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Papaya: A Household Nutritive Fruit Tree and Resourceful National Boost for Economic Recovery in Nigeria

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Abstract
Papaya or paw-paw as it is globally known is a tropical fruit tree. It is suitable for consumption, and has high nutritive values. It has many culinary and cuisine uses meant for abundant health benefits for mankind. It has different species all of which look alike and contain large minerals, vitamins and other nutrients necessary for human healthy living. Papaya production thrives in tropical and humid climates; it intercrops well with some others like vegetables, maize, banana, plantain and many more. Drugs like 'force up' and herbicides like 'DD Force' have been developed for use in papaya cultivation. Scientifically improved and genetically engineered cultivars resistant to Papaya Ringsports Viruses (PRV) have been developed for large scale papaya production The benefits of large scale papaya farming is multi-faceted – it provides sufficient energies, vitamins, minerals and many other constituents for human good health. It increases individual health wellbeing and family finances, creates job opportunities for the populace, boosts, normalizes and stabilizes national food security, economic resources and foreign reserves through exports especially for developing economies such as Nigeria

Key words: Papaya, household nutritive fruit tree, national resource boost, economic recovery.

Introduction

Papaya (paw paw) is a tropical fruit tree. It is a green skin fruit which turns yellow or red flesh with black seed when ripe. It has brownish round robust soft stem. Papaya is of three types - the male, the female and the hermaphrodite. It is nutritive and medicinal. Its fruits and leaves are edible. Its skin pulp, tree latex are curative, and all its other parts including the seeds and leaves are useful in many different ways including for tendering meat, expelling mosquitoes, brewing beer, and many more. Growing papaya, as elaborated in "An Overview of Global Papaya Production, Trade and Consumption" (2014), flourishes in the tropical and humid regions. Chia and Manshavolt (2015) corroborated this view point in their work on "why some papaya plants fail to fruit."

Nigeria is a tropical country. It has sunshine almost all the year round. It is also a rain forest nation. Even in the peak of dry season, there are tangential rains and humid weathers both during harmattan and semi-dry seasons ("About the country Nigeria (2017)." Principally, Nigeria is affected by four climate types - the tropical rain, the tropical savanna or humid, the Sahel or tropical dry, and, the highlands or mountain climates ("The human and physical characteristics of Nigeria", 2017). Its state of tropical, sub- or semi-tropical and humid climates, makes the growing of papaya apposite, especially in the southern parts which are endowed with these unique favourable

ephemeral atmospheric features (Jos Plateau Forest-grassland Mosaic Terrestrial Ecoregions, 2017).

An individual with a poor health state and less than $1 a day per capita income, needs regular intake of papaya to improve his health condition essentially because of its high nutritive and medicinal values as well as its availability all the year round. A family with poor income per capita needs proceeds from papaya to improve their income status, while a nation with dwindling resources such as the poor Nigerian economy bedeviled with dreaded debilitating economic difficulties resulting from her over-dependence on oil, lack of copious diversification of her other natural endowments, and lucid mismanagement and looting of her coffers, imperatively needs resources from papaya exports, to assist revive her bartered economy. It also requires proceeds from papaya exports to reawaken her dwindling foreign earnings and resuscitate her structural decays, by creating jobs for the teaming jobless citizens, thus instituting national food security and consolidating foreign reserves.

This study exhumes the numerous benefits of papaya fruit tree. It elucidates the culinary, cuisine, medicinal and industrial uses of papaya as well as its nutritional values both for human healthy living and national economic emancipation. It examines if resources generated from papaya exports are tangible enough to impact on or assist revive the country's oil-based devastating economy, as well as aid her genuine strides for concerted national development through providing jobs and enhancing food security as well as boosting export earnings and consolidating foreign reserves.

Understanding papaya

Papaya is a tropical, sub-tropical or semi-tropical fruit tree. It is known in many communities of different countries of the world by different names as listed in Table 1.

Table 1. Various Names of Papaya

Country	Names
Arabic	Fafay, babaya
Creol	Papayer, papaya
English	Bisexual paw paw, papaw tree, melon tree, papaya
Filipino	Papaya, lapaya, kapaya
French	Papailler, papaya
German	Papaya, melon nembraum
Indonesia	Gedang. Papaya
Japanese	Kates
Klimer	Ihong, doeum lahong
Lao	Sino-tibetan, houng
Luganda	Papaali
Malaysia	Papaya, betek, ketalah, lapaya
Sinhale	Pepol
Spanish	Figuera del monte, fruta bomba, papaya, papaita, lechosa
Nigeria:Igbo, Hausa	Okparu, popo gwanba
Swahili	Mpapai
Thai	Makua, thet, malahor, loko
Tigrigna	Papaya

Vietnamese	Du du
Bengali	Pappaiya
Hindu	Papeeta
Timil	Pappali, pappayi

Varieties of Papaya

There are three types of papaya – the male (staminate), the female (pistillate) and the non-male-female (hermaphrodite). These three types are distinguished on the basis of their flowers. They are recognizable during their flowering stages. The female types of papaya fruits are usually sweeter. They are more of round in shape than the fruits from the hermaphrodite. The male papaya tree does not yield fruit. Its presence in a papaya garden or farm is to pollinate the female trees to make them yield fruits (Taxonomy of Plants, 2011) and (Morton, 2015).

Origin and Distribution of Papaya

Papaya is native to central and northern South America, but origin of the Philippines and the US State of Hawaii. It was introduced from Philippines through Malaysia to India ("Hawaii Papaya Varieties", 2015). There is yet no trace of how and when papaya came to Nigeria. It may not be unconnected to the early explorers of the various continents of the world including Africa, especially the voyagers like Christopher Columbus (who called papaya the "fruit of the Angels"), and the Lander Brothers – John Lander and Richard Lander, who explored the sea routes to India, the Upper and the Lower Niger in Nigeria respectively in the 18th century (Boning 2016). Papaya is said to be the World Healthiest Food. It is delicious, sweet, with musky undertones and soft, butter-like consistency (Papaya Production Guide, 2016). Growing and distribution of papaya have thrived in many countries of the world including India, Brazil, Indonesia, Mexico and Nigeria, especially in the southern parts of the latter with ephemeral atmospheric climates ("An Overview of Global Papaya, Trade & Consumption", 2014); Chia and Manshavolt, 2015).

Description and classification of papaya

Papaya is a large tree-like plant with a single stem growing from 5 to 10m., that is, 16 to 30 feet tall. It has spirally arranged leaves confined to the top of the trunk. The lower trunk is conspicuously scarred where leaves and fruits are borne. It has large leaves, approximately 50 to 70cm or 20 to 28 inches in diameter. The leaves are deeply lobed with seven lobes. Papaya trees are usually dioecious, that is, for such large plants, the trees are usually unbranched, unless lopped. The flowers appear on the axis of the leaves, maturing into large fruits of about 15 to 45cm or 5.9 to 17.7 inches long, and 10 to 30cm or 3.9 to 11.8 inches in diameter. The fruit is a type of berry which ripens when it feels soft, that is, as soft as a ripe avocado or a bit softer, with its skin attaining amber to orange hue. Papaya was the first transgenic fruit tree to have its genome sequenced (Heywood, Brummitt, Culham & Serberg, 2017).

Cultivation and Production of Papaya

Papaya is a delicate fruit tree. Any disturbance to its roots at very tender ages makes it have stunted growth or sluggish development, and this affects its growth and yield, if, however, it survives. It does not transplant well too. The best and most effective practice on papaya farming is to plant the seeds directly to where they will grow without transplanting them from either nursery or wild (Mossier & Crane, 2008). Papaya seeds germinate better and faster if the gelatinous envelope (sarcotestae) surrounding the seed is removed by means of the fingers and use of sterilized soil to avoid nematode infestation and damping-off. The farmer thins first between 4 to 6 weeks after emergence and second finally between 4 to 6 months when flowers appear. Apply 14:14:14 (5 to 10gms.) of fertilizer earliest in the hole before planting; use 60gms of aminonium sulfates as soon as plants are well established and show new growth, and apply potassium at 2:1:3 ratio in deficient soil (Papaya Production Guide, 2016).

The Papaya Production Statistics from Food and Agricultural Organization (FAO) of the United Nations (2013), corroborated these assertions, and further posited that:

> *... for a good result, papaya seeds are planted 5 meters apart from each other. The best practice is clear a piece of land, turn the refuse to ashes, get the best species of ripe papaya and sprinkle them on the land – a couple of dozen per bed or ridge is a good amount. Cover the seeds lightly with more compost, and then mulch the patch well. The seeds germinate in a couple of weeks or longer.*

The FAO of the United Nations (2013), further advised that:

> *… in about two months or less, clear the weeds around the crops. Do not dispose the refuse. Allow it to decay there as manure to the land. Transport the sprinkled germinated seeds slightly covered with compost and mulch the patch well, after some more two or three months. During transporting, leave only two stands in the planted spot. This is necessary because one of the two may turn out to be male.*

It again reported that although the male papaya does not fruit, it is very much needed for pollinating the female, pointing out that one male is needed for every ten to fifteen female papaya fruit plants to ensure good pollination and healthy fruiting. At this stage, a chemical called 'uproot', 'force up', DD Force or any other herbicides, should be sprayed on the farmland after three months. Do the same the next six months, and in three weeks time or so, you will observe the fruiting getting interesting. From this time, 'it takes about three months to be strong and start fruiting or yielding and after some time ripening' (Cunningham & Nelson, 2012) concluded. Most commercial papaya orchards contain only hermaphrodites which self-pollinate and yield fruits regularly. But Carica papaya and other female species cultivated in most tropical and sub-tropical countries, which originally came from Southern Mexico, particularly Chiapas and Veracruz, Central America and Northern South America, require male species for pollination.

Carica papaya is cultivated in the world in an area of approximately 3.88Lakhha with a production capacity of over 8.05 million trees. In India specifically, papaya is cultivated in an area of 73,000ha with a production of 23.17lakh tones (Singh, 2017). In his view, papaya gained more global importance owing to its high palatability and

fruiting all the year round; its regularity in fruiting and highest productivity per unit area; its high nutritive values; as well as its multifarious uses as food, medicine and industrial input.

Papaya impacts to economic and nutritional propitiations tremendously and has a highly remunerative effect as a short duration fruit-crop. If well cultivated, papaya grows rapidly. It fruits within three years depending on soil and care. It is highly frost-sensitive and thus limits its production to tropical, sub-tropical and humid climates. Papaya flourishes in good temperature - 2^0C, but 29^0F temperature is very harmful to it if not fatal to its survival, growth and fruiting (Rivera-Pastrami, Yahia & Gonzalez-Aguilar, 2010).

In Florida, Carica papaya growth is generally limited to the southern parts of the states, but in California especially, cultivation of Carica papaya is limited to private gardens as is in Los Angeles, Orange and San Diego countries ("Hawaii Papaya Varieties", 2015). This is similar to what obtains in Nigeria. Growing of papaya thrives in Nigeria, especially in the southern parts with ephemeral climates. Production of Carica papaya flourishes in Imo, Anambra, Ebonyi, Enugu, Abia states and many more, which have favourable ephemeral atmospheric and humid temperatures. Cultivation of Carica papaya is most preferable in sandy, well-drained soil, as standing water kills the plant within 24 hours (The human and physical characteristics of Nigeria, 2017), and ("Hawaii Papaya Varieties", 2015).

Species and Genetically Engineered Papaya Cultivars

Papaya has 22 species originally. Carica papaya is the genetically engineered accepted cultivar. It is so binomially named as the accepted fruit of the plant because of its resistance to Papaya Ringspots Viruses (PRV) after scientific treatments. It is of two kinds – the sweet red or orange flesh, and the yellow flesh. In Australia, these are called "red papaya" and "yellow papaya". These distinctions are observed when both species ripe, but if unripe, they are both called green papaya (Chandrika, Jansze, Wickramasingle & Warnassuriya, 2013). These types should not be confused with the original four cultivars - mountain papaya *(Vasconcellea pubescens)* found in South America; "pawpaw" *(Asimina triloba)* prevalent in Eastern North America; flowering quince *(Chaenomeles speciosa)*, and Chinnese quince *(Pseudocydonia chinensis)* which, like Carica papaya, are sometimes called 'mugua' as denoted by Ronald and Williams (2010). The large fruited, red fleshed 'Maradol', 'Sunrise' and 'Caribbean Red' papaya often sold in U.S. markets are commonly grown in Mexico and Belize. Papaya Ringspots Virus (PRV) outbreak gravely affected the original species before they were scientifically genetically altered and improved (Chandrika, et al., 2013).

In 2011, researchers in the Philippines reported that by hybridizing papaya with *Vasconcellea quercefolia*, they had developed conventionally bred non-genetically engineered papaya which is also resistant to Papaya Ringspots Virus (PRV) (Morton, 2015) and (Mossier & Crane, 2008). In response to the Papaya Ringspots Virus (PRV) outbreak in Hawaii in 1998, genetically altered papaya species were approved and brought to market including 'Sun Up' and 'Rainbow' varieties. Varieties resistant to PRV have some DNA of this virus incorporated into DNA of this plant. By 2010, 80% of Hawaiian Carica papaya plants were genetically modified. The modifications were made by scientists of the University of Hawaii who made the modified seeds available to

farmers without charge (Genetically Altered Papaya Save the Harvest, 2015) and (Hine, Holtsmann & Raabe, 2015).

With the genetically and improved altered and the conventionally bred non-genetically engineered papaya species, both of which are resistant to pest infestation, production of papaya in greater quantities is made simple and less risky as human efforts exerted in its cultivation are no longer wasted by the destructive effects of Papaya Ringspots Viruses (PRV). In consequence, four varieties, amongst others, are now profitably en vogue.

Table 2: Four varieties of scientifically and conventionally improved papaya resistant to Papaya Ringspots Viruses (PRV)

S/no	Varieties	Explanation	Approximate fruit weight
1	Cavite special	This is a popular semi-dwarf type that blooms in 5 to 8 months after planting	The fruit weighs from 3 to 5 kilo each and mainly eaten fresh
2	Sunrise Solo	This is a newly improved high quality selection with reddish orange flesh	Each of this fruit weights half a kilo
3	Waimanlo	This is a high quality variety with orange yellow flesh	The fruit weighs from one kilo to one-half kilo
4	Sinta	This is the first Philippine-bred hybrid papaya. It is, semi-dwarf, sweet and fleshy	This weighs between 1.2 to 2.0 kg per fruit

Source: Papaya Production Guide (2016) www.whfoods.com/genpage.ph.d?

Nutrition and Health Benefits of Papaya

Papaya is taken as food for human healthy living because it contains reasonable quantities and qualities of nutrients which boost good health. Good health is a state of complete physical, mental, social and spiritual well being of an individual, and not a mere absence of diseases and infirmity (Institute of Medicine, Board on Global Health, Committee on Emerging Microbial Threats to Health in the 21st Century, 2013). One of the major factors which leads to sound human health is nutrition. Good nutrition promotes health status, while poor nutrition reverses same. Eating good and right types of foods and fruits like papaya, helps to make an individual soundly healthy (WHO, 2015).

Papaya contains a lot of nutrients which are needed for good human health. It is rich in energy, vitamins, minerals and other constituents which are necessary ingredients for healthy living (Brekke, Chan & Cavaletto, 2016). The energy contents of papaya is contained in table 3, while some other ingredients' contents of papaya are contained in tables 4, 5 and 6 and aggregated per 100g or 3.5oz.

Table 3: Energy content of papaya

S/no.	Description	Aggregate
1	Energy	179g (43kcal)
2	Carbohydrates	10.82g
3	Sugars	7.82g
4	Dietary fiber	1.7g
5	Fat	0.26g
6	Protein	0.47g

Source: United Nations Food and Agricultural Organization FAOSTAT Chart 2016

Papaya fruits are good sources of vitamins A, B, C and many more. Some of the vitamin contents of papaya are contained in Table 4, and aggregated per 100g or 3.5oz.

Table 4: Vitamin contents of papaya

S/no.	Description	Aggregate	%
1	Vitamin A equiv.	474g	6
2	Beta-carotene	427ug	6
3	Cutein zeaxanthin	89ug	
4	Thiamine (B_1)	0.023mg	2
5	Riboflavin (B_2)	0.027mg	2
6	Niacin (B_3)	0.357	2
7	Pantothenic acid (B_5)	0.191mg	4
8	Folate (B_9)	38ug	10
9	Vitamin C	62mg	75
10	Vitamin E	0.3mg	2
11	Vitamin K	2.6ug	2

Source: United Nations Food and Agricultural Organization FAOSTAT Chart 2016.

Additionally, papaya fruits are rich in minerals. Table 5 contains some of the minerals in papaya using US recommendations for adult aggregated per 100g or 3.5oz.

Table 5: Mineral contents in papaya

S/no.	Description	Aggregate	%
1.	Calcium	20mg	2
2.	Iron	0.25mg	2
3.	Magnesium	21mg	6
4.	Manganese	0.04mg	2
5.	Phosphorus	10mg	1

6.	Potassium	182mg	4
7.	Sodium	8mg	1
8.	Zinc	0.08mg	1

Source: United Nations Food and Agricultural Organization FAOSTAT Chart 2016.

As a wonderful fruit tree, papaya fruit is not limited to energy, vitamin and mineral provisions alone. It contains some other constituents which feed human cells such as lipids and sterols that provide critical support for healthy cellular uptake of nutrients and cellular export of wastes and metabolities, all of which are useful to human healthy living as is seen in table 6, aggregated per 100g or 3.5oz.

Table 6: Other constituents in papaya

S/no.	Content	Aggregate
1.	Lycopene	183ug
2.	Pectin	
3.	Papain	
4.	Phytochemicals	
5.	Carotenoids	
6.	Polyphenols	
7.	Benzyl isothiocyanates	
8.	Benzyl glusocinates	
9.	Prunacin-cyanogenic substance	

Source: United Nations Food and Agricultural Organization FAOSTAT Chart (2016).

Interpretations: ug = micrograms
mg = milligrams
iu = interpretation units

Note: *In a hundred gram serving, papaya fruit provides 43 calories and is a significant source of vitamin C (75% of the Daily Value, DV) and a moderate source of folate (10% DV), but otherwise has negligible content of nutrients percentages are roughly approximated using US recommendations for adult*

Evidently, papaya skin, pulp and seeds contain lycopene, pectin, papain and phytochemicals as well as carotenoids, polyphenols, benzyl isothiocyanates, benzyl glusocinates and prunacin-cyanogenic substance (Chandrika, et al., 2013). Its seeds contain cyanogenic substance or prunacin (Krishna, Paridhari & Patel, 2008). It has skin and pulp that increase during ripening (Sagon, 2014). The green papaya fruit and the tree's latex are rich in papain which is a 'proease' used for tenderizing meat and other proteins as practiced by indigenous Ameicans and people of the Caribbean region (Mantok, 2015). It is now included as a component in some powdered meat tenderizers, fermenting of liquors, pre-shrinking wool quality, making soap for washing clothes (Ronald & Williams, 2010). Papain is extracted to make digestive enzyme dietary supplements and is also used as ingredients for chewing gums, with the United States,

Mexico and Puert Rico, the largest producers (Search the USDA National Nutrient Database for Standard Reference, 2010).

Culinary and Cuisine Uses of Papaya

Ripe and unripe papaya fruits are differently used for distinct purposes. The ripe papaya makes for a favourite breakfast and dissert because it is a fruit that is available all the year round. It is also used to make fruit salads, purees, refreshing drinks, jam, jelly, mamalade, candies and crystallized fruit. Unripe papaya fruit is picked or cooked as vegetable. The tender leaves of papaya are uniquely prepared and eaten, depending on choices of people in different regions of the globe (Morton, 2015).

Furthermore, for culinary and cuisine purposes, papaya fruits are more elaborately used in distinct ways by people of different countries and cultures. In most countries, ripe fruit of papaya is usually eaten raw, without the skin or seeds. Unripe papaya is eaten cooked, usually in curries, salads and stews. Green papaya is used in south-east Asian cooking, both raw and cooked. In Thai cuisine, papaya is used to make Thai salads such as 'som tam' and Thai curries like 'kaeng som' when still not fully ripe (Lilind, 2011).

In Indonesian cuisine, the unripe green fruit and tender leaves of papaya are boiled for use as part of 'lalab' salad, while the flower buds are 'sauteed' and stir-fried with chilies and green tomatoes as 'minahasan' papaya flower vegetable dish. In Brazil, unripe papaya fruits are used to make sweets or preserves. The black seeds are edible and have a sharp, spicy taste. They are sometimes ground and used as a substitute for 'black pepper'. And in some parts of Asia, the tender leaves of papaya are steamed and eaten like 'spinach' (Rivera-Pastrami, et al. 2010).

Papaya has a relatively high amount of 'pectin', which is used to make jellies, albeit the smell of unripe fresh papaya flesh, strikes some people as unpleasant ("Search the USDA National Database for Standard Reference", 2016). In Nigeria, the numerous papaya culinary and cuisine uses are uncommon. The ripe papaya fruit is ordinarily eaten raw; sauce from cooked leaves is taken for cure of malaria. Papaya seeds are used as vermifuge and abortifacient (for induced abortion) (Sagon, 2014; Nwofia, Ogimelukwe & Eji, 2012). Knowledge of its other numerous uses is still a farce. It is believed that with the current spate of technological development which turns the world into a small global village, and the rapid imbibing of scientific innovations and cultural diffusions, global interactions will intensify quicker spread of knowledge and educate many people of other nations including Nigerians on the many other culinary and cuisine uses and values of papaya fruits to humanity and nationhood.

Medicinal benefits of papaya

Papaya contains papain which is an alkaloid that is used for heart depressant, amoebicide and diuretic. Some countries grow papaya in large quantities mainly for extraction of papain. Papain is an enzyme present in the latex of papaya which is collected mainly from the green fruit. Papain has a lot of good uses in beverages, foods and pharmaceutical industries, chill-proofing beer, tendering meat, drug preparation for digestive ailments, and for treatment of gangrenous wounds. Papain is also used in

treating hides, degumming silt, and softening wool. Its medical benefits include using papaya leaf to get rid of mosquitoes by burning it, making its leaves into tea to cure malaria, and even make beer (Siegler, Pauli, Nahrestedt & Leen, 2012; Sagon, 2014; Nwofia, et al., 2012).

In Nigeria, especially in the southern parts, papaya leaves are cooked in combination with 'lemon grass' and 'dogoyaro' leaves and the sauce taken as tea for treatment of malaria (African journal of traditional complementary and alternative medicines, 2016). Unripe papaya fruit is grated and sieved using its latex liquid to cure hepatitis and malaria sicknesses. The efficacy of these concoctions for treatments of these ailments have not been scientifically established, but they have been effective over centuries in most developing countries such as Nigeria (Titanji, Zafou & Njemenya, 2008). They are among the leaves which are used as herbs for traditional treatment of malaria, dissolution of cholesterol in the heart or body generally, and such other related illnesses (Nwofia, et al. 2012). It is best recommended for prevention since its intake fortifies one's body with adequate energy, vitamins and minerals needed for good body defense or immunity from attacks of various diseases.

Papaya side effects and allergies

Unripe papaya releases 'latex fluid'. This causes irritation on human skins and reacts in some people who are allergic to it. Excessive consumption of ripe papaya may cause 'carotenemia'. Carotenemia is 'the yellowing of soles and palms' although it is not harmful to man. Consumption of large quantities of papaya is recommended because papaya contains about 6 percent of "beta-carotene" found in carrots which is the most common cause of 'carotenemia' and which is not harmful to human well-being (USDA national database, 2016); Titanji, et al., 2008; Krishna, et al., 2008; and Mantok, 2015).

Empirical global studies on papaya

Some countries of the world have climates which are favourable for growing papaya in large quantities. A few of them and the quantities they produced in 2013, as examples, are listed in table 7 below:

Table 7: Countries and quantities of papaya they produced in 2013

S/no.	Country	Quantity produced (in tones)	%
1.	India	6.9mtns	
2.	Brazil	3.0mtns	
3.	Indonesia	0.9mtns	
4.	Mexico	0.8mtns	
5.	Nigeria	0.8mtns	
	Total	12.4mtns	
	India and Brazil put together	9.9mtns	87

Source: USDA Nutritional Database (2016).

In 2013, a total of 12.4 million tones of Carica papaya were produced by five countries of the world which were considered the largest papaya producers. As shown in table 7, India produced 6.9mtns. Brazil followed with 3.0mtns, while Indonesia produced 0.9mtns. Mexico and Nigeria produced 0.8mtns each in 2013. India and Brazil put together produced 9.9mtns or 87 percent, thus, standing glaringly out to be the world largest Carica papaya producers in 2013 (Papaya Production Statistics from Food and Agricultural Organization of the United Nations, 2013).

Before India became the largest Carica papaya producer in 2013 with 6.9mtns followed by Brazil with 3.0mtns, Brazil had, in 2005, been adjudged the biggest world producer of Carica papaya with 1.7 megatonnes of the Caribuia Spanish papaya species (River-Pastrami, et al. 2010). The reason for the drop in Brazil's papaya production is not known, but it will not be unconnected to drop in her governments' and individual farmers' interests and investments in that regard.

Papaya is gaining popularity among tropical fruits' producers in the global communities. It is now ranked fourth in the total tropical fruit production after bananas, oranges and mango (USDA Nutritional Database, 2016). Papaya intercrops favourably with some other crops including banana, plantain, oranges, guava, maize, and such similar others, but care should be taken to avoid its roots on water-logged surfaces. Papaya production, globally, has grown significantly over the years, mainly as a result of consistent increases in production in India, US and a few other countries.

Cultivation of papaya in Nigeria has not been extensively carried out in the scale desirable by individual farmers and governments irrespective of its numerous economic, health and industrial benefits. After ranking fourth with Mexico with a capacity of 0.8mtns each in 2013, Nigeria suddenly completely vanishes in the global list of papaya producing nations. The reason may not be far-fetched from that which made Brazil to drop tremendously from her peak production in 2005. Papaya farming creates jobs in varied degrees, improves good health for citizenry, increases pharmaceuticals and boosts revenues for individuals, families and governments. May be governments are naïve of the abundant benefits of this vital economic nutritive fruit tree. It is a business one can embark upon without much capital input especially in the tropical, sub- or semi-tropical and humid regions of the southern parts where it flourishes best, and one which governments can invest on in all its ramifications with minimum or no much risks to help revive the country's age long oil-failing economy.

Problems affecting Papaya Production

Diseases and pests

Viruses

In their treatises on 'Florida crop/pest management profile' and 'Papaya Ringspot Virus' (PRV), Gonsalves, Tripathi, Carr and Suziki (2017) and Mossier, (2008), respectively, established that Papaya Ringspot Virus (PRV) is a well-known virus within plants in Florida. The first signs of the virus is yellowing and vein-clearing of younger leaves as well as motting yellow leaves. Infected leaves may obtain blisters, roughen or narrow with blades skicking upwards from the middle of the leaves. The petioles and stems may develop dark green greasy streaks and in time become shorter. The ringspots are circular, and have c-shaped markings that are darker green than the fruit itself. In the later stages of the virus, the markings may become gray and crusty. The viral infections impair growth and reduce fruits quality. One of the biggest effects which viral infections have on papaya is on its taste. One major way to protect papaya from the virus is genetic modification (Mossier, et al. The papaya mosaic virus destroys the plant until only a small tuft of leaves are left. The virus affects both the leaves of the plant and the fruits.

Leaves show thin, irregular, dark green lines around the borders and clear areas around the veins. The more severely affected leaves are irregular, the more linear in shape.

The virus infects the fruit at any stage of maturity. Fruits, as young as two weeks old, have been spotted with dark-green ringspots about 1 inch in diameter. Rings on the fruit are most likely seen on either the stem or the bossom end. In the early stages of the ringspots, the rings tend to be many closed circles, but as the disease develops, the rings will increase in diameter consisting of one large ring. The difference between the ringspot and the mosaic viruses is the ripe fruit in the ringspot has motting of colours while the mosaic does not (Hine, et al, 2015).

Fungi

The fungus – anthrocnose – is known to specifically attack papaya, especially the mature fruits. The disease starts out small with very few signs, such as water-soaked spots on ripening fruits. The spots become sunken, turn brown or black and may get bigger. In some of the older spots, the fungus may produce pink spores. The fruit ends up being soft and having an off flavour because the fungus grows into it. The fungus' powdery mildew occurs as a superficial white presence on the surface of the leaf in which it is easily recognized. Tiny, light yellow spots begin on the lower surfaces of the leaf as the disease starts to make its way (Enphytica, 2011).

The spots enlarge and white powdery growth appears on the leaves. The infection usually appears on the upper leaf surface as white fungal growth. Powdery mildew is not as severe as other diseases. The fungus phythophothora blight causes damping-off, root rot, stem rot, stem girdling and fruit rot. Damping-off happens in very young plants by wilting and killing the plant. The spots on established plant start out as water-soaked lesions at the fruit and branch scars (Enphytica, 2011, and Gonsalves, et al. 2017).

These spots get bigger and cause the death of the plant. The roots are severely and rapidly infected, causing the plant to rapidly brown and wilt away collapsing within days. The most dangerous feature of the disease is the infection of the fruit because it causes harm to people who consume it. The biggest evidence that the fungus is present is the water-soaked marks that appear first along with the white fungus that grows on the dead fruit. After the fruit dies, it shrivels and falls to the ground (Hine, et al., 2015).

Pest

On "Why some papaya plants fail to fruit", Chia, et al (2015), attributed it to many causes such as pest infestations like fruit fly. According to them, the papaya fruit fly is mainly yellow with black marks. The female papaya fruit fly has a very long, slender abdomen with an extended ovipositor that exceeds the length of its body. The male papaya fruit fly looks like the female with the difference of a hairy abdomen and no ovipositor. Long slender eggs are laid inside the fruit by the female papaya fruit fly. The larvae are white and look very much like the regular fruit fly larvae.

The female fruit fly is capable of laying 100 or more eggs, and they are laid during the evening or early morning in groups of ten inside young fruit. They usually hatch within 12 days of being in the fruit where they feed on the seeds and interior parts of the fruit. When the larvae mature (usually 10 days after being hatched), they eat their way out of the fruit, drop to the ground, and potate just below the soil and emerge within one to two weeks as mature flies. The flesh of the papaya must be ripe for the fly to migrate

towards the surface of the fruit because unripe papaya juice is fatal to them. The papaya will turn yellow and drop to the ground if it is infected by the papaya fruit fly.

There are two spotted spider mites of 0.5mm long brown or orange-red or a green, greenish-yellow translucent oval pest (Cunningham, et al. 2012). They all have needle-like piercing-sucking mouth parts and feed by piercing the plant tissue with their mouth parts, usually on the underside of the plant. The spider mites spin fine threads of wetting on the host plant, and when they remove the sap, the mesophyll tissue collapses and a small chlorotic spot forms at the feeding sites. The leaves of the papaya tree turn yellow, grey or bronze. If the spider mites are not controlled, they cause the death of the fruit-tree.

Papaya white fly lays yellow, oval eggs which appear dusted on the undersides of the leaves. They eat the papaya tree leaves, therefore damaging the fruit. There, the eggs develop into flies in three stages called instars. The first instar has well-developed legs and is the only mobile immature life stage. The crawlers insert their mouth parts into the lower surfaces of the leaf when they find it suitable and usually do not move again in this stage. The next instars are flattened, oval and scale-like. In the final stage, the pupa white flies are more convex, with large, conspicuously red eyes (Cunninghan, et al., 2012).

Remedies

Science has provided some useful assistance to these distracters which prohibit free cultivation and production of papaya. First, it founded and established scientifically genetically engineered and conventionally non-engineered modified papaya species which are resistant to viruses, pests and fungi. Second, it founded some herbicides such as Delstate TotalSystem Herbicide; DimeForce Crackdown Best Cypermelhrin; Dragon Active Ingredients – Dichloride; Attacke Lambdacyhalothrin; Perfect Killer Chlorrphyriphos, and many others which kill these diseases and encourage free cultivation of papaya by farmers. Similarly, science has also provided drugs which support papaya fruiting. Such drugs are not limited to Ever fruit; Z-force or Zeb Care; Sunphosate 360SL.; Glyphossate, and Orizo plus (Gonsalves, et al. 2017), and (Hine, et al. 2015). Advent of the papaya virus killers and fruiting drugs makes cultivation and production of papaya farmer-friendly. With the drugs for papaya diseases like ‘uproot’, ‘force-up’, DD Force and other herbicides readily available, cultivation and production of papaya in whatever quantity by farmers, is rather, now, reasonably a hitch-free exercise or a reality.

Conclusion

Papaya species have been improved for maximum production. First was the Carica papaya species which was scientifically genetically engineered by Hawaiian university researchers in 1998, and later the conventionally non-genetically engineered species by Philippine researchers in 2011. Drugs for papaya diseases and pests are now readily available. They include “uproot”, “force up”, and other herbicides. They are used according to their directions to subdue the fungi, viruses, and many other diseases as well as control pests which prohibit excellent fruiting and flourishing of papaya farming.

If cultivated bountifully, papaya will solve some human needs such as providing food security, nutrition and medicine for the teaming populace; it will provide incomes

for the individuals, families, federal, state and local governments through internal sales and exports. Papaya production will create jobs for millions of nation's jobless youths through its farming, harvesting and marketing interactions. It is a business any one – rich or poor, sound or impaired, educated or illiterate – can comfortably embark upon with minimum capital input, and it will mint millions of Naira regularly for both the individual farmers and the governments with absolutely little or no much risks. Continued proceeds from papaya will re-enliven withering Nigerian families' wellbeing, regularize national foreign earnings and stabilize government reserves, augment the country's ever troubled oil-troubled sources, and normalize internal economic affairs through food security and job creation.

India had independence in 1958, while Nigeria got her own in 1960 from their colonial masters. India now thrives well in papaya production and exports, and enjoys some degrees of national security through food sufficiency and employment benefits. Nigeria should do the same and earn similar glory in the global papaya production race!

Recommendations

The federal, state and local governments should arrange through banks to release N10 million naira interest-free loan with 6 years moratorium and without collaterals, to every duly registered individual farmer who indicates sufficient interest in papaya production. The money is to acquire land plus other logistics only, especially in the rural areas.

1. The federal, state and local governments should acquire differently improved papaya species and distribute them in their millions to those given such loans and others for improved production of papaya *free a*s was done by the Hawaiian University Researchers in 1998 in their country. This will be done and quickly too through the Ministry of Agriculture and their liaison offices in various states in Nigeria carefully and seriously eluding unnecessary intermediaries.
2. The federal, state and local governments should acquire all the necessary drugs and supply them to those who are given such loans and improved papaya species free to enhance speedy and continued papaya production for internal food sufficiency and export earnings, especially the beginning farmers their first times.

3. The federal, state and local governments should ***themselves*** embark on large scale papaya production through their various organs and agencies different from the individual and corporate farmers as is done in rice production. These agencies will include but not limited to ministries of agriculture and natural resources.

4. The federal government should challenge all Nigerian Universities, other tertiary institutions and governments' agricultural and research institutes as well as private researchers to embark on vigorous rigorous researches to establish scientifically, the traditional medicinal efficacies of papaya concoctions for treatments of malarial and other ailments for internal uses and exports, and should patent such discoveries to the discoverers with a whooping cash reward of N10m each. This will boost morals of researchers

and help save Nigerians from over-dependence on foreign drugs. It will also increase indigenous pharmaceuticals, reduce costs by abrogating medical services abroad, create jobs, and add some feat on national repute, plus numerous other such benefits.

5. Through the media, farmers should be adequately reached, informed, enlightened and guided on the appropriate techniques for continued large papaya cultivation, and workshops should be organized regularly for stakeholders to ride home such knowledge and experiences.

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