Stimulating Real Sector Output through Research and Development: The Nigerian Institute for Oil Palm Research (NIFOR) Experience

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I. Introduction

The real sector encompassing agriculture, manufacturing, mining and oil and gas, has always been the major engine of growth of the Nigerian economy contributing significantly to employment, wealth creation and the nation's income. It is well known that before the 1970s when petroleum became the major revenue earner in Nigeria, agriculture and other sectors of the real economy provided the bulk of employment and national income in the country. The growth of the real sector over time has been driven by government policy stimulus and to some extent, by research and development support, as in the case of some agricultural commodities such as oil palm, cocoa and groundnut.

Given a fast growing population (estimated growth rate of about 3.2 per cent, CBN, 2009), the imperative for the country to create job opportunities and meet some of her food and industrial raw materials needs cannot be over-emphasized. In Nigeria, agricultural production has remained in the hands of small farmers and producers, and the nation's population has continued to be fed, clothed and provided income through activities around the sector. This underlies the importance of the sector in the nation's economy.

The major issues limiting agricultural productivity in Nigeria include low yields, due to the use of low technology inputs, poor yielding seeds and livestock, lack of or poor adoption of improved production technologies, poor infrastructure, poor access to finance and poor marketing structures. Thus, to raise productivity and stimulate the sector, these problems need to be mitigated through adequate research and provision of technologies which would lead to competitive production.

The crops for which the Nigerian Institute for Oil Palm Research has the national mandate to provide research support are oil palm, coconut, raphia palm, date palm and recently Shea. For the purpose of this paper, discussions will focus mainly on the oil palm.

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II. The Oil Palm and the Real Sector in Nigeria

The oil palm is indigenous to Nigeria and has consequently been exploited in its natural groves and homesteads in the country from time-immemorial. Fossil and linguistic evidence as well as genetic diversity strongly support contention that the crop is native to West Africa. Being the centre of origin, the oil palm has been a significant part of the economy and social life of the people of Nigeria and West Africa. It is an intricate part of the economy and life of the people of Southern Nigeria, especially in the Southeast as well as the Middle Belt of Nigeria. As a source of edible oil, it is very important to the people of Nigeria, contributing to food security, health and well-being of the citizens.

Palm oil and palm kernel were among the earliest commodities of legitimate trade after the inglorious slave trade between Nigeria and Europe. There are accounts of trading in palm oil between the people of Nigeria and merchants from Europe as early as the 15th century and, by the 19th century the international trade in palm oil had assumed great importance such that by 1830, the trade was 12,000 tonnes rising to 30,000 tonnes in the 1860s and 87,000 tonnes in 1911. In the case of palm kernels, exports were reported to have started in 1832. Palm kernel exports in 1905 was 157,000 tonnes and by 1911 it was 232,000 tonnes (Usoro, 1974; Omoti, 2009).

Although there were production and exports from some other African countries including the Congo, Cote d' Ivoire and countries of South-East Asia namely, Indonesia and Malaysia at the turn of the 20th century, Nigeria dominated the industry in terms of production and exports up to the 1960s. Nigeria's production during the late fifties and early sixties accounted for about 39.0 per cent and 40.0 per cent of world production of palm oil and palm kernel, respectively, while the export values were about 33.0 per cent and 57.0 per cent, respectively (Usoro, 1974; Omoti, 2009). All of the production at the time came mainly from the natural and semi-natural groves and from about 10,073 hectares established plantations and 4,674 hectares of small holder plantings in the country (Omoti, 2009).

The exports of palm oil and palm kernel from Nigeria in recent years, have dwindled significantly due to a number of factors including increased domestic consumption as a result of population growth, slow pace of growth of new plantings and declining exploitation, area and productivity of the groves, (Hartley, 1988; Udom 1986; Omoti, 2009).

III. Current Global Situation of the Oil Palm

The industry, which has stagnated in terms of growth and declined phenomenally in value and contribution to the GDP of Nigeria and other African producing nations since the 1970s has, however, continued to grow substantially in South East Asia.

Table 1: World production of some vegetable oils 2000 – 2008 ('000 tonnes)

Oils	2000	2001	2002	2003	2004	2005	2006	2007	2008
Palm Oil	21,867	23,984	25,409	28,259	30,987	33,846	37,142	38,674	43,118
Palm Kernel Oil	2,698	2,947	3,044	3,347	3,581	3,978	4,344	4,496	4,989
Soya bean oil	25,563	27,828	29,850	31,241	30,729	33,612	35,278	37,354	37,164
Cottonseed oil	3,850	4,052	4,221	3,987	4,367	4,978	4,903	5,043	5,029
Groundnut oil	4,539	5,141	5,178	4,508	4,706	4,506	4,382	4,194	4,445
Sunflower oil	9,745	8,200	7,610	8,917	9,423	9,785	11,191	10,843	10,687
Rapeseed oil	14,502	13,730	13,343	12,698	15,088	16,294	18,510	18,746	19,847
Corn oil	1,966	1,962	2,016	2,017	2,025	2,133	2,264	2,319	2,408
Coconut oil	3,261	3,499	3,098	3,270	3,040	3,237	3,083	3,114	3,130
Olive oil	2,540	2,761	2,773	2,904	3,110	2,965	2,798	3,020	3,081
Castor Oil	497	515	438	425	500	540	535	524	603
Sesame oil	705	747	807	810	831	868	860	831	803
Linseed oil	705	648	581	594	635	626	695	693	643

Source: Adapted from MPOB Statistics (2009)

The enterprise of oil palm is carried on at all levels from the homestead to large complex industrial scale. Arising from the versatility of the use of palm oil and the growing global demand for oils and fats and recently, biofuels, the oil palm industry has witnessed phenomenal growth in the last fifty years. With a global value of output estimated at about US$45 billion as at 2008 (Omoti, 2009), the crop has arguably brought economic prosperity to the rural areas, where there would have otherwise been no major economic activity to benefit the generality of the people. Resulting from the substantial expansion of the industry in Indonesia

since the mid-1990s, palm oil has since 2004 overtaken soybean as the leading vegetable oil in terms of total output and trade (Table 1). The Oil World Annual Statistics and those of MPOB show that the global production of palm oil doubled in a decade from 20.625 million tonnes in 1999 to 43.118 million tonnes in 2008 (Table 1). During the same period, annual production in Indonesia tripled from 6.25 million tonnes in 1999 to 19.3 million tonnes in 2008, thus consolidating the dominance of Asia in global output (Table 2).

Table 2: Major producers of palm oil 1999-2008 ('000 tonnes)

Country	1999	2002	Mean Annual Growth per cent 1999 - 2002	2005	Mean Annual Growth per cent 2002 - 2005	2008	Average Annual per cent change 1999 - 2008
Indonesia	6,250	19,370	16.6	14,100	16.5	19,330	23.3
Malaysia	10,554	11,909	4.3	14,962	8.5	17,734	7.6
Thailand	560	600	2.4	700	5.6	1,170	12.1
Nigeria	720	775	2.6	800	1.1	860	2.2
Colombia	500	528	1.9	661	8.4	800	6.7
Ecuador	263	238	-3.2	319	11.3	415	6.4
Papua New Guinea	264	329	8.2	310	1.9	400	5.7
Cote d'Ivoire	264	205	-7.5	320	18.7	330	2.7
Others	1,250	1,455	5.5	1,674	5	2,079	7.4
Total	20,625	25,409	6.3	33,846	11.1	43,118	12.1

Source: Adapted from MPOB Statistics (2009)

Some of the reasons adduced for the stagnation or slow growth of the industry in Africa including Nigeria, are political instability and conflicts in some of the producing countries, weak and uncompetitive production systems, inadequate and inefficient processing equipment, lack of access to financing and credit for new developments in the sector, little innovation among majority of players in the industry and low rates of replacement of old plantings and dwindling productivity (Kajisa, et al, 1997; Jannot, 2003; Omoti 2004).

Unlike in South-East Asia, where the developments in the industry were driven by large scale industrial plantations with active and significant private sector participation, the development of plantations of oil palm in Nigeria has largely

been the result of various government policies and programmes co-funded or funded by multilateral agencies including the World Bank, European Union, FAO, UNDP and others (Omoti, 2009). The role of the private sector in large scale industrial plantations systems in the country has been very minimal. The lack of internal financing instruments, the withdrawal of the World Bank and other multilateral agencies from tree crop funding in Nigeria during the 1990s, the withdrawal of the Government (State and Federal) from the commodity chains and the long time (often several years) it took to implement the privatization of the State-owned companies, the lack of substantial new investments, all exacerbated the decline and stagnation of the industry in Nigeria and much of Africa (Jannot, 2003; Omoti, 2009). Growing global demand for green energy and for oils and fats, coupled with internal demands, the quest for economic growth, rural development and poverty alleviation provide opportunities for new investments and enhanced growth of the sector in Nigeria.

IV. How has Research and Development (R&D) of NIFOR Stimulated the Real Sector?

The world trade in palm oil at the turn of the 20th century and up to the Second World War, was dominated by countries of British West Africa (largely Nigeria), the Belgian Congo (later Zaire and now the Democratic Republic of Congo), and the Far-East Asia notably the Netherlands' East Indies, (Sumatra and Java) now Indonesia. At the beginning of this period, exports from the British West African Countries accounted for about two-third of the world palm oil trade. However, as a result of increased production and exports from the Netherlands' East Indies, which had at the outset adopted plantation development of oil palm on a large scale, exports from Africa began to face stiff competition. This development influenced the then colonial government of British West Africa to put in place policies and strategies to improve oil palm production and palm oil output in British West Africa (NIFOR, 2005).

At that time, the decline in palm oil exports from Nigeria was adduced to poor quality of oil produced, the absence of plantation development on any substantial scale and the use of inefficient methods. Given the contribution of palm oil and palm kernels export earnings to the national economy, it was thought that Nigeria's economy would be negatively impacted unless production methods in the country were improved upon through research. Indeed, those concerns are still valid today. Arising from the various agricultural conferences in West Africa between 1927 – 1930, was the recommendation that research should be undertaken by local Departments of Agriculture with a view to improving the oil palm industry in the various territories. This recommendation

led to the establishment of the Oil Palm Research Station (OPRS) in 1939, which later metamorphosed into the Nigerian Institute for Oil Palm Research (NIFOR). Research at NIFOR is driven by:

- the needs of the industry and the national policy on agriculture
- the need to advance knowledge that enhances sustainable production of its mandate crops.
- need for improvement on the genetic potentials of the mandate crops of the Institute
- strategic research priorities seeking innovative ways of overcoming the many technical constraints to production
- need for value-addition to products of these crops
- significant cognizance of the production systems with the smallholder operator in focus.
- principles and criteria of the Roundtable on Sustainable Palm Oil (RSPO)
- emerging issues, e.g. climate change

Innovation is a key element in the sustainability of any industry. It is carried out through generation of processes and services that are nurtured by competitive production leading to high-value products. Innovation is driven and reinforced by research and development. Globally, palm oil business is today a multi-billion dollar industry. The industry worldwide, has benefitted immensely from the outcomes of research and development activities and technological advances through improvements in fresh fruit bunch and oil yields per unit area, reduced inputs, leading to and maximization of oil production from a smaller land area than would otherwise have been (Basiron, 2007).

As an outcome of research and development in major oil palm research centres and laboratories, palm oil is now a major source of sustainable and renewable raw material for the world's food industry (with palm oil being an ingredient in one of every ten food products), oleochemical and biofuel industries. Research and development strategies, coupled with the right policy mix, have greatly impacted and driven the industry through the application of good and appropriate science and technology (Basiron, 2007). The phenomenal growth of the global area under the crop during the last fifty years and output from 1.5 million tonnes in 1961 to about 40 million tonnes in 2009 has largely been facilitated by outcomes of research and development. The industry has also grown from its simple upstream scale of plantations to downstream production including refineries, oleochemical and bio-diesel plants, spawning other service industries such as mill fabrication and manufacturing and ancillary services and

providing employment for arrays of personnel ranging from the simple plantation labour, to world class engineers and scientists.

IV.1 Oil Palm Genetic Improvement

As noted by Hartley (1988), Corley and Tinker (2003), Basiron (2007), progress in breeding to enhance yields has greatly contributed to the viability of oil palm cultivation and ensured that it continues to improve, and such progress has stimulated expansion of cultivation.

According to the genetic principle of fruit character inheritance of the oil palm that was earlier elucidated by Beirnaert and Vanderweyen (1941), oil palm cultivation depended mainly on the *dura* fruit form, which was less productive of palm oil than the *tenera* variety. Since the Beirnaert and Vanderweyen's theory of inheritance of fruit character of the oil palm, various studies in major oil palm research centres have been undertaken to produce high yielding oil palm hybrid varieties with high oil yield, high oil extraction rates (OER) and high iodine value. The outcome of research at the NIFOR (e.g. Broekmans, 1957a, 1957b; Hartley, 1957; Blaak, et al. 1963; Sparnaaij, et al. 1963) have greatly contributed to procedures adopted worldwide for oil palm genetic improvement.

Research work at the NIFOR led to the demonstration of the value of *dura* x *pisifera* cross, which give a progeny, consisting exclusively of the desired *tenera* (thin-shelled) hybrid variety, which has since become the variety of choice in commercial cultivation of the crop. This has become the basis of controlled pollination and production of hybrid *tenera* oil palm seeds all over the world. The outcome of early research efforts at the NIFOR in the search for high yielding oil palm, was the release of the D x P *tenera* hybrid Extension Work Seed (EWS) by NIFOR in the 1950s, whose yield was more than five-folds that of the unimproved grove palms. This became the basis of the present breeding programmes initiated about 1957 – 1959 following the modified reciprocal recurrent selection method.

NIFOR's breeding programme overtime has significantly improved the fresh fruit bunch and oil yield of the oil palm (Okwuagwu, et al. 2005) as shown in Table 3. Even though the crop is indigenous to West Africa, but because of less the favourable climatic conditions of drought periods, higher soil moisture deficits and lower sunshine hours, especially during the rainy seasons in West Africa, yields are generally higher in South East Asia. Therefore, continuous efforts are being undertaken to improve the yield through breeding to overcome the climatic limitations to achieving genetic yield potentials of the crop. Within the climatic

limitations of Nigeria, NIFOR's breeding programme has led to the development of high yielding, early maturing, disease resistant/*Fusarium* tolerant hybrid oil palm variety (the *tenera* hybrid) which yields 15 - 25 tonnes fresh fruit bunch (FFB) and 3-5 tonnes of palm oil as against 3 - 5 tonnes FFB or 0.5 tonnes palm oil per hectare of unimproved palms in the natural groves, representing five-fold increase. These materials also come into fruiting two and half years after planting as against seven years for the unimproved palms. Some estates in Nigeria already record yields of 19 – 25 tonnes per hectare in mature plantings of these materials. From selections among materials in the second breeding cycle, superior materials yielding 20-25 tonnes FFB per hectare per year under the soil moisture deficit and low sunshine hours limiting regimes of the oil palm belt of Nigeria have been identified (Okwuagwu, et al. 2005) and have been introduced into the seed gardens from which planting materials are produced for farmers.

Breeding the oil palm for resistance to the devastating *Fusarium* wilt disease has been high on NIFOR's research agenda (Okwuagwu, *et al*. 2005). Arising from the breeding programmes and the procedures for screening materials against the devastating *Fusarium* wilt, it has become possible to undertake re-planting of oil palm in locations where high infestation of the disease would otherwise have occurred (Cochard, *et al.* 2005). Cochard, *et al.* (2005) noted that as a result of breeding for resistance to *Fusarium* wilt, it has become possible to grow and sustain the oil palm in several locations in West Africa where the disease is a problem.

Large-scale germination of the oil palm seed used to be difficult and unpredictable, until research at NIFOR elucidated techniques for breaking the natural dormancy of oil palm seeds. This has led to development of techniques for large-scale seed production, which ensures early, uniform and high percentage (up to 90.0 per cent) germination. Globally, elite *tenera* hybrid seeds and seedlings of oil palm are now produced in large quantities using this technique for distribution to farmers. NIFOR produces over 8 million sprouted seeds annually and supplied about 26 million sprouted improved oil palm seeds to farmers in Nigeria between 1999 and 2008, based on demand.

Table 3: Quality Attributes of Oil Palm Planting Materials and Performance of Improved Materials in Farmers Fields under Improved Management Practices

Attributes	Un-improved Farmers Materials	NIFOR tenera hybrid	Performance of the NIFOR tenera under Farmers Field
Maturity/time of first fruiting (years)	5 - 7	$2^1/_2$	$2^1/_2$
Yield (FFB) tonnes ha^{-1} $year^{-1}$	3 – 5	15 - 25	15 – 25
Oil yield tonnes ha^{-1}	0.5	3 - 3.5	3 – 3.5
Fusarium wilt resistance	No	Yes	Yes

Source: NIFOR

IV.2 Crop Management Practices

Other than breeding for high and improved yields, NIFOR's research efforts have provided agronomic packages, which assure sustained and optimum productivity of oil palm, at all stages of its life cycle, and environmental protection and sustainability. In general, the agronomic, soil fertility management and crop protection practices adopted in the cultivation of oil palm in Nigeria and elsewhere, are based on recommendations from the output of research in NIFOR. This has guaranteed good and sustainable yields under the limitations of the climatic and soil conditions of Nigeria.

IV.3 Small and Medium Scale Processing

The oil palm enterprise in Nigeria is widely carried on by homestead and small producers who contribute over 80.0 per cent of national palm oil and palm kernel output. The processing techniques adopted by this group of producers are very inefficient, resulting in 20 – 50 per cent losses of potential palm oil production. Therefore, the adoption of improved processing techniques can dramatically impact on national palm oil output. In recognition of the dominance of this group of producers, improving the methods of palm oil production at the small and medium scale has been high on the research agenda at NIFOR. Research output in this direction, which began since 1959, when the Stork Hydraulic and Press was first developed and tested at the then WAIFOR (now NIFOR) and incorporated into the Pioneer Mills, has deepened, as NIFOR has over the time developed appropriate and efficient small-scale milling equipment. Arising from the efforts of the ground work of the collaboration that began in 1974 with the United Nations Development Progarmme (UNDP), the Institute designed and fabricated an integrated small-scale processing equipment (SSPE) comprising

(i) Sterilizer/cooker
(ii) Rotary stripper
(iii) Horizontal digester
(iv) Hydraulic hand press and
(v) Clarifier

Consolidating on this groundwork, further research in the Institute has led to improvements to the equipment and the hydraulic hand press has been replaced with a digester screw press. The SSPE is now available in three categories ranging in capacity from 0.5 to 1.5 tonnes FFB per hour. The Institute has also designed and fabricates palm kernel recovery units.

IV.4 Other Technologies Developed and Promoted

Various technologies to address aspects of value-addition and utilization of the enormous biomass resulting from oil palm production and palm oil processing, have been developed and promoted by the Institute. While these technologies have in no small measure enhanced the productivity and profitability of the sector, their adoption rates have, however, been low (Table 4). This is largely attributed to the weak nature of the dominant small scale production system of the oil palm industry in Nigeria, the weak extension linkages and inadequate access to investment funds.

Table 4: Some Technologies Developed and Promoted by NIFOR

Technology	Incremental value	Adoption	Challenges
NIFOR SSPE	Improved extraction of palm oil, 18.0 per cent extraction against 10.0 per cent by traditional methods, lower FFA, higher palm oil quality, reduced drudgery	Widely copied. NIFOR fabricated SSPE contributed 20.0 per cent to total national milling capacity in 10 years in a 2005 survey	Weak extension linkages, cost of SSPE, cost of inputs, ethics of local fabricators
Kernel recovery units	Higher kernel recovery	Low	Weak extension linkages, cost.
Banga sauce	Commercial canned product, higher income, preservation, longer shelf life	Low	Weak extension linkages and high initial investment cost. Need to scale down scope of technology
Bottled palm sap (palm wine)	100per cent product integrity, prolonged shelf life of palm sap, added value	Low	Weak extension linkages and high initial investment cost
Bio-diesel from palm and palm kernel oil	High, green energy	Low	High investment cost, competition from edible and other industrial uses of palm oil
Briquette from wastes (Fuel)	Higher income, waste utilization, environmental sanitation	Low	Weak extension linkages, cost
Utilization of POME for livestock feed	Higher income, waste utilization, environmental sanitation, alternative source of energy in livestock feed	Low	Weak extension linkages, cost. Competition from other sources of livestock feeds
Composting of empty bunch refuse for organic fertilizer	Higher income, waste utilization, environmental sanitation	Low	Weak extension linkages

Source: NIFOR

V. Roundtable on Sustainable Palm Oil (RSPO) and Stimulating Oil Palm Sector in Nigeria

There has been growing global environmental concerns and negative campaigns about the environmental implications of continued expansion of the oil palm industry. Some of these campaigns, genuine as they may sometime seem, are largely driven by competitors producing other oils and are sometimes overhyped. In response to these concerns and campaigns, the RSPO seeks to promote the growth and use of sustainable palm oil through cooperation and stakeholders in the oil palm production and supply-value chain (RSPO, 2007). The RSPO is a global, multi-stakeholder initiative on sustainable palm oil. Members of RSPO and participants in its activities are drawn from different backgrounds, including plantation companies, manufacturers and retailers of palm oil products, environmental NGOs and social NGOs and from many countries that produce or use palm oil (RSPO, 2007). Recognizing that sustainable palm oil production can only be achieved within the framework of legal, economically viable, environmentally appropriate and socially beneficial management and operations, the RSPO has defined a set of principles and criteria for sustainable palm oil production. Some of these issues have before the institution of the RSPO, driven and will drive the direction of research at NIFOR.

VI. The Future

Palm oil will remain a leading vegetable oil in the world, as its versatility of use becomes unfolded with evolving knowledge, science and technology. With increasing population, demand for bio-diesel and other uses, global demand for palm oil will continue to increase in the face of increasing land shortages in South East Asia which presently account for about 90.0 per cent of global palm oil production and export. Increasing environmental campaign pressures including global issues of High Conservation Value Forests (HCVF) and land shortages could change the course of expansion of plantings in South East Asia. These issues mean that Africa and Nigeria, in particular, will inevitably become the hub for new developments of the industry to meet rising global demands for palm and palm kernel oil.

Challenging as these opportunities seem for expansion of production of the crop in Nigeria, future growth of the oil palm industry in the country, based on industrial estate models, could be hampered with the present land tenure system. Therefore, future growth will be based on improvement and integration of small holder production systems with the large scale industrial model. Currently, the productivity of the small-scale production system falls far short of the global benchmarks. Consequently, improvement on the current low productivity of the

small-scale producers can in the short-term significantly improve the national palm and palm kernel output and supply. In the long run, to be locally and globally competitive, producers must deploy cutting edge technologies starting from using improved planting materials. The sector will require some regulation in its operation including sourcing planting materials, production and marketing in order to ensure that producers adopt competitive and global best practices.

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