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Appraising the Value Addition Dynamics in Oil Palm Production in Nigeria

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Abstract: *This study assessed the value addition dynamics in oil palm production in Nigeria. Oil palm cultivation have imparted positively to the economic development of Nigeria by providing income, employment, and export revenue. Some key types of value addition dynamics noted include: processing, refining, fractionation, packaging, branding and marketing and value chain integration. The major palm oil extraction techniques witnessed are traditional methods, mechanical extraction methods, solvent extraction and few others. While, the major palm kernel oil extraction techniques are harvesting and collection, cleaning and separation, cracking and dehulling, storage and packaging: Value addition in palm oil refining and quality enhancement is achieved through degumming, neutralization (alkali refining), bleaching, deodorization, quality control and testing, packaging and distribution. It was discovered that the major usage of both palm oil and palm kernel products are cooking oil, bakery and confectionery products, margarine and shortening, processed foods, cosmetics and personal care products, detergents, pharmaceuticals, candles and animal feeds. It was concluded that value addition in oil palm cultivation is crucial for the sustainable growth of the oil palm business in Nigeria and offers of economic benefits, enhances market access, and contributes to food security.*

Keywords: Oil Palm, Oil, Value addition, Production, Palm Kernel Oil, Nigeria

1. Introduction

The oil palm (Elaeis guineensis Jacq.) has its origins in the tropical rainforest area of West Africa. The primary belt traverses the southern latitudes of Cameroon and Côte d'Ivoire.
The countries included in this region are Côte d'Ivoire, Ghana, Liberia, Nigeria, Sierra Leone, Togo, Angola, and the Congo, specifically in the equatorial area. The oil palm, known as Nkwu in Igbo and Ope in Yoruba, is indigenous to the humid tropics of West Africa, the Congo basin, and Central Africa. It can be found growing naturally in secondary forests (Ugochukwu et. al., 1999 in Ajani et al, 2012).
Oil palm cultivation in Nigeria has a rich historical background, dating back to pre-colonial times when it was grown for domestic consumption (Nweke and Onokala, 2017). Since then, oil palm has grown to be a significant crop in the area, influencing the economic climate there.

Oil palm is believed to have originated in West Africa, including the present-day region of Nigeria. Early evidence suggests that African communities used oil palm fruits for various purposes, including cooking oil and traditional medicine (Hart and Hart, 2010). Prior to European colonization, oil palm was well established among local communities in what is now Nigeria. Nigeria formerly held the position as the foremost global producer of oil palm prior to the period of rapid growth in crude oil production. Malaysia, which arrived in Nigeria during the 1970s to acquire oil palm seeds and seedlings, has now assumed the dominant position. The oil palm plantation and its associated companies currently play a crucial role in the Malaysian economy (Goodluck and Joseph, 2024). It is typically propagated by seed through pre-nursery and field nursery procedures and it is the most important source of vegetable oil of all oil-bearing plants and have high yield

Oil palm exhibits the highest oil yield per unit area in comparison to other oil crops such as shea butter, rubber, sesames, coconut, groundnut, Jatropha, moringa oleifera, and castor oil. Additionally, it yields two distinct oils - palm kernel oil and palm oil. The oil palm tree yields timber, thatching materials for roofing, and brooms for use in homes and factories. One of the roots of the economic crisis in Nigeria is essentially disequilibrium in the country's external trade and payments as it has been noted that the oil palm subsectors' foreign exchange profits have decreased. The main commodity of the tree crop, palm oil, subsequently vanished from Nigeria's export list in 1977. (Ahaotu, 2023). According to the Central Bank of Nigeria (CBN), palm oil exports contributed significantly to Nigeria's non-oil export earnings in recent years (CBN, 2020).
Palm oil is a crucial ingredient in Nigerian cuisine and is used in various dishes. It plays a vital role in providing dietary calories and nutritional content. Red palm oil is widely used in traditional Nigerian soups, stews, and sauces, making it an essential component

of local diets. Oil palm cultivation allows for agricultural diversification, reducing the state's reliance on a single crop for food and income. Oil palm has cultural implication in many ethnic communities in Nigeria. It is often used in cultural and religious ceremonies. In some communities, palm fronds and oil are used in traditional rituals and celebrations. Oil palm planting and processing serve as a vital source of income and sustenance for communities in Nigeria. Sustainable oil palm cultivation practices are gaining importance in Nigeria to mitigate environmental impacts, such as deforestation and biodiversity loss. Initiatives promoting sustainable and certified palm oil production are being implemented to balance economic benefits with environmental conservation (Omobowale, and Adebayo, 2012).

2. Objectives of the Study

i. Examine the current status of oil palm production in Nigeria.
ii. Define and analyze value addition dynamics in oil palm production
iii. Highlight the importance of value addition:
iv. Identify value addition dynamics in the oil palm sector

3. Current Status of Oil Palm Production in Nigeria

Nigeria has historically been a prominent global producer of oil palm products, encompassing palm oil and palm kernel oil. It is frequently acknowledged as the primary oil palm producer in Africa. (Obahiagbon, Ogunniyi, and Udoh, 2019). Smallholder farmers play a significant role in oil palm cultivation in Nigeria, contributing a substantial portion of the country's production. These farmers often operate on family-owned or community lands (Okon *et al.,* 2017). While smallholder farming is predominant, there are also commercial oil palm plantations and agribusinesses operating in Nigeria. These plantations aim to improve production efficiency and promote value addition. Nigeria produces both palm oil and palm kernel oil for export and domestic consumption (Goodluck and Joseph, 2024)

The oil palm industry in Nigeria faces challenges related to sustainability, including deforestation, biodiversity loss, and environmental impacts. There is a growing emphasis on sustainable and environmentally friendly practices. (Oyinlola *et al.* 2019). The Nigerian government has implemented various initiatives to promote the oil palm sector, including interventions to support smallholder farmers, improve processing technology, and enhance value addition (Nwafor, 2019).

4. Value Addition of Oil Palm Production

The oil palm industry in Nigeria has long been a significant contributor to the state's economy. However, to maximize its potential, there is a growing need to focus on value addition in oil palm production. Value addition in oil palm production refers to the process of increasing the economic worth of oil palm products by improving their quality, shelf life, and marketability. Involves many processes, including processing, packaging, branding, and marketing, intended at providing higher-value products. (Akinyemi and Adepoju, 2018). Value addition in the oil palm sector is of paramount importance due to its multifaceted impact on the agricultural industry, the economy, and societal well-being. Value addition involves a series of activities, which can vary depending on the type of agricultural product and the intended market. These activities may include:

i. *Processing:* Transforming raw agricultural materials into processed products. For example, milling grains into flour, extracting oil from seeds, or drying and preserving fruits and vegetables.
ii. *Packaging:* Packaging agricultural products in an attractive and functional manner to protect them from spoilage, damage, and contamination during storage and transportation.
iii. *Branding:* Creating a unique identity for agricultural products through branding and labeling. This helps consumers recognize and trust the product and may command a premium price.
iv. *Marketing:* Promoting the product to reach a wider audience and increase its demand. Effective marketing strategies can include advertising, distribution, and market research.
v. *Quality Control:* Ensuring consistent quality and safety standards are met throughout the value chain, from production to the final product.
vi. *Diversification:* Developing new and innovative products or product variants to cater to different market segments and consumer preferences.
vii. *Market Access:* Expanding market access by complying with regulatory requirements, certifications, and standards, which can facilitate exports and access to international markets (Akinyemi, and Adepoju, 2018)

5. Importance of Value Addition

Value addition in oil palm production offers several importance (Oyinlola, 2019; Owutuamor, Iruo, and Ologidi (2019). They embrace:

i. *Economic Growth and Income Generation:* Value addition increases the economic worth of oil palm products, leading to higher market prices and increased income for farmers and stakeholders. This, in turn, stimulates economic growth and reduces poverty in oil palm-producing regions.
ii. *Market Diversification:* Value-added products diversify the market portfolio, reducing reliance on raw palm oil exports. This ensures more stable income streams for farmers and mitigates the impact of volatile global palm oil prices.
iii. *Job Creation:* Value addition requires additional labour in processing, packaging, and marketing, resulting in increased employment opportunities, especially in rural areas where oil palm cultivation is prevalent.
iv. *Food Security and Nutrition:* Value-added palm oil products, such as cooking oil, margarine, and soap, contribute to improved food security and nutrition by providing a range of affordable and essential products to consumers.
v. *Enhanced Export Potential:* Processed and branded oil palm products are more likely to meet international quality standards and certifications, enabling access to global markets and increasing foreign exchange earnings for the country.
vi. *Technology Adoption:* The pursuit of value addition drives the adoption of modern processing technology and techniques, leading to improved efficiency, productivity, and product quality.
vii. *Sustainable Practices:* Value addition can incentivize sustainable and environmentally friendly practices in oil palm cultivation and processing, reducing negative environmental impacts such as deforestation and biodiversity loss.
viii. *Brand Recognition and Trust:* Branded and value-added products create a distinct identity and reputation for Nigerian palm oil in the global market, enhancing consumer trust and preference.
ix. *Rural Development:* Value addition supports the development of rural communities by providing infrastructure, training, and access to markets, which contributes to overall rural development and empowerment.
x. *Innovation and Research:* The pursuit of value addition drives innovation and research in the oil palm sector, leading to breakthroughs in crop management, processing technology, and product development.
xi. *Value Chain Integration:* Value addition supports deeper integration along the oil palm value chain, from smallholder producers to processors and marketers, creating a more efficient and organized sector.
xii. *Product Diversification:* Through value addition, a vast range of oil palm-based products, including cosmetics, pharmaceuticals, and biofuels, can be generated, decreasing waste and maximizing the usefulness 6of the palm tree.

Value addition in the oil palm sector not only enhances economic returns but also contributes significantly to rural development, food security, and sustainable agricultural practices. It is a strategic approach that can lead to a more resilient and prosperous oil palm industry in Nigeria.

6. Dynamics of Value Addition

Value addition operations in agriculture, especially the oil palm sector, cover a range of activities targeted at enhancing the economic worth of agricultural products (Oyinlola, 2019; Owutuamor, Iruo, and Ologidi; 2019; NIFOR, 2021). These processes enhance product quality, marketability, and consumer appeal. Some key types of value addition dynamics include:

i. *Processing:*
Milling: Extracting oil from palm fruit bunches through mechanical processes, yielding crude palm oil (CPO) and palm kernel oil (PKO).
Refining: Further processing of CPO to remove impurities and enhance quality, resulting in refined, bleached, and deodorized (RBD) palm oil.
Fractionation: Separating palm oil into different fractions (olein and stearin) to create specialized products with varying melting points.
ii. *Packaging:* Proper packaging ensures product protection, hygiene, and convenience. Attractive and functional packaging enhances the product's appeal to consumers.
iii. *Branding and Marketing:*
Branding: Creating a unique and recognizable identity for palm oil products through branding, labeling, and logo design.
Marketing: Promoting the product through advertising, market research, distribution, and sales strategies to reach a wider audience and build consumer trust.
iv. *Quality Control:* Implementing quality control measures throughout the value chain to maintain consistent product quality and safety standards.
v. *Diversification:* Developing new products or product variants using palm oil as a base, such as palm oil-based cosmetics, biofuels, and pharmaceuticals.

vi. *Product Development:* Innovating and creating value-added products from palm oil, such as specialty oils, margarine, soaps, and detergents.
vii. *Market Access and Export Compliance:* Meeting regulatory requirements, certifications (e.g., RSPO - Roundtable on Sustainable Palm Oil), and international quality standards to access global markets and comply with sustainability norms.
viii. *Sustainable Practices:* Implementing sustainable and environmentally friendly practices in oil palm cultivation and processing, such as adhering to zero-deforestation commitments and biodiversity conservation.
ix. *Technology Adoption:* Embracing current processing technology, machinery, and equipment to improve efficiency and product quality.
x. *Research and Development:* Investing in research and development to advance crop management practices, develop new processing techniques, and create innovative palm oil-based products.
xi. *Market Linkages and Value Chain Integration:* integrating smallholder farmers, processors, and marketers to strengthen ties along the palm oil value chain to optimize distribution and production.
xii. *Infrastructure Development:* To lower post-harvest losses and improve product quality, investments should be made in cold chain infrastructure, storage, transportation, and processing facilities.
xiii. *Compliance and Certification:* Adhering to environmental, social, and sustainability certifications to meet consumer preferences and access premium markets.

7. Palm Oil Extraction Techniques

Palm oil extraction is a crucial step in the production of palm oil, and various techniques are employed to separate the oil from the palm fruit bunches (Owuamanam, Udom and Udo, 2015; NIFOR, 2021). The primary goal is to extract crude palm oil (CPO) and palm kernel oil (PKO). Some common palm oil extraction techniques include:

Traditional Methods: Manual Hand-Pressing: In traditional palm oil production, the harvested fruit bunches are boiled to loosen the fruit from the bunch. Then, the fruit is manually pressed to extract the oil. This method is labor-intensive and yields relatively low quantities of oil.

Mechanical Extraction Methods: Screw Press (Expeller Press): Mechanical screw presses are widely used for palm oil extraction. The fruit bunches are cooked, and the softened fruit is fed into a screw press. The press uses mechanical pressure to extract oil from the fruit. The resulting oil-water mixture is then separated using clarification techniques.

Hydraulic Press: Hydraulic presses use hydraulic pressure to extract oil from the fruit. The fruit pulp is placed in a hydraulic press, and pressure is applied to squeeze out the oil. This method is more efficient than manual pressing but less so than mechanical screw presses.

Solvent Extraction: Solvent extraction is used to obtain palm kernel oil (PKO) from the palm kernels. It involves soaking the kernels in a solvent, typically hexane, to dissolve the oil. The oil-solvent mixture is then separated, and the solvent is evaporated to leave behind the crude palm kernel oil.

Continuous Sterilization and Pressing: In modern palm oil mills, continuous sterilization and pressing is a common method. The fresh fruit bunches are sterilized using steam to loosen the fruit from the bunches. The sterilized fruit is then mechanically pressed to extract the oil. This method is more efficient than traditional methods and is widely used in large-scale palm oil mills.

Digestion and Pulp Pressing: In some palm oil mills, the fruit bunches undergo a digestion process after sterilization. During digestion, enzymes break down the cell walls of the fruit, making oil extraction easier. The digested fruit is then mechanically pressed to extract the oil.
Centrifugation: Centrifugation is used in the clarification step after oil extraction. It involves spinning the oil-water mixture in centrifuges to separate the oil from the water and other impurities. This process helps in obtaining clean crude palm oil.

Fractionation and Super Critical Fluid Extraction (SCFE): Palm oil can be fractionated to create various fractions, such as palm stearin and palm olein, each having unique characteristics. Usually, fractionation is accomplished by chilling the oil to cause some fractions to crystallize and separate. SCFE is an advanced extraction technique that uses supercritical carbon dioxide as a solvent to extract palm oil. This method is known for its ability to produce high-quality oil with minimal environmental impact.

8. Palm Kernel Oil Extraction

Palm kernel oil extraction is the process of obtaining oil from the palm kernels, the seed of the oil palm fruit. This oil is distinct from crude palm oil (CPO), which is extracted from the fleshy mesocarp of the fruit. Palm kernel oil (PKO) has various industrial and culinary applications and is an essential ingredient in the production of a wide range of consumer goods (Saw, 2019; Akinyemi and Adepoju, 2018; NIFOR, 2021). The main steps involved in palm kernel oil extraction are:

Harvesting and Collection: Palm kernels are collected from the oil palm fruit bunches after the fruits are processed for crude palm oil (CPO). The collected kernels are typically sun-dried to reduce moisture content.
Cleaning and Separation: It's possible that the gathered palm kernels include extraneous objects, stones, and sand. To get rid of these contaminants, they are cleansed. To further eliminate dirt and undesired particles, separation techniques including air separation and gravity separation are employed.

Cracking and Dehulling: The oil-rich kernel inside palm kernels must be accessed by removing the hard outer layer, or husk. Cracking machines are used to break the palm kernels and separate the inner kernel from the outer husk.

Cooking/Steaming: The cracked kernels are then subjected to cooking or steaming at high temperatures (usually around 85-90°C). This process softens the kernels and makes oil extraction more efficient.

Mechanical Extraction: After cooking, the softened palm kernels are fed into a mechanical press, often a screw press (expeller), to extract the oil. The mechanical press applies pressure to the kernels, squeezing out the oil.

Solvent Extraction (Optional): In some cases, especially in large-scale industrial settings, solvent extraction is used to obtain more oil from the palm kernels. Hexane is a common solvent used for this purpose. The solvent dissolves the oil, and the resulting mixture is then separated to recover the solvent and the extracted oil.
De-solventizing (Solvent Extraction): In the event that solvent extraction is used, any leftover solvent is eliminated by de-solventizing the extracted oil.
Filtering: Solids and contaminants may be present in the produced palm kernel oil. In order to achieve pure, clear palm kernel oil, it is usually run through filtering devices like plate and frame filters.

Refining (Optional): Depending on the intended use of the palm kernel oil, it may undergo further refining processes, such as degumming, bleaching, and deodorization, to improve its quality and remove any undesirable components.

Storage and Packaging: The final palm kernel oil is stored in clean, food-grade containers and may be further processed into various products or packaged for distribution and sale.

9. Palm Oil Refining and Quality Enhancement

Palm oil refining is a critical process that transforms crude palm oil (CPO) into a high-quality, marketable product suitable for various applications, including cooking, food processing, and industrial use. The refining process removes impurities, unwanted components, and contaminants while enhancing the quality and stability of palm oil (Bakar, Hashim, Alshammary and Alsaqqaf, 2021; NIFOR, 2021). The main steps involved in palm oil refining and quality enhancement are:

Degumming: The first step in palm oil refining is degumming, which aims to remove phospholipids and other gum-like substances from the oil. These impurities can cause oil quality issues and reduce its stability. Degumming is typically done by adding water to the oil and then centrifuging or settling to separate the gums from the oil.

Neutralization (Alkali Refining): In the neutralization process, the oil is treated with an alkali solution, usually sodium hydroxide (NaOH), to remove free fatty acids (FFAs) and other acidic impurities. The chemical reaction between the alkali and FFAs forms soap, which is separated from the oil. This step helps improve the oil's taste and color.

Bleaching: Bleaching is performed to remove pigments, residual impurities, and traces of undesirable compounds, such as oxidation products and contaminants. Activated clay or activated carbon is commonly used as adsorbents to absorb and remove these substances. The oil is heated and mixed with the adsorbent before being filtered to separate the adsorbent from the oil.

Deodorization: Deodorization is a crucial step to remove volatile compounds responsible for off-flavors and odors in the oil. Steam is passed through the oil under vacuum conditions to evaporate and carry away these undesirable compounds. Deodorization helps improve the oil's sensory properties, making it suitable for cooking and food processing.

Fractionation (Optional): Fractionation is employed to separate palm oil into various fractions with distinct melting points, such as palm olein (liquid) and palm stearin (solid). Fractionation can improve the oil's functionality and versatility in different applications, such as frying and margarine production.
Winterization (Optional): Winterization is a process used for palm olein to remove saturated triglycerides that can cause cloudiness or crystallization at lower temperatures. By cooling the oil and then removing the solid fractions, the resulting palm olein remains clear and liquid even at lower temperatures.

Quality Control and Testing: Throughout the refining process, the oil is subjected to quality control tests to ensure that it meets established standards for color, odor, taste, and other sensory attributes. Quality control measures also verify compliance with regulatory and industry standards.

Packaging and Distribution: After refining and quality testing, the final palm oil is packaged in clean, food-grade containers and distributed to consumers, food manufacturers, and industrial users.

Palm Oil-Based Products
Palm oil-based products are widely used in various industries, including the food, cosmetics, pharmaceutical, and industrial sectors. Palm oil and its derivatives are valued for their versatility, stability, and affordability. However, the production and use of palm oil have raised environmental and sustainability concerns, leading to efforts to promote sustainable palm oil production and the responsible sourcing of palm oil-based products (Echendu, Chukwu, Okafor and Okafor, 2013; NIFOR, 2021; Nnamonu, (2018). Some common palm oil-based products are:
Cooking Oil: Palm oil is one of the most commonly used cooking oils worldwide. It is favored for its high smoke point and stability at high temperatures, making it suitable for frying and deep-frying applications.

Bakery and Confectionery Products: Palm oil and its fractions, such as palm olein and palm stearin, are used in the production of baked goods, pastries, chocolates, and confectionery items. They contribute to texture, shelf life extension, and a smooth mouth-feel.

Margarine and Shortening: Palm oil and its derivatives are key ingredients in the manufacturing of margarine and shortening products, providing a solid fat base for spreads and baking.

Processed Foods: Many processed foods, including snacks, instant noodles, and ready-made meals, contain palm oil or its derivatives as ingredients for their texture, flavor stability, and shelf life.

Cosmetics and Personal Care Products: Palm oil and its derivatives are used in a wide range of cosmetic and personal care items, such as soaps, shampoos, lotions, lipsticks, and moisturizers. They serve as emollients, thickeners, and stabilizers.

Detergents and Cleaning Products: Some cleaning products, including laundry detergents and household cleaners, contain palm oil derivatives, particularly as surfactants and emulsifiers.

Pharmaceuticals: Palm oil-based derivatives are used in pharmaceutical formulations, such as capsules and topical ointments, to enhance drug delivery and stability.
Candles: Palm stearin, a solid fraction of palm oil, is utilized in the production of candles due to its ability to hold fragrance and maintain a stable structure.

Biofuels: Palm oil can be converted into biodiesel, a renewable and environmentally friendly alternative to fossil fuels.

Animal Feed: As a byproduct of the extraction of palm kernel oil, palm kernel expeller is utilized in animal feed formulations as a source of energy and protein.

Industrial Applications: Palm oil and its derivatives are utilized in diverse industrial applications, including lubricants, bio-based polymers, and oleochemicals.

Palm Kernel-Based Products
Palm kernel-based products are derived from the kernels of oil palm fruit. These products have a wide range of applications in various industries, including agriculture, food, energy, and industrial sectors (Echendu, Chukwu, Okafor and Okafor, 2013; NIFOR, 2021). Some common palm kernel-based products:

Palm Kernel Oil (PKO): Palm kernel oil is extracted from the palm kernels, as opposed to palm oil, which is extracted from the mesocarp of the fruit. PKO is used in the production of detergents, soaps, and cosmetics as well as in the preparing and cooking of food.

Palm Kernel Cake (PKC): After the oil extraction process, the remaining palm kernel meal is known as palm kernel cake. PKC is a valuable ingredient in animal feed formulations due to its protein and energy content. It is used in livestock and poultry feed.

Palm Kernel Expeller (PKE): Palm kernel expeller is a co-product of palm kernel oil extraction. It contains residual oil and is also used in animal feed production as a source of protein and energy.

Biofuels: Palm kernel oil can be used as a feedstock for the production of biodiesel. Biodiesel made from palm kernel oil is considered a renewable and environmentally friendly alternative to fossil fuels.

Palm Kernel Shell (PKS): Palm kernel shells are the hard-outer shells of palm kernels. They have high calorific value and are used as biomass fuel for power generation and industrial boilers. PKS is considered a renewable energy source.

Activated Carbon: Palm kernel shells can be converted into activated carbon, which is used in various applications, including water purification, air filtration, and the production of activated carbon filters.

Palm Kernel-based Oleochemicals: Palm kernel oil and its derivatives are used in the production of oleochemicals, which are chemicals derived from natural oils and fats. Oleochemicals are used in the manufacture of soaps, detergents, cosmetics, and industrial products.
Cattle Feed: Palm kernel cake and palm kernel expeller are valuable components in cattle feed formulations. They provide essential nutrients and energy for livestock.

Palm Kernel-based Cosmetics and Personal Care Products: Palm kernel oil and its derivatives are used in cosmetics and personal care items, such as soaps, shampoos, lotions, and creams.

Palm Kernel-based Pharmaceuticals: Palm kernel oil is used in pharmaceutical formulations, including capsules and topical creams.

Industrial Applications: Palm kernel oil and its derivatives are used in various industrial applications, including lubricants, coatings, and the production of bio-based plastics.

10. Empirical Studies

Some empirical studies are necessary for this paper. Aina *et al*. (2021) explore the Nigerian Ondo State palm oil value chain. Its main goals include an in-depth analysis of the actions taken by each player in the palm oil value chain, a careful evaluation of the value addition that takes place at each stage of the chain, an assessment of the cost and profitability factors throughout the palm oil value chain, and the naming of the difficulties faced by its stakeholders. A multistage sampling approach was used in the research methodology to choose 96 respondents from two local government areas in the state. Structured surveys made it easier to collect data, and the gross margin approach was used to analyze it. The results of the gross margin analysis showed how profitable and viable the palm oil industry was in the study area. With a gross ratio of 0.85, a monthly gross margin of 171,000 and net returns of 117,000 were established. Furthermore, the profit margin for marketers of palm oil was 138,000 with a gross ratio of 0.89. Nevertheless, some challenges were faced during processing operations, with a prominent problem being a lack of water supply. Conversely, palm oil marketers voiced their concerns about the outrageous transportation costs and erratic palm oil supplies. It is advised that government action take the form of supplying the palm oil mills with reachable and potable water and enhancing the palm oil industry's road network in order to address these issues in processing areas. These steps can help the palm oil value chain in Ondo State continue to grow and succeed, promoting the participants' economic advancement and bettering their standard of living.

According to Owutuamor et al. (2019), oil palm processing and value addition challenges were explored in the Anyama District of the Ogbia local government area, Bayelsa State, Nigeria. These challenges included socioeconomic factors, value chain processors, cost and returns, and issues. Six communities and ten palm fruit farmers, respectively, were chosen for the study using a purposeful and random sampling strategy. Using percentages, the mean, and cost and return analysis, the primary data obtained through the use of questionnaires was evaluated. The bulk of the respondents were married men between the ages of 41 and 50 who had some type of schooling, lived with 1-4 other people, and had 20 to 25 years of experience in the field, according to the results. Additionally, it was discovered that the value-added processing of palm fruit to storage is profitable, yielding N1.40 returns for every Naira (N1.00) invested in products made from fruits and nuts, such as palm oil and palm kernel oil, respectively. The amounts of profits were

impacted by restrictions such high shipping costs, theft, a lack of storage facilities, and unfavorable weather. Therefore, it is advised that the State Government and government-affiliated entities build more motorable roads or update the ones that already exist and provide storage facilities to palm oil growers at reduced costs.

According to Sarku and Appiah (2017), the study evaluated the financial viability of value addition in agricultural production, particularly the earnings and jobs created by adding value to palm fruits in the Ghanaian oil palm business in the Kwaebibirem District. An interview schedule and a sample of 40 respondents provided the source of the study's data. The data was analyzed using descriptive statistics, including percentages, mean scores, and frequency distributions. Respondents stated that they process the palm fruits to produce fermented palm oil, fermented palm kernel, sludge, fiber, and palm oil. One drum of 259.88 litres of palm oil is produced from one tonne of palm fruits, which is the principal benefit of adding value to palm fruits. From the sale of 1 drum of palm oil, processors made an average of GH242.555. Employment opportunities and positive ripple effects on the local economy are among the benefits of adding value to palm fruits. The money earned from processing palm fruits to increase their value was used to meet the demands of the household in terms of health, education, and other socio-cultural requirements. According to the report, standard measuring tools should be provided to help farmer-processors benefit from their operations.

With a random selection of sixty (60) male and sixty (60) female palm oil processors, Agwu *et al.* (2017) examined gender differences in profits among oil palm processors in Abia state, Nigeria. According to the results of the cost and return analysis, processing palm oil was very profitable in the study region, with male processors earning more money (92,842,000) than female processors (47,590,570). At a one percent probability level, the findings indicated that there was a substantial difference in profit between male and female processors. The study also discovered that factors like processing methods and revenue, as well as fixed and variable costs, are affected on the profitability of male and female processors. In order to increase efficiency in processing and other related operations, the study indicated that women should be provided with the appropriate support and those barriers that generate uneven opportunities for men and women should be removed.

11. Conclusion

Value addition in oil palm production is essential for the sustainable growth of the oil palm industry in Nigeria. It offers economic benefits, enhances market access, and contributes to food security.
The choice of palm oil extraction technique depends on various factors, including the scale of production, available resources, and desired oil quality. Modern palm oil mills often employ a combination of mechanical and automated processes to achieve efficient and high-quality oil extraction. Additionally, sustainability and environmental considerations are becoming increasingly important in the selection of extraction techniques in the palm oil industry. It's important to note that palm kernel oil extraction can be carried out using various scales of equipment, from small-scale manual operations to large industrial processing plants. The choice of extraction method depends on factors such as production capacity, available resources, and product quality requirements.

The value addition dynamics include: processing, milling, refining, fractionation packaging, branding and marketing, branding, marketing, quality control, diversification, product development, market access, export compliance, sustainable practices among others.
The palm oil-based products that contribute to economic growth are cooking oil, bakery and confectionery products, margarine and shortening, processed foods, cosmetics and personal care products, detergents and cleaning products, pharmaceuticals, candles, biofuels, animal feed and industrial applications. While, the palm kernel-based products are palm kernel oil, palm kernel cake, palm kernel expeller, biofuels, palm kernel shell, activated carbon, palm kernel-based oleochemicals, cattle feed, palm kernel-based cosmetics and personal care products and palm kernel-based pharmaceuticals. The value addition dynamics in oil palm production is essential and offers economic benefits, enhances market access, contributes to food security and sustainable growth of the oil palm industry in Nigeria

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