



Review

Potentials of Avocado farming as an alternative crop in the Coffee-Banana based farming systems – the case of Kagera Region, Tanzania: Review

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The agricultural production in Kagera over the last decades has not kept pace with the growth of population in the region. For many centuries, Kagera has primarily depended on coffee and bananas for livelihood and to lesser extent growing of pine trees. Currently, the farmland and the productivity for predominant crops is diminishing due to population pressure, shrinkage of the farm land, the decline in soil fertility and climate change all making unsustainable livelihood thus necessitating serious intervention. Crop diversification therefore can be a great strategy. Avocado is an important alternative crop to farmers as there are high potential and suitability of the agro-ecology coupled with high domestic and export market demand. Besides, avocado can have multiple benefits to the community especially to improve farmers' income, increase land productivity, sustainability and food security because the crop is high yielding and has lots of essential nutritional benefits. Having ideal growing conditions, and the government promoting avocado farming in recent years, it's high time that Kagera farmers fully embark in avocado farming for economic growth and food security. Moreover, their ease of maintenance and ability to be inter-cropped with other crops makes the crop an excellent alternative to farmers. In this review article, local, regional and global avocado production trend, importance, potentials and opportunities, some constraints and future direction in relation to Kagera region and Tanzania at large have been discussed.

Keywords: Avocado, Kagera region, Agro-ecology, Tanzania

INTRODUCTION

Kagera is the Region located in the northwest Tanzania comprising administratively seven districts namely Bukoba, Muleba, Missenyi, Karagwe, Kyerwa, Biharamulo and Ngara. Most native people in Kagera are characterized of having a more or less homogeneous culture of being tied strongly to ancestral land whereby possession of that land is unevenly distributed to clans and families. Most families own small pieces of land that are getting smaller and smaller through generations as a population in the region is increasing tremendously (Mwijage et al., 2016). More importantly, the culture in Kagera has been tied to banana and coffee for

generations in mixture with some fruit trees and seasonal crops such as beans in a home garden commonly locally known as *Kibanja*. In recent decades, pines plantation has gained importance particularly in the originally communal grasslands literally known as *Rweya*.

For many years, families with small land had access to communally owned land on which they grew seasonal food crops like cassava, ground nuts (*Arachis hypogaea*), Bambara nuts (*Vigna subterranea*) and finger millet (*Eleusine coracana*). Public land was also accessible for free-range grazing of cattle, sheep and goats on communal

arrangements. Today, this public land has been, in most cases privatized to individual families where pine (*Pinus sp.*) and *Eucalyptus sp* trees are often planted for family business. This quick transformation of Bukoba agricultural land into forestry has negative impact in terms of food security and dwindling land productivity in relation to the predominant banana (*Musa sp.*) and coffee (*Coffea arabica*).

Kagera Region has been hit by a number of shocks since the 1970s. Some of these are the Kagera War in the 1970s, the rapid spread of HIV/AIDS in the 1980s, the decline in the price of main crops, the adverse effects of climate change, the loss of soil fertility, and the emergence of various crop diseases are a few of these shocks (Pantaleo, 2020). Moreover, in September, 2016, the region was struck by an earthquake of the magnitude of 5.7 on a Richter scale that left thousands of people homeless and hundreds of people injured or dead. All these persistent tremors are perceived to have rendered most household incomes in Kagera region highly uncertain from one year to another, thereby causing increasing poverty rate in the region (TAHA, 2019).

Emergence of Avocado farming in Kagera and associated constraints

The presence of a large domestic and foreign market for avocado, favorable weather and ecological conditions gives Kagera region a great potential. However, there are several constraints in relation to avocado production such as the social and cultural habits of the population which is inclined to coffee-banana-based for many generations. The food habit and dietary preferences for banana, economic reasons of the local consumers and absence of nutrition intervention programs using horticulture constrains avocado production in the region. Recently, there has been increase in demand for avocado and the awareness for export opportunities. In fact, Kagera has a comparative advantage in many aspects including favorable climate and relatively good road network that justifies the potential of the crop in the region.

Lack of improved varieties is also one of the constraints in avocado production and productivity in the region. Local varieties that are available have low yielding potential with low quality which doesn't fulfill the current international and/or domestic market demand in terms of quantity and quality. Thus, this review article tries to improve the understanding on current status of avocado production in Kagera region as compared to the national and global trend and make future recommendation. In this review, an over view on botanical description and agronomic requirements of avocado, current status and trend of the region and Tanzania, nutritional value of avocado, potentials, opportunities, constraints, recent efforts made in avocado production have been discussed and future

recommendations are made.

An overview on botany description and agronomy

Avocado (*Persea americana* Mill.) is a dicotyledonous plant from the *Lauraceae* family originating from Latin America and the west indies where it was growing in the wild (Subba et al., 2023) Cultivation of avocado was first reported in Mauritius in 1780, and reported first time in Zanzibar in 1892 (Juma et al., 2019), but extensive cultivation of this fruit is reported to increase since the 1900s.

The avocado tree grows to a height of 10 to 12 meters in its natural subtropical- tropical habitat (Jalata, 2021). The tree's growth and development are variable. The avocado tree produces fruits all year round and is particularly productive. The majority of academics still refer to "cultivars" like "Hass" or "Fuerte" as "varieties" (Bender, 2001). Within the grouping, varieties mostly adhere to certain common features, however hybridization between races that are also "horticulturally" graft compatible happens frequently (Mokria et al., 2022)

Avocado can be grown from seeds or from seedlings. Grafting techniques is often done to improve the variety by increasing its resistance to diseases, improving yield and increasing its adaptability to different soils. Standard field management involves proper planting appropriate varieties, mulching to reduce moisture loss and controls weed growth. Irrigation is vital at several stages of tree development and during fruiting cycle of the tree. Fertilization using well decomposed manure twice a year such as during the onset of long and short rains as well as topdressing with 120g of CAN is recommended.

Furthermore, other management practices include pruning at early stages before flowering and upon completion of harvesting encourages lateral growth and multiple framework branching. Tree canopy height should always be maintained at 70% of its row width in order to allow light to penetrate, improve yield and provides a superior tree structure. Thinning that involves removing some of the already formed fruits as well as regular weeding are all important management operations in order reduce competition for nutrients and water therefore ensuring high-quality fruits.

In addition, among other management techniques includes early pruning prior to flowering and after harvesting that promotes lateral growth and multiple frameworks branching (Jakhwal et al., 2024). According to (Wang et al., 2023), 70% of the tree's width is the ideal tree canopy height to increase light penetration, increase yield, and produce a remarkable tree structure.

Commercial and nutritional importance of avocado

Globally regarded as a "superfood," avocado fruit is increasingly becoming a vital and lucrative crop for local,

Table 1. Global avocado production in 2019

Country	Production Area	Production	Productivity	Rank
Mexico	215942	2300889	10.7	1
Dominican Republic	14190	661626	46.6	2
Peru	42788	535911	12.5	3
Colombia	63534	535021	8.4	4
Indonesia	35136	461613	13.1	5
Kenya	23298	364935	15.7	6
Brazil	15315	242932	15.9	7
Haiti	39916	231719	5.8	8
Chile	29224	162988	5.6	9
Israel	10520	138766	13.2	10

Source: (FAOSTAT, 2019)

regional, and international trade (Subba et al., 2023). In most instances, avocado is grown and sold directly to consumers, therefore doesn't need to be processed or have flavor enhancers added. The fruit can be grown in environmentally sustainable methods since their natural skin reduces the need for packing and provides some disease and insect resistance (Dreher and Davenport, 2013). According to a recent study, the value of the worldwide avocado industry is expected to reach US\$ 22 billion by 2026, with 6% annual growth predicted. The export and import prices of avocado considerably vary by country of origin and destination. Recently, Tanzanian avocados have fetched high prices whereby the export value earned \$8.6 million USD in 2018 (Avocado Market Outlook, 2023). Avocado has many socioeconomic, ecological and environmental benefits and contributes to income, food and nutrition requirements of households and communities (Juma et al., 2019). Fruits are eaten raw (ripe) and also flavors soups, ice cream and milkshakes (Subba et al., 2023). The fruit has soluble vitamins (A, C, K1, B-6, & E) which are less common in other fruits and is high in protein and several important minerals including Zinc, K, and Selenium (Dreher & Davenport, 2013). Furthermore

According to (FAOSTAT, 2019) the world top ten largest avocado producers are Mexico followed by Dominican Republic, Peru, Colombia, Indonesia, Kenya, Brazil, Haiti, Chile and Israel (Table 1).

The area coverage and production in Mexico is significantly higher than other producing countries globally. On the other hand, the productivity of avocado in some of these counties like Dominican Republic is specifically the highest (46.6 tons/ha) followed by Brazil (15.9 tons/ha), Kenya (15.7 tons/ha), Israel (13.2 tons/ha), Indonesia (13.1 tons/ha), Peru (12.5 tons/ha), Mexico (10.7 tons/ha) which are even exceeding the world average productivity (Table 1).

Tanzania's production and exportation of avocado

Avocado as a crop was brought to Tanzania by German

avocado oil is easily digestible, largely unsaturated fat acids and has low sugar content being able to reduce cholesterol and cardiovascular disease (Dreher & Davenport, 2013). In addition to that avocado also contributes to mitigate and adapt to climate change impacts through absorbing atmospheric carbon dioxide and improving the soils and microclimate conditions, leading to sustainable and increased food production. It is also proved to be a very profitable commercial crop for both export and local consumption (Jalata, 2021).

Avocado production and productivity status

The recent (FAOSTAT, 2019) data revealed that avocado is produced globally on about 920,000 ha of land and production of more than 6.4 million tons showing about the productivity of 7 tons per ha. Besides this, in the last two decades data shows avocado production and area coverage globally is increasing linearly (Figure 1). About 70% of production comes from Latin American countries followed by Africa (14%), Asia (12%), Europe (2%) and Oceania (1.6%) (Figure 2). This indicates globally the production of avocado is increasing.

settlers in the late 1800s (Juma et al., 2019). At that point, avocado trees served a variety of functions, including the manufacture of lumber, animal feed, and shade in coffee plantations. In an effort to capitalize on the expanding global avocado market, avocado growers in Tanzania have been planting new cultivars since 2000 (Juma, et al., 2019). Smallholder farmers did not start growing Hass avocados until 2007 in order to supply the European markets with the variety's demand (Freshela, 2023).

Due to the increasing demand for avocados from both domestic and foreign markets, avocado growing has become more and more popular in Tanzania in recent years. According to Juma et al. (2019), Njombe, Mbeya, Songwe, Iringa, Kilimanjaro, and Arusha is listed as prominent avocado-producing regions in the country, with a minor amount of production going to Tanga, Kigoma, Kagera, and Morogoro. The majority of growers in these

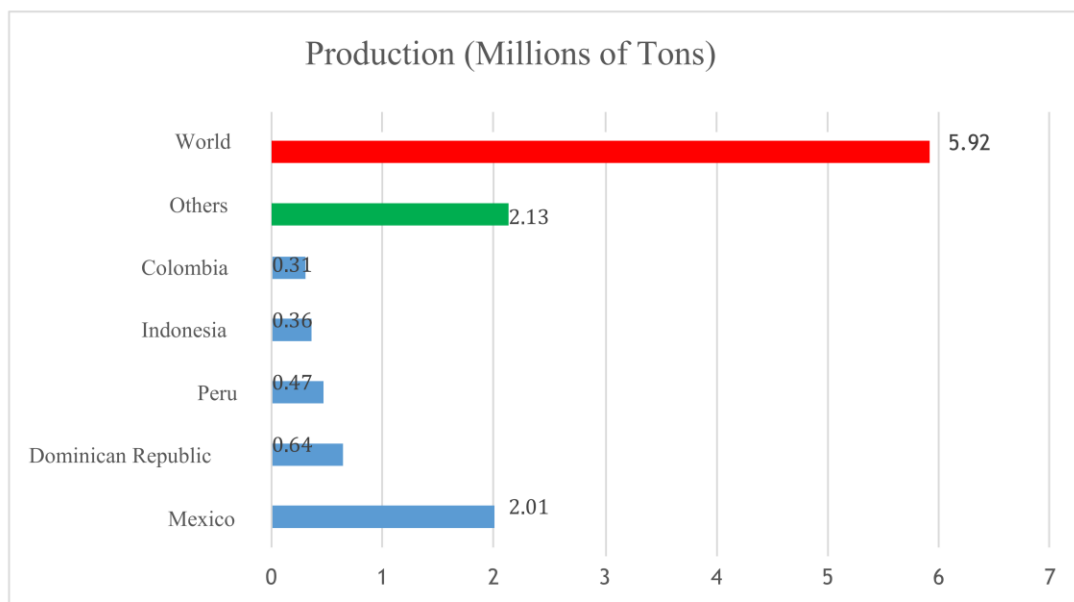


Figure 1: Representative global avocado production

Production share of Avocados by region

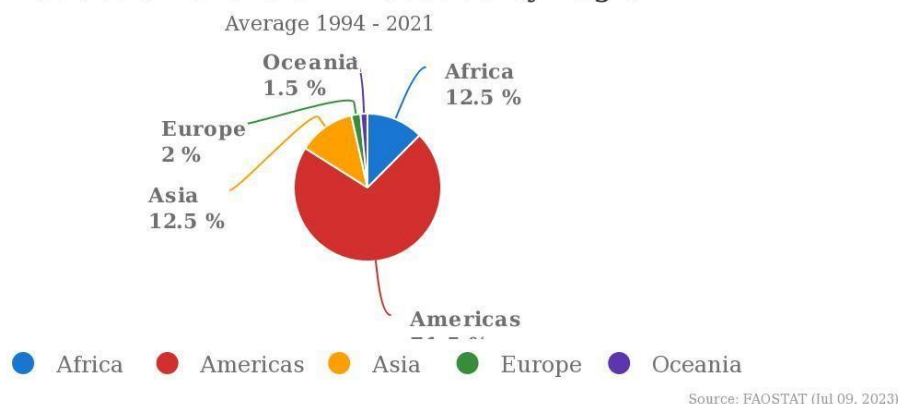


Figure: 2 Global avocado production shares by region

areas are, however, smallholder farmers who cultivate avocados for their own consumption or to sell in regional and international markets. These smallholder farmers often own several hundred avocado trees surrounding their homesteads. According to Tanzania Agricultural Research Institute (TARI), about fifteen different types of avocado are farmed in Tanzania, whereby producers choose their varieties depending on how marketable the avocado variety is as well as how resistant the fruit is to logistics and transportation.

Optimal avocado growth Requirements

Avocado can suitably produce in sole crop and

intercropping system such as coffee and other horticultural crops including spices.

Characteristics of potential avocado varieties

Hass, *Persea americana* x "Hass" is the most common commercial variety globally that was developed from Guatemalan avocado (Subba et al., 2023). This variety yields fruit all year round and is responsible for 80% of the avocados grown worldwide (Bhore et al., 2021). When fully ripe, it has a deep purple hue (USAID, 2019). It is advised to plant 7 meters apart by 8 meters, and plants can reach maturity 8 to 9 months after they flower. The fruits are of oval-shape with small to medium seed and easy

Table 2. Summary of optimum ecological requirements for avocado farming

	Optimum or ideal conditions	Conditions for Kagera
Altitude	1,200-2,500 m a.s.l	1,200 - 1,700m a.s.l
Annual rainfall	1,000 – 1,200 mm of rainfall	600mm - 2,500mm
Growing temperature	25 – 30 °C	16 - 28°C
Soils	Wide variety of soils, ranging from almost completely sandy to clay soils, as long as good drainage is available, fertile, well aerated, pH of range 5 – 7	Deep, fertile well aerated, good drainage, sandy or alluvial loams pH range of 5.1 – 6.5

characterized by easy peeling, great taste, outstanding shelf-life and good shipping characteristics with one of the longest harvesting seasons (USAID, 2019).

The dark green and or brown skin fruit of the Hass variety is easily removed from the pulp and does not become thick as it ages. Furthermore, the fruit has tiny seed, non-fibrous pulp whose oil content is 20%. The tree is very productive and vigorous growth and resistance to pests and diseases (Jalata, 2021).

Fuerte, *Persea americana* x "*Fuerte*" hybrid is the second largest commercial variety behind Hass. The fruit is characterized by a smooth, green skin of medium thickness. It has a large seed and a buttery pulp, and is referred to as a "green skin." It has an oil content of 16–18 percent (Jalata, 2021). It is a B-type blossom type which most grower's plant adjacent to Hass for a more consistent production cycle. This variety tends to produce heavily in alternate years (USAID, 2019) However, both *Hass* and *Fuerte* avocados can be planted together since they belong to different floral groups in order for cross-pollination to occur.

Puebla, *Persea americana* x "*Puebla*," is generally utilized as rootstock by farmers due to its disease resistance and lack of fiber (Bhore, et al., 2021). The meat is flavorful, juicy, and green. It grows quickly and is upright with drooping branches. After flowering, this variety typically reaches maturity in 5-7 months (USAID, 2019).

Nabal, *Persea americana* x "*Nabal*" hybrid is a round shaped avocado fruit of Guatemala origin. It has green/yellowish fruit of exceptional quality (USAID, 2019). The tree is always upright, bears heavily but has a tendency of alternate bearing. The recommended spacing for this variety is eight meters apart and tend to mature at 8-9 months after flowering (USAID, 2019).

Pinkerton, (*Pinkerton* × *Persea Americana*) - The fruits have light or dark green skin and have a long and pear-shaped form. The tree bears heavily and on regular basis, with moderate spreading characteristics. Standard recommended spacing for this variety is six meters apart. Because of their regular production, good flavor, high oil content—along with their relatively easy peeling texture

and type A flower, this avocado is highly recommended (Alder, 2022).

Markets for Tanzania Avocados

Tanzania's avocado exports has increased at a compound annual growth rate of 35% between 2013 and 2017, reaching over 4.4 thousand tons in 2017 from 1.4 thousand tons in 2013, according to the International Trade Centre (ITC). The Tanzania Private Sector Foundation (TPSF) reports that 7,551 tons of avocados worth a combined USD 8.5 million were shipped by Tanzania to Europe, Africa, and Asia in 2018 alone. In fact, Tanzania's avocado exports have grown impressively over the past few years, according to the TIC. The export value in Tanzania also climbed from 0.1% to 0.4% in 2019 that was more than 8.5 times the value in 2013 in addition to Tanzania gaining market share globally. According to ITC estimates, the EU accounts for 1.5% of Tanzania's agricultural exports, meaning that the majority of potential to grow avocado exports are there (Tanzania Investment Centre, 2023).

Opportunities and investment potentials for avocado farming in Kagera region


Kagera region has a comparative advantage in avocado production due to reliable ecological conditions including reliable rainfall pattern and optimum temperature favorable to avocado farming (Table 2). The estimated yield potential for avocado particularly for Hass cultivar is 300 kg to 600 kilograms per season/tree depending on soil fertility and management practices (Mokria et al., 2022).

In the avocado value chain

Tanzania is seeing a rise in the popularity of avocado production as new farms sprout up throughout the nation (Table 3), focusing on Hass and Fuerte, that are the two commercial varieties targeted at the export market (Juma et al., 2019). These varieties have huge demand in the World market and make the product a potential

Table 3. Represent Production seasonality of avocado by regions in Tanzania

Region	Verities	J	F	M	A	M	J	J	Au	Sep	Oct	Nov	Dec
Arusha	Fuerte												
Kilimanjaro	Hass &Fuerte												
Ruvuma	Fuerte												
Iringa	Hass &Fuerte												
Mbeya	Hass &Fuerte												
Songwe	Hass & Fuerte												
Rukwa	Fuerte												
Kigoma	Green varieties												
Kagera	Hass & Fuerte												
Mwanza	Green varieties												
Manyara	Fuerte												
Njombe	Hass & Fuerte												
Geita	Green varieties												
Mara													

Key  High volume  Low volume

significant contributor to foreign earnings and government revenue if harnessed well. Apart from increased export volume, there is also an appetite of investment in the value addition for Avocado particularly for many local varieties that are confronted with unreliable markets, fruit damages, and lack of market information, low prices and poor transport systems (Malekela, 2022).

Commercial plantation

Opening of large plantations to produce larger volumes of fruits for export are recommended in the Southern Highlands, Northern Zone and Lake zone particularly Kagera and Mara regions. At the moment vegetable and

fruits production in Tanzania is still dominated by small-scale farming. Largely, smallholders are involved in the production due to the higher requirements in terms of investments, inputs and land. Production intensification could be a key strategy to reduce the cost price implying more efficient production practices while, at the same time, provision of proper knowledge and skills to farmers are a necessity.

Processing

In Tanzania, avocados are hardly processed at the time since people prefer them raw. There is a little (local) market demand for dried fruits, and there are low-tech

methods for doing so. However, investing in the avocado processing and canning industries could lead to the manufacture of associated goods such as food pastes, cooking oil, and nutritional supplements (TAHA, 2019). There are currently five industries in Tanzania that process avocados: two of these companies create crude oil, which is used to make cosmetic and medical items, while the other three produce refined avocado oil (TanTrade, 2023).

Manufacturing of farm inputs

In Tanzania, like in other developing countries increased growth in agricultural production depends on continuous improvement through technological changes. This requires a sustained and rapid growth in the use of agricultural inputs such as seeds, fertilizers, pesticide, farm implements and farm machinery. Manufacturing of inputs and value addition facilities such as sorting, cleaning, grading, packaging and processing, packaging materials, cold rooms, horticulture and logistic support services poses potential investment area in avocado value chain (Mistary, 2022)

Conclusion

For small-scale farmers in particular, avocado is a versatile fruit plant that may boost income, land productivity, sustainability, and food security. The crop may provide complementary advantages for small businesses and the local economy in developing communities. Therefore, the Tanzania's horticulture crop portfolio can be successfully diversified through commercial avocado growing and increasing the industry's worth. But at the moment, avocado output is significantly less than its geographical potential. To meet market standards for product quality, this industry must overcome a number of obstacles related to production and trade capacity, as well as the ability to develop entrepreneurial skills. Significant policy changes is necessary that aims at boosting productivity and competitiveness, value chain upgrading, export diversification, and crop standards and quality improvement. In order to achieve this for sustainable production of the crop, consideration of the following key aspects would be important:

- That there should be awareness creation among farmers about the importance of avocado because of available nutritional value, food security and income for sustainable development.
- Introduce innovative ways to enhance the production and trade capacity of avocado value chain actors including access to finance, research and innovation, networking and linking micro, small, medium and large scale strategic investors in the avocado industry.
- The creation of additional nurseries and the improvement of cooperative efforts with other groups in order to facilitate the rapid and simple propagation of the enhanced

avocado seedlings.

- Tanzanian government is presently having a great political will to support avocado farming. Since the government is committed to raising productivity and expanding the production area, farmers are encouraged to grab such opportunity for betterment of livelihood and social economic development.

Conflict of interests

The authors declare that they have no conflicting interests.

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