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Abstract

Agriculture plays a large role in Kenya's economy, employing more than 40 percent of Kenya's total population and more than 70 percent of the country's rural inhabitants. Sustainable agriculture in Kenya can improve crop yields, stimulate the economy and help mitigate climate change. Kenya is implementing a range of programs to increase sustainable agriculture, these are important steps to help the country build a prosperous future for all who live there. Over the years the land being farmed has seen a slow fertility degradation resulting in worsening yields per hectare, however total output have increased due to clearing and expansion. This study was anchored on transaction cost theory. Based on the concept of transaction cost theory, farmers' participation in the market is constrained by transaction costs incurred during marketing such as information search costs, negotiation costs, monitoring costs, cost of transporting products to market, cost of sorting and grading and cost of harvesting. By adopting literature review based methodology, the study reviewed relevant literature to obtain main themes. The findings revealed that farmers who participate in export markets differ significantly from nonparticipating farmers as they are more experienced and have somewhat larger farms, have received more training, and own more avocado trees of the Hass variety, the type favoured in export markets. The study established that living near a well-functioning avocado farmers' group is positively associated with participation in export markets and that participation in avocado export markets has positive impacts on incomes, revenues, prices, and labour inputs. The study found that Kenya has over 40 different varieties of Avocado with Hass as the main export variety and Fuerte is preferred for processing. Other commercial varieties identified in Kenya include Keitt, Reed, Booth 8, Simmonds, Pinkerton, Nabal, Puebla, Tonnage, Ettinger, Hayes, G6 and G7.These popular varieties are Hass, Fuerte, and Puebla. The study concludes that agriculture often places significant pressure on natural resources and the environment, as such sustainable agricultural practices are intended to protect the environment, expand the Earth's natural resource base, and maintain and improve soil fertility. Sustainable agriculture is about increasing profitable farm income, promoting environmental stewardship, enhancing quality of life for farm families and communities and increase production for human food and fiber needs. The study also concludes that the domestic market is the largest source of demand for Kenyan avocados accounting for over 80% of the total production and the rest are exported as fresh fruits or processed and exported as crude oil. Based on the conclusion,

the study recommends that for the avocado fruits from Kenya to compete favourably in the global market, efforts must be made to ensure that the factors that affect fruit quality are addressed.

Keywords: *Avocado, Variety, Export market, Sustainable, Agriculture, Afforestation.*

1.1 Background of the Study

The demand for food is growing globally as the world's population explodes, and to meet this demand, agriculture needs to increase yields without compromising the ability of future generations to provide for their food requirements (Ritson, 2020). The answer to preserving our environment and stopping further damage to the ecosystem lies in sustainable farming a system which is sustainable environmentally, socially and economically (Brooker *et al.*, 2021). According to Anibaldi, Rundle-Thiele, David and Roemer (2021), sustainable farming means producing food, fibre, plant or animal products without harming natural resources and land and considering social responsibilities such as working and living conditions of farmers and workers, the needs of rural communities, and health and safety of the consumer both in the present and the future. Agriculture often places significant pressure on natural resources and the environment; sustainable agricultural practices are intended to protect the environment, expand the Earth's natural resource base, and maintain and improve soil fertility (Ritson, 2020).

Based on a sustainable development goal (2018), sustainable agriculture seeks to: increase profitable farm income, promote environmental stewardship, enhance quality of life for farm families and communities and increase production for human food and fiber needs. Sustainable agriculture frequently encompasses a wide range of production practices, including conventional and organic. Sustainable agriculture is designed with the intention of preserving the environment, expanding the earth's natural resources, all while creating a quality of life for animals and humans (Odularu, 2020). Sustainable agricultural allows for the desires of society's food and textile needs to be met without the fear of inhibiting the earth's natural resources for future generations. In addition to preserving the earth's natural resources, sustainable agriculture benefits the environment through helping maintain soil quality, reducing erosion, and preserving water (De Corato, 2020).

Tsangas *et al.* (2020) argue that, in order to maintain a sustainable lifestyle, agriculturalists focus on certain criteria in order to compete with current sustainability practices. This criteria consists of creating a healthy environment, while ensuring economic profitability in addition to maintaining social and economic equity. Alhassan (2019) opine that every member of the food system can manage a sustainable lifestyle through remaining consistent within this criterion. Through sustainable farming practices, single-crop agriculture is eliminated by placing multiple crops on the same plot of land by combining tall, sun-loving plants with shorter shade-loving plants. This approach enables farmers to grow more crops using less land while also preserving the environment (Alhassan, 2019). Although with this approach, one of the biggest disadvantages to sustainable agriculture is that you are unable to grow as many crops at a single time considering a more sustainable approach typically leads to fewer crops in one plot so plants don't leach nutrients out of the soil. For farmers who want to continue to produce mass agriculture, sustainable farming practices are often hard to abide by; to food production, there are several overall goals related to sustainable agriculture, including saving water resources, reducing the use of agrochemicals, and promoting biodiversity in crops and ecosystems (Cui, Zhang, Chen, Zhang, Ma, Huang & Dou,

2018). Sustainable agriculture also focuses on maintaining the economic stability of Elmtaryds and helping farmers improve their Agri skills and quality of life.

Organic farming is one approach to increasing sustainability in agriculture that is market-driven and growing rapidly (Eyhorn, Muller, Reganold, Frison, Herren, Luttikholt, & Smith, 2019). The origins of organic farming come from a focus on improving organic matter in the soil in order to grow healthy plants that can resist pests and diseases, and that provide maximum health to the people and animals that eat them. One guiding principle is the use of natural materials for crop production and the avoidance of synthetic materials (e.g. fertilizers, pesticides), another principle is to work with the natural systems and processes as much as possible, concurring with the Organic farming. Thus, organic farming shares virtually all the goals articulated by sustainable agriculture proponents (Eyhorn et al., 2019). As organic farming expanded in the 1980s, certification programs became necessary to guarantee to the consumer that the product they were buying, and generally paying a higher price for, was indeed produced as they expected.

The 'no chemicals' or 'no synthetics' principles were often the strongest impressions in the consumer mind (Abdussalam-Mohammed, Qasem Ali & Errayes, 2020). Organic matter, a key consideration in organic agriculture, is arguably the most important aspect of sustainable soil management, tillage is a practice that can quickly degrade organic matter (Abdussalam-et al., 2020). Since tree fruit and vine systems are perennial and typically involve little tillage after planting, they can be very conducive to increasing soil organic matter. On the other hand, tree fruit and vine crops typically require a high level of pest management to produce marketable crops. Most avocado farmers in Kenya use organic manure instead of nonorganic fertilizer hence, improving organic matter in the soil in order to grow healthy avocado that can resist pests and diseases, and that provide maximum health to the people that eat them. This enhances sustainability of agriculture in the country.

In India, Millions of farmers have rejected chemical pesticides as part of a growing movement that favours natural alternatives (Muenster, 2018). Non-pesticide management is a sustainable approach to pest control operating on the theory that an infestation of one type of insect indicates a disturbance somewhere in the environment; getting to the root of the problem instead of treating the symptoms can both balance the insect population and improve crop health overall (Singh, 2021). The switch to natural farming methods began as a grassroots movement. In 2000, the 900 or so villagers living in Punukula, Andhra Pradesh, suffered from a number of debilitating issues. Farmers reported health problems that ranged from acute poisoning to death. Pest infestations regularly destroyed crops as insects developed resistance, causing farmers to take out loans to buy an increasing number of expensive chemical pesticides. Families faced crippling healthcare costs, crop failure, loss of income, and debt, all directly related to pesticides. There is a shift from sustainable to commercial agriculture in some areas in India where farmers can avail the opportunities to increase their income in agriculture. The increasing demand for organic foods and fibre, and the by-products would certainly open a new vista in consumerism.

Sustainable agriculture in Kenya is becoming more important as the world's climate changes and the Kenyan government relies on a bountiful harvest for export (Nyberg, Musee, Wachiye, Jonsson, Wetterlind & Öborn, 2020). For the Kenyan farmers, it is more than just an economic statistic but a way to feed their families and themselves. As climate change wreaks havoc in eastern and southern Africa and what used to be modern farming techniques become outdated, the people have learned to adapt (Nyberg et al., 2020). In order to combat changing rain patterns and decrease

in rainfall, farmers in Kenya are learning how to adopt new farming techniques. Where once farmers mono-cropped (planted only one seed type or plant such as a cereal grain) now there is intercropping (the planting of multiple seeds and plant types such as cereal grain planted with legumes). This helps the farmers by increasing their crop output and provides insurance against the failure of one of the crops. In multiple small studies done by the International Maize and Wheat Improvement Center, the multi-cropping system introduced improved agricultural output and reduced the reliance on herbicides and fertilizers (Kamau et al., 2018).

Studies have shown that the major threat to sustainable agriculture in Kenya is the overuse of industrial fertilizers, herbicides, and pesticides (Moya, Parker & Sakrabani, 2019; Karuku, 2018). Heavy use of these chemicals may increase crop yields in the short term but will decrease the soil quality over time; the low crop yields over time will not only hurt the Kenyan economy but also the people (Moya, Parker & Sakrabani, 2019). Consequences of low crop yields are a lack of money to buy food or just the lack of food availability. An NGO called ACE Africa is working on community livelihood programs to educate farmers and their families on the proper use of these chemicals. They are also teaching farmers the importance of crop rotation and mulching. Different types of crops use different nutrients from the soil. By planting one type in one field this year and a different one in the same field next year, nutrients will have time to naturally replenish. By mulching or placing plant matter over top of a field that was just planted, moisture is retained, so a farmer has to use less water. Also, nutrients from the dying plants seep into the soil, decreasing the need for fertilizers.

Agriculture plays a large role in Kenya's economy, the agricultural industry employs more than 40 percent of Kenya's total population and more than 70 percent of the country's rural inhabitants (Kenya National Bureau of Statistics, 2019). Any country can benefit from sustainable agriculture, but it is even more important that those with a heavy reliance on agriculture make sustainability a priority in their decision-making. Sustainable agriculture in Kenya can improve crop yields, stimulate the economy and help mitigate climate change (Omondi, Oluoch, Kosura & Jirström, 2017). Kenya is implementing a range of programs to increase sustainable agriculture and according to Wawire, Wangia and Okello (2017), these are important steps to help the country build a prosperous future for all who live there. Kenyan horticultural sector includes a wide range of fruits and vegetables as well as an export oriented flower subsector; the country's tropical and temperate climate zones favour the cultivation of a wide range of horticultural crops (Tyce, 2020). In the coastal lowlands, farmers grow mangoes, citrus fruits, cashew nuts, bananas, hot pepper, brinjals and melons. Crops grown in the middle altitudes include banana, mango, avocado, pineapple, grapes, passion fruit, pawpaw, citrus, flowers, onions, garlic, tomatoes, kale, cucumbers, peppers, okra and French beans. At higher elevations, avocado, pears, apples, plums, carrots, cabbage, peas, potatoes and flowers are grown. Horticultural production in Kenya benefits from a climate that allows year-round cultivation, fertile soils and a competitive labour force (USAID, 2018).

Avocados are cultivated in tropical and Mediterranean climates of many countries, with Mexico as the leading producer of avocados, supplying 32% of the world total in 2019 (Muriithi, & Kabubo-Mariara, 2020). The fruit of domestic varieties has a buttery flesh when ripe and depending on the variety, avocados have green, brown, purplish, or black skin when ripe, and may be pear-shaped, egg-shaped, or spherical. Commercially, the fruits are picked while immature, and ripened after harvesting. Avocado trees have been grown in South Africa for many years; there are many old West Indian seedling trees in Durban, Natal, that must be well over fifty years of age. Until

1925 the avocado trees in South Africa consisted chiefly of West Indian seedling trees (Steyn, 2020). Attempts have been made to bud the West Indian seedling but nurserymen, in general, were only moderately successful, hence the percentage of budded avocado trees of the West Indian race prior to 1925 was very small, in fact negligible.

In South Africa, the main avocado production areas are concentrated in the north-east of the country, in the latitudes ranging from 22° to 30°S (Bara & Laing, 2020). This region is characterized by warm, wet summers and cool, dry winters; the high summer precipitation (>1000 mm per annum in most areas) and warm temperatures contribute to a high incidence of root rot caused by Phytophthora cinnamomi. The phosphorous acid injection technique for root rot control was developed at Westfalia Estate (Darvas et al., 2014), to protect the susceptible seedling rootstocks used at the time. New plantings are established on clonal rootstock, mainly Duke 7, which is known to have some tolerance to root rot. Of the total avocado production of avocado in South Africa, approximately 55% is exported, while 35% is consumed nationally and 10% is processed into oil (Kallideen, 2020). Export is both by air and by sea; the main route being overland to Cape Town (1 800 km) in refrigerated trucks, and then shipment by sea to Europe. The proportions transported by sea and by air, roughly 50-50 until 1985, changed dramatically as a result of advances in postharvest - technology, and 97% is now exported by sea. Air transport has stabilized at around 3% of total exports, and this takes place in the beginning and towards the end of the South African avocado export season. As transport and marketing account for approximately two thirds of the total costs and production for one third, the profitability of the avocado industry in South Africa depends in the first place on controlling transport and marketing costs, and secondly on controlling production costs (Randela, 2018). The varieties of avocado grown in South Africa includes; bacon, reed, Edranol, Fuertes, Hass, Pinkerton and Ryan.

Kenya resides in an ideal location for avocado growth, as avocados thrive in subtropical climates such as the Pacific Americas, South-east Asia, and Africa. African avocados are argued to be some of the greatest, with majority of the exported varieties coming from Kenya (Njuguna, 2018). According to Toukem, Yusuf, Dubois, Abdel-Rahman, Adan and Mohamed (2020), Kenya has over 40 varieties of Avocado where Hass is the main export variety and Fuerte is preferred for processing. Other commercial varieties identified in Kenya include Keitt, Reed, Booth 8, Simmonds, Pinkerton, Nabal, Puebla, Tonnage, Ettinger, Hayes, G6 and G7.These popular varieties are Hass, Fuerte, and Puebla. From the farms, the fruit is sent straight to pack houses where it is processed and prepared, ready to ship. There are a lot of native avocado tree varieties in Kenya. The main varieties of avocado grown in Kenya are Hass (20%) and Fuerte (80%) for export market and Pueble, Duke and G6 for the domestic market (Mellado & Ferrari, 2019).

Approximately, 70% of the fruit is grown in Central and Eastern regions, with Central region being the leading producer (Horticulture Crop Production Report, 2020). Avocado production is dominated by smallholders who constitute 85% of total avocado growers in the country (Wasilwa et al., 2017). The volumes of Hass avocados from Kenya is likely to continue rising as many farmers are making the switch to avocados, with Hass being seen as the most popular with great demand in global markers. The Hass avocado variety is the most popular Kenya avocado for export because it enjoys a good market in Europe as compared to the other varieties (Wanjiku, Waceke, & Mbaka, 2021). Hass is originally from Guatemala and one of its most prominent features is that it turns dark purple when ripe. Feurte is the avocado used to make guacamole and is a hybrid between both a Mexican and a Guatemalan subspecies of avocados, this plant matures in 6-8 months after flowering with its season beginning between March and April. There is more of

Feurte grown in Kenya as compared to South Africa (Wanjiku, Waceke, Wanjala & Mbaka, 2020). Kenya has quickly established itself as Africa's second highest avocado exporter, South Africa being first. France is the leading country purchasing Kenya avocados; Europe generally buys the most avocados because of the overall lacking climate for growing avocados. Kenya's location plays a huge part in the production of delicious avocados, attracting many global companies to buy avocados from Kenya. The government of Kenya has taken several initiatives aimed at enabling the Kenyan avocado industry to fully comply with global standards and regulations (Ministry of Agriculture, 2019). Bodies like KEPHIS and HCD are actively involved in monitoring as well as educating both farmers and exporters.

The acreage under avocado has been increasing steadily in Kenya over the years, in 2015 the acreage under avocado production was 13,305Ha, in 2020 the area was almost doubling and thought to have surpassed the 20,000Ha and Kenya is now positioning herself as Africa Lead Avocado Exporter since 2017 (International Food Policy Research Institute, 2021). Most of the Kenyan avocado farmers are found in Murang'a, Nyeri, Kiambu, Kisii, Meru and the entire Mt. Kenya region. The other regions that avocado farming is taking shape include Nandi, Bomet, Uasin Gishu, Trans- Nzoia, Bungoma and Siaya counties. The leading export varieties from Kenya are Hass, Fuerte and Pinkerton (International Food Policy Research Institute, 2021). Kenya exports the indigenous varieties too often reefed to as ''Jumbo''. Kenya does value addition by processing avocado oil. Recently, Kenya successfully exported frozen avocados to China, in 2016 avocado earned Kshs. 4.63 billion accounting for 8 percent by value of fruit sub-sector (KNBS, 2019).

The domestic market is the largest source of demand for Kenyan avocados accounting for over 80% of the total production and the rest are exported as fresh fruits or processed and exported as crude oil (Mwangi, 2020). In the domestic market avocados are sold locally through market vendors, small retail outlets, supermarkets and hotels. Prior to 2004-2005 the local market involved primarily wholesale and retail fresh fruit sales. However, since then three avocado oil processors have opened businesses in Kenya and provide a growing market opportunity for Grade 2 avocados which are not suitable for export or sale in the domestic fresh fruit market (USAID, 2018). The processors produce crude oil that is sold for further refining and processing in Europe, South Africa or the United States (USAID, 2018). In the export market, Kenyan fresh avocados are sold primarily in Europe and the Middle East, with France being the largest buyer. Other main export markets include United Arab Emirates, the Netherlands, the United Kingdom and Germany (Mwangi, 2016). In addition, avocados are primarily shipped sea freight to Europe which contributes to Kenya's cost competitiveness. Approximately one third of avocado production is exported.

Kenya has been part of the international supply base over the past 20 years with the majority of the fruit going to France and Holland (Ministry of Agriculture, 2019). In 2016, avocado contributed KES4.63 billion from 246,057 tons of fruits accounting for 8% by value of the fruit sub-sector, the value increased form 4.45 billion in 2015 to 4.63 in 2016 which was a 4.2% increase from 2015 (KNBS, 2017). This was due to improved prices in the international market as well as opening of the Russian market that demands high volumes of Fuertes avocados which were not very popular in the European market. In 2018 Avocados are believed to have earned Kenya a whooping Kshs 9 Billion in Revenue and by November 2020, a 4kg bag of Hass avocados retailed at Ksh 800, a 33% rise from the prices in November 2019 (KNBS, 2020). This could only mean that the prices will continue rising in future. With China's vast population, the demand will only rise overtime; the first shipment of the frozen avocados was sent by March 2020 by Diren

Packaging, a Kenyan avocado exporter and new connections have also been established in Netherlands, by the packaging company.

Kenya currently exports Mainly to European Union, United Arab Emirates, Saudi Arabia, Russia, Singapore, Egypt, Malaysia, Oman, Hong Kong, Qatar, Kuwait, Morocco, South Africa and Ghana. The European Union is the leading importer of avocado from Kenya followed by United Arab Emirates. Kenya exported 81,097981.78 Kgs of avocados in 2018 which was an on Year. In 2019 which was an off year Kenya exported 28, 319,770.07 Kgs. From January to June 2020, the County has exported 58, 426,760 .06 Kgs valued at Kshs 8 billion. The leading county was Murang'a that accounted for 53% by value of produce followed by Kisii, Kiambu and Nyamira that contributed 11%, 9% and 4% respectively of the total. The factors that led to a high value in Murang'a were county government intervention in marketing as well as inclusion of Kakuzi avocado data that was previously unreported. Although the avocado exports have marked an increased growth to the EU market, there were a host of constraints and challenges faced by the Kenya avocado export sector.

1.2 Statement of the Problem

In Kenya the current population is estimated at 47 million and expected to nearly double to 95 million by 2050 (KNBS, 2020). Agriculture in Kenya is a fundamental instrument for sustainable development, poverty eradication and food security. The Kenya Vision 2030 highlighted the growth of the Agricultural Sector as a major challenge and the Kenyan Government is striving to improve agricultural productivity through numerous government and donor supported programs (Leshore & Minja, 2019). Climate change is worsening Kenya's aridity situation because the increased weather variability is not suitable for sustainable food production as only 15-17% of the land used for agriculture in Kenya has sufficient soil fertility and rainfall to be farmed (Timler et al., 2020). Agriculture is the largest contributor to Kenya's GDP and Kenya's exports. Over the years the land being farmed has seen a slow fertility degradation resulting in worsening yields per hectare, however total output have increased due to clearing and expansion.

Kenya ranked 8th globally (2.1% of market share) in 2019 in export of avocados shipping out 59,000 tons with annual value of Ksh 10.6 Billion, behind Mexico, Netherlands, Peru, Spain, Chile, Colombia and the United States (KNBS, 2019). Among the top exporters, the fastest-growing avocados exporters since 2015 were: Colombia (up 1,607%), Dominican Republic (up 424.2%), Morocco (up 206.6%) and Kenya (up 161.5%). In 2020, up to end of October Kenya had exported 68,000 tons valued at Ksh. 14 Billion. The Kenyan Avocados are grown naturally in the most ideal conditions in the world right on the equator; thus they require very little crop protection, making them mostly organically grown and produced. Kenya's equatorial climate allows it to produce avocado throughout the year (Kimaru, Muchemi & Mwangi, 2020). The Fuerte is available from February and Hass variety being available from March. 70% of the avocados are grown by smallholder farmers who have 5-20 trees per homestead, 20% by medium scale farmers who have over 100 trees and 10% by large commercial plantations which have 10 hectares or more in production. Starting 11th November 2020, Kenya was expected to close the avocado export season until February 2021. The key to Kenya's success is in the use of the latest technology, availability of technical training and easier access to markets. To enhance the quality of our produce, industry associations and other players have trained and supported producers and exporters on requirements for international accreditations on food safety and traceability.

Smallholder avocado farmers in Kenya face several big barriers to participating in export markets, some of these challenges faced by these avocado farmers in accessing export markets included capital and liquidity constraint as they often don't have enough capital to meet the high costs of participation in export markets (Karing'u et al., 2020). For instance, being able to buy or grow higher quality avocados. In most cases, contract farmers need to harvest the produce themselves and transport it to collection sheds or company premises. Their payment then usually arrives after a delay of one to two weeks. Limited access to production technologies and institutional support. For instance, credit and training; this means smallholder avocado farmers are left out of important parts of the value chain, poor infrastructure in rural areas a lack of good roads makes it difficult and costly to bring produce to markets in far-off areas (Karing'u et al., 2020).

Several constraints and challenges face the avocado export sector in Kenya and can be highlighted as; the quality of Kenyan arrivals vary a lot due to the nature of the production as the majority of the fruit is small holder grown and has lots of variance during production; the packaging is also not strong enough and this results in consistent claims and lack of confidence from the markets; disruptions to shipping and less capacity available also slow the markets down as Northern Europe does not want as much Fuerte (Edna, 2019). The initial development of the Kenyan imports of avocados was controlled by a number of large French importers who used Kenyan production to cover gaps in the market and on average paid prices 20-30% cheaper than other origins. The buying patterns in Europe have changed significantly and the French have lost their dominance. This study therefore sought to evaluate avocado varieties and export markets for sustainable agriculture and afforestation in Kenya by adopting a literature review based methodology.

1.3 Research Objectives

i. To examine sustainability of agriculture through avocado varieties and export markets in Kenya.
ii. To evaluate the impact of avocado varieties on afforestation in Kenya.

2.1 Theoretical Review

This study was anchored on transaction cost theory. Based on the concept of transaction cost theory by Coase (1937), farmers' participation in the market is constrained by transaction costs incurred during marketing such as information search costs, negotiation costs, monitoring costs, cost of transporting products to market, cost of sorting and grading and cost of harvesting (Key et al., 2000). These costs were deemed to limit avocado farmers' participation in export market. It was also assumed that an avocado farmer would not participate in a given market when transaction costs incurred in that market outweigh the benefits received from the market (Musemwa et al., 2008). The theory of transaction cost is explained by use of Heckman two stage model by Key et al. (2000). Further, the study argued that fixed transaction cost influence smallholder farmers market participation while proportional transaction costs affect both market participation and extent of participation. Heckman two stage models developed by Heckman (1979) has shown good results by studies evaluating transaction costs and market participation (Alene et al., 2008; Bwalya et al., 2013; Muricho et al., 2015). Therefore this framework was used to conceptualize the effect of transaction costs on farmer's decision on export market participation and extent of participation for sustainable agriculture and afforestation in Kenya.

2.2 Empirical Review

2.2.1 Sustainability of Agriculture through Avocado Varieties and Export Markets

Using data from a survey of large avocado farmers in Kenya, Amare, Mariara, Oostendorp and Pradhan (2019) examined the determinants and impacts of smallholder-producer participation in avocado export markets on labour inputs, farm yields, sales prices, and incomes, using a switching regression framework to control for selection effects. The study found that farmers who participated in export markets differed significantly from nonparticipating farmers: They were older, had somewhat larger farms, had received more training, and owned more avocado trees of the Hass variety, the type favoured in export markets. Living near a well-functioning avocado farmers' group was also positively associated with participation in export markets. Participation in avocado export markets had positive impacts on incomes, revenues, prices, and labour inputs. However, there was an offsetting effect in terms of higher prices and lower volumes, reflecting the stricter quality requirements of export markets. Applying a decomposition analysis, they found that not only differences in endowment sizes, but also differences in returns from endowments in export versus domestic markets, were key to understanding differences in yields, revenues, sales prices, and labour inputs. The study recommended that policymakers should not only focus on resource accumulation for farmers, but also pay attention to the inclusiveness of export market participation for smallholder farmers.

Karing'u, Isaboke and Ndirangu (2020) investigated the role of transactional costs on smallholder avocado farmers' participation in the export market and the extent of participation in Murang'a County, Kenya. The data for the study was collected from 384 avocado farmers in Murang'a County, following stratified sampling. The Heckman two-stage model was used for analysis. The study findings showed that the cost of information search was an important variable that impedes smallholders' participation in export marketing while harvesting costs inhibits the extent of participation in export marketing. Regarding access to market information, the analysis showed that 98.11% of farmers in the export market had access to market information, while 97.84% of domestic farmers also had access to information on avocado marketing. Farmers in the study area had access to various radio, phone SMS and television programs tailored to broadcast information on agribusiness farming that increases their knowledge about avocado farming. Annor et al. (2016) noted that access to the information on markets enables farmers to be aware of current market requirements in the export market for example sanitary and phytosanitary requirements. Results further revealed that the agricultural trainings on avocado farming methods attended were significantly higher for export market participants implying that increased agricultural training may increase farmers' knowledge on export market standards.

Uosukainen (2018) while analyzing what factors get in the way of smallholder farmers participating in export markets in a survey which included 790 avocado-farming households in Kenya found that exporting more of Kenya's avocado production could raise the incomes of Kenyan smallholder farmers. But, to do so, programmes and policymakers need to reduce the barriers that smallholders face when they want to participate in export markets. The barriers found to be hindering the farmers from participating in export market included the costs of harvesting, transport and having liquidity; there were also farmers' organization transaction costs, such as membership fees and the opportunity costs of time when attending meetings. The study found that the main barrier hindering avocado farmers from participating in export market was capital and liquidity constraint. They often don't have enough capital to meet the high costs of participation

in export markets. For instance being able to buy or grow higher quality avocados. In most cases, contract farmers need to harvest the produce themselves and transport it to collection sheds or company premises, their payment then usually arrives after a delay of one to two weeks. The study further established that participating in export markets raises avocado smallholder farmers' incomes by nearly 39%. This is mostly on account of higher prices offered in international markets. For example, a dozen Hass avocados, distinguished by their dark green and brown skin and smaller than average avocado stone, sell for 3.5 Kenyan Shillings ($0.03) in domestic markets. But they fetch nearly double, 6 Kenyan Shillings ($0.06), in global export markets.

A study by Boen (2019) showed that Hass avocado fruit produced in the less humid (dry) Agro-ecological zones(AEZs) have higher oil content compared to those from the more humid (high potential) AEZs in Kenya. This means that even when avocado fruits possess similar physical attributes such as size and peel colour, they may vary significantly in internal quality attributes including the oil content which determines their competitiveness in the export market. The high demand for avocado fruit, especially in the export market often pushes farmers to harvest the fruits early in the season (often prematurely) to meet their contractual obligations (Gibbs & Steele, 2018). Knowledge of the maturity indices for various avocado varieties so as to guide farmers on when to harvest the fruit without compromising the quality is important. Immature harvest not only affects the oil content but also negatively affects the eating and keeping quality of the fruit. Fruits that are harvested too early (prematurely) have low pulp dry matter, watery texture, poor flavour, shrivel during ripening and don't ripen evenly. These attributes have negatively impacted traders and consumers perception of avocado fruit from Kenya. As the global demand for avocado fruit continues to increase, more farmers (not only in Kenya) will increase production to take advantage of the market opportunities. For the avocado fruits from Kenya to compete favourably in the global market, efforts must be made to ensure that the factors that affect fruit quality are addressed (Gibbs & Steele, 2018). There are various postharvest technologies and practices that can be applied to preserve quality after harvest. These include technologies for cold chain management, ethylene management, waxing to minimize gaseous exchange and water loss among others. However these technologies can only preserve the existent quality after the fruit is harvested. Therefore efforts must be made to ensure optimal quality at harvest and harvesting the fruit at the right stage of maturity. For Kenya's avocado fruits to compete favourably in the market place (domestic and global), there is need for concerted efforts and interventions from various stakeholders including farmers, traders, policy makers and researchers.

Hakizimana and May (2018) sought to find out if smallholder avocado production could help reduce poverty and improve food security through internal markets. Using the avocado industry in Giheta-Burundi, the study argued that some emerging tree crops such as avocados presented enormous opportunities to income generation and food security for small-scale farmers. The study suggested that small-scale avocado farming presents the economic, market and health potentiality to contribute to a viable and sustainable rural economy through internal markets thereby reducing levels of poverty and malnutrition in this area. From a policy perspective, the study suggested that the avocado sector needs to be supported by both the private and public sectors, irrespective of whether the crop is consumed, traded domestically or exported. Increasing the capacity of avocado production and trade will then enable small-scale farmers and vendors to gain greater income from this sector.

Omolo, Tana, Mutebi, Okwach, Onyango and Okach (2017) carried out an analysis of avocado marketing in Trans-Nzoia district, Kenya. The study used both primary and secondary data;

primary data was collected using questionnaires and observation, while secondary data was obtained from published and unpublished materials. Different players in avocado marketing were considered for study. The sample consisted of 30 farmers, 10 retailers and 10 consumers, selected using simple random sampling method. Data was analyzed using SPSS statistical package. The findings of the study indicated that middlemen played a vital role in marketing of avocado for small holder producers and that a lot of marketing challenges such as transportation facilities, low prices and lack of market information existed for marketing agents. However, the study found that low prices and lack of market information were the major marketing problems experienced by most farmers. Other marketing problems facing farmers during marketing of avocado included damages when ripening, unreliable market, lack of transport facilities and lack of support in marketing by the government. Damages when ripening originated from the poor harvesting methods used by farmers. Farmers prick the fruits which then fall of the hard ground. During ripening, the fruits begin to rot from the side in which they fall on the ground. Despite all these problems, slightly over 10% of farmers did not experience any marketing problems. In most cases, middlemen used pick-ups to carry the fruits in bags, which they sold in markets far away like in Lodwar and Mombasa. Those farmers who sold directly to the market took their fruits to the village/local markets during market days only. This was mainly on small-scale as farmers placed the fruits in small bags, which they carry on their heads or backs.

In a study by Chacha (2013), cost of inputs such as agrochemicals, fertilizer, irrigation, labour, and seedlings; farm size and amount of fruits harvested in kilogrammes (Kgs), price of output per Kg sold either to middlemen, contracted buyers or at spot-markets were used to estimate profitability. Costs regarding to marketing of the fruits were not considered. Average costs such as labour costs per hectare, cost of seeds, cost of insecticides, cost of chemicals, cost of irrigation and other costs such as fuel costs and average revenue were used to calculate gross margins in direct marketing and broker marketing channels among onion farmers in Ethiopia (Taye & Ponguru, 2017). The study also did not include transaction costs in the analysis, further the study only considered only two marketing channels while more informal marketing channels exist among smallholders in developing countries. Muthini *et al.* (2017) estimated gross margins of mango farmers using average price per piece less average cost of fertilizer, labour and pesticides across various marketing channels used by farmers. Although the study estimated gross margin under different marketing channels, transaction costs were not included.

A study by Njuguna (2018) on effect of marketing mix strategies on export performance of avocado firms in Kenya indicated that the majority of avocado growers are small scale farmers with different methods of production and therefore the quality of the Kenyan avocados varies. There is also a lack of confidence in the international markets due to the claims that the packaging of Kenyan avocados is not strong enough. Initially, the international market for Kenyan avocados was dominated by French importers who exploited the Kenyan production to meet the rising demand in the European market and paying 20-30% lower than the other importers (Johnny, Mariara, Mulwa & Ruigu, 2019). The European Union has well-documented standards for avocados that China has also embraced even after giving Kenyan avocados a nod. For instance, the EU and China outline that the fruits should be clean and free from debris. Furthermore, they should be free from pests and diseases, the stalk should be intact and mature to enable them to ripen uniformly at room temperature. Additionally, they must undergo inspection and certification from KEPHIS. The greatest challenge that might face Kenyan avocados is the ability to adhere to international standards and to prevent loses, farmers should ensure that they plant high quality and

certified seedlings (Njuguna, 2018). They should employ professional farming standards to prevent their avocado trees from being affected by pests such as thrips, and moth insects. They are also susceptible to fungal diseases such as anthracnose, root rot, Cercospora, and scab. Anthracnose, Cercospora and Scab can be controlled using copper-based fungicides. Root rot can be prevented by getting high quality, grafted, and treated seedlings.

As indicated by Kimaru, Muchemi and Mwangi (2020), in Kenya there has been avocado production consolidation in Kenya between 2007 and to date as the industry decided to reduce the loadings due to commercial reasons and strategically focused on improving the production of the fruit in the fields, developed stronger and more attractive packaging, worked on a number of different add-ons that helped modify the atmosphere in the reefer containers that would help the fruit travel and last longer and there has been more stringent controls on maturity index and opening of export season by the government regulators. During this time more of the new plantings which were predominantly Hass have come online. This automatically opened up new markets in Spain and Northern Europe. The quality has been excellent and Kenyan fruit is now achieving considerably better prices and despite the Kenyan share of the European market dropping from 31% to 5%, the value has increased by 11%. The growth in value of the Kenyan avocado exports to EU can be attributed to largely to the Hass Variety which fetches better premium than Fuerte variety.

According to Kariuki (2020), the European market achieves good prices as long as the weekly import volumes stay below 1,000,000 cartons [4,000 MT]. With increased volumes from Peru imports into Europe were crossing this threshold and prices were affected; South Africa had also suffered devastating damage from hail storms and so Kenya had a bumper year (Juma et al., 2019). Spanish and Israeli production has been affected by extreme drought, and the collapse of Agrexco, and the recession in Spain has slowed down their production and again given more opportunities to Kenya. As the fruit matures at different times in the year depending on altitude, rainfall and temperatures, farmers market their fruit differently to a range of outlets. A key factor on how far the fruits go from the production region depends heavily on the infrastructure, local conditions & consumption habits (Tambwe, 2019). Kenyan farmers initially produced and sold the avocados for the export markets only and all the production that was not sold due to slow markets or quality issues was fed to livestock or left to rot. Over the past decade Kenyans have now started to actively eat avocados and an active national education & marketing drive needs to be embarked upon. The avocado value chain has developed with a business oriented approach that aims at capturing the best return at each stage of production, processing and trading (Kariuki, 2020). The chain is made up of several individual players, who are closely linked to each other and depend on each other's trust, co-operation, communication and ability.

2.2.2 Avocado Varieties and Afforestation

Denvir, Arima, González-Rodríguez and Young (2021) while assessing ecological and human dimensions of avocado expansion in México indicated that in 2016 the expansion of agricultural frontiers accounted for 98 percent of deforestation in Mexico. The study asserted that while the booming production of avocado has contributed to the country's economic growth, it has also caused deforestation and degradation in central and southern Mexican forests. The study suggested that to continue this economic growth without further deforestation, it was crucial that a comprehensive sustainability certification scheme be implemented to safeguard Mexico's rich biodiversity. Global Forest Watch (2020) data shows that forest clearing to establish avocado

plantations has pushed into the boundaries of the RBMM. Satellite images in Mexico reveal large areas with agricultural ponds, often with traces of burning, a distinct pattern indicative of avocado expansion. While deforestation inside the reserve due to illegal logging has been reduced from its peak between 2003 and 2005, the expansion of avocado now poses a threat. Indeed, municipal subsidies for avocado have been encouraging forest clearing. In 2017, four of the six Michoacan municipalities that form the reserve received a total of 1.25 million pesos from the Ministry of Agriculture and Rural Development (SAGARPA) to create avocado orchards.

Ulomi (2017) in a study evaluated afforestation for mitigating against land degradation on Kilimanjaro highlands, Kibosho West Ward, Moshi Rural District. The data were collected through focus group discussion, interviews, questionnaires, survey, secondary data reviews and observation. The study found that land degradation was brought by deforestation and to address the issue of deforestation, goal and objectives were set through involving stakeholders. Implementation was conducted following the needs assessment which indicated what interventions to undertake to achieve the intended goals and objectives. Through socio-economic survey two strategies to tackling the problem were identified, the first was the awareness creation and capacity building for community members and Village leaders and second was tree seedlings production and tree planting by community members. During project implementations training on tree nursery operation at grass root level was conducted and the tree seedlings included avocado seedlings. It was indicated that avocado trees were being used in reclaim degraded land. Implementation results showed that tree nurseries groups were formed and a number of tree nurseries increased from 1 to 44 with a total of 151,000 avocado tree seedlings. It was recommended that the Moshi Rural District Council to establish sustained afforestation programmes.

Ayala (2020) in a study titled 'Avocado: The 'Green Gold 'Causing Environment Havoc' revealed that Mexico produces more avocado than anywhere in the world, but the "green gold", as it is known, is consumed mainly in North America, Europe and Asia. Each year, 11 billion pounds of avocado are consumed around the world. A few weeks ago, every six minutes, a truck full of avocados was leaving the Mexican state of Michoacán for export to the USA in preparation for the most important date for avocado producers in the year: the Super Bowl, which sees 7% of the annual avocado consumption in only one day. The study however showed that despite this massive creation of value and success, extensive avocado production in Mexico has substantial and irretrievable environmental costs and damages. Disproportionately huge demand for the fruit is creating a climate change effect, forest lands with diverse wildlife have been destroyed to produce avocado, and many more were intentionally burned to bypass a Mexican law allowing producers to change the land-use permit to commercial agriculture instead of forest land, if it was lost to burning.

3.0 Research Methodology

The study adopted literature review based methodology in which an effective and well-conducted review as a research method was used to create a firm foundation for advancing knowledge and facilitating theory development on avocado varieties and export markets for sustainable agriculture and afforestation in Kenya. By integrating findings and perspectives from many empirical findings, literature review method was used to address research questions with a power that no single study has.

4.0 Findings and Discussions

The literature reviewed revealed that farmers who participated in export markets differed significantly from nonparticipating farmers as they were older, had somewhat larger farms, had received more training, and owned more avocado trees of the Hass variety, the type favoured in export markets as indicated by Pradhan (2019). The study established that living near a well-functioning avocado farmers' group was positively associated with participation in export markets. Participation in avocado export markets had positive impacts on incomes, revenues, prices, and labour inputs. However, the study found that there was an offsetting effect in terms of higher prices and lower volumes, reflecting the stricter quality requirements of export markets. It was further established that not only differences in endowment sizes, but also differences in returns from endowments in export versus domestic markets, can be key to understanding differences in yields, revenues, sales prices, and labour inputs.

As indicated by the reviewed literature, most of the farmers in the export market in Murang'a had access to market information, and 97.84% of domestic farmers have access to information on avocado marketing. Most avocado farmers in rural parts of Kenya have access to various radio, phone SMS and television programs tailored to broadcast information on agribusiness farming that increases their knowledge about avocado farming. Thus is in agreement with the assertions of Annor *et al.* (2016) who noted that access to the information on markets enables farmers to be aware of current market requirements in the export market for example sanitary and phytosanitary requirements. Results further revealed that the agricultural trainings on avocado farming methods attended are significantly higher for export market participants implying that increased agricultural training may increase farmers' knowledge on export market standards.

From the literature, the barriers hindering the farmers from participating in export market includes the costs of harvesting, transport and having liquidity; there were also farmers' organization transaction costs, such as membership fees and the opportunity costs of time when attending meetings. Of all the above listed barriers, the main barrier hindering avocado farmers from participating in export market was capital and liquidity constraint. They often don't have enough capital to meet the high costs of participation in export markets. For instance being able to buy or grow higher quality avocados. In most cases, contract farmers need to harvest the produce themselves and transport it to collection sheds or company premises, their payment then usually arrives after a delay of one to two weeks. The study further established that participating in export markets raises avocado smallholder farmers' incomes by nearly 40% which is mostly on account of higher prices offered in international markets. For example, the study found that a dozen of Hass avocados, distinguished by their dark green and brown skin and smaller than average avocado stone, sell for 3.5 Kenyan Shillings ($0.03) in domestic markets, but they fetch nearly double, 6 Kenyan Shillings ($0.06), in global export markets.

Further, from the reviewed literature it is evident that middlemen play a vital role in marketing of avocado for small holder producers and that a lot of marketing challenges such as transportation facilities, low prices and lack of market information existed for marketing agents. However, the low prices and lack of market information are mostly sited as the major marketing problems experienced by most farmers. Other marketing problems facing farmers during marketing of avocado included damages when ripening, unreliable market, lack of transport facilities and lack of support in marketing by the government. Damages when ripening originated from the poor harvesting methods used by farmers. Farmers prick the fruits which then fall of the hard ground.

During ripening, the fruits begin to rot from the side in which they fall on the ground. Despite all these problems, slightly over 10% of farmers did not experience any marketing problems. In most cases, middlemen used pick-ups to carry the fruits in bags, which they sold in markets far a way like in Lodwar and Mombasa. Those farmers who sold directly to the market took their fruits to the village/local markets during market days only.

The study also found that, following the increase in demand for avocado in the local and international market, avocado farmers in Kenya have been generating a lot of income since most farmers in different parts of Kenya are tuning in to avocado farming to reap something from the profitable industry; in the export market, avocados are likely to be the game-changer crop, especially Hass avocados which are highly nutritious. In the recent past, Europe has been the most targeted market for Kenyan Avocado. China giving a nod to the Kenyan avocados has been a major development that has been boosting the avocado market. According to recent reports, it is evident that big markets in Europe and China are showing more interest in avocados from Kenya. For instance, avocado exports to China and Europe have increased by more than 1000 times and the projection is still growing. The consumption of Hass avocados has risen by 150% in Europe in one decade, which shows that there is a development in the avocado farming industry.

The study found that approximately 70% of avocado fruit is grown in Central and Eastern regions, with Central region being the leading producer. Avocado production is dominated by smallholders who constitute 85% of total avocado growers in the country and the volumes of Hass avocados from Kenya is likely to continue rising as many farmers are making the switch to avocados, with Hass being seen as the most popular with great demand in global markers. The Hass avocado variety is the most popular Kenya avocado for export because it enjoys a good market in Europe as compared to the other varieties. Based on the findings, Hass is its most prominent features is that it turns dark purple when ripe. Fuertes is the second most common variety of avocado used to make guacamole and is a hybrid between both a Mexican and a Guatemalan subspecies of avocados, this plant matures in 6-8 months after flowering with its season beginning between March and April.

5.0 Conclusion

This study concludes that agriculture often places significant pressure on natural resources and the environment, as such sustainable agricultural practices are intended to protect the environment, expand the Earth's natural resource base, and maintain and improve soil fertility. Sustainable agriculture is about increasing profitable farm income, promoting environmental stewardship, enhancing quality of life for farm families and communities and increase production for human food and fiber needs. Sustainable agriculture frequently encompasses a wide range of production practices, including conventional and organic. Sustainable agriculture is designed with the intention of preserving the environment, expanding the earth's natural resources, all while creating a quality of life for animals and humans.

Based on the reviewed literature, it suffices to conclude that Kenya is located in an ideal location for avocado growth, as avocados thrive in subtropical climates such as the Pacific Americas, South-east Asia, and Africa. African avocados are argued to be some of the greatest, with majority of the exported varieties coming from Kenya. Currently, Kenya has over 40 varieties of Avocado where Hass is the main export variety and Fuerte is preferred for processing. Other commercial varieties identified in Kenya include Keitt, Reed, Booth 8, Simmonds, Pinkerton, Nabal, Puebla, Tonnage, Ettinger, Hayes, G6 and G7.These popular varieties are Hass, Fuerte, and Puebla.

Based on the findings as discussed above, the study concludes that the domestic market is the largest source of demand for Kenyan avocados accounting for over 80% of the total production and the rest are exported as fresh fruits or processed and exported as crude oil. In the domestic market avocados are sold locally through market vendors, small retail outlets, supermarkets and hotels. In the export market, Kenyan fresh avocados are sold primarily in Europe and the Middle East, with France being the largest buyer and other main export markets include United Arab Emirates, the Netherlands, the United Kingdom and Germany. In addition, avocados are primarily shipped sea freight to Europe which contributes to Kenya's cost competitiveness. Approximately one third of avocado production is exported. While the booming production of avocado has contributed to the economic growth of Kenya, it has also caused deforestation and degradation in forests.

6.0 Recommendation

The study recommends that, for the avocado fruits from Kenya to compete favourably in the global market, efforts must be made to ensure that the factors that affect fruit quality are addressed. There are various postharvest technologies and practices that can be applied to preserve quality after harvest. These include technologies for cold chain management, ethylene management, waxing to minimize gaseous exchange and water loss among others. However these technologies can only preserve the existent quality after the fruit is harvested. Therefore efforts must be made to ensure optimal quality at harvest and harvesting the fruit at the right stage of maturity. For Kenya's avocado fruits to compete favourably in the market place (domestic and global), there is need for concerted efforts and interventions from various stakeholders including farmers, traders, policy makers and researchers.

From a policy perspective, the study suggests that the avocado sector needs to be supported by both the private and public sectors, irrespective of whether the crop is consumed, traded domestically or exported. Increasing the capacity of avocado production and trade will then enable small-scale farmers and vendors to gain greater income from this sector. The study recommends that policymakers should not only focus on resource accumulation for farmers, but also pay attention to the inclusiveness of export market participation for smallholder farmers. Finally, the study recommends that avocado farmers in Kenya should employ professional farming standards to prevent their avocado trees from being affected by pests such as thrips and moth insects. They are also susceptible to fungal diseases such as anthracnose, root rot, Cercospora, and scab. Anthracnose, Cercospora and Scab can be controlled using copper-based fungicides. Root rot can be prevented by getting high quality, grafted, and treated seedlings. In so doing, they will be encouraging sustainable agriculture in the country. This study suggests that to continue this economic growth without further deforestation, it is crucial that a comprehensive sustainability certification scheme be implemented to safeguard rich biodiversity. It also suggests that all underutilized land in Kenya should be put into Avocado farming as a way of afforestation, reforestation and mitigation to climate change. Borehole projects to be targeted for climate change mitigation through avocado farming.

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APPENDIX 1: AVOCADO PROCESSING AND PACKAGING FOR EXPORT

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