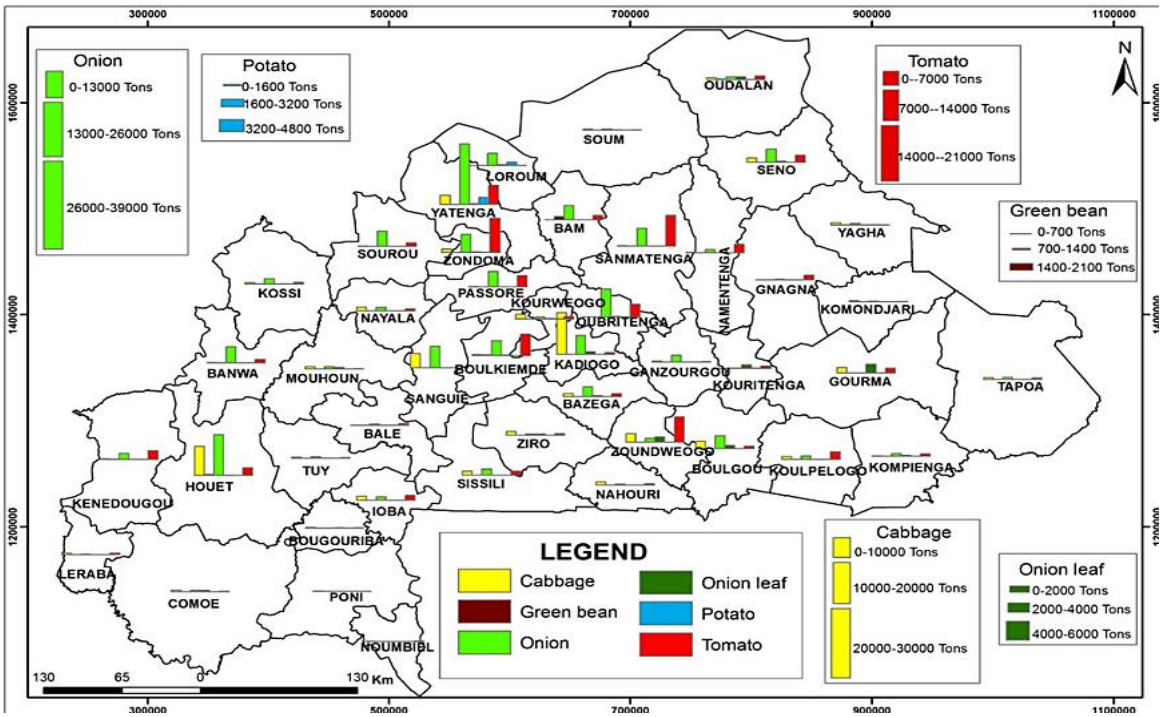


Figure 7.2: Comparison of horticultural crop harvested areas
Source:(Sanfo et al., 2017)

The horticultural products from Burkina Faso are mainly sold at the farm gate (more than 50%) and marketplace (49%). Due to the perishability of the products, storage is very challenging (Figure 7.3).

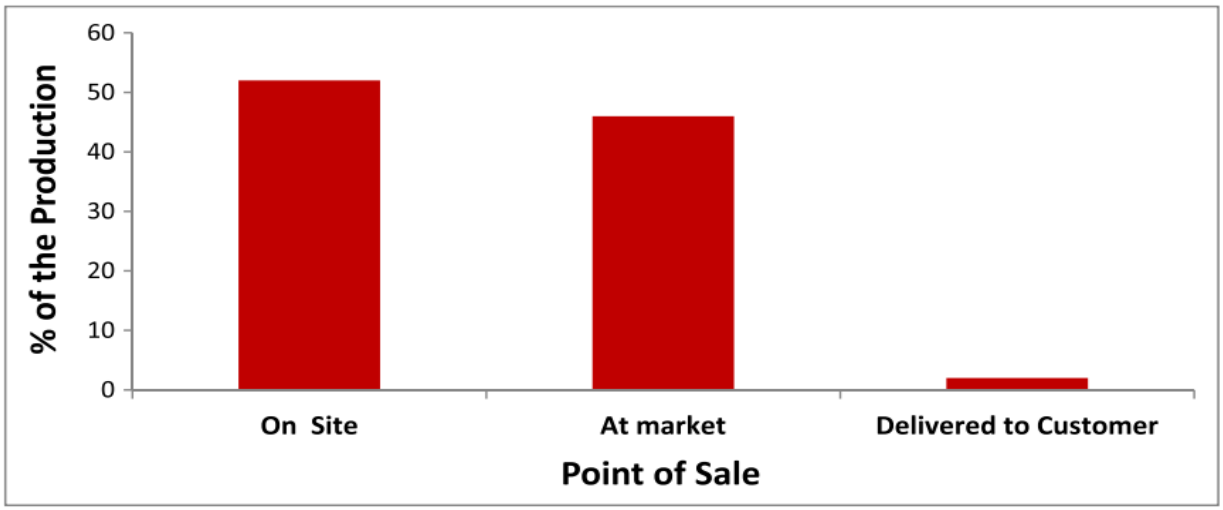


Figure 7.3: Percentage of production by point of sale
Source: Sanfo et al. (2017)

[6]https://burkina24.com/2021/12/21/burkina-faso-jus-de-fruits-malia-le-bon-gout-de-lafrique-produit-a-bobo/

7.3 Landscape Challenges and Opportunities

Horticulture-Biophysical

Inputs (including seeds supply)

According to the literature review and the key informants, the main inputs challenges include production, inputs supply, processing, and trade of horticultural products.

- **Inputs for horticulture production**
  - Low supply of appropriate fertilizer;
  - Low supply of local seed (90% of the seed is imported by Nankosem SA);
  - Low supply of appropriate pesticides;
  - Low supply of appropriate storage facilities
  - Low supply of mangoes flies' pesticides

- **Challenges for horticulture Production**
  - Small production plots;
  - Water scarcity at certain times of the year (March-May);
  - Low supply of storage facilities;
  - Non-respect for technical itineraries by producers;
  - Training manuals in French, whereas producers only speak local languages;
  - The presence of pesticide residues prevents good marketing of fruit and vegetables;
  - Poor access to finance due to climatic risks;
  - Drought and floods

Production

The total area sown under market gardening in 2019 is 54,678.4 hectares. The average area per region is 4,206 hectares. The main production regions in terms of area are Boucle du Mouhoun (9759.02ha), Hauts-Bassins (7,762.50 ha), Centre-North (7,558.45 ha), Centre-South (5,909.86 ha) and North (5904.17 ha). The regions where market gardening is less practised are the South-West (480.89 ha), the Sahel (563.75 ha), and the East (1,623.66 ha).

The national onion yield is 19 tonnes per hectare. This level remains well below the maximum achievable yield of 40 tonnes/ha. The Cascades and South-West regions have the highest yields (26t/ha), while the Centre-East and Centre-South have the lowest yields (14t/ha) (Figure 7.4).

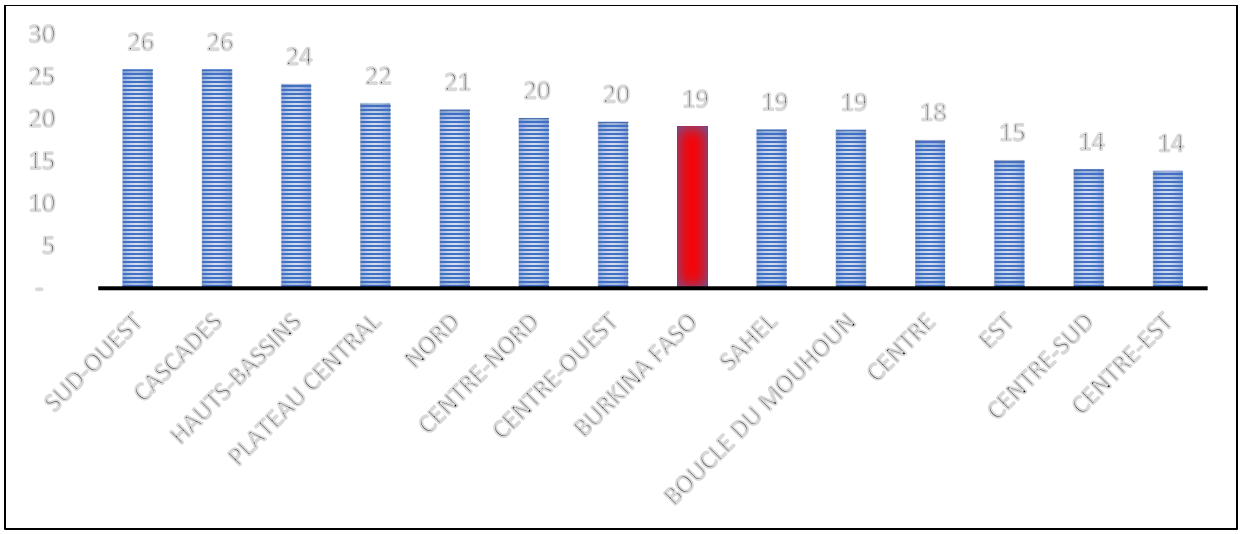


Figure 7.4: Onion yield (in t/ha) per region
Source: DGESS/MAAH, 2019.

The graph (Figure 7.5) shows the yield of cabbage. It shows a national yield of 24 tonnes/ha. This value is generally low compared to the threshold yield of 50 tonnes/ha. The highest yield is achieved in the Hauts-Bassins (37 tonnes/ha), followed by the South-West (32 tonnes/ha) and the Centre-East (30 tonnes/ha). The Centre region has the lowest yield (11 tonnes/ha).

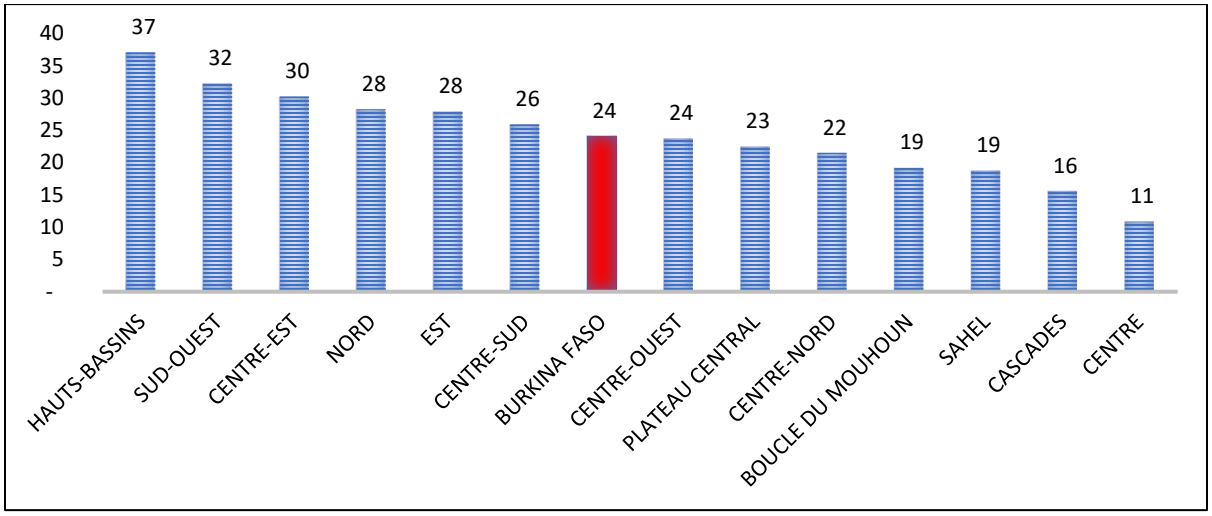


Figure 7.5: Cabbage yields by region (in t/ha)
Source: DGESS/MAAH, 2019

For tomatoes, the graph below shows that the national yield is 21tonnes per hectare, about 2.5 times lower than the maximum achievable yield of 50 tonnes per hectare. The Sahel region has the highest yield (33 tonnes/ha), followed by the North (28 tonnes/ha) and the Boucle du Mouhoun (24 tonnes/ha). The lowest yield is obtained in the Centre-South (9 t/ha) (Figure 7.6).

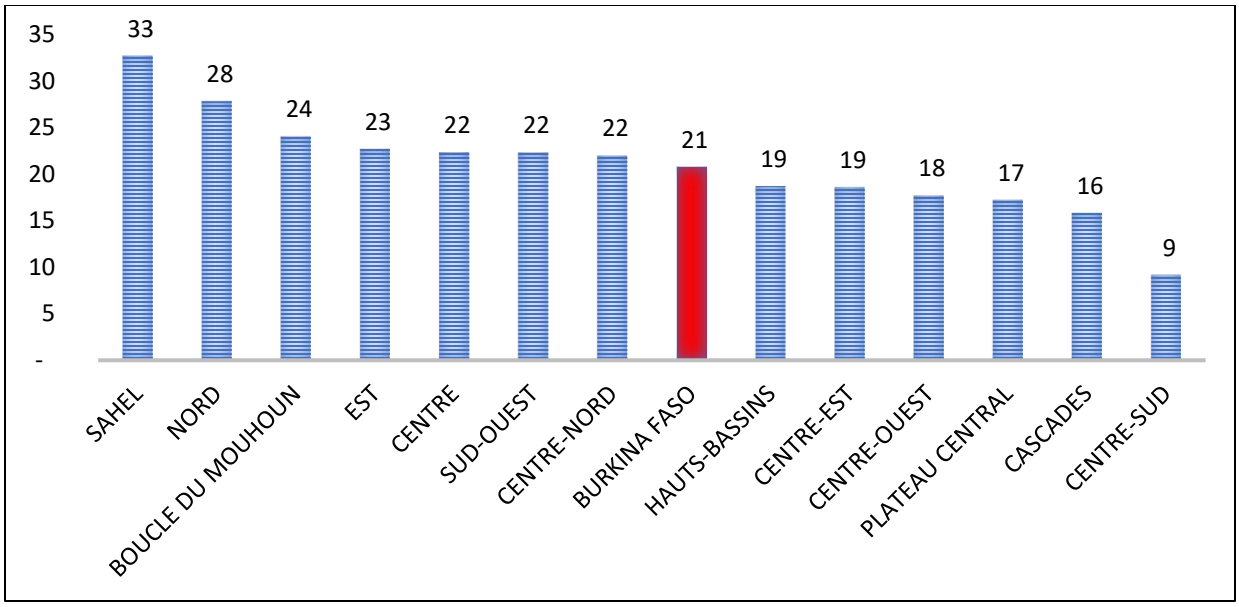


Figure 7.6: Tomato yields by region (in t/ha)
Source: DGESS/MAAH, 2019.

Income generated from some vegetables

The cultivation of onions, tomatoes, cabbage, and local aubergines in the dry season provides more than 123 billion, 48 billion, 78 billion, and 20 billion francs respectively to market gardeners in Burkina Faso (Table 7.3). For onions, the Boucle du Mouhoun region appears to be the most affluent with more than 36 billion CFA francs in income from the sale of onions by their market gardeners. It is in the South-West region that the sale of onions provided less in monetary terms to market gardeners (259 million).

The sale of tomatoes brought in more than 78 billion at the national level, including more than 5 billion in several regions: the Mouhoun loop, the centre, the centre-east, the centre-west, the centre-south, the high basins, and the north. Cabbages are grown more in the high basins, the sale of which has enabled these market gardeners to earn more than 12 billion CFA francs.

Local aubergines are sold more in the Centre-North region, where sales are estimated at 12.5 billion CFA francs. In the Centre Region, the production of local aubergines for sale is smaller, with sales estimated at around CFA 56 million.

Table 7.3: Income from sales of vegetable crops (in millions of FCFA)

Region	Onion	Cabbage	Tomato	Local Eggplant	Okra
Boucle Du Mouhoun	36 521	3 004	7 950	814	908
Cascades	361	4 878	2 533	527	19
Centre	2 464	1 260	11 128	56	35
Centre East	6 477	2 267	9 304	913	162
Centre-North	11 475	2 552	13 863	12 588	88
Centre-West	17 187	3 786	6 987	2 518	138
Centre-South	4 479	3 257	5 156	355	88
East	3 068	4 373	3 260	180	112
Hauts Bassins	11 116	12 277	8 672	789	455
North	24 027	8 432	5 134	737	257
Plateau Central	4 427	411	2 964	528	294
Sahel	1 824	1 509	815	493	1 692
South-West	259	789	1 081	226	135
BURKINA FASO	**123 685**	**48 794**	**78 848**	**20 723**	**4 384**

Source: DGESS/MAAH, 2019.

Market gardening production is mainly intended for marketing. Indeed, more than 80% of the production of each of the four main vegetable crops is intended for sale. At the national level, 83% of onion production is sold. This marketing rate varies from one region to another. In the Centre and Centre-South, almost all of the production is destined for sale. The lowest rates are recorded in the Cascades and the Central Plateau, at 59% and 58% respectively.

The marketing rate for tomatoes and cabbage is at least 70% in all regions. Similarly, the marketing rate for local eggplant varies between 67% and 99% in the regions. Except for the Centre-West region, where the marketing rate is 67%. These sales are those that take place at the time of harvest.

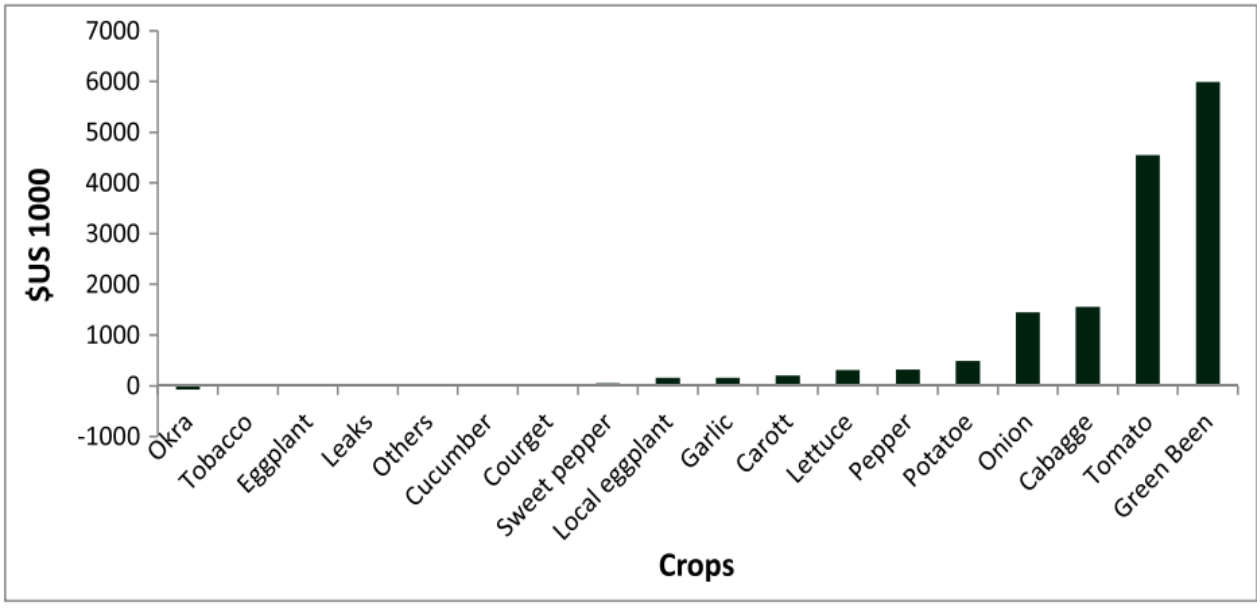


Figure 7.7: Net incomes in main crops per hectare
Source: Sanfo et al (2017)

Water access

The essential inputs for fruit and vegetable production are the natural resources of land and water. Burkina Faso has a large potential of irrigable land reaching 233,500 ha, of which about 12-14% is currently exploited (AFC, 2015). There are 54,678 hectares of irrigated vegetable plots (DGESS, 2018), and 8% of the 142,500 hectares of fruit trees are irrigated.

Irrigated vegetables include onions, tomatoes, cabbage, and lettuce, which covered 75% of the 27,000-30,000 ha in 2008. Fruits and vegetables are also grown on 500 ha of lowland where water accumulates in wells and reservoirs during the rainy season (Ouédraogo et al., 2019). Overall, the production period for vegetables, which depends largely on water availability varies from 3 to 10 months between September and July

Market gardening in Burkina Faso is practised in its entirety in small areas. At the national level, the area under vegetable production is between 4,000 and 6,000 hectares depending on the season. There are three types of vegetable farms:

Urban farms, are located within cities, either along the waterways (such as the market gardens on both banks of the Houet in Bobo-Dioulasso), or downstream and around the dams built inside the cities.

Peri-urban farms are located in the suburbs of cities around wells, boreholes, and dams, within a radius of 30 km of the towns. Near Ouagadougou, peri-urban farms exist in Saaba, Koubri, Loumbila and Boulbi. Bama is an important area for peri-urban agriculture near Bobo-Dioulasso, as well as Bobo-Dioulasso as well as Goinre for the city of Ouahigouya.

Rural farms, located in rural areas, often near dams and water reservoirs. Examples include the market garden sites of Guiedougou, Kongounsi, and Lake Dem. Also, the main challenges for the market include parasite attacks, water shortage, and pest control.

Improved varieties

Although the country attaches great importance to horticulture, national research remains low, especially in the field of seeds and specific inputs. The input sector is largely dominated by the following specialized companies: INERA, NANKOSEM, KING AGRO, SOPAGRI, SEMAGRI, SAPHYTO, EXOTIMEX, TIGRE AGRO. The focus on Burkina Faso is mainly on Tomatoes, Green beans, Onions, Cabbage, Potatoes, Peppers, Green peppers, and Carrots for vegetable farming. In the case of fruits, Burkina Faso is more focused on mango, cashew nuts, bissap (BARRO, Nanama, Coulibaly, Dieni, & Cordea, 2021).

The main varieties developed by National Research Institute (INERA) from 2007 to 2020 are five papaya varieties which include FBPA-1; FBPA-2; FBPA-2; FBPA-3; FBPA-4 and FBPA-1-13-1. Also, tree crop varieties such as mangoes and cashew have been developed by the National Research Institute. They include the following varieties: Brooks, Kent, Lippens, Amelie, Keitt for mango (MRSI[7], 2014).
Although vegetable varieties are also developed by national research, farmers are more focused on imported seeds, of which NANKOSEM is the leader in Burkina Faso. It is also known that NANKOSEM has an efficient distribution network covering the whole country with 11 distribution shops unlike INERA, whose seeds are very little multiplied by firms and distributed. The link (https://nankosem.com/plans/) indicates the varieties available at NANKOSEM Burkina Faso.

[7] National Catalogue of Agricultural Species and Varieties of Burkina Faso (http://fagri-burkina.com/Docs/BF_2014_Catalogue_especes_varietes_agricoles_BF_Final.pdf)

Underutilized Neglected & Indigenous crops

Marginal crops in Burkina Faso include okra, garlic, strawberries, lettuce, aubergine, squash, watermelon, and tobacco.

Postharvest management of fresh products

Post-harvest management of horticultural products remains a challenge in Burkina Faso. Indeed, the lack of appropriate infrastructure and logistics means that tomato, green bean, lettuce, fresh mango, and chili farmers suffer huge losses at the end of each production cycle. Only onions, cashew nuts, and shea nuts are products that producers manage to preserve before the sale. Recently, with the advent of drying technologies, dried mango and chili are beginning to be better preserved before sale.

Processing and packaging

Packaging horticultural products remain difficult in Burkina Faso. Indeed, there are very few local packaging factories. Most packaging needs to be improved, especially for freshly harvested products. According to MAAH (2019), only mangoes and cashew are processed in Burkina Faso. The other horticultural products are mainly used as raw materials (exports and national consumption). With mango, for example, there are nearly 15,000 producers, 14 international exporters, 76 drying units, one industrial unit (DAFANI), 5 packaging centres, 1,255 ha of orchards, and a total of 1,500 ha of fruit.

7.4 Natural resources

Water

According to the Ministry of Agriculture (2018), 58% of farms have a permanent water supply and 86% of sites are permanent. Regarding the permanence of the site, the Cascades region has the highest proportion of permanent sites (94%), followed by the East, Centre, and Central Plateau regions (86%). The proportion of permanent sites in the North is the lowest (56%).

Soil–fertility

The majority of producers combine organic and mineral fertilization. However, the Ministry of Agriculture states that application rates remain insufficient, especially for organic fertilizers. The volume of fertilizer used was estimated at 6,411 tonnes, of which 65% was nitrogen, phosphorus, and potassium (NPK), 30.3% urea, and 4.8% phosphate. Fertilizer use is satisfactory for NPK and urea, as the average rates used are 635 and 296 kg/ha for NPK and urea, respectively. However, for organic fertilizer, farmers applied a rate of 2.7t/ha which is below the recommended rate of 10-20 t/ha. Furthermore, the majority of fertilizers available on the market are not for fruit and vegetable production.

Climate

Most of the horticultural crops are produced during the dry season. Water shortage, drought, flood, and wind are the main climatic problems faced by farmers concerning fruits and vegetable production. For mango and cashew, pest attacks, and flies are the obstacle in the production sector (Nebie, Dabire, Fayama, Zida, & Sawadogo, 2021).

7.5 Socioeconomic

Women and youth in horticulture

Market gardening is most important in the Centre-West, followed by the Centre-North, Boucle du Mouhoun, North, Centre-East, Hauts-Bassins, Centre, Cascades, and East. Market gardening was little practised in the South-West, Sahel, Central Plateau, and Centre-South regions. However, some regions

stand out for the strong presence of women among market gardeners, notably the Sahel region where 83% of market gardeners are women, although the activity is relatively small. The Centre-North and Centre-East regions follow with 63% and 59% of market gardeners being women respectively. In the other regions, women represent less than 44% of market gardeners.

According to MAAH (2018), the majority (55.52%) of Burkina Faso's vegetable producers in 2018 are over 35 years old. The Eastern region is the one with the youngest people aged 35 and under, who account for 60.59%. The Centre region concentrates more producers aged over 35, whose proportion reaches 75% of the total for the region. Similar results were found by Sanfo et al. (2017) when analysing market gardeners in Burkina (Figure 7.8).

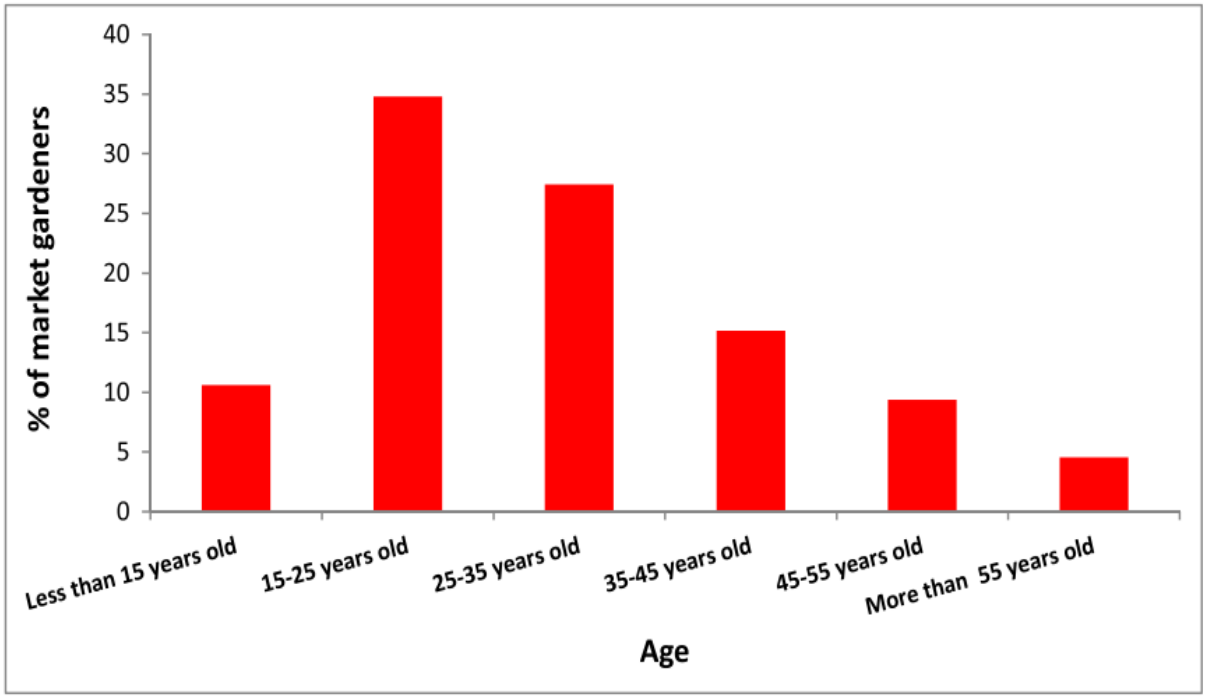


Figure 7.8: Percentage of market gardeners by age group
Source: Sanfo et al. (2017)

Marginalized groups in horticulture

Crops such as sorrel, Kenaf, Urena, potato, sunflower, sesame seed, and fonio are the most marginal in Burkina Faso. Admittedly, the sesame market is developed but varietal creation and other aspects are neglected.

Market and consumption

Burkina Faso has a growing market for fruits and vegetables both locally and internationally. It supplies the West African sub-region with mangoes, onions, and tomatoes. Niger, Ghana, and Côte d'Ivoire are the main African mango, onions, and tomato destinations. The transport to the sub-region is by truck. Burkina Faso's mango exports represent 0.5% of world mango exports, placing it in 31st place in the world exports, making it the 31st largest exporter in the world after Mexico, the Netherlands, Peru, Brazil, and India. According to MAAH (2019), the value of Burkina Faso's mango exports amounted to US$15.1 million, representing 7,322 tonnes of mango exports in 2017. The annual growth rate in value between 2013 and

2017 is 26%. It was 6% between 2016 and 2017. Burkina Faso's main buyers of mango are the Netherlands (33%), the UK (19%), Germany (19%), Germany (17%), France (9%), Italy (6%), USA (6%), Spain (3%).

Horticulture contributes significantly to food security, employment, social inclusion, and the creation of green spaces. Despite these benefits, the sector is bedevilled with many challenges. Farmers are subject to the scarce and contentious availability of land and water resources as well as to the rudimentary nature of the equipment used, the poverty of the soil, and the health risks incurred by the use of untreated wastewater, chemical fertilizers, and pesticides.

Agribusiness opportunities

The interviews identified business opportunities in production, processing, and marketing.

- **At the production level**, cooperatives and individual producers stressed that they have difficulties in accessing biopesticides and pesticides that can effectively treat fresh mango. This is therefore an opportunity for any company that can make mango-friendly pesticides and biopesticides available. Also, in the case of tomatoes, there are serious problems with storage and transportation to client countries (Ghana and Cote d'Ivoire). Any company that can offer adapted storage and logistics technologies is therefore welcome.
- **At the processing level**, there are almost no factories that process tomatoes or onions. There is only processing of mango and cashew nuts. There is therefore the need for entrepreneurs who can process tomatoes and other vegetables. Mango and cashew nuts are processed, but their waste (cashew apple, mango skin) is still very little used by agribusinesses. In addition, there is a severe lack of packaging material suppliers for horticultural products in Burkina Faso. This is therefore a business opportunity according to the actors we met.
- **At the marketing level:** the rejection of mangoes linked to the fruit fly, for example, is one of the causes of rejection of the Burkinabe mango abroad.

7.6 Horticulture Research Priorities

Opinions of Farmers and Farmers Organisations

- Improvement of plant material to increase yield.
- Update data on production, raw cashew nut yields by region
- Assess the quality of raw cashew nuts
- Improvement of plant material to increase yield.

Researchers 'opinions on research priorities

- Genetic characterization of a collection of accessions of local species (black nightshade, great nightshade or gboma, amaranth, squash)
- Characterization of fungi responsible for Solanaceae fungal diseases in Burkina Faso
- Selection and creation of high-performance tomato and onion varieties adapted to market needs
- Selection and creation of local eggplant varieties resistant to the most pathogenic fungus in Burkina Faso.

Inputs providers' opinions on research priorities

- Comparative effect of pheromone traps and foliar insecticides on fruit flies
- Selection of resistant and early varieties
- Creation of local varieties of vegetable seeds
- Comparative studies of the adaptation of existing varieties of fruits and vegetables to different seasons

Processors' opinions on research priorities

- Research on equipment that consumes less electricity
- Research on types of technologies for the preservation of fruits and vegetables
- Research on sustainable packaging for fruits and vegetables

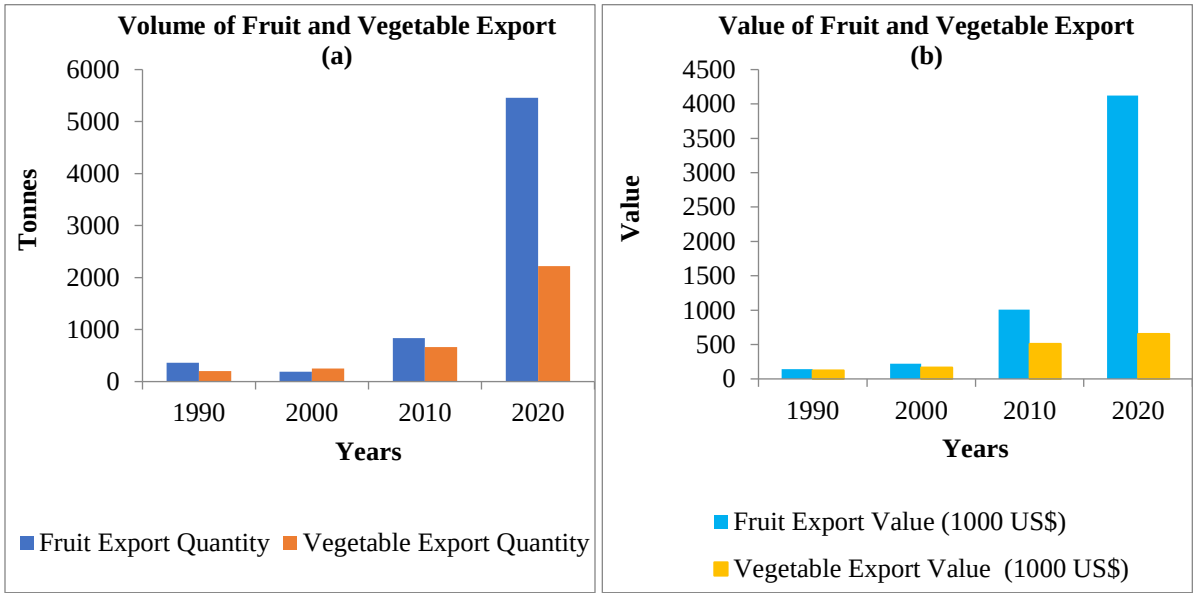
Exporters 'opinions on research priorities

- Renew orchards
- Control of the diseases and pests

TOGO

8.1 Introduction

Togo is an agrarian country. Agriculture employs the majority (70%) of the country's labor force and contributed about 40% of the GDP (Julien, Kossi, & Aklésso, 2021). The fruit and vegetable sector contributes more than 20% to the agricultural GDP and employs more than three workers per farm unit (Radji and Kokou, 2017). Horticulture production plays a significant role in poverty reduction and the welfare of agricultural households (Radji and Kokou, 2017). Togo accounts for 0.07% of exports of fruits and vegetables from the West African Economic and Monetary Union (WAEMU) zone to the European market. However, the export of fruits and vegetables has been increasing over the last few decades. Vegetable export remained low and stable from 1990 to 2000. However, it increased significantly in 2010 and 2020 (Figure 8.1a). The value of vegetable export in 2020 was also higher than that of 2010 (Figure 8.1b).



Figures 8.1a and 8.1b: Volume and value of fruit and vegetable exports
Source: FAO (2020)

Fruit export remained higher than vegetable export. Fruit export has had significant increases in recent years. The export of fruits increased from 188 tonnes in 2010 to 5,455 tonnes in 2020. Similar trend was observed for the value of fruit exports. The area under fruit production increased from 7,221 hectares in 1990 to 9,823 hectares in 2020. Vegetable production area also increased slightly from 24, 550 hectares to 29,431 hectares in 2020. As a matter of fact, between 1992 and 1994, the area dedicated to vegetable production was more than 30,000 hectares.

Between 1990 and 2020, fruit production increased from 46,358Mt in 1990 to about 66,823Mt in 2020. However, vegetable production has been declining over the last three decades. Vegetable production declined from 158,700 tonnes in 1990 to 149,504 tonnes in 2020.

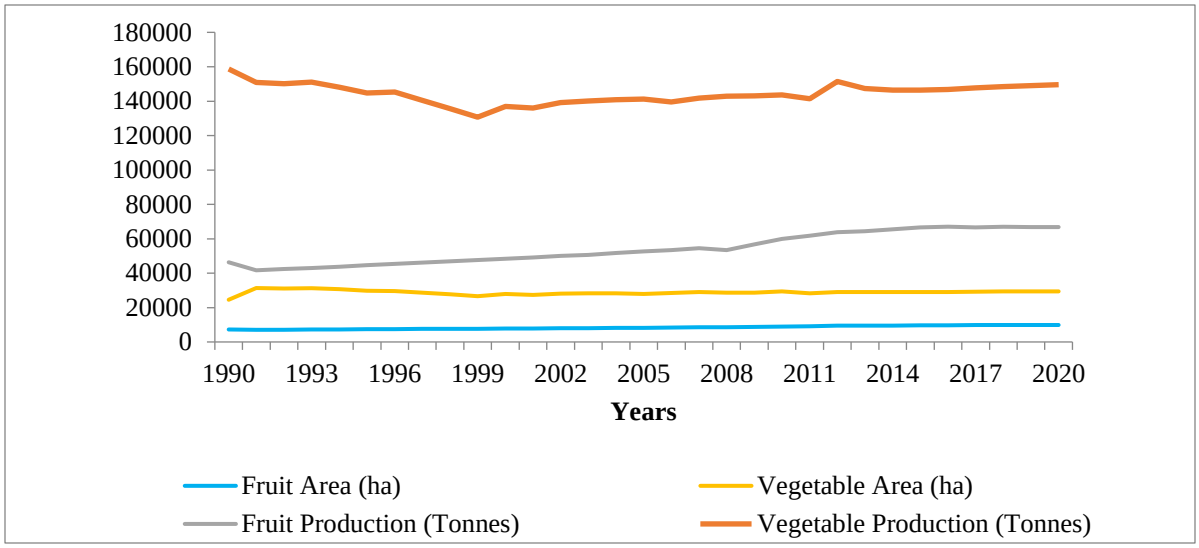


Figure 8.2: Production of Fruit and Vegetable Exports
Source: FAO (2020)

8.2 Biophysical

Production and Productivity of Major Fruits and Vegetables in Togo

Bananas, oranges, pineapples, and tomatoes are among the major fruits and vegetables produced in the country. In 2020, oranges ranked first in land area under cultivation, followed by bananas. This is because banana has a higher yield (12.1Mt) than orange (4.6 tonnes/ha). The area under pineapple production and yield of pineapples remained unchanged between 2019 and 2020 (Table 8.1).

Table 8.1: Production and Productivity of Major Fruits and Vegetables in Togo

	Area (ha)			Yield (tones/ha)			Production (tones)		
Crops	2019	2020	% change	2019	2020	% change	2019	2020	% change
Bananas	1996	2018	1.1	12.2	12.1	-0.8	24383	24398	0.1
Oranges	3227	3237	0.3	4.6	4.6	0.0	14873	14925	0.3
Pineapples	230	230	0.0	8	8	0.0	1843	1847	0.2
Tomatoes	1262	1257	-0.4	4.2	4.1	-2.4	5250	5214	-0.7

Tomato land area, yield and output declined by 0.4%, 2.4%, and 0.7% between 2019 and 2020.

Chemical Inputs

Inputs used in horticulture production are fertilizer, seeds, and agrochemicals. The fertilizer application for vegetables and fruit is done with chemical and organic fertilizers. Chemical fertilizers are imported, while organic fertilizers are locally produced. There is a general subsidy for targeted smallholder farmers in the country for chemical fertilizer.

Most of the vegetable crops are produced at the small scale level and can be produced throughout the whole country. Fruits such as pineapple can only be produced in the maritime and plateaux regions by about 4,000 producers where the climatic conditions are favourable. Most of the production is sold fresh only about 12,000 tons are processed into juice (organic and conventional).

The major farming seasons of vegetable crops are the rainy seasons. Currently, a large part of the vegetable and fruit production are rainfed. There is also the production of vegetable crops using manual irrigation during the dry season where investments have been made to achieve a year-round water supply, these consist of small dams along regional streams and basic pump and pipe surface irrigation. Savana and Kara regions are the major production areas for tomatoes, onions and melons during the dry season because of special climatic conditions in these regions.

Post-harvest

The main post-harvest problems, on the international market, are the presence of insects in the produce. For example, there have been occasional interceptions of batches of cassava leaves with whiteflies (*Bemisia tabaci*) and recent interceptions of eggplants with various pests, mainly shoot moth (*Leucinodes orbonalis*) as well as fruit flies, moths and thrips which also affect mangoes and leafy vegetables. The local market, is oblivious of the presence of these insects.

Processing and Packaging

Vegetable processing is not well developed in Togo. Processing is done only to traditional vegetables such as ademe and okra which are dried. Fruits processing into juice (orange, pineapple and mangoes) or dried (pineapple and mangoes). The most important companies involved in food processing in Togo include Tropic Bio, Junabio, Agro-Food, Julado Rehoboth, Rimouski, Allbio Togo etc, Safleg, Setrapal, Pronatura. The processing of pineapple in juice is developing in Togo, like the Jus Délice factory located in Gbatope, 47 km north of Lome. The construction of this factory began in November 2018 and it was inaugurated at the end of April 2019. It was developed with an investment of 1.7 billion CFA francs (nearly 2.6 million euros) from the support of the European Union and German cooperation. Jus Délice is produced from "organic" pineapple juice. It aims to obtain ISO 22000 certifications to continue to develop its export market, particularly the European Union.

Natural Resources

Most vegetable crops are irrigated manually with watering cans, but fruits such as mangoes, oranges and pineapples are mainly rainfed. The waters used in the irrigation of vegetables are either underground water (wells) or surface water (reservoir or lowland water), that is why more vegetables are produced close to the lowlands. The fruits are more produced not only on fertile soils but also on suitable soils. It is thus noted that the region of the plateaux (the most fertile zone of the country) is the region where various types of fruit (bananas, mango, orange avocado etc) are more produced.

8.3 Socioeconomic

Women in Horticulture

The horticulture sector is one of the few income-generating opportunities for women in rural and urban areas in Togo and therefore has a huge impact on development. Rural women represent 56.4% of agricultural workers and 43% of goods processors. They are important in the horticulture value chain.

Market and Consumption

Fruit and vegetable consumption in Togo, which has been only around 100g per person per day in recent years, is significantly lower than the WHO recommended intake of 400 g of fruit and vegetables per day. The supply of fruit and vegetables has fallen by around a third since 1990 after an increase in the early 1990s proved unsustainable. Fruit and vegetable production in Togo only meets a quarter of domestic demand.

Trade

Togo mainly exports its horticulture product to sub-Saharan Africa (52%), East Asia (37%) EU (9%) and Nort America (2%) (Figure 8.3).

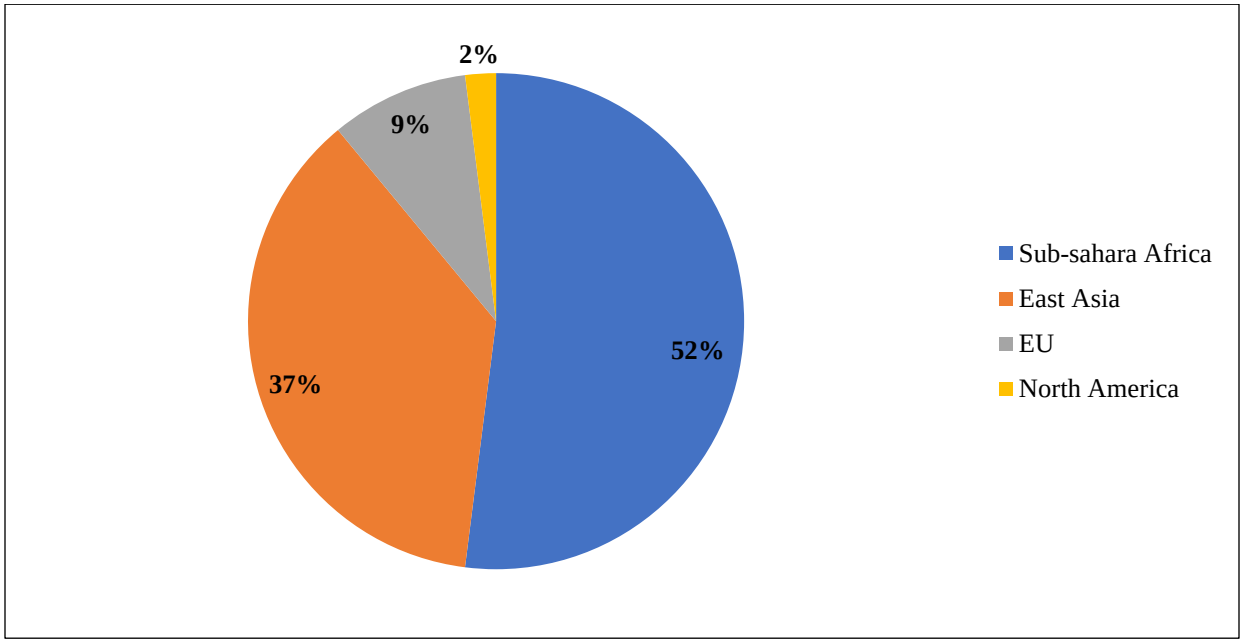


Figure 8.3: Distribution of export countries for Togolese horticultural products

Research, Education and Training

Research in the horticulture sector is conducted by School of agriculture (ESA/UL) and by National Agronomic Research Institute (ITRA). Most of this research is conducted on a crop-by-crop basis.

The higher school of agronomy trains its learners in horticulture. Farmers, for their part, receive capacity building from ICAT and NGOs.

SENEGAL

9.1 Introduction

Senegal, located in the westernmost part of West Africa, covers an area of 196,722km with an estimated population of 16.7 million people in 2020. The GDP of Senegal was $24.64 billion with per capita GPD of $1,471.8 (World Bank, 2020). About 58% of the population is under 20 years old, with 55.7% has formal education. Service, agriculture and industrial sector contribute 49.94%, 17.03%, and 23.22%. Horticulture production is a backbone of the Senegalese economy due to production of food, income for rural people, employment and foreign exchange through exports. The added value of its products and the existence of a potential market both domestically and internationally make horticulture very attractive and profitable.

Senegal is endowed with favorable climatic conditions for horticultural production in different areas of the country: Cape Verde region, the Niayes, the Senegal River valley, eastern Senegal, Casamance, center of Senegal. Moreover, the practice of horticultural crops has become a tradition in the northwestern part of the country which practically serves as a learning zone for the rest of the other regions. The growing urban demand for fruit and vegetables and the development of export market of these products to Europe with the presence of international airport infrastructure in the capital are remarkable factors supporting the growth of this sector. The sector is steadily increasing despite the difficulties that still remain despite goals set by the State.

9.2 Geography and Markets

Senegal's closeness to EU makes the country a potential hub for horticultural crop production in West Africa. The country is appromxiately 5,139.3 kilometers from EU coupled with favourable climatic and soil conditions for horticultural production in different areas of the country including the Niayes, Senegal River Valley, eastern Senegal, Casamance, and Valley in Saloum (center of Senegal). The main horticultural exports are products such as melon, cherry tomatoes, sweet corn, green beans, squash, sweet potatoes, etc. The national market and exports to countries in the sub-region, absorb a very good part of this national production.

Notable production practices

The region Niayes extending from Dakar to St Louis, is credited with more than 60% of crops produced in Senegal, and provides onions, potatoes, carrots, kale, cherry tomatoes, eggplants, lettuce, pepper. The Senegal River Valley area specializes in industrial tomato production (90 000 tons in 2010), onions (between 30 000 and 60 000 tons) and sweet potato (more than 60 000 tons/year).

- Valley of Lower Saloum, where African vegetable types are sold (Bisap, okra, Jaxatu).

Fruit crops are including:

- In Lower Casamance (mangoes, bananas, citrus fruits) and
- Other production clusters are the medium Casamance area (Bananas),
- The Dakar-Pout - Mboro, and Dakar- Mbour with productions of mango, citrus, papaya.
- Eastern Senegal Tambacounda with the area around the Gambia valley (bananas and mangoes).

The future potential expansion zones of fruit crops are:

- The Senegal River Valley with the axis Dagana - Podor
- Bakel for Banana
- Kolda for mangoes and bananas.

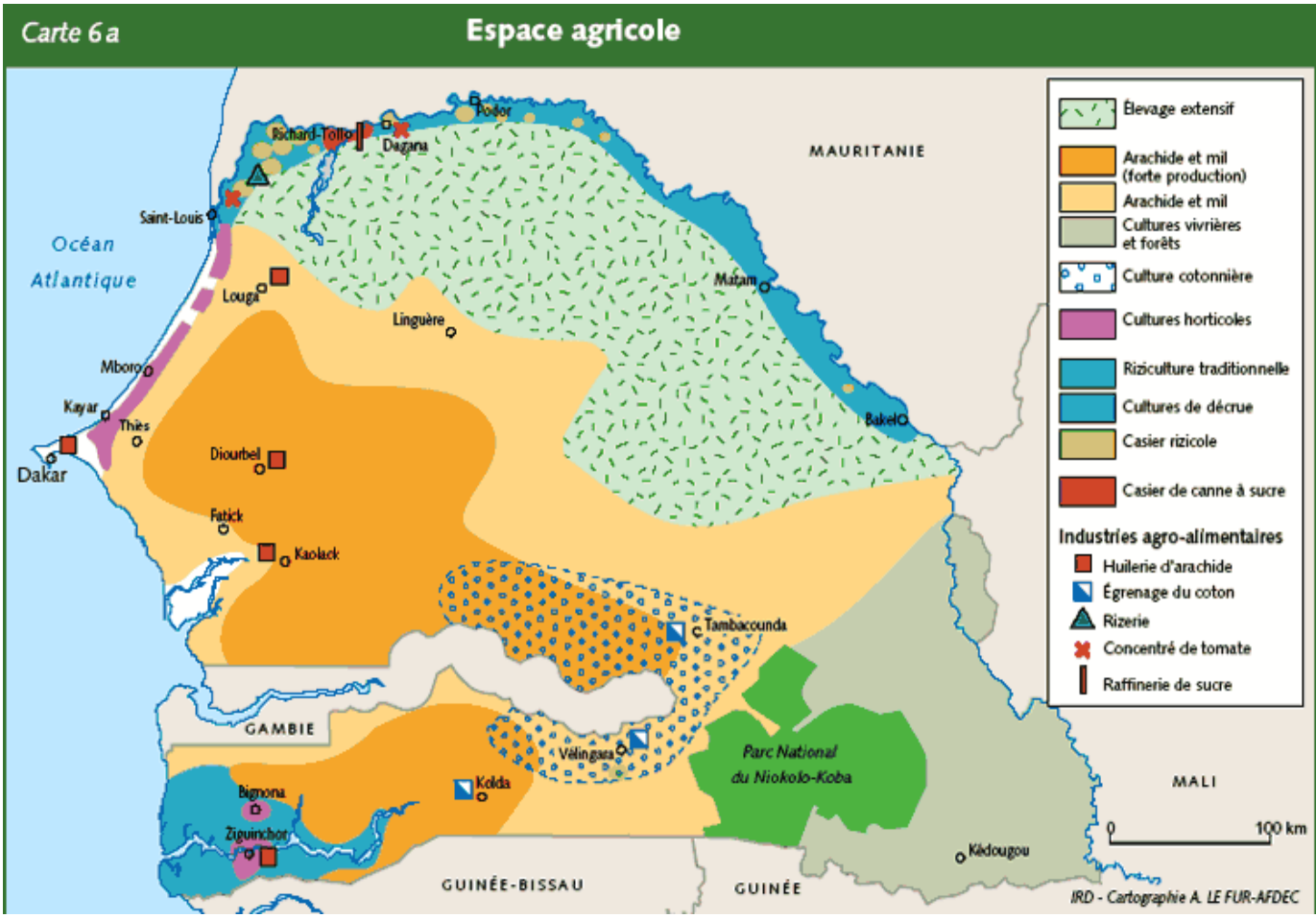


Figure 9.1: Agricultural Areas in Senegal

The Senegal River Valley region and the Niayes are the main production areas for onions in Senegal. These locations account for 85% of annual production. Exponential growth in demand for onions locally has led to new smaller production regions. In 2016, Thiès, Kaolack, Touba and Kolda produced approximately 15% of overall onion production. The large size of the onion market has also attracted interest from large scale industrial agriculture with a few important investments having been made in the recent years. Farmers pump water from the river, and use gravity irrigation or pumps to irrigate their fields.

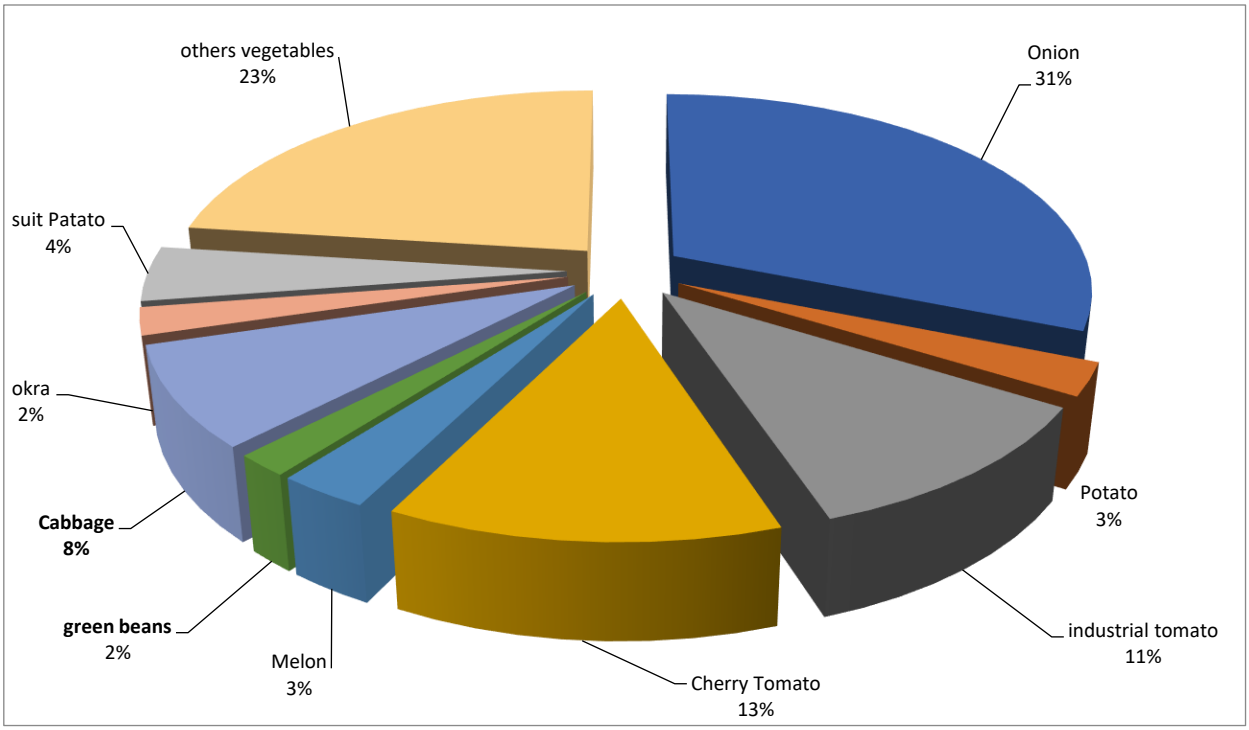


Figure 9.2: Distribution of vegetable production in Senegal (%) in 2012

Source: DH Data 2012

9.3 Challenges and opportunities in Horticulture Sector

Horticulture – Biophysical

Inputs (including seed supply)

The market for horticultural inputs and seeds is very well organised in Senegal. Most inputs such as seed and fertilizers are imported. The producers source various fruits and vegetable seeds from international private sector companies. Quality seed is supplied by companies such as Bejo Seeds, who have a strong working relationship with these firms. For the more vertically integrated producers who produce in multiple countries, inputs in general are sourced for the entire group, rather than for their Senegal locations alone. Pesticides certified for use in the EU are not available in Senegal. Local multiplication of vegetable seed is only done on a very small scale by cooperatives in the sector. Even small-scale producers typically access green bean and sweet corn (and other vegetable crops such as tomatoes, aubergine, squash etc) seed via input suppliers.

Production

Table 9.1: Fruits and Vegetable Production in Senegal (2012-2019)

Commodities	2010/2011	2012	2013	2014	2015	2016	2017	2018	2019
Onion	190 000	210 000	230 000	245 000	367 500	393 225	400 000	434 112	444 871
Potato	12 500	15 000	20 000	29 680	52 230	67 485	118 783	140 000	158 875
Industrial tomato	110 000	80 000	50 000	97 513	57 700	32 000	70 000	77 000	73047,6
Cherry tomato	50 000	80 000	110 000	83 000	82 500	70 000	68 000	71000	78 396
Melon	15 000	20 000	18 000	20 000	19 000	21 500	28 000	24532	25 632
Green been	10 500	10 000	14 000	10 500	15 500	15 000	18 700	18815	20 879
Cabbage	50 000	55 000	55 000	51 182	55 500	60 000	76 116	105096	189 618
Okra	13 000	15 000	15 000	15 000	15 000	15 000	14 500	14000	22 185
Sweet potato	35 000	30 000	30 000	28 350	35 000	70 000	72 000	89397	96 360
carrot	-	-	9 500	10 500	11 500	12 000	16 000	17085	24 600
Hibiscus sabdariffa	-	-	1100	1 200	1 200	1400	1300	1500	1678
Other vegetables	15 400	160 000	168 000	160 500	185 800	207 700	200 000	209751	215 875
Vegetables	**640 000**	**675 000**	**710 000**	**741 925**	**886 930**	**953 310**	**1 083 399**	**1 202 288**	**1 349 016**
Mango	120 000	125 000	130 000	131 500	125 000	130 000	132 000	128 450	130 000
Banana	30 000	35 000	35 000	35 575	36 500	37 000	30 000	31 422	33 110
Citrus	50 000	45 000	40 000	50 000	50 000	50 000	45 000	48 500	52580
Other fruit products	20 000	25 000	35 000	36 000	35 000	36 500	30 000	35 700	59 750
Total Fruits	**220 000**	**230 000**	**240 000**	**253 075**	**246 500**	**253 500**	**237 000**	**244 072**	**275440**
Total fruits and vegetables	**680 000**	**905000**	**932000**	**995 000**	**1133430**	**1206810**	**1 320 399**	**1 446 360**	**1 624 456**

Improved varieties

Farmers in Senegal source seeds largely from the private sector. A variety of seeds are available in Senegal that allows for production in both the cold season and the early part of the hot season. Importers form the cornerstone of this portion of the onion value chain. Tropicasem is a major player, importing seeds that have been tested for being suitable for local conditions.

Postharvest management of fresh products

In Senegal, there is lack of infrastructure for large production areas. For example, the region of Casamance region, which provides 55% of the national mango production, has no cold storage infrastructure.

- Since 2000, the state has started a program for cold storage in Rao, in the north of the country, with 9 cold rooms, a total capacity of 2500 tons, but this infrastructure is currently facing a problem with the management of the structure
- High Cost of rental: 30 million FCFA / month
- High Cost of electricity and water
- Another challenge is post-harvest losses due to pest infestation. For example, due to fruit flies, Senegalese mango farmers lost up to 30-40% of national production across the country.

Problems in postharvest industry

- No access to appropriate technologies
- No transformation in product quality
- No access to finance for marketing and processing
- Dearth of technological and business information
- Insufficient technical and commercial partnerships
- Processing industries, are facing equipment problems;
- The high cost of the raw material.
- Lack of managerial and commercial building technical capacity

Processing and packaging – value addition to horticultural crops

The processors are faced with high cost of raw materials, which makes it difficult to expand. Regarding packaging, a lot of effort remains to be done to be competitive.

Natural resources

Water

The main water for horticulture production is mainly rainfed. Other major rivers which provide water for irrigation include;

- The Senegal River which is 1,770 km long and its watershed extends over 337,000 km^2, 60,000 of which are in the national territory. The current inter-annual flow of this river is around 410 m^3/s per year on average.
- The Gambia River is 1,150 km long, of which 477 km are in Senegalese territory. Its average annual flow at Gouloumbou is 135 m^3/s (1970-1995) and 70 m^3/s at Kédougou. Its watershed covers an area of 77,100 km^2.
- Lake Guiers: The volume of Lake Guiers is estimated at 601 million m^3, when the body of water reaches the dyke at 1.80 IGN. It is fed by the Senegal River from the Taouey Canal. This lake is a particularly vital ecosystem for the entire northwestern part of the country, but also a very important permanent freshwater reserve.

Soil

Soils can be grouped into four main types include sandy soil, loamy soil, clay soil. and humus soil.

Farms that observe increased yields are planted on soils are deep, well aerated, rich, free of obstacles, with little relief, low slopes, a suitable water regime and other natural factors. Most horticultural soils are not hydromorphic.

Climate

The climate is of the Sudano-Sahelian type characterized by the alternation of a dry season from November to May and a rainy season from June to October. The average annual rainfall follows an increasing gradient from north to south of the country.

9.4 Socio economic

Women in Horticulture

Women ownership of horticultural land are very rare. These lands are registered in the name of their husbands. They however invest in the purchase of seeds, and agricultural inputs, to be paid in kind at harvest. Women are mainly involved in the marketing of harvested products; they buy at farm gates and supply most retail markets in large cities.

Youth and Horticulture

Most of the workforce on horticultural farms is made up of young people. About 60% mostly engage in manual irrigation. Young girls and women of working age are mainly involved in harvesting and packaging fruits and vegetables.

Market and Consumption

Demand for Nutritious Fruits and Vegetables

The fruit and vegetable sector offers an example of the dynamism displayed by this type of activity. Upstream there is a very diversified production of fruits and vegetables extended in space and time.

Market Access (including product forms and price trends)

Currently in Senegal, horticulture production is very profitable business. However, transportation, processing, installation around these processing plants, input supply are areas that require significant investment.

Value-added horticulture products

Horticultural products are sold on the field, however entrepreneurs (men and women) come to buy and add value to them, by processing, packaging and transporting them to distant markets.

Trade

The export campaign for horticultural products starts immediately in January of each year for cold off-season speculations such as vegetables. For mango, exports start in May. Export volumes has increased significantly in recent years, ranging from 65,778 tons in 2012 to 107,977 tons in 2019.

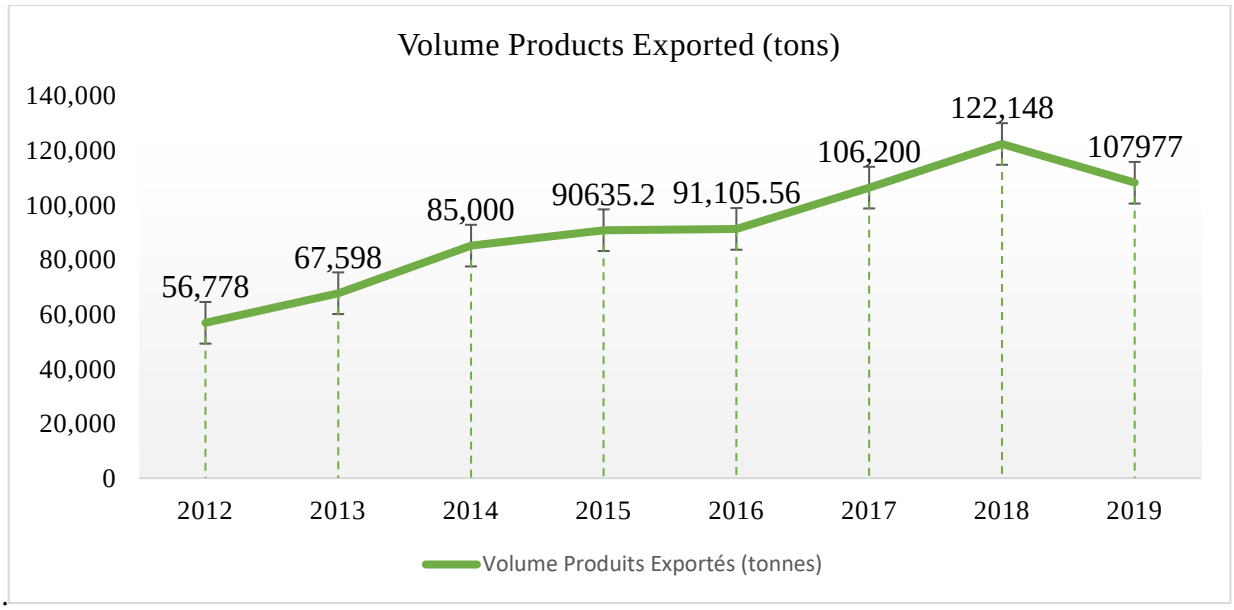


Figure 9.3 Volume of products exported from 2012- 2019 in MT

Engineering and technology

Senegal has a very high level of technologist, who have learned all the facets of modern agriculture, from irrigation to harvesting, including other technical production routes; now remains to disseminate it the modern technologies on a fairly generalized level.

Production Technology and Supplies

Production technologies and supplies of inputs and equipment exist in Senegal, but the availability of credit necessary for their acquisition of these technologies remains a challenge.

Postharvest packaging, cooling, cold storage, drying

In recent years, there has been a sustained development of agro-food processing activities with the emergence of small and micro enterprises mostly in urban areas.

In Senegal, post-harvest losses of variable amplitude ranges from 30% for cabbage, 50%, for onion, to over 40% for the mango.

- For the cabbage, cold storage at 4-5 degrees for 2-3 weeks is necessary.
- Mango, with marmalade, syrup and dried mango slices, jam, drink nectar.
- For the onion, there is the dried onion, onion powder made primarily with white varieties, to season gri lled meats.

Apart from direct consumption at the household level, cabbage undergoes no further processing for the moment. It is mainly used in Senegalese rice and fish dishes. Households in Dakar (92%) use cabbage at least once a day but this high frequency of use does not correspond to a large cabbage consumption per household.

There were cabbage processing technologies sponsored by the Association of Unions of vegetable Niayes (AUMEN) in 2014, with the Food Technology Institute (ITA) in Senegal.

The marketing of cabbage is through urban and rural markets. Distribution channels are mainly oriented towards local demand.

Research, education and training

Agricultural research, the National Agency for Agricultural and Rural Council (ANCAR), and Directorate of horticulture are currently carrying out plans for lead producers to be competitive on the national and international markets, producing healthy vegetables of impeccable quality.

Education and training needs in horticulture

Education of horticultural professions needs to be strengthened. There is a need for capacity building for producers.

Research capacity of technical vocational institutes, universities and research institutes

Agricultural research is well established in Senegal; Within this structure, horticultural research, with the creation of the Center for the Development of Horticulture (CDH), founded in 1972, has even trained a very good part of the executives of the sub-region. This center with all the specialties aims to take care of all the issues related to horticulture on a national scale. Senegal has all the training structures related to horticulture; indeed, the various 5 universities are inserted within the departments of agriculture / horticulture. In addition, there are training centers for horticultural technicians and senior technicians at all levels.

Extension capacity in public and private sector

At the national level, we have a rural extension structure, the National Agency for Agricultural and Rural Advice (ANCAR). This is a competent structure, which has specialized personnel at all levels, yet suffers from a lack of workforce and logistical resources, to better respond to requests from producers. At the NGO level, there are several structures working in rural development, which also do agricultural and horticultural extension at the national level.

Policy and Horticulture

Since 2000 the state has adopted new policies and strategies, for the modernization and intensification of agriculture, crop diversification, food security, poverty reduction, access to foreign markets and rising incomes.

SIERRA LEONE

10.1 Introduction

Sierra Leone is a small country located on the west coast of Africa between Latitudes 7ºN and 10ºN and Longitudes 10ºW and 13ºW. It is bordered on the Northwest by the Republic of Guinea, on the Southeast by the Republic of Liberia and on the southwest by the Atlantic Ocean. Sierra Leone is divided into Northern, North-western, Eastern and southern regions with fourteen districts (Bombali, Karene, Kabia, Portloko, Tonkolili, Koinadugu, Fabala, Kenema, Kono, Kailahun, Bo, Bonthe, Moyamba and Pujehun) and the Western Area (Figure 10.1). The climate is characterized by the wet season (May-October) and dry season (November-April). The country has a conducive agricultural environment consisting of optimum temperature conditions, an abundance of rainfall and many rivers with great irrigation potential to support year-round horticulture production.

The country has a land area equivalent to 72,300 km^2 with the uplands and lowland occupying 60,650 km^2 and 11,650 km^2 respectively. About 5.4 million (ha) (74%) are fertile arable lands which have great potential for crop production (Population and Housing Census, 2015). These attributes, coupled with the relatively all-year-round normal temperature conditions and the abundance of rainfall and rivers, makes the production of diverse crops including vegetables and fruits possible in most parts of the country.

The economy of Sierra Leone is dominantly agrarian. About 89% and 58 % of the population engaged in farming in 2004 and 2015 respectively. The agriculture sector contributes the largest share of the gross domestic product (GDP) during the period 2010-2019 (Figure 10.2). Although a decline from 54.6% in 2011 to about 48% in 2013 was reported, it employs more than 70% of the country's labour force (Population and Housing Census, 2015; World Bank, 2019). The crop subsector's contributions to agricultural GDP ranged from 29-37 %, of which horticultural crops contributed between 3-4 % during 2010-2013 (Figure 10.3). The agriculture sector in Sierra Leone is still dominated by smallholder subsistence farmers who use traditional tools, with limited farm inputs.

Figure 10.1: Map of Sierra Leone showing regions and districts.
Source: IFAD, 2020.

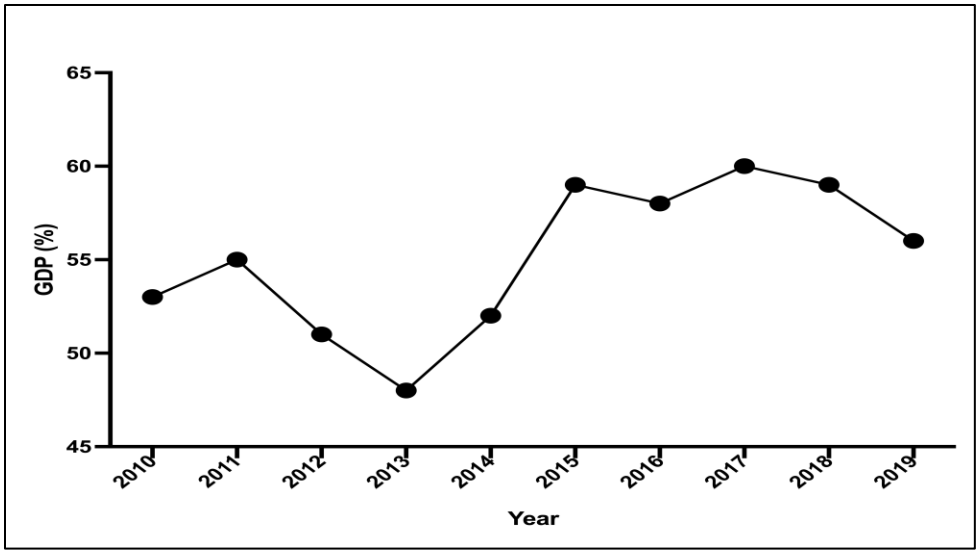


Figure 10.2: Trend analysis of the contribution of the agriculture sector to Sierra Leone's GDP (%) from 2010-2019

Horticultural crops are cultivated in all the regions of Sierra Leone in both the upland and low land ecologies. However, the production of horticultural crops is more concentrated in certain regions /districts. For instance, the cultivation of pepper is predominantly carried out in both the northern and southern regions; Okra cultivation is done in the northern and the eastern regions. The cultivation of pepper is done in Koinadugu, Port Loko and Tonkolili districts in the north and Pujehun in the south, while okra is cultivated in Bo district in the south (Figure 36).

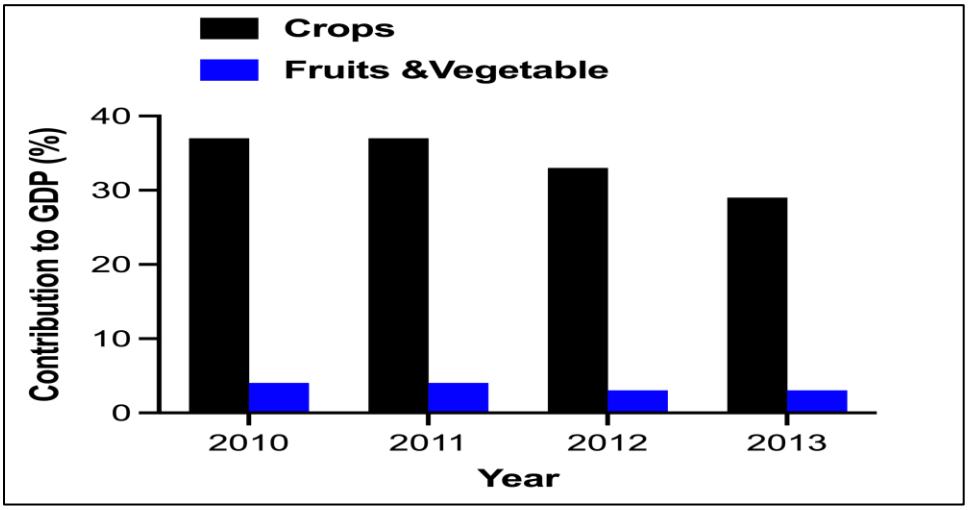


Figure 10.3: Trend analysis of the contribution of the vegetable and fruit subsector to Sierra Leone's GDP (%) between 2010-2013 **(Source PEMSD 2015)**

However, okra yields are relatively low in all districts (Figure 10.4), despite variations in the cultivated area at regional and district levels. Except for pineapple, which is concentrated in the Moyamba district, south of the country (Head of Horticulture division, MAFFS), the cultivated area and yield data are not available.

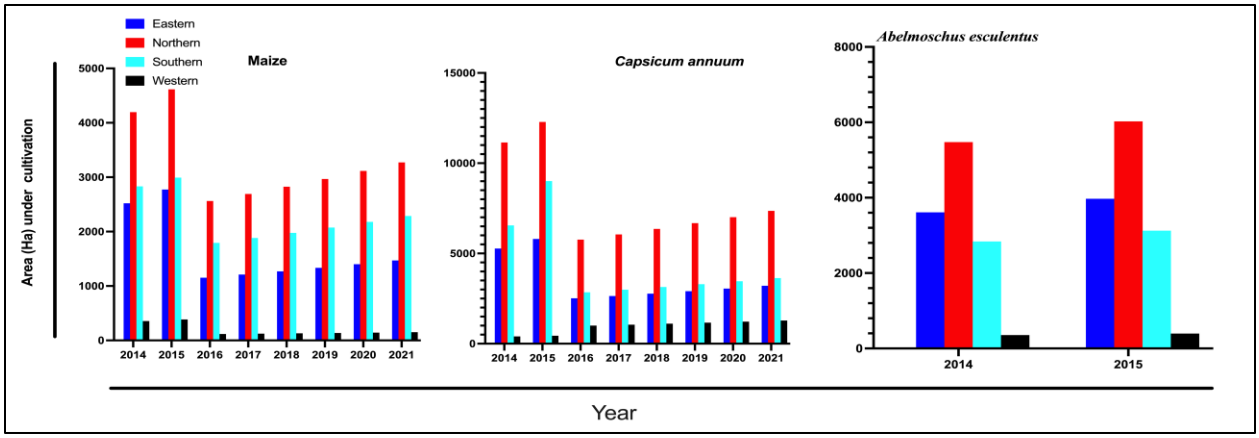


Figure 10.4: Area (Ha) under *Zea mays*, *Capsicum annuum* and *Abelmoschus esculentus* cultivation by region from 2014 -2021. **(Source: PEMSD of MAFFS).**

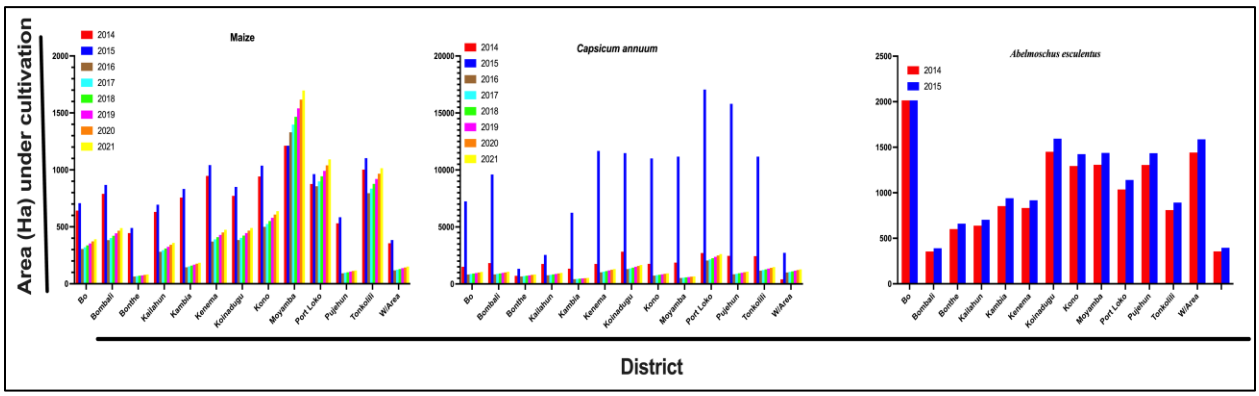


Figure 10.5: Area (Ha) under *Zea mays*, *Capsicum annuum* and *Abelmoschus esculentus* cultivation by district from 2014 -2021.

Source: PEMSD of MAFFS

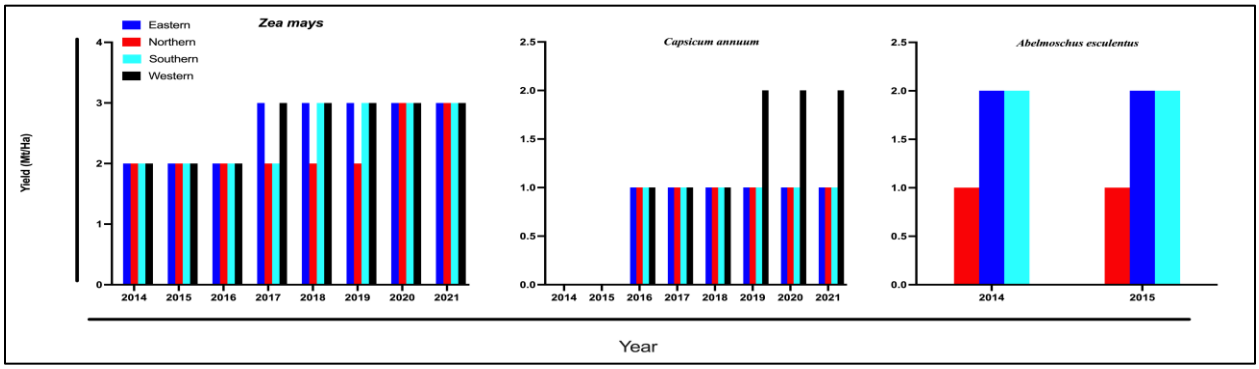


Figure 10.6: Yield (Mt/Ha) of *Zea mays*, *Capsicum annuum* (2014 -2021) and *Abelmoschus esculentus* 2014 -2015 by region.

Source: PEMSD of MAFFS

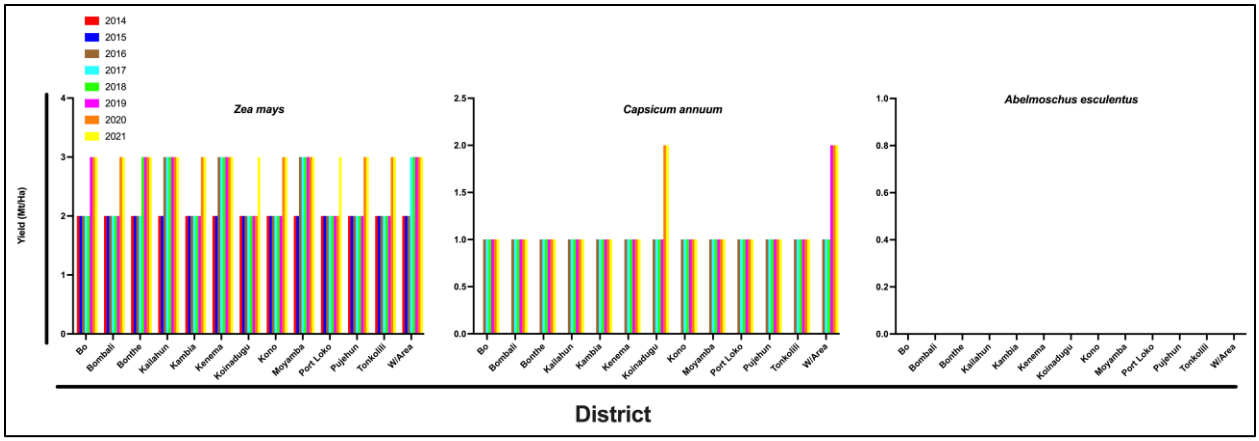


Figure 10.7: Yield (Mt/Ha) of *Zea mays*, *Capsicum annuum* (2014 -2021) and *Abelmoschus esculentus* (2014 -2015 by district).

Source: PEMSD of MAFFS

In the vegetable subsector, the main crops include exotic types such as onion (*Allium cepa*), okra (*Abelmoschus esculentus*), pepper (*Capsicum annuum*), eggplant (*Solanum melongena*) and tomato (*Solanum lycopersicum*) (Head of Horticulture division MAFFS). Other widely grown and consumed indigenous vegetables include the leafy greens mainly cassava (*Manihot esculenta*), sweet potato (*Ipomoea batatas*) and krain krain (*Corchorus olitorius*) which are often neglected and corn (*Zea mays*). Exotic vegetables that are less widely grown and consumed include cabbage (*Brassica oleracea*), lettuce (*Lactuca sativa*), and carrot (*Daucus carota*). In the fruit subsector, the popular fruits include mango (*Mangifera indica*), pineapple (*Ananas comosus*), orange and lime (*Citrus species*), Avocado pear (*Persea americana*) and banana/plantain (*Musa species*).

In Sierra Leone, the development of the horticulture sector is very slow. The sector lacks a well-organized growers association, and research. In addition, women's access to production inputs (seeds, fertilizer and agrochemicals), finance and markets is a major barrier to production. Vegetables produced by farmer associations are purchased by hotels, restaurants and petty traders. However, vegetables produced by individual farmers do not have real markets. The horticulture subsector in Sierra Leone is underdeveloped and has several challenges.

10.2 Challenges and Opportunities

Horticulture-Biophysical

Inputs

Supplies of fertilizers and pesticides are inadequate for domestic requirements and are mainly sourced from imports as there are no local fertilizer/pesticide manufacturing industries in the country. In addition, these inputs are expensive and inadequate for the majority of growers of vegetables and fruits.

Quality seeds (hybrids/improved seeds) of locally cultivated fruits and vegetable crops are not available. Seeds of vegetables are sourced from imports (exotic). Seeds of exotic vegetable crops including those of lettuce, cabbage, onion and carrot are very expensive.

Improved varieties

No locally developed (bred/improved variety) cultivars of horticultural fruits and vegtables has been released. A catalogue of locally bred crop varieties so far released included cereals (rice), tubers (cassava and sweet potato) and legumes (cowpea and soybean and groundnut).

Underutilized Neglected and indigenous crops

The green leaves including cassava, sweet potato and krain krain (*Corchorus olitorius*) are rich in minerals and have high economic and market demands. They form part of the daily intake of vegetables for most Sierra Leoneans. Thus, estimation of the area of cultivation, yield/ha and production values and market price trends for varieties/cultivars of cassava, sweet potato (exclusively consumed as green leaves) and krain krain are hitherto, not determined.

Postharvest Management of Fresh Products

- Postharvest losses are high due to a lack of appropriate postharvest management techniques such as controlled ripening, edible coating, temperature management, and chemical treatment methods.
- There is a total lack of cold-chain from farm gate to market centres due to the absence of cooling vans or cool storage centers for harvested horticultural products.
- Food quality control is a major problem. Both export and locally consumed vegetable and fruit products are supposed to be sanitized prior to their release for export or to local markets. Due to the high cost and unavailability of agrochemicals, smallholder farmers cannot afford to fully adhere to phytosanitary requirements for their products. For export markets, exporters are required to obtain a quality certificate from the Ministry of Agriculture, Forestry and Food Security.

Processing and Packaging

- Processing and packaging of horticultural products are challenging issues in Sierra Leone, especially for rural smallholder vegetable farmers which are indicated by the high level of postharvest wastage.
- There are limited processing (with exception of drying chili pepper and canning of pineapple), packaging and storage facilities in the country, as such most vegetables and fruits are harvested and consumed fresh and producers are not able to benefit from value addition.

10.3 Natural Resources

Water (availability, quality and accessibility)

Sierra Leone has two main seasons-wet season and dry season. Since the horticulture crop production system in the country is exclusively rainfed, water availability, accessibility and quality are major challenges during dry season cultivation even though the country is blessed with nine rivers.

Soil

- Due to increased pressure on arable lands as a result of population increase and a decrease in the land fallow period, there is an overall decrease in soil fertility levels especially in upland areas resulting in overall low crop yield.
- Upland soils - the most dominant - are generally ferralitic, shallow and susceptible to low fertility with high aluminium contents. The remaining lowland soils, which are relatively better in fertility, are subjected to seasonal or permanent water logging, inadequate drainage and again have related problems of high iron and aluminium content.

Climate

At the global level, Sierra Leone's contribution to global warming is negligible. However, Sierra Leone is likely to be disproportionately affected by the impacts of climate change as a result of limited adaptive capacity and widespread poverty. Rising sea levels and increased risk of flooding, changes in rainfall and

temperature patterns, and intermittent droughts are among the already experienced effect of climate change reported by key actors of the horticultural crop value chain. These are reported to negatively impact horticultural crop production through damages to crops, delay in product transport and crop/product loss.

10.4 Socioeconomic

Women in Agriculture

The horticulture sector is dominated by smallholder farmers mostly women. Leo (2015), reported that women accounted for about 85% of the total labour. Despite that, they tend to handle the less labour-intensive tasks in the value chain including nursery establishment, planting, ongoing management and the majority of the postharvest activities. Women are also essential as aggregators and are exclusively the main actors of the retailer component of the horticultural value chain.

Youth and horticulture-roles of youths in horticulture, barriers

The government of Sierra Leone, in a bid to mainstream youth in development planning, developed the National youth policy in 2003, which is anchored on the notions of youth empowerment and the creation of responsible citizenry. Although generally, agriculture and specifically horticulture have the potential to employ youths, MAFFS has not developed a specific policy to mainstream youth in the horticulture subsector. This serves as a major barrier to identifying the specific roles of the youth in the horticulture industry.

10.5 Market and Consumption

Demand for nutritious fruits and vegetables

The roles of fruits and vegetables in maintaining health are well acknowledged and seen as important. Vegetables and fruits are important sources of minerals such as phosphorus, iron and calcium, vitamins A, B and C and sometimes proteins (Nutrition data, 2015). In 2014, the trade database reported significantly more imports than exports for vegetables (ComTrade, 2015). The total reported vegetable import amounted to $8.65 million while reported export in the same year amounted to $217,733. This suggests that local vegetable production is not adequate to meet the local demand. Although export and import data for fruits are not reported in this review, fruits such as pineapple, banana, pear, citrus (lime and orange) have high local demand, indicated by their prices at the retail level on the Freetown market. For instance, a single pineapple cost about $1.5 while a single pear cost about $1 (Key informant, 2022).

Market Access

Vegetables and fruits can be found in markets of all sizes, with the primary vegetables being onion, leafy greens (cassava, sweet potato and krain krain), okra, eggplant, chili pepper, and onions and in the case of fruits being banana, pear, pineapple, orange, mango. However, access to markets by the producers is a major constraint due to poor road infrastructure. Both fruit and vegetables are often sold as fresh products. Prices are not constant throughout the year. Although there are no market survey reports indicating price trends of horticultural crops, vegetables are most expensive in the dry season and are least expensive in the rainy season while fruit prices are more expensive during the offseason and least expensive when in season.

Value-added horticultural products

The transformation of fruits and vegetables is generally underdeveloped or limited in Sierra Leone, except for drying chili pepper and canning of pineapple. The lack of processing and refrigerated storage facilities are the major bottlenecks. Thus, the majority of the country's horticultural products are exposed and consumed fresh.

Agribusiness opportunities

Potential for agribusiness exists at various points along the horticultural crop value chain from production to retail. Major constraints of the horticulture sector are the lack of modern technology and mechanized equipment for use in the cultivation of crops. Supplying labour-saving agricultural equipment like tractors, power tillers, ploughs, and harvesters are opportunities for investors. Adding value to horticultural products through processing and manufacturing presents an opportunity for investors from both domestic and international markets.

Trade

Vegetable and fruit exports are minimal. However, ComTrade (2015), reported vegetable exports to the Gambia. Although export data are not available, Guinea and Liberia are potential regional markets for horticultural products given their proximity to Sierra Leone. Additionally, chili pepper and eggplant exports to Austria were reported in 2014, and chili pepper exports to Canada, Bahrain and Germany in 2012. However, the value and volume of exports were not reported for these periods., Information on exports of fruits and vegetables to regional and international markets are difficult to access locally. This can be attributed to either key players involved in the trade of horticultural products not taking record of their transactions or are not willing to release relevant information upon demand by researchers. This was evident during information gathering exercise for the current review and is a serious impediment to institutions and researchers engaged in horticultural products trade and could serve to obscure the country's output/performance for the horticultural sector.

10.6 Engineering and technology

Production technology and supplies

Sierra Leone Agricultural Research Institute (SLARI) is the institution charged with the responsibility to develop technologies to enhance crop production in the country. However, given the limited resource (financial) base of the institution, very little is being done in the area of technology development to enhance horticultural crop production, although greenhouse production at the Kabala horticultural research centre in the Koinadugu district is at its earliest stage of development. Development of climate-smart horticultural crop varieties (hybrids) is also a big challenge since no locally bred and improved horticultural crop variety/cultivar has ever been released in the country.

Postharvest packaging, cooling, cold storage

These are among the main challenges facing the horticulture sector since there are limited or no post-harvest packaging materials, cold storage centres, cooling van/refrigerated vehicles in country.

Processing of horticultural products

There are limited processing facilities in the country. Among the horticultural crops, chili pepper is processed through drying whilst pineapple is canned into fruit juice. Due to the limited availability of postharvest processing and packaging, and cooling/cold storage facilities in the country, huge quantities of the harvested products are lost.

10.7 Research, Education and Training

Education and training needs in horticulture

To improve the horticulture sector in Sierra Leone, the need for training horticulturists is paramount. Training needs in the following areas were identified: postharvest management and value addition. In addition to post harvest handling of horticultural products, disease management, pest management, nutrient management, marketing of horticultural produce, nursery management, packaging of horticultural products,

land management, transplanting, orchard management, raising seedlings, greenhouse/protected cultivation and horticultural crop genetic resources development and conservation are needed.

Research capacity of technical vocational institutes, universities and research institutes
Research is a critical component of higher education systems. Research creates new knowledge or utilizes existing knowledge to bring about innovative applications directed towards specific practical aims and objectives. Universities/research institutions with high research output are ranked high in terms of academic standards. In Sierra Leone, there are three institutions: Sierra Leone Agricultural Research Institute (SLARI), Njala University (NU) and the University of Sierra Leone (USL) mainly involved in horticultural research. The research capacities of these institutions are not strong and research outputs are low. Several obstacles hinder these institutions' efforts towards the research capacity building which include: lack of or inadequate funding, lack of conducive research environment and infrastructure including laboratory space, basic laboratory instruments and chemicals, research gardens/stations/growth chambers, greenhouses, internet facility, unreliable electricity supply, lack of information due to poor access to electronic databases, e-journals, e-books, and lack of mentorship.

Extension capacity in the public and private sector
An efficient horticultural extension service is crucial to increasing the knowledge of agronomic techniques and skills of smallholder farmers to improve productivity, food security and livelihoods. Due to major challenges including the lack of resources, poor knowledge of improved horticultural technologies, high illiteracy levels among the farmers, the extension capacity of the public sector workers is very weak. Furthermore, most of the extension staff in the MAFFS are males who find it difficult to work with exclusive women groups since women dominate the horticulture sector.
Local, regional and national government policy intervention to improve the horticulture sector
There are no clearly outlined local, regional and national policy interventions to improve horticulture in Sierra Leone.

Policy and horticulture
There is no policy specially targeting horticulture development in Sierra Leone.

Opportunities for horticulture sector development in Sierra Leone

- Strengthening the research capacity of research institutions to develop and conserve horticultural crop genetic resources including climate-smart (short duration, temperature and drought resistant, hybrid, disease resistance) crops as well as in various aspects of horticultural crop production including greenhouse/protected cultivation, postharvest management and food safety, pests and disease control, nutrient management, market systems and market channels, gender and women empowerment.
- Strengthening of the capacity of extension staff of the MAFFS and NGOs to facilitate training of horticultural crop producers and other value chain actors.
- Establishment of solar-powered cold storage facilities and provision of refrigerated vehicles to minimize postharvest losses of horticultural crop products during storage and transport.
- Establishment of modern irrigation systems for dry season cultivation of horticultural crops
- Establishment of greenhouse facilities to enhance the production of quality horticultural crop products.
- Establishment of fertilizer and packaging materials production industry and agri-processing and packaging facilities.

10.8 Horticulture Research Priories

The diversity of horticultural crops (local) in this country is enormous but little or no efforts are being made to tap their potential to enhance food security and nutrition. It is necessary to investigate the horticultural crop genetic resources base of the country to facilitate their development and conservation.

To promote ongoing horticultural production, it is imperative to conduct a needs assessment of horticultural crop producers and other actors in the horticulture value chain to enhance production, processing and packaging, storage and transport, and minimize post-harvest losses.

Key identified challenges associated with the horticulture subsector include

- Lack of policy for horticulture development
- Inadequate and high costs of agricultural inputs such as fertilizers, pesticides, and quality seeds
- High postharvest losses due to the lack of appropriate postharvest management techniques, cold storage centres and refrigerated vehicles, processing and packaging facilities
- Poor extension services
- Poor rural road infrastructure
- Lack of modern irrigation technology for dry season cultivation

Key areas of possible interventions/opportunities for horticulture development

- Strengthening the research capacity of research institutions
- Strengthening the extension capacity of the public and private sector
- Establishing solar-powered cold storage, greenhouse, agri-processing and packaging facilities, and provision of refrigerated vehicles
- Establishing modern irrigation facilities

SUMMARY AND CONCLUSIONS

BIOPHYSICAL

Inputs Supply: Conventional inputs such as fertilizers, seeds, pesticides, land, and labour play an important role in fruit and vegetable production in West Africa. Inorganic fertilizers and pesticides are widely used in fruit and vegetable production in West Africa, but fertilizer application rates are still lower than those of Asia and Latin America. Most farmers are unaware of which pesticides to use and how to apply them, thereby putting the health of their customers in danger. However, almost all the countries do not engage in commercial production of inorganic fertilizers and pesticides but import them from Morocco, Asia, and Europe to meet farmers' demands. Improved seeds are also imported into West Africa. However, there are few seed-producing companies and public research institutions in Ghana and Nigeria. Farmers source their inputs from multiple channels, including their own saved seeds, neighbours, informal markets, commercial input dealers and seed-producing companies. Only a few countries, including Ghana, have subsidies on inorganic fertilizers and improved seeds in the agricultural sector.

Production and Productivity of Horticultural Crops: The horticultural sector in West Africa is mainly dominated by fruits and vegetables. Production and marketing activities are largely informal. However, the sector supports social and economic development in West Africa. Vegetable production is dominated by tomatoes, onions, and chilies, while pineapples, oranges, mangoes, pawpaws, and bananas are the main fruit produced. The total area under fruit and vegetable production has increased over the last three decades. Production of fruits and vegetables has more than doubled since 1990, but the region is not self-sufficient in fruit and vegetable production due to low yields.

Improved Varieties of Fruits and Vegetables: For vegetables and most fruits, farmers use local varieties and informal seed sources. The formal commercial seed sector serves only a small portion of vegetable producers, more often supplying commercial markets with quality seeds and improved varieties, such as for tomato, onion, and peppers. MD2, Smooth Cayenne, Sugar Loaf (Pan de Azucar), Red Spanish, Queen Victoria and Abacaxi are the dominant improved varieties of pineapples grown by farmers. For orange, Washington navel, crimson blood orange, hamlim, and late Valencia are among the major improved varieties cultivated by farmers. Kent, Keitt, and Springfield are the major mango varieties grown. The major improved varieties of bananas grown in West Africa include Cavendish, Mysore (Alata kwadu, local variety), and Gros Michel varieties are the widely grown and preferred bananas in Ghana. The main varieties of pawpaw planted in Ghana are Solo dwarf, Hortus Gold, and Bluestem. Green chilies, Scotch bonnet, and Bird's eye are widely grown in Ghana and Nigeria. Recent improved varieties of tomatoes in Ghana include Kwabena Kwabena, Kopia, AdopeShiteAdopte, Mako Ntose, Pectomech, Power Roma, Techiman (CSIR, 2022), and Eva F1, Padma F1, COBRA, Sultan, Raja, and Gigantico. Bawku Red and Galmi are the two main varieties of onions grown in Ghana.

Postharvest Management of Fresh Products: The main postharvest management practices of fruits and vegetables identified in West Africa include precooling, washing and disinfecting, sorting and grading, packaging, storage, and transportation. These management practices help maintain the quality and increase the shelf life of fruits and vegetables. Precooling is done with the help of refrigerators. Cleaning and disinfection are done by washing the product in clean water and disinfectants. Sorting and grading are done

to eliminate unwanted products from the harvest, and also to determine prices. Generally postharvest management such as cleaning, disinfection, grading and sorting as well as cooling/refrigeration is not practiced for fruits and vegetables sold on the local market.

Pests and Diseases: Pests and diseases are major problems in fruit and vegetable production because they cause significant crop loss for farmers. This includes diseases such as anthracnose, powdery mildew, alternaria, stem-end rot viruses, nematode infestation. *Pseudocercospora* leaf and fruit leaf spot of citrus, Cape St Paul wilt for coconuts, bacteria black spots (BBS) and pests (fruit fly, mealybug, termites, mango bugs)in mango.

NATURAL RESOURCES

Water: Water for fruits and vegetable production is mainly from irrigation, rainfall or wastewater. However, farmers depend mainly on rainwater for fruit and vegetable production. Water availability and quality are a challenge to the development of the horticulture sector. Most urban farmers use wastewater, which carries microbial and chemical hazards. In West Africa, less than 10 percent of the fertile land is farmed under irrigation.

Climate: West Africa has diverse agroecology and climate. The region has several climate zones suitable for fruit and vegetable production. Forest ecology has bimodal rainfall patterns, while savannah ecologies have monomodal rainfall pattern. However, there is a continuous decline and fluctuations in rainfall in West Africa due to climate change. Most savannah areas also experience a log dry period. Yet, there is a limited adoption of climate-smart practices by farmers in West Africa.

Soil: The soils in West Africa are relatively less fertile, compared to other regions of the world. Most soils contain abundant coarse material either gravel and stone, or concretionary materials which affect their physical properties. The coarse sand particles limit the water retention capacity of the soils, which compromises the resistance to drought for the crops. Ferralsols is the well-known, strongly weathered reddish or yellowish soil in West Africa.

SOCIOECONOMICS

Women in Horticulture: In West Africa, women play a significant role in the horticulture industry, especially in the post-production side of the vegetable value chain – such as processing and marketing/sales. They are more active in the production of mostly leafy and indigenous crops. Women account for more than 50% of the workforce in the horticulture sector in West Africa. In The Gambia, women constitute over 60% of the workforce in the horticultural sub-sector (Fatty et al., 2017). However, their ability to access land and other resources for production is dependent on their husbands or fathers.

Indigenous Peoples in Horticulture: Horticulture production is an indigenous activity in West Africa. Horticulture production takes place throughout every country in West Africa. It is mainly undertaken by all ethnic groups for home consumption and export. However, there are spatial distributions of fruit and vegetable production among ethnic groups across the region.

Youth and Horticulture: Youth participation in agriculture is low in West Africa. The Youth are being encouraged in agri-business along the horticulture value chain, and greenhouse farming (Greenhouse

Village Initiative-MOFA). As part of the government of Ghana efforts to open opportunities for increased production and exports of vegetables after the 2015 European Union export ban on select vegetables, the concept of greenhouse villages was introduced in 2017. The idea of the greenhouse village is to establish strong agribusiness in the vegetable sector to attract both Ghanaian youth and international investors. The objective is to place Ghana as a key competitor in the export of fresh vegetables and cut flowers. The project trained about 537 youths including those with degrees, HND and certificate holders. The three-month intensive training session covers all areas of greenhouse vegetable cultivation, starting from setting up a nursery, crop production, fertigation, pest and disease management, handling, marketing, and branding of the produce.

MARKET AND CONSUMPTION

Demand for nutritious fruits and vegetables: Demand for fruits and vegetable have grown steadily over the last decade in West Africa due to rising urbanization, population, and income coupled with the expansion of traditional markets, the hospitality industry, and fruit processing units. However, there are still disparities in the consumption of fruit and vegetables across West Africa and between income classes within countries. The consumption of fruit and vegetables is below the FAO/WHO daily recommendations of 400 g/capita. Ghana has the highest consumption of fruits (189kg/capita/yr), followed by Guinea (97kg/capita/yr), while Mali has the highest consumption of vegetables (97kg/capita/yr), followed by Senegal (86kg/capita/yr). Vegetable consumption increased for most countries in West Africa (Benin, Burkina Faso, Cote d'Ivoire, Ghana, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and The Gambia), compared to fruit consumption. Benin, Ghana, Senegal, and Mali have witnessed some growth in fruit consumption over the last decade.

Market Access: Fruits and vegetables produced in West Africa are destined for local and international markets. Locally, the marketing of fruits and vegetables is dominated by informal actors, operating largely in open markets. The local market comprises about 70 percent of the fresh fruits and vegetables' markets in Ghana and other West African countries. Farmers supply the fresh produce mainly to domestic bulk suppliers, itinerant suppliers, and other suppliers such as supermarkets, hotels, and restaurants. In addition to informal marketing outlets, which are smaller, street shops, hawkers, and well-built markets, formal retail outlets such as supermarkets and specialty stores also engage in the sale of fruits and vegetables.

Value-added Horticulture Products: Fruits and vegetables are mostly sold fresh, limiting value creation and value addition by producers and marketers. Producers and traders engage in primary activities such as cleaning, sorting and grading. Poor storage, contributes to high post-harvest losses, food safety problems and a low product shelf life.

Agribusiness Opportunities: This is an excellent opportunity for investors to help introduce disease-resistant varieties and the use of tissue culture technology. Greenhouse gardening, integrated pest management, and use of organic fertilizers also provide opportunities for farmers to produce safe fruits and vegetables in West Africa.

TRADE AND STANDARDS

West Africa trades in a variety of fruits and vegetables. The major export market for fruits and vegetables are Europe and North America. Exports of fruits and vegetables in West Africa have been unstable due to

production and institutional challenges. In most cases, farmers are unable to meet food safety and sanitary standards set by foreign markets. Exports of pineapples, bananas, and mangoes, especially in Ghana fell in 2020 due to restrictions imposed by COVID-19. However, exports of pineapples in Cote D'Ivoire have remained high in recent years. The volume of orange and pawpaw exports increased exponentially in Ghana. Nigeria exports just a little of its fruits and vegetables. The main exported fruits and vegetables are the indigenous types consumed by Nigerians in the UK.

ENGINEERING AND TECHNOLOGY

There is very little use of engineering and technology in horticulture production in West Africa. Most reviewers reported low application of engineering and technology when it comes to the production and supply of horticultural products. Nigeria, Mali, Liberia, Ivory Coast, Burkina Faso, and Togo provided no evidence to this effect. Though, in recent years, drones have been used in pest, disease, and weed surveillance, as well as water stress monitoring in agricultural production, most countries in West Africa are yet to adopt these new technologies.

Application of engineering and technology in postharvest packaging, cooling, storage and drying is low in West Africa. There is no evidence of post-harvest packaging, cooling, cold storage and drying of fruits and vegetables in Togo, Gambia, Liberia, and Sierra Leone. In Burkina Faso, only mango and cashew are processed. In Nigeria, though fruits and vegetable processing is at the infant sage, about 9 companies are into the processing of tomato, dried fruits, vegetable mix and dried spices. These factories are located in Kaduna, Kanu, Abuja, Legos, Ogun and Oyo states. Mali has a unit for storage of horticultural products (PLAZA). This is a modern refrigerated and packaging warehouse located in Bamako, and other infrastructures for fruits and vegetable processing are also located in the main producing regions such as Sikasso, Koulikoro, and Bougouni. Some private women's cooperatives also have postharvest packaging, cooling, cold storage, and drying equipment. In Ghana, major companies engaged in processing fruits such as mango, pineapple and coconuts are Bomarts, Blue Skies and HPW FRESH AND DRY LTD.. These companies apply engineering in the washing of fruits, peeling and cutting, removing and sorting and packaging. They also have PLC controlled dryers for drying processed fruits. In addition, Shed 9 at Tema Harbor, a world-class, dedicated fruit terminal, also provides cold storage for pineapple and other horticultural products in Ghana.

RESEARCH, EDUCATION AND TRAINING

Horticulture is knowledge-dependent and a highly integrated activity whose success depends on research and development activities. Findings from the review revealed that there is no regional centre for research and development in horticulture in West Africa. However, individual member states conduct research and training based on public and private institutions and facilities available to them. In Ghana, there are three public universities and five agriculture colleges for teaching and training in agriculture and horticulture-related fields. The public universities include the University of Ghana (UG), the University for Development Studies (UDS), and Kwame Nkrumah University of Science and Technology. Also, in Sierra Leone, there are three institutions namely Sierra Leone Agricultural Research Institute (SLARI), Njala University (NU) and the University of Sierra Leone (USL) that are mainly involved in horticultural research. Research and training in horticulture in Togo are done by the School of Agriculture (ESA/UL) and by National Agronomic Research Institute (ITRA). The research conducted is crop-specific. Similarly, several research institutions in Mali including (i) Rural Polytechnic Institute for Training and Applied Research (IPR/IFRA): considered one of the best agricultural engineering schools in the region (ii) Institute of Rural Economy (IER): agricultural research policies; approval and certification of agricultural inputs; and importation, testing and distribution of the latest crop varieties (iii) The DNA (National Directorate of Agriculture) Agricultural Learning Centers (CAA), University of Bamako (FSEG), (iv) Sahel Institute

Permanent Interstate Committee for Drought Control in the Sahel (CILSS) CILSS): leads a common regional regulatory framework for pesticides as well as the approval process for new pesticides and (v) International Crops Research Institute for the Semi-Arid Tropics (ICRIS) (CGIAR network) International research institute actively conducting crop research in Mali and leading a world-class geographic information system (GIS) unit in partnership with IER are among few research institutions that undertake horticulture-related training. However, these public and private research institutions are confronted with challenges such as the (i) lack of or inadequate funding, (ii) lack of conducive research environment and infrastructure including laboratory space, basic laboratory instruments and chemicals, research gardens/stations/growth chambers, greenhouses, internet facility, unreliable electricity supply, (iii) lack of information due to poor access to electronic databases, e-journals, e-books, and lack of mentorship.

Extension-related services in the horticulture sector are mainly undertaken by the public sector in various countries. Private sector participation is relatively low or non-existent. These public extension agents work under the ministry of food and agriculture of the various countries, basically trains small-scale and commercial fruits and vegetable producers in good production practices, pest and disease control, post-harvest management practices (handling, washing, packaging, transportation etc), and food safety standards. However, in Ghana, recently there has been concern about private sector-driven technical support in the fruits and vegetable sector.

REGIONAL AND NATIONAL POLICY ENVIRONMENT

There is no policy for the horticulture sector in West Africa. Issues regarding the horticulture sector in the sub-region are mainly addressed through the ECOWAP/CAADP. On the trade front, African Union SPS Policy Framework lays out a roadmap to maximize the efficiency and effectiveness of SPS systems on the continent to facilitate intra-African agricultural and food trade. The review revealed that national agriculture policies are the main policies guiding the production, processing and export of horticulture products (fruits and vegetables) in member countries. Also, other countries implemented programmes and projects in collaboration with donors to enhance the production, processing and export of horticulture products.

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