

Citrus Fruits Value Chain Development in Nigeria

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ABSTRACT

Citrus is one of the world's most important economic fruit crops. It belongs to the group of fruits that includes oranges, lemon, limes, grape fruits and tangerines. Many citrus fruits are generally eaten fresh. Oranges and grapefruit juices are popular breakfast beverages, but more astringent citrus such as lemons and limes are used for garnishing or in cooked dishes. Citrus fruits are also made use of in production of squashes, citrus fruit powders, marmalade and other flavouring agents. After the extraction of the juice from the fruit, the resulting fruit pulp is a possible livestock feed and the rind oil is an expensive commodity in the international market. Citrus seeds are also known to contain sweetening agents, which are being studied as probable sugar substitute. Citrus peels can be used for the production of citric acid, lactic acid, feed yeast and vinegar. The leaves, flowers, peels, fruits and dried bark of citrus have important medicinal values. The dried bark of citrus is a raw material for the production of insecticides. Citrus has also found use in the pharmaceutical, cosmetic and soap industries. Citrus is grown globally with the largest commercial cultivation in Brazil and China. The 2007 Food and Agricultural Organization's report rated Nigeria as the 9th citrus producing country with annual average production capacity of about 3,325,000 tonnes. However, citrus fruits produced in Nigeria are mostly consumed locally without much value addition. In an effort to promote increased production and processing of tropical fruits in the country, the Federal Government banned the importation of packed juice in 2002 and then launched a Presidential Initiative on Tropical Fruits Production in 2005. This paper examines the citrus value chain in Nigeria, efforts towards the development of citrus value chain, challenges and strategies for harnessing the potentials of citrus fruits for economic development of the country. The paper identifies lack of value addition as the major constraint in harnessing the citrus potentials in Nigeria. Other challenges identified include post harvest losses due to poor road network, lack of infrastructure for storage and preservation, lack of improved varieties, poor R&D funding and poor handling of the fruits during harvesting and transportation. Strategies for effective development and utilization of citrus potentials in Nigeria were identified to include establishment of cold storage infrastructure across the country to reduce post harvest losses, adequate funding of Research for the development of improved varieties, establishment of citrus orchards, establishment of processing clusters and dedicated development of citrus value chain in Nigeria. Nigeria's immense potentials in citrus production if well harnessed, will position the country in the lead in world trade production of the commodity and can save the country up to \$480 million in import bills.

KEYWORDS: Fruits, citrus, post harvest losses, value chain, processing cluster.

1.0 INTRODUCTION

The citrus fruits belong to the group of fruits that includes oranges, lemon, limes, grape fruits and tangerines. Citrus fruits are the highest value fruit crop in terms of international trade. There are two main markets for citrus fruit viz the fresh fruit market and the processed citrus fruits market (mainly orange juice). Most citrus production is accounted for by oranges, but significant quantities of grapefruits, lemons and limes are also grown.

Citrus is one of the most widely grown fruit trees in sub tropical Africa. It is believed to have been introduced into the region by the colonial administrations and missionaries. Since its introduction in Nigeria, citrus has become fully adapted and it features within the cropping systems of the country especially in regions from latitude 6°N – 9°N. The varied ecological and climatic conditions suitable for the production of citrus confer on the Nigeria immense comparative advantage and the potential to lead the world in citrus production and trade. Horticulture sub-sector suffered neglect during the colonial and post-independence era in Nigeria. The horticultural sub-sector started receiving due attention in 1975 when the Federal Government of Nigeria with the assistance of UNDP/FAO, established the National Fruits and Vegetable Research and Demonstration Centres (NFVRDC), which eventually transformed to the National Horticultural Research Institute (NIHORT), with citrus as one of the most important mandate crop (Jolaoso, et al., 2011).

In Nigeria, citrus production is still at its infancy (Amih and Adelaja, 1988), since most of the existing plantings are in mixed cropping systems with cocoa, kola, coffee, rubber, etc. Only a few large plantations are in existence. Most of the present plantings were done with un-budded seedlings. NIHORT (2000) also reported

that 45% of citrus currently produced in the country is consumed fresh and 30% are wasted due to post-harvest losses and 25% are processed. Commercial cultivation of fruits, citrus inclusive for large scale processing into various fruit products has not really started in Nigeria (Adeyemi, 2005).

There is little investment in citrus processing in Nigeria, despite the fact that investment in the processing of fruits (citrus) has good economic returns. Citrus can be processed into various value added products. Investment in processing of citrus fruits into juice concentrates and other products will greatly reduce the waste experienced especially during seasons of glut. This paper examines the citrus value chain in Nigeria, efforts towards the development of citrus value chain, challenges and strategies for harnessing the potentials of citrus fruits for economic development of the country. This is done using technical information obtained from national survey conducted by the Raw Materials Research and Development Council (RMRDC) on different commodities under the National Raw Materials Information System (Jolaoso et. al., 2011)

2.0 SOCIO-ECONOMIC IMPORTANCE OF CITRUS

2.1 Major Products from Citrus

It has been established worldwide that about a third of citrus fruit production goes for processing, the rest being eaten fresh. Also the most important processed citrus product is orange juice, representing about 80% of the total citrus juice production. The proportion of grapefruit utilization for processing is similar to that of orange. In contrast, however, nearly all small citrus fruits of tangerine type are intended for consumption in the fresh market. Lemon and lime are somehow different since they are normally consumed in association with other food products.

In the citrus processing industry, the raw juice constituting about 50% of the processed fruit, the peel residue and the seeds are the major products or by-products and from these sources a lot of industrial products are derivable. For example, single strength (natural) fruit juice (orange, lime/grapefruit, etc.), concentrated juice, citrus fruit powders and fruit (orange) flour are some of the major industrial products derived from the raw juice. Also, the pressed peel, citrus pulp and meal, peel oil, citric and lactic acids, brandy spirit, feed yeast, vinegar, marmalade, candied peel and citric pomade are products derivable from peel residue. Products derivable from the seeds are seed oil and meal. The inter-relationship between citrus products and by-products is shown in figure 1.

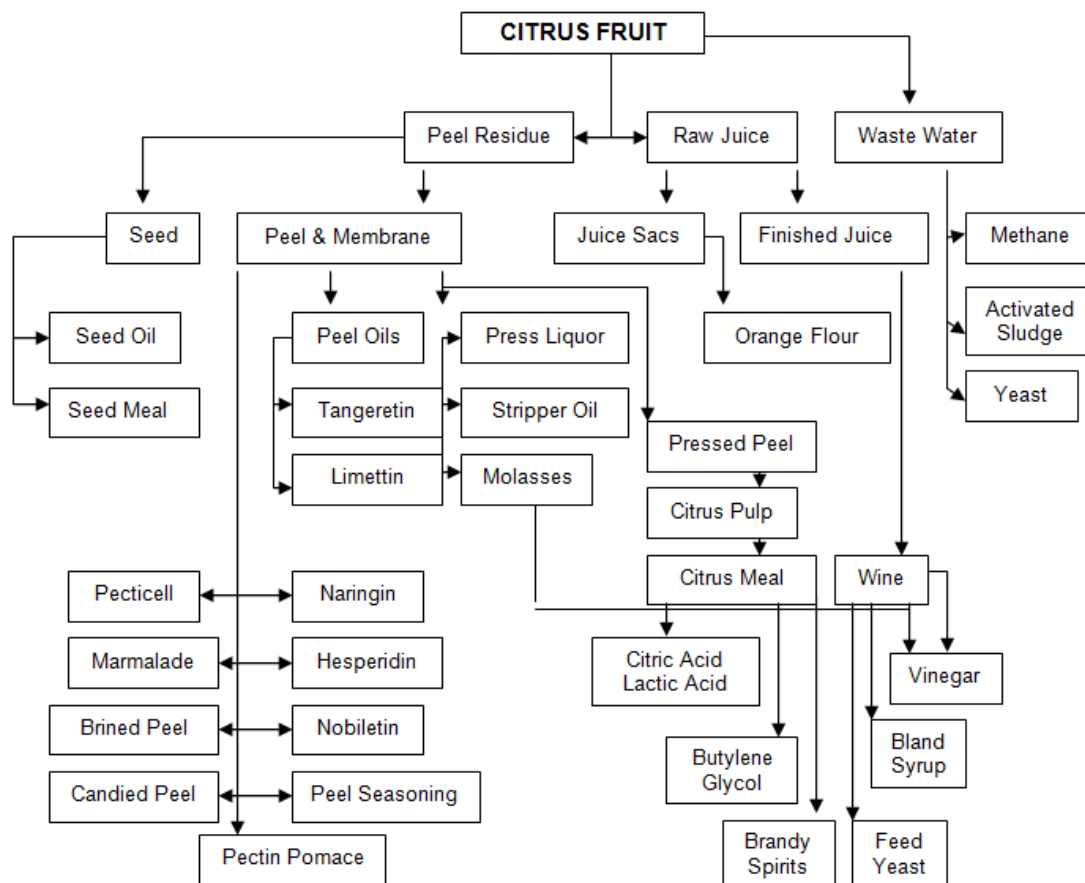


Figure1. Inter-relationship of citrus products and by-products.

Source: Hendrickson and Kesterson, (1965).

The level of sophistication of the citrus fruit utilization therefore depends on the technology available within the various citrus producing countries, and the dynamics of the cost of derivable products locally or internationally. Processed citrus products include; Orange juice products (freshly squeezed orange juice, orange juice production (single strength), orange squash and concentrated juice production), Dehydrated citrus product (fruit juice powder, low moisture orange granules and marmalade and jam), Citrus by-products (dried citrus pulp, citrus molasses, citrus peel oils, distilled citrus oil, flavonoids, citrus seed oils and pectin substances), and Fermented products (vinegar, feed yeast, citric and lactic acids).

2.2 Culinary Uses of Citrus

Many citrus fruits such as oranges, tangerines, grapefruits are generally eaten fresh. They are peeled and can be split into segments. Oranges and grapefruit juices are popular breakfast beverages, but more astringent citrus such as lemons and limes are used for garnishing or in cooked dishes. Their juices are used as ingredient in varieties of dishes, e.g. in salad dressing and squeezed over cooked meat, fish or vegetables.

Citrus is an important fruit tree especially in the production of single strength fruit juices and concentrates. Citrus juice contributes about 26% of the dietary vitamin C requirement, 0.9% of total daily calories and 1.7% of the daily carbohydrate intake of an average man.

After the extraction of the juice from the fruit, the resulting fruit pulp is a possible livestock feed and the rind acid (oil) is an expensive commodity in the international market. Citrus seeds are also known to contain sweetening agents, which are being studied as probable sugar substitute. The compound Naringin (a flavonoid) and neohesperidin dihydrochalcone from grapefruit and pummelo have application as artificial sweeteners. They are said to be 1000 times the sweetness of sugar and produce a long-lasting sweetness slow to develop, with an after taste like licorice or menthol. Citrus peels can be used for the production of citric acid, lactic acid, feed yeast and vinegar.

2.3 Medical Uses of Citrus

The leaves, flowers, peels, fruits and dried bark of citrus have important medicinal values. The dried bark of citrus is a raw material for the production of insecticides. Citrus has also found use in the pharmaceutical, cosmetic and soap industries. As a dietary supplement, citrus has been used to stimulate appetite, treat ringworm infection, relief stomach upset and aid insomnia. The fruit and peel are included in nasal decongestants and weight loss products. The unripe orange fruit and its rind are good in relieving insect stings, while the bark and root are antiseptic for the treatment of toothaches. Juices of the ripe fruits are good as appetizer, for healthy teeth, bones and gums and known to promote healing of wounds and sores. Another medicinal use is in the area of easing inflammations due to skin bruises and muscle pains. Hesperidin is a bioflavonoid, found at doses up to 8% in dried citrus dry peel, is a strong vasopressor agent (reduce blood pressure). Citrus pectin is reported to reduce cholesterol by 30%, aortal plague by 85% and narrowing of coronary arteries by 88% in animal feeding studies. Other areas of medicinal application are in contraceptives, laxatives, purgatives, sedatives and treatment of wide ailments such as diarrhea, vomiting, cancer therapy drugs, etc.

2.4 Global Production of Citrus

Citrus is currently grown commercially primarily in countries between the latitude 40⁰N to 40⁰S. Brazil is now the largest producer in the world followed by United States, China, Spain, Mexico, Italy, Japan, Egypt, Argentina, Turkey, Israel and Morocco. South Africa and Nigeria are other smaller producers in Africa (FAO, 1994). Table 1 shows the major producing countries of different citrus fruits while Table 2 shows top ten total citrus fruits producers in 2007.

Table 1. Major producing countries of the different types of citrus fruits

CITRUS TYPE	PRODUCING COUNTRY
Oranges	Brazil, United States, Mexico, India, Spain, China, Iran, Italy, Egypt, Indonesia.
Small citrus	Nigeria, China, Syria, Guinea, Japan, Saudi Arabia, India, Sierra Leone, Angola, Tunisia.
Lemons and limes	Mexico, India, Iran, Spain, Argentina, Brazil, United States, China, Italy, Turkey.
Grapefruit	United States, China, South Africa, Mexico, Israel, Cuba, Argentina, India, Turkey, Tunisia.

Source: FAO, (2004)

Table 2. Top ten total citrus fruits producers in 2007 (tonnes)

Country	Grapefruit	Lemons & Lime	Oranges	Tangerines, etc	others	Total
Brazil	72,000	1,060,000	18,279,309	1,271,000	-	20,682,309
China	547,000	745,100	2,865,000	14,152,000	1,308,000	19,617,100
USA	1,580,000	722,000	7,357,000	328,000	30,000	10,017,000
Mexico	390,000	1,880,000	4,160,000	355,000	66,000	6,851,000
India	178,000	2,060,000	3,900,000	-	148,000	6,286,000
Spain	35,000	880,000	2,691,400	2,080,700	16,500	5,703,600
Iran	54,000	615,000	2,300,000	702,000	68,000	3,739,000
Italy	7,000	546,584	2,293,466	702,732	30,000	3,579,782
Nigeria	-	-	-	-	3,325,000	3,325,000
Turkey	181,923	706,652	1,472,454	738,786	2,599	3,102,414
World	5,061,023	13,032,388	63,906,064	26,513,986	7,137,084	115,650,545

Source: FAO, 2007

Total production and consumption of citrus fruit has grown strongly since the 1980s. Production of oranges, tangerines, lemons and limes have all expanded rapidly. The rise in citrus production is mainly due to the increase in cultivation areas, improvements in transportation and packaging, rising incomes and consumer preference for healthy foods (UNCTAD, 2007).

Table 3 shows the major exporting countries of different types of citrus fruits, Table 4 gives the major grape producing countries in the world for 2010 – 2011, while Table 5 shows major Orange Producing Countries in the World (2010-2011).

Table 3. Major exporting countries of different types of citrus fruits

CITRUS TYPE	EXPORTING COUNTRY
Oranges	Spain, South Africa, United States, Greece, Morocco, Netherlands, Turkey, Egypt, Australia, Italy
Small citrus	China, Israel, South Africa, Cyprus, India, Netherlands, Pakistan, United States, Spain, Mexico
Lemons and limes	Spain, Argentina, Mexico, Turkey, United States, South Africa, Netherlands, Brazil, Italy, Greece
Grapefruit	United States, South Africa, Israel, Turkey, Netherlands, Belgium, Spain, Argentina, Cyprus, Bahamas

Source: FAO (2004).

Table 4. Major Grape Producing Countries in the World (2010-2011)

Country	Area of Ha	Production in Tonnes	Productivity T/Ha
China	643,900	8,653,900	13.4
Italy	777,500	7,787,800	10.0
USA	382,348	6,220,360	16.3
Spain	1,002,100	6,107,200	6.1
France	787,133	5,848,960	7.4
Turkey	477,786	4,255,000	8.9
Chile	188,200	2,755,700	14.6
Argentina	223,685	2,616,610	11.7
India	111,000	1,235,000	11.1
Iran	220,836	2,255,670	10.2
Others	2,412,798	19,586,055	8.1
World Total	7,227,286	67,322,255	9.3

Source: FAO (2012)

Table 5. Major Orange Producing Countries in the World (2010-2011)

Country	Area in Ha	Production in Tonnes	Productivity T/Ha
Brazil	843,088	19,112,300	22.7
USA	260,132	7,478,830	28.8
India	324,000	3,255,000	10.0
China	375,789	5,003,289	13.3
Mexico	334,573	4,051,630	12.1
Spain	127,500	3,120,000	24.5
Egypt	101,263	2,401,020	23.7
Italy	103,313	2,393,660	23.2
Indonesia	58,000	2,032,670	35.0
Turkey	53,236	1,710,500	32.1
Others	1,185,601	15,898,367	13.4
World	3,766,495	66,475,266	17.6

Source: FAO (2012)

2.5 Citrus Production in Nigeria

In Nigeria, about 3,900,000 tonnes of citrus fruits were produced from an estimated hectareage of 800000 hectares of land in 2012 (FAO, 2014). Citrus is grown in the rainforest and guinea savannah, most of these farmlands are in the remote part of the country. There are two main markets for citrus fruit in Nigeria: the fresh fruit market and the processed citrus fruits market (mainly orange juice).

Most citrus production is accounted for by oranges, but significant quantities of grape fruits, lemons and limes are also grown. Total production and consumption of citrus has grown strongly since the 1980's. The rise in citrus production is mainly due to the increase in cultivation areas, improvements in transportation and packaging, rising incomes and consumer preference for healthy foods (UNCTAD, 2008). Major citrus producing states in Nigeria include Benue, Nassarawa, Kogi, Ogun, Oyo, Osun, Ebonyi, Kaduna, Taraba, Ekiti, Imo, Kwara, Edo, and Delta. Figure 2 shows comparison between Nigeria and other citrus producing countries, while Figure 3 shows the rise in citrus production in Nigeria.

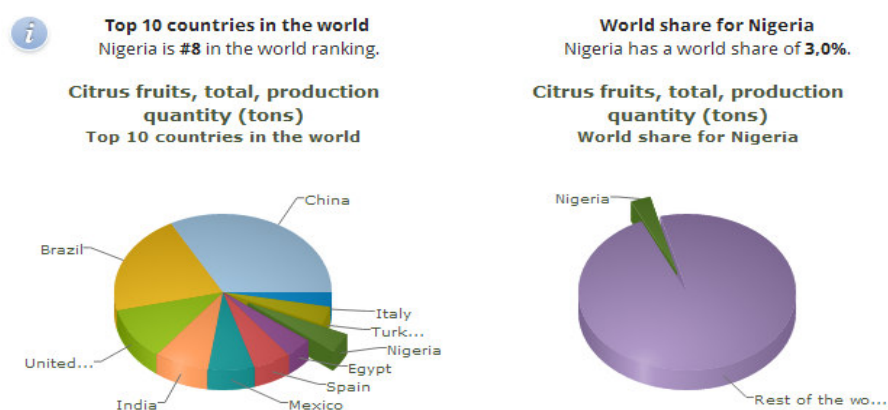


Figure 2: A Comparison between Nigeria and other Citrus Fruit Producing Countries

Source: www.factfish.com

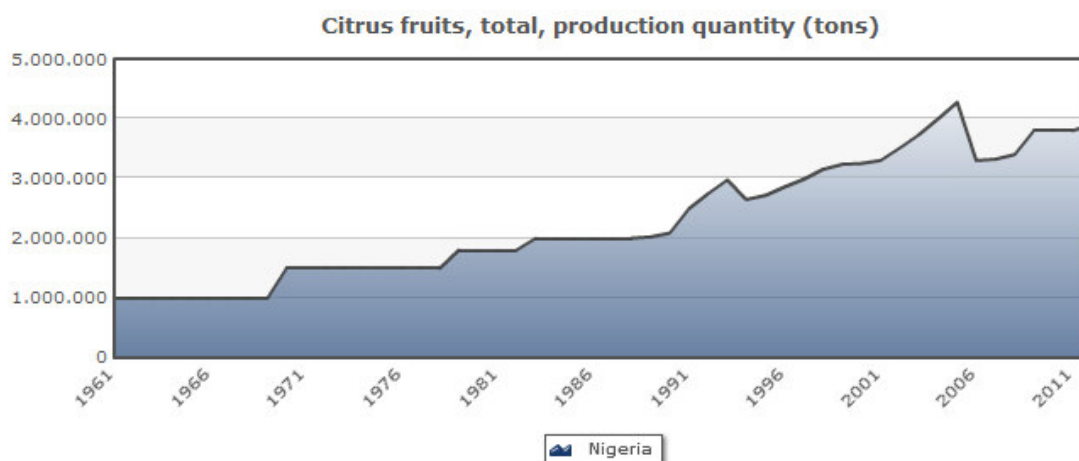


Figure 3: Rise in Citrus Production in Nigeria
 Source: www.factfish.com

2.6 Demand and Supply Status of Citrus in Nigeria

Demand for citrus in Nigeria has grown rapidly over the past decade and this growth is expected to continue to rise. Compared to an estimated 15 million consumers of citrus fruit and juice in 2002, market size more than tripled to an estimated 55 million (approximately 37% of population) in 2007. Nigeria's demand for consumer-pack fruit juice was estimated at more than 200 million litres (over 90% of which was imported) prior to the ban on consumer pack fruit juice in 2002 by the Federal Government of Nigeria. Since the ban, consumption of fresh and processed citrus has further increased by approximately 10% per year. Fruit juice consumption has grown from 200 million litres in 2002 to 320 million litres in 2007. The market for fruit concentrate, Pre-mix and Syrup (concentrates) has thus risen from 1.5 million kg in 2002 to about 30 million kg in 2007 (GAIN Report, 2009). This, coupled with the increased knowledge on the health benefits of fruits and the demand by processors for fresh fruits is an indication of the weight of promise citrus offers Nigeria if its value chain is sufficiently developed. Nigeria's demand for fruit juice concentrate is shown in Figure 4.

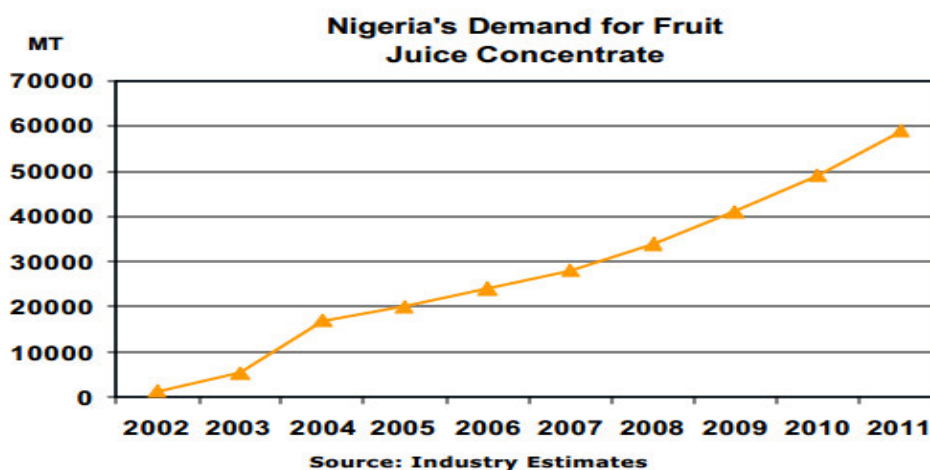


Figure 4: Nigeria's Demand for Fruit Juice Concentrate

3.0 TECHNICAL APPRAISAL OF CITRUS VALUE CHAIN

3.1 Citrus Supply Chain

In the orange marketing chain, harvested fruit may go to the fresh fruit market, in order to be consumed fresh, or squeezed freshly at home to be consumed as juice, or it may enter the processing industry, in order to obtain orange juice (mainly in the form of Frozen Concentrated Orange Juice, FCOJ, for ease of transport in international trade) and other by-products. Orange supply chain for industrialized nations is shown in figure 5. In Nigeria however the supply chain is poorly developed and disorganized requiring improvement for investment opportunities to spin off.

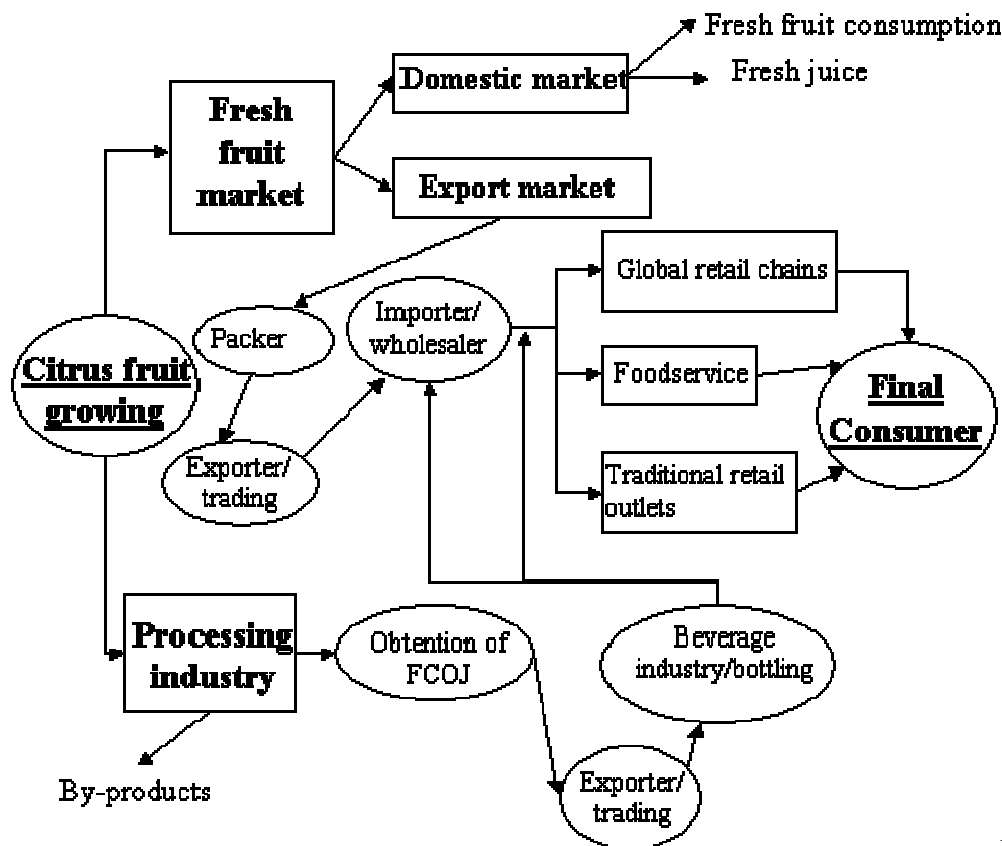


Figure 5: Orange Supply Chain in industrialized Nations
 Source: UNCTAD, (2007)

3.2 Citrus Value Chain

The concept of value addition is a vital component of the overall strategy for addressing global market competition, post-harvest losses and food security (Porter, 1985; Gibbon, 2001). The strategy of value addition on agricultural produce provides ample opportunity for revenue generation, employment generation and effective post harvest management. The processing of agro raw materials into various innovative products promotes market acceptability and gives the products high economic value which consequently brings higher income to the producer (Onwualu, 2009a; Onwualu, 2010; Olife, et al., 2013a, b). Processing also expands the horizon of human participation in the production process and therefore creates awareness for employment generation in the downstream activities such as packaging, marketing, retail, exports, etc (Onwualu, 2009b).

Farm inputs (nurseries, fertilizers and agro chemicals) are at the bottom of the citrus value chain with end points in large processing and exporting companies and the local domestic market (figure 6). Major actors in the value chain for industrialized nations include farmers and commercial orchard owners, citrus pickers, local fruit marketers and exporters, citrus processing factories, industries that engage in the utilization of by-products for the production of specialty products.

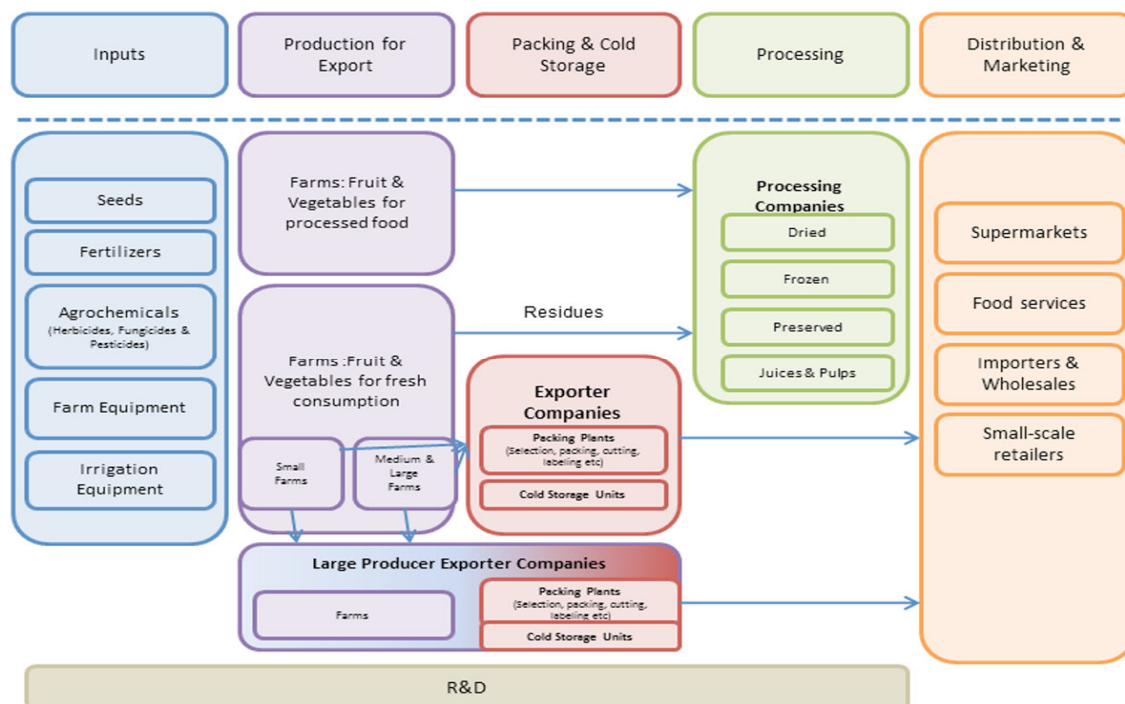


Figure 6: Citrus Fruit Value Chain in Industrialized nations
 Source: Adapted from Karina, *et al.*, 2011

However the citrus value chain in Nigeria is not developed (figure 7). Farm inputs are at the bottom of the value chain with end points in fruit juice processing companies and domestic fresh fruit markets. Major actors include plantation owners, family orchard owners, transporters, local fruit marketers, fruit juice processing companies, eatries that engage in direct crushing (fresh juice production and selling).

Concentrate production is not well developed in the country judging by the fact that there is only one concentrate plant in Nigeria located in Benue State. Most of the fruit juice companies only reconstitute imported fruit juice concentrate and packaging them in tetra packs or cans.

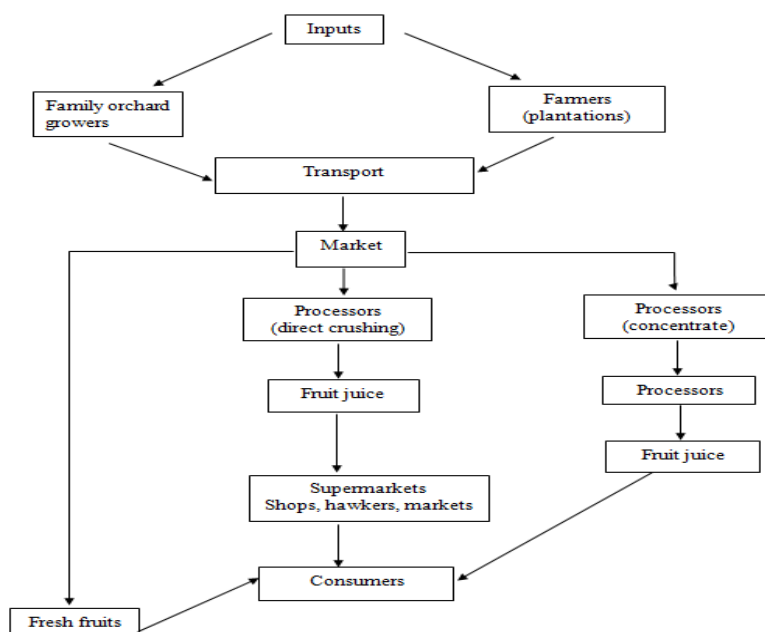


Fig. 7: Citrus Value Chain in Nigeria

There are no packing and cold storage facilities for fruits in Nigeria. The transportation from farms to the market is crude (figure 8).



Figure 8: Sacks of Oranges for transportation to the market

The availability of fruits is short-lived due to their seasonal and highly perishable nature. A large percentage of the citrus are also consumed directly as they came from the orchard. Consequently, about 30-60% losses are recorded annually during peak harvesting seasons due to lack of appropriate storage facilities and process technology (Onwualu, et al.,2013).

3.3 Interventions Towards Developing Citrus Value Chain in Nigeria

Citrus production was introduced to Nigeria by the Federal Department of Agriculture and missionaries in the 1930s (Adigun, 1992). Subsequently it was spread throughout the country and is currently rated as the most widely planted fruit tree in Nigeria. It features in diverse cropping systems which include the multistoried home gardens, cocoa plantations, food crop plots and a few pure stand orchards (Amih, 1985).

Nigeria produced 3% of total world citrus output between 2000 and 2004. This ranked the country ninth among the major producing countries of the different types of citrus fruits, thereby making it a major producer of citrus (UNCTAD, 2007). However, the production of citrus in Nigeria is mainly for local consumption. Area of citrus increased steadily at about 72000 hectares in 1999 from 30,000 hectares in 1961. Output of citrus increased steadily from 1000 tonnes in the 1960s to 3,250 tonnes in the early 2000. However, for many years, citrus output stagnated at the same level (Yusuf and Falusi, 2000).

The Federal Government of Nigeria over the years have set up Research Institutes, Universities and special facilitating agencies to increase, improve and sustain the pace of production, utilization and marketing of tropical fruits, citrus inclusive. These agencies/organizations over the years have increased the knowledge pool of the country, in areas of R&D, on production and utilization, in domestication of technology, and in fabrication of process equipment for tropical fruits. Agencies that have contributed to the development of tropical fruits in Nigeria include National Horticultural Research Institute (NIHORT), Ibadan; Federal Institute of Industrial Research, Oshodi (FIIRO); Nigerian Stored Products Research Institute (NSPRI), Ilorin; National Biotechnology Development Agency (NABDA), Abuja; National Centre for Agricultural Mechanization (NCAM), Ilorin; Tree Crop Development and Marketing Company (TRECDEM); Kano State Horticultural Institute and Raw Materials Research and Development Council (RMRDC), Abuja.

In 2002, the government of Nigeria placed an import ban on fruit juices in retail packs, fruit juice drinks, fresh and dried fruits. It was expected that the ban on the importation of these items will stimulate growth in citrus production. Fruit juice manufacturing companies have already taken advantage of the ban to establish orchards to feed their plants.

Also, in order to promote increase in the production of tropical fruits like citrus, The Presidential Initiative on Tropical Fruits Production in Nigeria was launched in 2005. A National Implementation Committee was set up to find ways of achieving 10% of the world tropical fruits production within 4 years.

In line with its mandate, the Raw Materials Research and Development Council (RMRDC) has been involved in programmes and projects aimed at supporting and expediting industrial development and self-reliance through optimal utilization of local raw materials as inputs for industries. A number of projects have been executed towards improving the Citrus value chain by RMRDC. Under the Model Factory and Joint Venture Project, The Council established a Fruit Juice Processing Plant in Kaduna and later ceded it to a private company.

The World Bank Step B Project provided a grant to RMRDC for development of the fruit juice industry in Nigeria. Other members of the project team include NABDA, FUMMAN and Niger Resources. The project upgraded tissue culture facilities at NABDA, NIHORT and NAGRAB. Planting materials of selected elite varieties of citrus and other fruits were produced distributed to farmers. Private sector organisations were encouraged to set machinery towards establishing Concentrate factories and plantations of fruits in order to decrease importation of concentrate. These were done through two stakeholders forums hosted by RMRDC in Lagos where most of the manufacturers were present (Jolaoso, 2011).

The Council also conducted a Survey of Citrus as an Agro-Raw Material in Nigeria and a book titled “Citrus Production and Processing in Nigeria” was published by the Council (Jolaoso et. al., 2011)

4.0 ISSUES MITIGATING AGAINST CITRUS VALUE CHAIN DEVELOPEMNT IN NIGERIA

Although Nigeria produces millions of tonnes of seasonal fresh fruits, very high post-harvest losses (30-60%) due largely to inadequate infrastructure and high-cost of transportation, continue to create demand for imports. The post-harvest sector includes all points in the value chain from production in the field to the food being placed on a plate for consumption. Post harvest activities include harvesting handling, storage, processing, packaging, transportation and marketing (Mrema and Rolle, 2002). Losses of horticultural produce are a major problem in the post-harvest chain. Lack of value addition is also a major constraint in harnessing the citrus potentials in Nigeria. Other challenges include lack of infrastructure for storage and preservation, lack of improved varieties, poor R&D funding and poor handling of the fruits during harvesting and transportation. The quantity of fruits produced in Nigeria is not enough, the quality of the fruits are poor, mainly traditional varieties with poor yield, and are difficult to harvest. Unavailability and non utilization of appropriate post harvest storage technology to preserve the fruits before processing leads to huge losses. Also, lack of organized farmers and marketing system that will ensure sustainable production, marketing and processing of fruits, little or no support from the government to grow, market, store and process fruits, lack of integrated packaging requirements and absence of commercial citrus orchards are other challenges facing the development of the citrus value chain in Nigeria. Reluctance of fruit juice manufacturers and other investors in investing in concentrate plants and poor packaging of fresh fruits also mitigates against citrus value chain development.

5.0 STRATEGIES FOR HARNESSING THE POTENTIALS OF CITRUS IN NIGERIA

Nigeria is the largest market in sub-Saharan Africa, with a population of over 150 million people and growing at 3% annually. Despite a huge number of consumers, the country’s fruit juice sector is under-developed and the nation remains a major importer of fruit juice concentrates and premix. Nigeria alone consumes about 50% of the total volume of fruit juice sold in Africa. Prior to 2002, all these were processed and packaged outside Nigeria but due to the ban on the import of packed fruit juice and lowering of tariff to 5% on imported fruit juice concentrates by the federal government in 2002, there are now factories in Nigeria that are doing the packing. However, about 95% of the concentrates are still being imported. This has been quantified to be above \$400 million per annum. If the country is to take advantage of the huge potentials in the fruit juice industry, the following strategies have to be implemented:

5.1 Controlling Post Harvest Losses

Over 50% of the fruits produced in Nigeria are lost in transit between farms and major urban markets. It is believed that such losses are avoidable and result from the farmers/middle men’s preference to sell at higher price in the markets rather than selling to processors without taking into account the cost of wastage. There is a need for efforts to be geared towards increasing production and curtailing post-harvest losses through proper value addition. Establishment of cold storage facilities across the country would greatly help in reducing wastes that accrue during the harvest season (Jolaoso, 2011).

Some technologies for reducing wastage include:

- i. Processing:
 - Juicing and concentration: Involves processing of fruits into juices and juice concentrates. Juices are packed in bottles, cans, cartons, bricks, etc while concentrates are stored in aseptic bags, drums or tanks. The concentrates could be stored for up to one or more years, while

- packages in cans and aseptic cartons have longer shelf-life.
- Drying: Involves cutting of fruits into slices or chips and dried to specified moisture content to increase shelf-life of products using solar, electric or combustible coal dryers.
- ii. Waxing: Involves the coating of fruits with wax to delay the ripening of fruits.
- i. Controlled atmosphere: A modern storage system which employs the use of:
 - Gas in an airtight condition to extends the shelf-life of the fruit;
 - Louvered bin houses
 - Refrigerated Vehicles
- ii. Biotechnology: Genetic Engineering/Gama Radiation involves genetic manipulation of crops to inactivate the enzyme (Polygalacturonase) in fruits to delay fruit ripening.
- iii. Handling: Involves careful picking of fruits and the use of specially designed carrying bins, plastic crates and collapsible wooden crates (Jolaoso, et. al., 2011)

5.2 Adequate Funding of Research and Development

There is the need to encourage R&D for the development of improved varieties to increase production output per hectare and produce fruits with desirable attributes and curtail post-harvest losses through value addition. It is expected that research and development outputs will be integrated backward. This can help in reducing the demand-supply gap in the fruit juice industry in Nigeria. The relevant institutes already established by government should be properly funded to develop technologies for the value chain.

5.3 Establishment of Processing Clusters

In order to maximize the potentials of citrus in Nigeria, efforts should be made to develop every level of the citrus value chain from input supply to processing. Public Private Partnership can be exploited through the establishment of citrus processing clusters for the production of concentrates and other products from citrus.

5.4 Establishment of Citrus Orchards

The absence of commercial citrus orchards and the low quality of citrus fruits result to low-capacity utilization in factories. Therefore, investment in the establishment of large orchards will be a welcomed development. Investors should be given incentives such as low interest rate on borrowed funds, tax holiday, guaranteed market, etc.

6.0 CONCLUSIONS

The importation of almost 95% of fruit juice concentrates into the country shows that there is a demand-supply gap in the fruit juice industry. This is currently costing Nigeria up to \$400 million in import bills. It is expected that the industry will integrate backward by investing in the establishment of citrus orchards, processing of fruit juice concentrates and other citrus products. This is a challenge which the fruit juice industries must tackle.

There are huge prospects for Nigeria in the fruit juice industry considering the large population of consumers, the vast arable land for citrus production and available human and material resources. Investments in citrus production and processing will have a great multiplier effect as it will not only improve the nation's economy, but will also ensure creation of millions of jobs and enhance the income and living standards of all the actors in the value chain.

At the root of the problem is Research and Development. All levels of the value chain require investments in the R&D to ensure improved cultural practice to increase yield per hectare, introduce exotic varieties, process technology and overhauling of the supply chain.

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