

GAINS OF AVOCADOS AND CONSTRAINTS TO SUSTAINABLE PRODUCTION IN NIGERIA

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ABSTRACT

Avocado is a green flesh, buttery texture and nut-like taste fruit. It comes from a tall, tropical evergreen tree called *Persea Americana*. Avocado is a large berry containing a single seed. Avocado is mostly found in the tropics and subtropics parts of the world. They do not ripen until after they have been picked or fallen off the tree. Different varieties have different peak seasons, which make avocados available year-round. Avocado trees are partially self-pollinating and often are propagated through grafting to maintain a predictable quality and quantity of the fruit. Avocados tree has been identified as having a number of social, health and economic significance from which the farmers and the nation can derive a number of benefits. In Nigeria, the production and harvesting performance of avocados are hampered by access to land and the availability of better planting materials and other farm inputs, farmers training and establishment of village based nurseries beds, lack of a comprehensive agricultural extension approach to boost avocados production among others factors.

Keywords: Avocado, Berry, Benefits, Nigeria, Farmers, Production

INTRODUCTION

Avocado is renowned for its light-green flesh, buttery texture and nut-like taste. Originally known as the alligator pear because of its shape and rigid, greenish-black skin, these fruits come from a tall, tropical evergreen tree called *Persea Americana*. It is classified as a member of the flowering plant family Lauraceae. Avocado is a large berry containing a single seed and is believed to have originated in the State of Puebla, Mexico, though fossil evidence suggests

similar species were much more widespread millions of years ago, occurring as far south as Peru and as far north as California at a time when the climate of that region was more hospitable to them (Yahia, 1997).

The native, undomesticated variety is known as a criollo, and is small, with dark black skin, and contains a large seed. The oldest evidence of avocado use was found in a cave located in Coxcatlán, Puebla, Mexico, that dates to around 10,000 BC. The avocado tree also has a long history of cultivation in Central and South America, likely beginning as early as 5,000 BC (Biale. & Young, 1971).

Avocado is mostly found in the tropics and subtropics parts of the world. Avocados bloom between February and May, but can be harvested all year because they do not ripen until after they have been picked or fallen off the tree. Different varieties have different peak seasons, which make avocados available year-round. The trees can grow 40 to 80 feet tall. Avocado trees are partially self-pollinating and often are propagated through grafting to maintain a predictable quality and quantity of the fruit. The leaves are large, leathery, and deep green with paler veins. Mature trees will shed a portion of their aging leaves during the flowering period. Some varieties drop more than others during this time. New leaves will develop almost immediately (Chilean Hass Avocado Committee, 2015).

There are different species of avocados and they are rich in monounsaturated fat that is easily burned for energy. There are various health effects of avocado consumption, particularly its benefits for cardiovascular disease, weight management, diabetes, and its ability to enhance body's absorption of nutrients. Due to its beneficial raw fat content, avocado enables human body to more efficiently absorb fat-soluble nutrients (such as alpha- and beta-carotene and lutein) in other foods eaten in conjunction. Adding avocado to salad allowed the body to absorb three to five times more carotenoids antioxidant molecules, which help protect your body against free radical damage. Avocados contain compounds that appear to inhibit and destroy oral cancer cells. *According to USDA (2014), avocados contain a complex package of phytonutrients, including carotenoids that may provide numerous health benefits. Carotenoids appear to protect humans against certain cancers, heart disease and age-related macular degeneration.*

They are a good source for good fat, protein, fiber, vitamin C, potassium, folic acid and other nutrients such as thiamine and riboflavin. Rich, creamy avocados are a kid-friendly fruit in many ways: They provide great taste, fun texture and they contribute valuable nutrients. Eating one-half of a fresh medium Hass avocado with a hamburger significantly inhibited the production of the inflammatory compound Interleukin-6 (IL-6), compared to eating a burger without fresh avocado. Avocados, which are actually classified as a fruit, are rich in monounsaturated fat that is easily burned for energy. They also provide close to 20 essential health-boosting nutrients,

including potassium, vitamin E, B-vitamins, and folic acid. Avocado can help optimize cholesterol levels within as little as one week; contains compounds that appear to inhibit and destroy oral cancer cells, and those that protect against liver damage (Mercola, 2016).

Avocados tree has been identified as having a number of social, health and economic significance from which the farmers in particular and the nation in general can derive a number of benefits. Nigeria especially the southern part is characterized by high annual rainfall, good temperature, fertile and well drain soil that favour avocados production. Avocados have survived overtime through natural means such as tree regeneration, self-reseeding, careless throwing of seeds after the flesh (mesocarp) are consumed. The seeds grow anywhere it is thrown because the environment is hospitable to them. Other natural agents like wind and running water aid its propagation.

Different Species of Avocado

Gwen

A seedling bred from 'Hass' x 'Thille' in 1982, 'Gwen' is higher yielding and more dwarfing than 'Hass' in California. The fruit has an oval shape, slightly smaller than 'Hass' (100–200 g), with a rich, nutty flavor. The skin texture is more finely pebbled than 'Hass', and is dull green when ripe.

Hass

While dozens of cultivars are grown, today, the 'Hass' avocado is the most common. It produces fruit year-round and accounts for 80% of cultivated avocados in the world. All 'Hass' trees are descended from a single "mother tree" raised by a mail carrier named Rudolph Hass, of La Habra Heights, California. Hass patented the productive tree in 1935. The "mother tree", of uncertain subspecies, died of root rot and was cut down in September, 2002. 'Hass' trees have medium-sized (150–250 g), ovate fruit with a black, pebbled skin. The flesh has a nutty, rich flavor with 19% oil. A hybrid Guatemalan type can withstand temperatures to $-1\text{ }^{\circ}\text{C}$ ($30\text{ }^{\circ}\text{F}$).

Lula

A seedling reportedly grown from a 'Taft' avocado planted in Miami on the property of George Cellon, it is named after Cellon's wife, Lula. It was likely a cross between Mexican and Guatemalan types. 'Lula' was recognized for its flavor and high oil content and propagated commercially in Florida. It is also very commonly used as a rootstock for nursery production, and is hardy to $-4\text{ }^{\circ}\text{C}$ ($25\text{ }^{\circ}\text{F}$).

Maluma

A relatively new cultivar, it was discovered in South Africa in the early 1990s by Mr. A.G. (Dries) Joubert. It is a chance seedling of unknown parentage.

Pinkerton

First grown on the Pinkerton Ranch in Saticoy, California, in the early 1970s, 'Pinkerton' is a seedling of 'Hass' x 'Rincon'. The large fruit has a small seed, and its green skin deepens in color as it ripens. The thick flesh has a smooth, creamy texture, pale green color, good flavor, and high oil content. It shows some cold tolerance, to $-1\text{ }^{\circ}\text{C}$ ($30\text{ }^{\circ}\text{F}$) and bears consistently heavy crops. A hybrid Guatemalan type, it has excellent peeling characteristics.

Reed

Developed from a chance seedling found in 1948 by James S. Reed in California, this cultivar has large, round, green fruit with a smooth texture and dark, thick, glossy skin. Smooth and delicate, the flesh has a slightly nutty flavor. The skin ripens green. A Guatemalan type, it is hardy to $-1\text{ }^{\circ}\text{C}$ ($30\text{ }^{\circ}\text{F}$). Tree size is about 5 by 4 m.

Bacon

Developed by a farmer, James Bacon, in 1954, Bacon has medium-sized fruit with smooth, green skin with yellow-green, light-tasting flesh. When ripe, the skin remains green, but darkens slightly, and fruit yields to gentle pressure. It is cold-hardy down to $-5\text{ }^{\circ}\text{C}$ ($23\text{ }^{\circ}\text{F}$).

Brogden

Possibly a cross between Mexican and West Indian types, 'Brogden' originated as a seedling grown in Winter Haven, Florida, on the property of Tom W. Brogden. The variety was recognized for its cold-hardiness to $-5\text{ }^{\circ}\text{C}$ ($23\text{ }^{\circ}\text{F}$) and became commercially propagated as nursery stock for home growing. It is noted for its dark purple skin at maturity.

Ettinger

A Mexican/Guatemalan cross seedling of 'Fuerte', this cultivar originated in Israel, and was put into production there in 1947. Mature trees tolerate four hours at $-6\text{ }^{\circ}\text{C}$ ($21\text{ }^{\circ}\text{F}$).

The fruit has a smooth, thin, green skin that does not peel easily. The flesh is very pale green.

Fuerte

A Mexican/Guatemalan cross originating in Puebla, the 'Fuerte' earned its name, which means strong in Spanish, after it withstood a severe frost in California in 1913. Hardy to $-3\text{ }^{\circ}\text{C}$ ($27\text{ }^{\circ}\text{F}$), it has medium-sized, pear-shaped fruit with a green, leathery, easy-to-peel skin. The creamy flesh of mild and rich flavor has 18% oil. The skin ripens green. Tree size is 6 by 4 m (19.7 by 13.1 ft).

Monroe

A Guatemalan/West Indian cross that originated from a seedling grown in Homestead, Florida, on the property of J.J.L. Phillips, it was patented in 1937 and became a major commercial cultivar due to its cold hardiness and production qualities. The fruit is large, averaging over 2 lb (0.91 kg) in weight, has an elliptical shape, and green, glossy skin. Hardy to $-3\text{ }^{\circ}\text{C}$ ($27\text{ }^{\circ}\text{F}$).

Sharwil

Predominantly Guatemalan, with some Mexican race genes, 'Sharwil' was developed in 1951 by Sir Frank Sharpe at Redland Bay, southern Queensland. The name "Sharwil" is an amalgamation of Sharpe and Wilson (J.C. Wilson being the first propagator). Scions were sent from Australia to Hawaii in 1966. A medium-sized fruit with rough green skin, it closely resembles the 'Fuerte', but is slightly more oval in shape. The fruit has greenish-yellow flesh with a rich, nutty flavor and high oil content (20–24%), and a small seed. The skin is green when ripe. It represents more than 57% of the commercial farming in Hawaii, and represents up to 20% of all avocados grown in New South Wales, Australia. It is a regular and moderate bearer with excellent quality fruit, but is sensitive to frost. Disease and pest resistance are superior to 'Fuerte'.

'Zutano'

Originated by R.L. Ruit in Fallbrook in 1926, this Mexican variety is hardy to $-4\text{ }^{\circ}\text{C}$ ($25\text{ }^{\circ}\text{F}$). The large, pear-shaped fruit has a shiny, thin, yellow-green skin that peels moderately easily. The flesh is pale green with fibers and has a light flavor (Mercola, 2016).

Harvest and postharvest

Commercial orchards produce an average of seven tonnes per hectare each year, with some orchards achieving 20 tonnes per hectare. Biennial bearing can be a problem, with heavy crops in one year being followed by poor yields the next. The avocado tree does not tolerate freezing temperatures, and can be grown only in subtropical or tropical climates. Several cold-hardy varieties are planted in the region of Gainesville, Florida, which survive temperatures as low as $-6.5\text{ }^{\circ}\text{C}$ ($20\text{ }^{\circ}\text{F}$) with only minor leaf damage (Delgado, 2009).

Like the banana the avocado is a climateric fruit, which matures on the tree, but ripens off the tree. Avocados used in commerce are picked hard and green and kept in coolers at $3.3\text{ }^{\circ}\text{C}$ to $5.6\text{ }^{\circ}\text{C}$ (37.9 to $42.1\text{ }^{\circ}\text{F}$) until they reach their final destination. Avocados must be mature to ripen properly. Avocados that fall off the tree ripen on the ground. Generally, the fruit is picked once it reaches maturity; Mexican growers pick 'Hass' avocados when they have more than 23% dry matter, and other producing countries have similar standards. Once picked, avocados ripen in one to two weeks (depending on the specie) at room temperature (faster if stored with other fruits such as apples or bananas, because of the influence of ethylene gas). Some supermarkets sell ripened avocados which have been treated with synthetic ethylene to hasten ripening. In some cases, avocados can be left on the tree for several months, which is an advantage to commercial growers who seek the greatest return for their crop; but if the fruit remains unpicked for too long, it falls to the ground (www.uc.org).

Health Benefits of Avocados

According to Kawagishim (2012), Avocados have a long list of potential health benefits. For example, besides its anti-inflammatory properties, previous research from Japan suggests it may also help protect against liver damage. In one study, laboratory rats were fed avocado and 22 other fruits. The rats were then given D-galactosamine, a potent liver toxin that interferes with cell synthesis and results in cell death. The rats fed avocado suffered the least amount of liver damage. The chemical-induced liver injuries resemble those caused by viruses, so the researchers suggested avocado could potentially offer support in the treatment of viral hepatitis. *Besides offering taste and nutrition, avocados seem to improve liver health.* Due to its beneficial raw fat content, avocado enables body to more efficiently absorb fat-soluble nutrients (such as alpha- and beta-carotene and lutein) in other foods eaten in conjunction.

Dudash, (2005), found that adding avocado to salad allowed the volunteers to absorb three to five times more carotenoids antioxidant molecules, which help protect body against free radical damage. He also found that avocados contain compounds that appear to inhibit and destroy oral cancer cells. Avocados can help improve lipid profiles in both healthy individuals and those with non-optimized total cholesterol levels). Healthy individuals saw a 16 percent decrease of serum total cholesterol level following a one-week long diet high in monounsaturated fat from

avocados. In those with elevated cholesterol levels, the avocado diet resulted in a 17 percent decrease of serum total cholesterol, and a 22 percent decrease of both harmful cholesterol and triglycerides.

Culinary uses

A ripe avocado yields to gentle pressure when held in the palm of the hand and squeezed. The flesh is prone to enzymatic browning, quickly turning brown after exposure to air. To prevent this, lime or lemon juice can be added to avocados after peeling.





Fig. 1: Indonesian-style avocado milkshake with chocolate syrup

The fruit is not sweet, but distinctly and subtly flavored, with smooth texture. It is used in both savory and sweet dishes. The avocado is popular in vegetarian cuisine as a substitute for meats in sandwiches and salads because of its high fat content.

Generally, avocado is served raw, though some species, including the common 'Hass', can be cooked for a short time without becoming bitter. Caution should be taken when cooking with untested species; the flesh of some avocados may be rendered inedible by heat. Prolonged cooking induces this chemical reaction in all species. It is used as the base for the Mexican dip known as guacamole, as well as a spread on corn tortillas or toast, served with spices. In the Philippines, Brazil, Indonesia, Vietnam, and southern India (especially the coastal Kerala, Tamil Nadu and Karnataka region), avocados are frequently used for milkshakes and occasionally added to ice cream and other desserts. In Brazil, Vietnam, the Philippines and Indonesia, a dessert drink is made with sugar, milk or water, and pureed avocado. Chocolate syrup is sometimes added. In Morocco, a similar chilled avocado and milk drink is sweetened with confectioner's sugar and hinted with orange flower water. In Ethiopia, avocados are made into

juice by mixing them with sugar and milk or water, usually served with Vimto and a slice of lemon. It is also common to serve layered multiple fruit juices in a glass (locally called *Spris*) made of avocados, mangoes, bananas, guavas, and papayas. Avocados are also used to make salads.

Avocados in savory dishes, often seen as exotic, are a relative novelty in Portuguese-speaking countries, such as Brazil, where the traditional preparation is mashed with sugar and lime, and eaten as a dessert or snack. This contrasts with Spanish-speaking countries such as Chile, Mexico, or Argentina, where the opposite is true and sweet preparations are rare (Adel and Mary, 2015).



Fig. 2: Sliced avocado

In Australia and New Zealand, it is commonly served in sandwiches, sushi, on toast, or with chicken. In Ghana, it is often eaten alone in sliced bread as a sandwich. In Sri Lanka, well-ripened flesh, thoroughly mashed with sugar and milk, or treacle (syrup made from the nectar of a particular palm flower) is a popular dessert. In Haiti, it is often consumed with cassava or regular bread for breakfast.

In Mexico and Central America, avocados are served mixed with white rice, in soups, salads, or on the side of chicken and meat. In Peru, they are consumed with tequeños as mayonnaise, served as a side dish with parrillas, used in salads and sandwiches, or as a whole dish when filled with tuna, shrimp, or chicken. In Chile, it is used as a puree-like sauce with chicken, hamburgers, and hot dogs; and in slices for celery or lettuce salads. The Chilean version of Caesar salad contains large slices of mature avocado. In Kenya and Nigeria, the avocado is often eaten as a

fruit eaten alone or mixed with other fruits in a fruit salad, or as part of a vegetable salad. Avocado slices are frequently added to hamburgers, tortas, hot dogs, and carne asada. Avocado can be combined with eggs (in scrambled eggs, tortillas, or omelettes), and is a key ingredient in California rolls and other rolled sausage. In the United Kingdom, the avocado became available during the 1960s when introduced by Sainsbury's under the name 'avocado pear' (Bergh & Lahav, 1996).

Diet and Clinical Research

Fulgoni (2013) showed that American avocado consumers had better overall diet quality, nutrient levels, and reduced risk of metabolic syndrome. High avocado intake was shown in one preliminary study to lower blood cholesterol levels. Specifically, after a seven-day diet rich in avocados, mild hypercholesterolemia patients showed a 17% decrease in total serum cholesterol levels. These subjects showed a 22% decrease in harmful cholesterol and triglyceride levels and 11% increase in helpful cholesterol levels. In a study of obese patients on a moderate fat diet (34% of calories), additional consumption of one avocado (136 g) per day over 5 weeks produced a significant reduction of circulating harmful cholesterol, an effect the authors attributed to the avocado's combination of monounsaturated fats, dietary fiber and the phytosterol, beta-sitosterol

Avocado as an Ornamental Plant

While not particularly popular, the avocado tree can be grown domestically and used as a (decorative) houseplant. The seed germinates in normal soil conditions or partially submerged in a small glass (or container) of water. The seed sprouts in four to six weeks, at which time it is planted in standard houseplant potting soil. The plant normally grows large enough to be prunable; however, it does not bear fruit unless it has ample sunlight. Home gardeners can graft a branch from a fruit-bearing plant to speed maturity, which typically takes four to six years to bear fruit (www.hab.org).



Fig. 3: Avocado fruit

Nutrition

Avocados provide nearly 20 essential nutrients, including fiber, potassium, Vitamin E, B-vitamins, and folic acid. They also act as a "nutrient booster" by enabling the body to absorb more fat-soluble nutrients, such as alpha and beta-carotene and lutein, in foods that are eaten with the fruit.

Good Fats and Heart Health

Avocados can help consumers meet the Diet and Lifestyle Recommendations of the American Heart Association (AHA), which among others are to eat less of the nutrient-poor foods while limiting the amount of saturated fat, trans fat and sodium you eat. Saturated fats increase risk for heart disease and, saturated and trans fats should be replaced with poly and monounsaturated fats. Mono and polyunsaturated fats, when consumed in moderation and eaten in place of saturated or trans fats, can help reduce blood cholesterol levels and decrease risk for heart disease. Avocados are one of the few fruits that provide "good" fats (AHA, 2010).

Avocados Can Be a Part of a Diabetes Diet

California Avocados are a delicious fruit and their nutrient-dense profile makes them a smart addition for anyone with (or without!) diabetes. Eating a diabetes-friendly diet is often perceived to be a challenge, but rest assured you don't have to sacrifice flavor and satisfaction when creating an eating plan that will help contribute to your healthful eating pattern, a key component of diabetes health management.

Eating one-half of a fresh medium Hass avocado with a hamburger significantly inhibits the production of the inflammatory compound Interleukin-6, compared to eating a burger without fresh avocado (Biale, 1942). Avocados, which are actually classified as a fruit, are rich in monounsaturated fat that is easily burned for energy. They also provide close to 20 essential health-boosting nutrients, including potassium, vitamin E, B-vitamins, and folic acid. Previous research has found avocado can help optimize cholesterol levels within as little as one week; contains compounds that appear to inhibit and destroy oral cancer cells, and those that protect against liver damage. The greatest concentration of beneficial carotenoids is in the dark green fruit of the avocado, closest to the peel. Therefore, "nick and peel" method helps to maximize the benefits from avocado.

Constraints of Avocados Production in Nigeria

The main challenge is the shortage in avocado production. Many Nigerians are not aware of its benefits. Almost all the avocados found in the market places were harvested from old trees planted by our ancestors during the time of colonial era. There are not much deliberate cultivation and propagation of the crop. This is as a result of scarce research work on avocados as it relates to Nigeria's climate.

In general, the production and harvesting performance of avocados are hampered by the following factors;

- a) Access to land and the availability of better planting materials and other farm inputs
- b) Farmers training and establishment of village based nurseries operated by farmers
- c) Lack of a comprehensive agricultural extension approach to boost avocados production

According to Blumenfeld et al. (2010), like other cash crops, production of avocado is influenced by various internal and external factors among which are the following:

- a) Old trees: the avocado trees have long been neglected. As a result, no serious efforts were made to replace ageing trees. In old plantations, these trees have outlived their productive years and productivity is low.

- b) Deforestation: this is a major problem affecting production. In the avocados producing areas, such as the Eastern and Western parts of the country, man quest for economic development in terms of construction of roads, houses, schools, and other facilities have created serious destruction of economic trees.
- c) Low yield varieties: most of the existing avocado tree varieties have low yields, resulting in low productivity.
- d) Land acquisition: majority of the production is attributed to small-scale farmers who have no organised avocados grove. The trees are found scattered here and there in the bush or in some residential places.
- e) Poor technology, high cost of production, unstable market system, high interest rate, low funding, and inadequate infrastructural facilities such as irrigation facilities, rural roads, stable power supply, water supply and poor exit services.
- f) Inadequate planting material such as viable (treatment and reasonability upkeep) seed and seedlings, inadequate availability of good planting material, inefficient extension network and inadequate farmers' training. Absence of innovation for extensive scale production and utilization of herbicides and pesticides hamper production Nigeria.
- g) Inadequate awareness on the economic importance of avocados: majority of Nigeria's citizens are ignorant of the many health benefits of avocados. There is also no knowledge of its usefulness as many food recipes.
- h) Dominance of small holdings and of wild avocado varieties: since there is dearth of researches, the avocados produced in Nigeria are of ancient species.
- i) Land acquisition: Due to land acquisition problem, large-scale farming is often difficult for small investors, in particular in the southern part of the country.
- j) High costs of inputs: inputs, such as chemicals, pesticides, fertilizer etc., are more often not accessible to the small holders.
- k) Transport: Nigerian's transportation system is not adequate. Although the country has a modern road network connecting cities, access roads to hinterland are poor. Most of the roads are un-tarred and in a state of disrepair.
- l) Low funding for Research and Development (R&D) activities: Timely availability of funds is the driving force of any research. In Nigeria, fund allocation from federation account for researches are inadequate, untimely and sometimes no funds allocation for necessary researches.

Inaccessibility of money and unfavourable Government strategies rank the highest among the challenges.

m) Weather and fire outbreak: As far as the climatic conditions are concerned, the better the weather during the flowering season, the better the harvest. When there is shortfall in rainfall or sunshine, the quality of the avocado is lowered. Fire outbreaks are common during dry season as well.

Onyemauwa (2012) noted non-ownership of farmland, pre-occupation with household chores, inadequate farm size, and high cost of processing, inadequate capital, high labour requirement in production and processing and difficulty in fertilizer procurement as constraints limiting farming in Nigeria.

REFERENCES

- [1] Bergh, B.O. & Lahav, E. (1996) Avocados. In: *Fruit Breeding*, vol. 1: *Tree and Tropical Fruits* (ed. J. Janick & J.N. Moore), pp. 113–166. Wiley and Sons, New York.
- [2] Biale, J.B. (1942) Preliminary studies on modified air storage of the Fuerte avocado fruit. *Proc. Am. Soc. Hort. Sci.* 41, 113–118.
- [3] Biale, J.B. & Young, R.E. (1971). The avocado pear. In: *The Biochemistry of Fruits and Their Products*, vol. 2 (ed. A.C. Hulme). Academic Press, New York.
- [4] Blumenfeld, A. & Gazit, S. (1970) Cytokinin activity in avocado seeds during fruit development. *Plant Physiol.* 46,331–333
- [5] Fulgoni, L.V. 2013. Results from the National Health and Nutrition Examination Survey (NHANES) 2001-2008. *Nutrition journal*
- [6] Onyemauwa, C.S. (2012). Analysis of Women Participation in Cassava Production and Processing in Imo State, Southeast Nigeria. *Journal of Economics and Sustainable Development*, 3 (5), 81-90
- [7] Yahia, E.M. (1997). Modified/controlled atmospheres for avocado (*Persea Americana* Mill). In: Kader, A.A. (ed.), *Proceedings*, vol. 3: *Fruits Other Than Apples and Pears*. Proc. CA Res. Conf., University of California, Davis, July13–18, pp. 97–103