

Impact of Supply Chain in Reducing Fruit Post-harvest Waste in Agric Value Chain in Nigeria

by

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Abstract

This paper is packed with the impact of the supply chain in reducing agric product waste in Nigeria, issues, and challenges, and why the Nigerian farmers are battling with frequent post-harvest losses, from farm to wastebasket. The main focus of this paper is to analyze the impacts, concepts, benefits of an integrated supply chain in the agriculture value chain and not seen as an isolated field packed with numerous challenges as experienced today. The author researched on the paper with dependence on primary data, secondary data, textbooks, reliable internet websites and operational case study since there is a scarcity of professional material in the subject area explaining the integration between supply chain and Agric value chain since supply chain constitute 50% of Agric value chain while Agric and finance-related input shared the remaining 50%. Also, the researcher interviewed some farmers, stakeholders, and indigenous agriculture value chain practitioners in Nigeria, regarding the reasons why agricultural produce is not profitable and marketable in Nigeria. At the end of the paper, the presenter proposed a number of recommendations for the Agric value chain integration in Nigeria. Significant among those are the government support on infrastructure, implementations of the people-friendly policy and adequate support to the farmers while Agric practitioners should implore information technology in the area of farming, harvest, data management, track & trace as well as supply and demand chain management.

Keywords: Nigeria, Agriculture, Farmers, supply chain, Business, Transport, shipping, value chain, Cold chain, fruits, Post- harvest.

Introduction:

The major market for Agric product and the processed fruit market in Nigeria are Kogi, Benue, Taraba, Ogun, Nassarawa, Oyo, Ekiti, Osun, Ebonyi, Kaduna, Imo, Delta, Edo, and Kwara. Basically, the fresh fruit market is in majorly in Lagos and partly Abuja which is miles away on average of 810 km which is 12 hrs 40 mins drive on good roads. Most of those Agric fruit production location does not have a functional airport, considering the pathetic poor road networks and transport facilities in the farms.

Fruits and vegetables are produced seasonally, but the market necessitates continuous products throughout the year. There is an age-long issue of matching product availability with consumer demand, which was solved by professionals, leaving individuals country or community to manage its value and supply chain efficiently. Below are the two-way solution:

- i. Selling fresh products during harvest and shortly thereafter

- ii. Processing the rest to meet demand during the rest of the year

Farmers, distributors, Producers, logistics providers, and other stakeholders are overstrained to get their products to the market swiftly, safely, and in a merchantable condition which seems insurmountable.

Process of Fruit Supply Chain:

- i. **Sourcing of raw materials:** One good thing about this fruit business is that most planting is done just once, after which it is all harvest. This continuous harvest commercial fruit farming is a means of earning a continuous stream of income. For examples, according to the Food and Agricultural Organization statistics, Nigeria produces about 3.4 metric tons of citrus fruits annually from about 3 million hectares of land, making it the 9th global producer and the largest producer in Africa, followed by Egypt, Morocco and South Africa (Ibrahim, 2019).
- ii. **Production:** Some of the problems which affect production in Nigeria includes frequent price fluctuations of fruits (due to its portability or denatured of fruits before getting to the consumers), poor harvest, post-harvest – processing, marketing, and storage, attacked by pests and diseases which reduce their market quality and quantity. Also, the threat of importation of foreign fruits and fruit concentrates (used to produce fruit juice and other end products like frozen concentrates, fragrant peels, pectin, flavors, etc.) as the annual national demand for fruit juices is presently estimated at 550 million liters, but the current supply is estimated at 135 million liters which represent less than 25% of the demand. According to DG RMRDC (Ibrahim, 2019)

In order to promote an increase in the production of tropical fruits such as 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's tropical fruit production within 4 years. About 30 – 50% of these citrus fruit gets spit on the way before getting to the final consumers in the urban centers

- iii. **Storage:** Lack of storage facilities in Agric sectors lead to fruits and vegetable becoming perishable in no time and eventually becoming a waste. This also erodes the profit from the hard earn farmer and demotivated others from entering into the business. Globally, post-harvest fruit and vegetable loss are as high as 30-40% and this is even higher in Nigeria (Ebimicowei et al., 2013).
- iv. **Retail distribution:** Retailing incorporates every one of the exercises engaged in selling Agric produce or directly to the end-user customers. A retailer is characterized as a middleman who sells, largely, to the final end-user or customer in piecemeal. A retailer may sell to an organization; however, the vast majority of his deals are made to industrial or household consumers. The retailer is the last connection and the most significant intermediary in the chain of distribution. Large scale manufacturing, in the present-day set-up, is equipped with the necessities of the end-user. The retail distributors in Nigeria are greatly challenged by the constant threat of fruit obsolescence and price declines for existing inventory, as well as the absence of developed supply chain and integrated IT management.

- v. **Wholesale distribution:** Wholesalers are merchant middlemen that take ownership of Agric products they sell. They operate directly between farmers, retailers, other wholesalers, traders, industrial institutions, and commercial users. Wholesalers do not sell in a significant amount to ultimate consumers. They, however, sell to those who will resell the goods or use them to produce other goods (“Distribution network management,” 2019).
Nigerian case studies had shown that the consumption and production of marketing food are spatially disconnected. Production is primarily in rural areas while consumption is in urban areas, overcoming this separation had been a major challenge, coupled with the economy sabotage caused by some of these middlemen (“Wholesale,” 2019).
- vi. **Food processing:** Food processing is the transformation of agricultural products into food, or of one form of food into other forms. Food processing incorporates numerous types of processed foods, from grinding grain to make raw flour to home cooking to complex industrial methods used to make convenience foods.
A primary food processing is required to make most foods edible, and secondary food processing turns the ingredients into familiar foods, such as bread.
Tertiary food processing has been condemned for advancing overnutrition and obesity, containing too much sugar and salt, too little fiber, and otherwise being unhealthful with respect to the dietary needs of humans and farm animals. There had been the prohibition of packed fruit in the past which ordinarily should increase consumption of fruit and process fruit juice but it is surprising that we only have one functional concentrate company in Nigeria while large numbers of concentrates are imported for production of fruit juice consumed in Nigeria (“Food processing,” 2019).

Global Agric Supply Chain Issues and solutions:

Below are five specific food supply chain problems that we often come across and tips on how to solve them according to the “network effect beyond supply chain,” 2019).

- i. **Lack of track and traces of fruits:** Track and trace of fruit is the ability to track the fruits all through the phases of the supply chain, this process is becoming more of a demand rather than a request among many consumers today. Many consumers now want to know where all fruits are located, and even to trace the available fruits with accurate data.
Solution: Block chain is one of the technologies that is under-utilized in fruit production in tracing fruit’s supply chain. This technology is a digital platform where users can store and share information across a network. This system enables users to look at all transactions simultaneously and in real-time with the advantages of on time distribution of information across network to avoid information being hacked, manipulated, or corrupted in any way.
- ii. **Inability to maintain the safety and quality of Agric products:** Today, the pressure on farmers to plant and distribute high-quality fruits that are safe is

becoming more challenging, Some of the common causes that affect the quality and safety of fruit are as follows;

- a. Poor storage and warehousing practices
- b. Delays in transportation and bad condition of road
- c. Industrial sabotage
- d. Adverse weather conditions

These are some of the reasons that the number of post-harvest fruits are sold cheaply to avoid total loss to perishable fruits.

Solution: Choosing an accredited testing laboratory that uses current measuring and testing equipment to ensure impeccable fruit quality and reliable quality assurance.

- iii. **Insufficient communication between parties:** Fragmented information and lack of communication can have a major impact on the fruit supply chain. Major reasons that caused these are the numerous parties involved in the value chain with little or no information of one another's operations. Poor communication causes wasted effort and slow down progress and can lead to suspicion among stakeholder along the chain. This issue deteriorates when working across borders.

Solution: Lack of communication should not be a huge problem today since technology has made it easier, faster, and more affordable to gain a full view of the fruit supply chain, and communicate with colleagues and peers

- iv. **Rising supply chain costs:** Operating a fruit production, supply chain oriented comes with many costs, some of the more important once include:
 - a. Fuel and Energy costs
 - b. Logistics and shipping
 - c. Labor and Manpower
 - d. Investment in new technology

Solution: These costs are significant, as such; keeping a check on operating costs and the constant trade-off will be the solution.

The technology implementation might be a significant cost too at the beginning, but it is cheaper at the long-run with excellent result.

- v. **Failure in warehouse storage and inventory management:** One of the major challenging areas in fruits production is inventory management. So as to control costs and look after quality, and fulfill customer's requirements, inventory must be painstakingly overseen. As both over production and under production without adequate storage have their economic effects. Over production will lead to perishable fruits and waste while underproduction will lead to customer disappointment. There is a definite trade-off between keeping customers happy and keeping inventory and lower waste.

Solution: Modern cold chain storage facilities solution can help manage inventory. In an ideal world, modern cold chain facilities enable real-time visibility to inventory, on-site off-site and in-transit, and support RFID, IoT and other real-time and automated tracking technologies can help in addition to data accuracy.

Another way to gain control and reduce inventory levels is to link the supply chain to sales at the malls, process industries or even export.

Nigeria Agric Supply Chain Issues:

- i. Lack of access to loans and grants by farmers or entrepreneurs to invest in commercial fruit and vegetable farm.
- ii. Inadequate Government support on basic amenities like;
 - a. Seedlings subsidy,
 - b. Motorable roads in areas with high concentration of fruit farms,
 - c. Agric airport for export of excess fruit,
 - d. Cold room and storage facilities,
 - e. Lack of adequate electricity, which has greatly impacted processing industries, leading to the closure of many.
- iii. Inaccessible Poor Road Network of rural areas: where a large amount of the fruits are produced: The fruits are usually prone to be perishable due to the bad roads and long hours of travel .
- iv. Lack of Modern Cultural Practices: Most fruit farmers customarily follows old and outdated cultural practices which limits best practice and innovation.
- v. Lack of research or expert opinion regarding the state-of-the-art and most productive cultural practice applicable, thereby exposing their farms to low productivity and ultimately loss of investment.
- vi. Pest and Diseases is another major problem affecting fruit's farmers in Nigeria. A challenge of pest and disease infestation is a major impediment to farmer's development. Premature fruit drop due to attack by nocturnal fruit piercing moths, termite damage to stem bark and tree roots and Genesis as well as death of budding seedlings.
- vii. Adverse weather conditions during the elongated dry season in Nigeria, fruit crop undergoes severe soil moisture stress. Hence, high seedling mortality and reduction in production size as even the matured trees are usually eminent to wilt during very low supply of water. (Adegbija D, information guide in Nigeria published 10th of October 2018).
- viii. Lack of labor and mechanized farming equipment: getting labor, especially for a large farm is a major economic sabotage. In cases where a mechanized form of labor is gotten, it is usually for a higher price.

Table 1: Broken Lines in Agric supply Chain in Nigeria¹

¹ Source: Authors field survey, 2019

Broken Links in Agri Supply Chain in Nigeria			
Production	Supply chain Issues	Processing industry	Marketing
Inefficient production	Inaccessible Poor Road Network	Lack of quality	Poor infrastructure
Low quality inputs	No modern storage facility like cold chain facilities	Poor return on investment	Process gap between demand and supply
Poor extension	High post-harvest wastage	Low capacity utilization	lack of sorting and grading line
Low demand linked production	Multiple intermediaries	Low processing	Malpractices in the marketing system
Inefficient post harvest	No specialised vehicle to convey fruit from farms	Lack of adequate electricity	No price structure
Low process industries	Poor marketing	Unfavourable government policy	Transport delay to market
Low labour force	Multiple taxation and levy at point of sales	Industrial and economy sabotage	Expensive means of transport to market
Poor handling as fruits are transported in open vehicles	No data to forecast demand and supply	Inaccessible Quality testing / assurance labs	Inadequate communication between parties
Adverse weather conditions	Disconnection between supply chain and agric value chain professionals	Lack of Common facility centres/ Incubation centres	Low Marketable surplus of a Large fruits
Pest and disease infestation	No agric airport for export of excess fruit supply		
Lack of mechanised farming equipments	No communication between seller and buyer		
Lack of research or expert opinion	Lack of suitable export policy		
Lack of Modern Cultural Practices	Lack of reliable and up-to-date Market Information		
Inadequate Government support for seedlings subsidy	Absence of Quick Transport Means		
Lack of access to loans and grants for farmers	Poor packaging practices		
Inefficient food safety	Long and multi-layered supply chain:		
Each segment working in an isolated manner resulting in multiple losses across the value chain			

How Supply Chain Can Help Solve Agric Value Chain Issues:

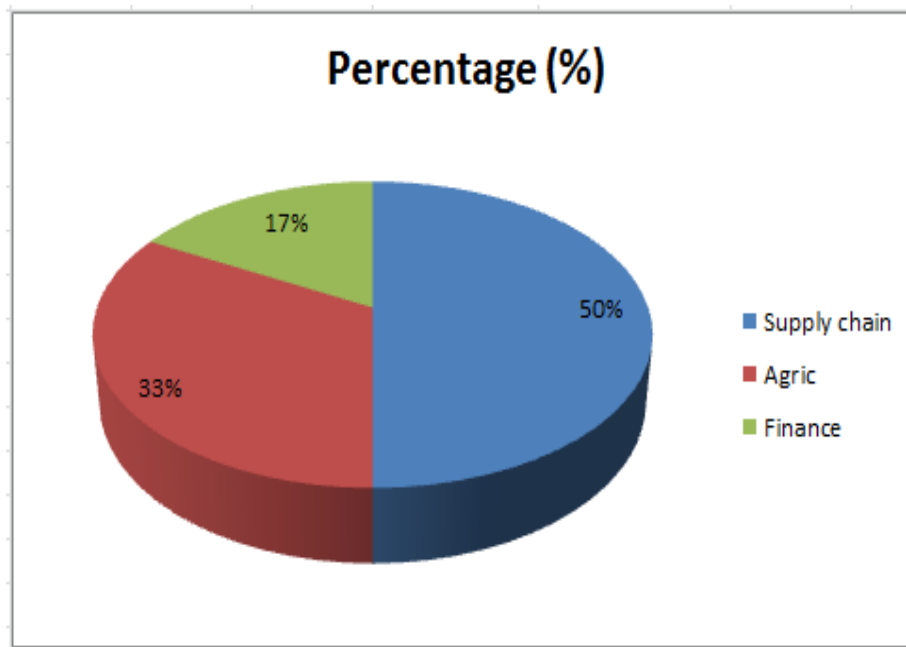
- i. Emphasizing the importance of chain quality control: These developments indicate that business strategies must now pay attention not only to traditional economic and technological features, but likewise to subjects like healthfulness, safety, taste, freshness of fruits and nutritional benefits; at the same time, shifting from mainly bulk production, towards the production of special fruits with high added value.
- ii. The rapid rise of supermarkets in developing countries (business day online posited that there had been increment of retail supermarket from 800,000 to 1.2 million in the last 4 years) but most of the stores are concentrated in the city and not in rural areas where farms are located; hence there will be more need of specialized transport to move it there safely and in merchantable condition;- Supermarket procurement regimes for sourcing of fruits, vegetables, dairy and meat intensely impact the business of the supply chains. The market necessitates product

- homogeneity, continuous deliveries, quality upgrading and stable shelf-life (Reardon and Timmer 2006).
- iii. Matching demand and supply: excess can be exported and/or shipped to process company as concentrate in food industries, beverage industries etc.
 - iv. Embracing ICT and mechanized farming, for example process of harvesting, counting, picking and washing of the fruits like oranges must be mechanized. Private firms will be willing to take charge if governments ensure enabling environment and right policies to protect local farmers and food chain industries. Also enhancement in data management to transform the order quantity procedures or their parameters using information from the supply chain. Chain partners can develop contracts and/or establish parameters, standards or procedures to facilitate and streamline their transactions. In addition, Eliminating all ‘time delays’ in goods and information flows from the supply chain; this can be achieved by better planning and better use of ICT and improved logistics.
 - v. Remove one or more intermediate ‘tiers’ in the supply chain by business take-over; the so-called ‘vertical integration’, where activities in one stage (e.g. productions) are absorbed by another (e.g. processings) is an example of this strategy.
 - vi. Establishment of Agric airport, functional export processing zone and specialized transport to reduce the lead time of the product range for a supply chain, from the moment the importer places an order to the time of actual delivery to the importer’s premises. If process is not streamlined, fruits might get perishable before it get to the importer. The Government might come in to streamline export process of fruit and also farmers might also go into partnership workshops with partners. Value chain performance measurements, agreements on responsibilities and the division of costs and revenues can be agreed upon. For successful project implementation, trust between partners in the chain must be upheld, especially the understanding of each other’s role, added value and gains for chain cooperation which will lead to a common competence to act as a whole. Ultimate departure times for distributing trucks can also implement strategies below;
 - a. Fixed purchase locations for certain products and quantities;
 - b. Stocking products, which are often ordered very late by customers or usually bought at supply locations far away;
 - c. Priority rules for supply transportation (although the planner is not aware of the time, he or she can be informed of the urgency by flashing icons on his or her screen).
 - vii. Encouraging and supporting process company sets up like food industry and beverage industries, retail and super market etc.
 - viii. Significance of production planning and scheduling, with a focus on high capacity utilization (Food And Agriculture Organization Of The United Nations Rome, 2007).
 - ix. Food processing : Van der Vorst et al., 2005 noted that a lot of issues related to the food processing industry that production planning and scheduling can solve with high capacity utilization.

- x. Collaborative demand planning and replenishment: retailers and manufacturers work together to assess consumer demand and to determine the most appropriate supply management and replenishment approach to meet this consumer demand.
- xi. Collaborative production: manufacturers and suppliers work together to harmonize the supply of raw materials and the production of end products in such a way as to minimize the stocks within the supply chain and maximize the responsiveness.
- xii. Collaborative logistics planning: coordinating transport and warehousing between the various parties involved, including shippers, logistics service providers, carriers and recipients.

Data analysis:

Pie chart 1: Agric value chain process in Nigeria between 2011~2015²



It should be noted that supply chain constituted 50% of total Agric value chain based on frequency of process flow given by FGN (2016) The Agriculture Promotion Policy (2016 – 2020). FMARD, Abuja, while Agric and finance shared the remaining 50%. In this vein, it is imperative to employ the service of supply chain professionals and government also provide enabling infrastructure for the Agric sector to survive.

Table 2 : Respondent Feedback and FMARD Failure Reasons³

² Author's survey adapted from FGN (2016) The Agriculture Promotion Policy (2016 – 2020). FMARD, Abuja

³ Source: Field survey adapted FGN (2016) The Agriculture Promotion Policy (2016 – 2020). FMARD, Abuja

Process failure	% of respondents	Project	Department	Failure reasons(captured FGN (2016) The Agriculture Promotion Policy (2016 – 2020). FMARD, Abuja)
Input supply(Inbound)	40	Database and procurement of fertilizer and seedlings	Supply chain	a,GES's limited focus and exit strategy set aside, with material implications for Ministry's budget, hence the sharp rise in indebtedness to banks.b,The system has many leakages from farmer registration and data capture to supply and distribution mechanism.c,Insufficient access to improved variety seeds e.g. still a 300,000MT gap between demand and supply of seeds
Agricultural Research Network	65	Plant research	Agric	a,Federal – State coordination of policy became significant challenge; some states made choices at odds with federal approach e.g. continuing direct procurement of fertilizer b,Absence of programme delivery infrastructure / unit at the federal and state levels; held back key implementation and donor funding c,Data collection and evidence based reporting remains weak, hence tracking results / M&E continues to be a challenge
Finanacing	60	Special fund,recapitalization and lending	Finance	a,Credit access particularly for small holders remains weak b,NIRSAL's 2013 change in credit guarantee rules disrupted market for agriculture financing until mid-2015 when rules were reviewed again c,Backlog of unpaid GES loans (estimated at ₦39 billion) has slowed down bank lending
Infrastructure and Logistics	30	Crop processing zone and concesion of warehouse and storage	Supply chain	a,Investment inflows into infrastructure and midstream logistics e.g. warehouses, storage, processing systems remains rudimentary b,Staple crop processing zone (SCPZ) strategy has not yielded results. for example, Kogi SCPZ has not taken off due to withdrawal of Cargill, The anchor investor from The project
Production	55	Agric extension and crop variety	Agric	a,Growth in food production remains limited due to gaps in input supplies e.g. rice; hence rice imports still exceed \$1 billion/annum. Outlined below is an <i>illustrative</i> "best estimates" of demand-supply gaps given data quality issues still present in Nigeria. It is anticipated that as production gaps are closed via yield improvements, per/ton equivalent costs will also decline, helping reduce food costs and ultimately, inflation
Market access	35	Commodity marketing cooperation	Supply chain	a,Post-harvest losses still an issue but improving moderately b,Illegal food imports remain an issue, depriving farmers of market opportunities

Table 3. Directional Measures⁴

⁴ Source: Author's SPSS analysis

Directional Measures

			Value	Asymptotic Standardized Error ^a	Approximate T ^b	Approximate Significance
Nominal by Nominal	Lambda	Symmetric	1.000	.000	8.660	.000
		Failure Dependent	1.000	.000	5.477	.000
		Respondent Dependent	1.000	.000	5.477	.000
	Goodman and Kruskal tau	Failure Dependent	1.000	.000		.462 ^c
		Respondent Dependent	1.000	.000		.462 ^c
	Uncertainty Coefficient	Symmetric	1.000	.000		.664 ^d
		Failure Dependent	1.000	.000		.664 ^d
		Respondent Dependent	1.000	.000		.664 ^d
	Ordinal by Ordinal	Somers' d	Symmetric	-.467	.361	-1.292
Failure Dependent			-.467	.361	-1.292	.196
Respondent Dependent			-.467	.361	-1.292	.196

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on chi-square approximation

d. Likelihood ratio chi-square probability.

Table 4 Symmetric Measures⁵

Symmetric Measures

		Value	Asymptotic Standardized Error ^a	Approximate T ^b	Approximate Significance
Nominal by Nominal	Phi	2.236			.224
	Cramer's V	1.000			.224
	Contingency Coefficient	.913			.224
Ordinal by Ordinal	Kendall's tau-b	-.467	.361	-1.292	.196
	Kendall's tau-c	-.467	.361	-1.292	.196
	Gamma	-.467	.361	-1.292	.196
N of Valid Cases		6			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

⁵ Source: Author's SPSS analysis

Table 5 Chi Square Tests⁶

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.000 ^a	25	.224
Likelihood Ratio	21.501	25	.664
N of Valid Cases	6		

a. 36 cells (100.0%) have expected count less than 5. The minimum expected count is .17.

We could conclude that the CHI square test carried out on data was not significant at 0.17 level (2-tailed $p > 0.0005$) of significance. ($X^2=22$, $df=25$). P -value > 0.05 ; indicates weak evidence against the null hypothesis (The P -value is not significant, indicating that there is no association between the variables) so we conclude that there is no significance difference between supply chain impact and Agric value chain.

In summary, we accept the null hypothesis that says that supply chain had an impact on Agric value chain, based on the respondent’s data, However, There are still post-harvest waste because the professional were not involved in the Agric supply chain process. In many cases, the farmers and middlemen doubled up as the supply chain practitioners that directly involved in procurement, warehouse/Storage, transportation as well as, supply and demand planning which most times, the result is not always palatable.

Conclusion:

The first step to understand the cost structure with accurate data. In a very simple supply chain, this can be done with spreadsheets. The more complex the supply chain, the more a technology solution is needed. Very complex supply chains are possibly better served with a network solution, so that, needs will be tied to integration of available networks.

It is worthy of note that being too cost-conscious can inhibit efficiency and growth. A costly technology solution can spare much as time goes on, making business increasingly effective, and progressively alluring to customers. It can also modernize Agric value chain business and make less vulnerable to competitive forces either locally or internationally. Rather than focus on cost, a value-cost calculation can be implored over the long term.

⁶ Source: Author’s SPSS analysis

Recommendations:

- i. It involves investment in modern cold chain equipment and processes.
- ii. Its investment in Agric facilities like growing, picking, transporting and extraction to final use.
- iii. Data management of all output; a weigh bridge and of course its sorted already by size, the total weight less truck weight gives the weight of the oranges. Once this is divided by the average weight you can get the number the truck is carrying.
- iv. The emphasis is only on planting and harvest, and not on warehousing, transportation, inventory, demand Management, packaging, distribution, shipping, etc.
- v. Continuation of the special Agric airports initiated by last gift. Perhaps, these oranges could have been shipped to Europe, North Africa, North America etc.
- vi. Involvement of supply chain professional to erase the gap of lack of understanding of the Agric value chain.
- vii. Government should place a strict import ban on fruit juices in retail packs, fruit juice drinks, fresh and dried fruits.
- viii. Policy enhancement and encouragement of Agro process industry fruit juices in the Nigerian markets like Chivita, Frutta, Edge, Lloyd's fruit squeeze, 5 Alive, Fumman, Chi Exotic, Dansa, Fan juice, Dudu, Cyway natural drink, etc. Common packaging is Tetra-Pak, Can, bottle (plastic and glass) and pouches.
- ix. Encouragement of Agric technology (production know-how) since there is lack of elite materials for fruit juice production and fruit juice concentrate as Nigeria only have just one company Teragro company in Jos who produce fruit juice concentrate (Hussein Yahaya, 2019 daily trust published date July 22, 2018).
- x. Encouragement of professionalism like getting input of Agric and supply chain professional on Agric process flow.
- xi. Promote establishment of standard safety and packaging, which will have integrated fruit processing and handling facilities. The Fruit Parks will have additional storage capacity for cold temperature and will have processing units for high value addition (secondary processing).

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