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Improving Nigeria's Economy through Diversification into Agricultural Enhancement

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ABSTRACT

Nigeria's agriculture requires a very strong boost because of increasing population and decreasing land resources due to environmental factors. This paper discussed the dynamics of agriculture and the important role of engineering and technology in providing the needed boost. The national agricultural policies and their impact on Nigeria's agriculture were highlighted emphasizing the previous and present roles of various organs of the government. After discussing the assets and liabilities of Nigeria's agriculture, the paper posits that the agricultural environment must be properly managed for sustainable agricultural productivity in view of emerging information technology. The future expectations and challenges facing the Nigerian agricultural engineers, agriculturists, scientists and environmentalists were also highlighted.

Keywords: Agriculture, Engineering, Technology, Policies, Sustainability, Productivity.

INTRODUCTION

While agriculture is the practice of cultivating the soil and raising livestock to produce plant and animals useful to humans and in some instances animals, agricultural inputs relate to those vital elements to be used to make agriculture both possible and profitable. These inputs are resources required to cultivate the land, produce crops including forestry, livestock including fishery, process, and store and distribute them. Agricultural inputs must therefore include diverse elements such as land, capital and labor as well as research, education, communication/information, and engineering/technology. All these inputs and many more constitute agricultural mechanization which must be harnessed, controlled and organized for improved agricultural practice. For mechanization management to succeed, some other inputs upon

which it will strive must be available. These include good and focused political manner of governance capable of formulating and implementing policies and laws that can accelerate the process of economic growth and development.

Mechanization management should address the challenges facing the future of food demand and supply as enunciated by Raoult Wack and Bricas (2001). The agricultural system practiced in Nigeria needs to exit from excessive reliance on fickle weather conditions (rain-fed) for year-round (irrigated) production of raw materials in the right quality and quantity at the right time for agro industrial development. There is the need to increase the research and development efforts as well as extension outreach. To progress technologically, the educational and technological capacities of the rural farmers must be improved in order to develop a true rural entrepreneurial capacity for aggressive competitive access to markets both locally and internationally. Even though women are included as rural farmers, there is need for special programmes targeted on them because of their roles as the dominant agricultural producers, traders and nutrition providers.

Agricultural development involves three approaches namely bio-chemical, socio-economic, and engineering known as the trio of technologies (Mrema and Odigboh, 1993). The biochemical approach includes the development of improved animal and plant species, animal and plant nutrients (fertilizer and feed) and plant and animal protection (veterinary drugs, pesticides and herbicides). The socio-economic approach includes financial packages and management programmes (economics, business management, accounting, sociology, extension services, agricultural marketing and pricing strategies).

The engineering approach deals with the provision of agricultural machines and equipment (be they human, animal or mechanically powered) for production and post harvest systems, handling and storage systems and farm structures, erosion control measures, water resources development as well as irrigation and drainage structures, meteorological systems, and the technologies for optimally utilizing the above and their proper and economic use and management.(Ani and Onwualu,2002; Ampratwum et al., 2004; Onwualu and Pawa, 2004). Agriculture is an important occupation in Nigeria with over 70% of her population depending on it directly or indirectly for

livelihood. It provides the bulk of employment, income and food for the rapidly growing population as well as supplying raw materials for agro-based industries. World current agricultural production has an average growth rate of 1.8% as compared to the 3% in the 1960s and therefore at a lesser pace than the demographic growth. The World Bank has shown that in Sub-Saharan Africa (to which Nigeria belongs) the annual food increase needs to reach 4%, i.e. more than double the current figure in order to achieve food security (IBRD, 1989). She suggests that this can be reached through a significant progress in plant and animal breeding that plays a key role in the development of the agricultural sector as well as a significant impact using appropriate farm mechanization (Pawlak et al., 2002). Due to a number of factors, which include rising population, increasing pressure on land resources, natural and man-made disasters such as drought, desertification, soil erosion and degradation (Raoult-Wack and Bricas, 2001), the problem of sustainable agricultural production in Nigeria has assumed greater importance than ever before. Nigeria and some Third World countries must recognized that food and raw materials independence is an internal affair of their countries and that if a properly articulated agricultural development plan is given priority in practice, it will lay the foundation for modernizing the entire economy.

The rate of growth of agricultural production in Nigeria should increase appreciably in order to mitigate hunger, starvation, diseases, raw materials dependence on foreign sources and food importation, as well as to improve on the quantity and quality of food per person and the well-being of the farmer and his family. This can be done by increasing agricultural productivity through mechanization. This has been done in such other countries like in China (Li, 2005) and in Oman (Ampratwum et al., 2004). Mechanization of agriculture helped transform American agriculture from the situation where one farmer fed 5 people in 1880 to that where one farmer could feed 80 people in 1982 (Ani and Onwualu, 2002). With 90% of Nigeria's agricultural work done with hand tools, 7% with animal-drawn tools and only 3% with engine powered technology, it is understandable that with the over 70% of the population engaged in agriculture, self-sufficiency in food still a mirage (Onwualu and Pawa, 2004). Nigerian agriculture has been very internationally uncompetitive in terms of quality, quantity, grades, hygiene, pricing and markets and will remain so until infrastructures are upgraded and

policy and institutional measures favoring it are put in place. Improvements in infrastructure – particularly productive investments in land improvements and water control, markets, processing and roads – are a key to overcoming the constraints imposed by high levels of population growth, combined with a shift in the ratio of rural to urban population. It is mechanization that will completely revolutionize the Nigerian agriculture.

Historical Background

The first people to turn from the hunting and gathering lifestyle to farming probably relied on their hands, perhaps aided by sticks and stones. Once tools such as knives, scythes and plows were developed, they dominated agriculture for thousands of years. During this time, most people worked in agriculture, because each family could barely raise enough food for themselves with the limited technology of the day.

With the coming of the industrial revolution and the development of more complicated machines, farming methods took a great leap forward. Instead of harvesting grain by hand with sharp blade, wheeled machines cut in continuous swath. Instead of threshing the grain by beating it with sticks, threshing machines separated the seeds from the heads and stalks.
These machines required a lot of power, which was originally supplied by horses or other domesticated animals. With the invention of steam power came the steam powered tractor, a multipurpose mobile energy source that was the groom-crawling cousin of the steam locomotive.

Agricultural steam engines took over the heavy pulling work of horses. They were also equipped with a pulley that could power stationary machine via the use of long belt. The steam-powered behemoths could provide a tremendous amount of power, because of both their size and their low gear ratios.
The next generation of tractors was powered by gasoline (and later) diesel engines. These engines also contributed to the development of the self-propelled, combined harvester and thresher – or combine for short. Instead of cutting the grain stalks and transporting them to a stationary threshing machine, these combines could cut, thresh and separate the grain while moving continuously through the field.

Dynamics of Agriculture

Engineers and scientists deal with forces and forces are vectors. Agriculture is an embodiment of various forces and would be considered as a vector with four components which must be thoroughly resolved to produce the desired effect of cultivating the land, producing crops and raising animals.

Component I – What

This component defines and visualizes agriculture as a way of life, occupation or business to produce the 5 F's: food, feed, fiber, fur and fuel. Without any alternative means or methods of producing these basic necessities, their output levels remain static making this component constant and bounded.

Component II – When

This component deals with timing of crop and livestock production and varies in space because of the dependence of agricultural production on soil, climate and weather. Despite slight modification of this component by components III and IV below, it is largely stable for any geographical location.

Component III – How

This component deals with the art of producing crops and livestock through acquired skill and practice. It is the application of the skills into farming. This is the mould or framework which may become a bottleneck when wrongly applied. It is highly influenced by component IV below.

Component IV – Why

This is the science or facts of agricultural activities. This component consists of a systematical organized body of knowledge about farming and interrogates all the other components and integrates them as follows:
On Component I, it makes modifications by the addition of or substitution with improved and high yielding varieties or breeds or species used in production.

On Component II, it introduces modifications in soil and weather e.g. tillage, fertilizers and irrigation as well as crop protection methods and equipment. It has altered crop production calendars, while feed lots have effectively

substituted grazing and range feeding in livestock production.

On Component III, its influence is highly ramified. It is the reason for scientific research in agriculture, it provides the platform for public policy in agriculture; it is susceptible to active opposition or resistance from man. The difference between success and failure of Component IV to make any impact on this Component III shows the level production. Whenever Component IV fails to make sizeable impact on Component III, agriculture stabilizes at the level of occupation (a job by which someone just earns a living). But where it favorably influences Components III, II, and to some extent Component I, agriculture becomes a business (a profession; a commercial activity by a company or other organization that buys and sells goods, makes products, or provides services). (Encarta World English Dictionary, 2005). It differentiates between small-scale and large-scale production.

Overview of Engineering Inputs Into Agricultural Production In Nigeria

In the discussion on the dynamics of agriculture, it was noted that component IV, which dealt with science and engineering "interrogates and integrates all the other components". It means that without science and technology and engineering ingenuity all the other components would not have any meaningful contribution to make in agricultural production. Scientists, technologists and engineers have a duty to ensure that their contributions in the other three components of agricultural dynamics are scientifically and technologically sound. Thus, they should ensure technology availability, adaptability, reliability and affordability, so that the assets and liabilities of Nigerian agriculture will be properly and adequately taken care of.

Assets

The assets, those useful things or attributes that contribute to the success of Nigerian agriculture are as follows:

- Diversity of cultivated, semi-cultivated and wild crops and diversity of genetic potentials in indigenous crop and tree species and breeds of livestock.
- Ecological adaptation of species and breeds.
- Ecological efficiency of various groups of crops and livestock
- Large areas of cultivated and cultivable land.

• Large, ready, but undefined internal market and potential external market.
These assets which are all-encompassing seem very few compared to the following liabilities.

Liabilities

These are the things that hold the success of Nigerian agriculture back. They constitute a bottleneck to it.

• Rapid decline in soil productivity under intensive use.
• Accelerated soil wastage through erosion (wind & water) and desertification
• Absence of local sources of soil amendments or nutrients
• Unbalance between crop water requirement and natural precipitation – needing irrigation facilities.
• Large numbers of preferred food crops as a result of zonal preferences
• Absence of sustained policies and basic adaptive research for improvement of local crops, livestock and processes.
• Declining work-force on the farm due to drift of labor from rural to urban areas, disease, old age and absentee farmers
• Lack of local fabrication and maintenance facilities for appropriate-capacity energy-saving production, processing and handling equipment.
• Inadequate stock of scientific knowledge of soils, crops, livestock, the environment, food preservation, conservation and combination.
• Heavy burden of diseases, pest, flood and drought.
• Preponderance of cultural and religious diversity.

With the above liabilities, there is no doubt that Nigeria's agriculture requires a lot of power to engineer and propel it past its present status, give it more life and nurture it to real growth of international repute. There should be self-sufficiency in food for the populace, agricultural raw materials for agro-industries and sufficient processed agricultural products for export. Engineering and technology will enhance production as consumers demand consistent supply of top quality products and services, placing emphasis on quality, safety, functionality and sustainability of agriculture (Opara, 2002).

Technical/Engineering Inputs Management

From the above discussions, it is obvious that agriculture is a complex biological production process which implies more than the known conventional factors of production and embraces the political, cultural and religious characteristics of the people. Thus the environment of agricultural production is conditioned by resource inputs which are not homogenous in character, location and mobility. Sustainability and profitability of agricultural production depend heavily on good management practices and capabilities to adapt to technical, economic and social changes. It requires making and implementing decisions involved in organizing and controlling a farm enterprise towards an objective, making purposeful use of limited resources with less complete information due to the role of various factors (Cros et al., 2003). Managing the technical/engineering inputs into agricultural production is expected to satisfy some of the above demands of society on agriculture which has been discussed by Munack (2002). They are to:

- Enhance the capacity to bring more land under cultivation. This will include field engineering in land clearing, cultivation, planting and harvesting.
- Enhance the capability to improve cultural practices and suitable irrigation and Fadama cultivation practices. This will include irrigation structures and equipment such as sprinklers, canals, field channels, drop structures, dams, spillways and reservoirs.
- Ensure high productivity and sustainability in the use of farmland by proper control of erosion and other forms of environmental degradation. This will include engineering inputs as in soil and water conservation by the provision of levees, terraces and structures to ameliorate soil erosion and wind breaks to stop desertification and desert encroachment.
- Ensure proper handling, processing and storage of farm produce to minimize post-harvest losses, which if not controlled can negate all efforts on increased farm production. This will include processing machines (millers, threshers, washers, crackers etc.), cribs and silos and their attendant conveyors.
- Ensure a proper operational and maintenance culture for agricultural equipment and farm machinery. This includes farm systems maintenance and administration including proper selection, application and maintenance/repair of equipment and control of obnoxious pests and diseases (Mijinyawa and Kisaiku, 2006).

• Ensure the development of a new crop of entrepreneurs in agricultural economics, extension, science and engineering who can aggressively market the achievement, developments and gains in agricultural engineering, systems and processes. This will include engineering input in training at tertiary level to produce middle and high level manpower and in research to develop appropriate machines, techniques, processes and general technology of adaptive nature.
• Ensure proper design and construction of facilities and infrastructure for agricultural production e.g. farm roads, water supply system, electricity in the farm, and farm houses for residential and livestock including cages. These must be environment friendly.
• Provide appropriate design and structures for aquaculture (ponds and water supply system for fish farming).
• Provide input in engineering consultancy e.g. in preparation of feasibility studies required in processing bank credit facility or agricultural loans for farmers.
• Encourage village type industries based on local agricultural output with specific emphasis on food production/food processing activities including packaging and marketing.
• Encourage the growth of rural industrial support efforts such as handicraft, blacksmithing for repairs and production of rural mechanical contraptions and spare-parts fabrication.
• Encourage the training of relevant personnel, drawn from the rural areas, in areas of servicing, maintenance and installation of facilities for rural improvement and industrialization as well as environmental cleanliness.
• Ensure sustainable (competitive, protecting the environment, socially compatible) production techniques by design of intelligent machinery, use of information technology, biotechnology and genetic engineering.
• Ensure the reduction of energy dependence from fossil sources through the use of renewable resources (biodiesel, bio-gas, bio-ethanol).

Present Scenario

Okigbo(1988) summarized the engineering and technological inputs presently used in traditional and "modern" conventional farming systems (Table 1). However, it is obvious that to transform Nigeria's largely traditional farming system to a modern one, there should be injected in the system substantial

engineering and technological inputs that are properly managed in terms of both environment and existing/potential technologies. For the agricultural development programmes to succeed, agricultural production, processing and utilization must necessarily move from the present subsistence nature to a commercial nature through mechanization which must be environment-friendly. Efforts are being geared towards the replacement of human operator with mechanical systems including automated ones (Raji and Alamutu, 2005) as human operations are inconsistent and less efficient. There is ample evidence to the effect that the contribution of internally generated technology in Nigeria's agricultural development is substantial, from Tertiary Institutions and Research Institutes, Ministries of Agriculture, the National Centre for Agricultural Mechanization (NCAM) and some private companies (Onwualu and Pawa, 2004). Appreciable achievements have been made in respect of food processing and storage especially at the family (small-size) levels. Development of grain silos and other storage systems has enabled the long-term storage of particularly bulk grain produce. Silos (5 – 2500MT capacities) and warehouses (200 – 5000MT capacities) have been built by Government Agencies (e.g. The National Strategic Grain Reserve Unit) for the storage of grain products at strategic locations all over Nigeria as intervention efforts and for research purposes to prevent food shortages; while private agencies utilize them for storage of bumper harvests. Warehousing of bagged grains stacked on pallets in well-ventilated buildings is widely used in research institutes and the National Seed Service Centers (NSSC) in Nigeria (Adewumi et al., 2005). The Crop Storage Unit (CSU) has developed on-farm storage units most relevant to each ecological zone. In an effort to reduce human drudgery, minimize labor costs and enhance overall productivity and efficiency, the national research system has designed, fabricated and tested an array of agricultural tools and equipment suitable for use under Nigeria's socio-economic environment and conditions. These need to be commercialized after proper field testing and distributed to farmers, even at cost.

Table 1.Inputs or technologies used in traditional and "modern" conventional farming systems.

DESCRIPTION	TRADITIONAL	MODERN
Local Area	Small (1-5ha)	Large (10-100ha or more)
Tools	Simple: Fire, Hoe, Axe, Digging Sticks and Machetes	Complex: Tractors and Implements, threshers etc.
Crops	Many Species (5-80) landraces, no genetic improvement, wide genetic base.	Few Species (1-3) Improved Narrow Genetic Base
Animals	Several Species	Usually 1 or 2 Species
Labour	Manual, Human Energy or Animal Power	Mechanical, Petroleum Fuels, Electric Energy
Soil Fertility Maintenance	Fallows, Ash, Organic Manures	Inorganic Fertilizers, Sometimes Manures, soil amendments, e.g. Lime, etc
Pest and Disease Management	Physical/Cultural	Mainly Mechanical/Chemicals, (Insecticides and Fungicides)
Crop Management	Manual	Growth Regulators for Defoliation, Control of Flowering, Fruit Drops, etc.
Harvesting	Manual or With Simple Tools	Mechanical – Tractor Plus Implements: Threshers, Combined Harvesters.
Post Harvest Handling and Drying	Simple Sun Drying or Over Fires	Mechanically Forced Air, Artificial Drying Using Petroleum Fuels, Sometimes, Refrigeration.

Source: Okigbo 1988

Government in putting in place appropriate infrastructure for mechanized agriculture in Nigeria, established NCAM at Ilorin for the development of low cost labor saving devices, machinery testing and machinery standardization in co-operation with Standards Organization of Nigeria (SON) and strengthened the Rural Agricultural Industrial Development Schemes (RAIDS) for the manufacture of intermediate prototype processing

machines with World Bank assistance. The African Regional Centre for Engineering Design and Manufacturing (ARCEDEM) was established in Nigeria by some African member states to develop and produce equipment prototypes in priority areas, including agriculture, for the creation of small and medium scale industries in Africa. The Agricultural Machinery Mechanics and Operators Training Centre (AMMOTRAC) were established to train operators and mechanics to drive and maintain farm machinery.

Scientists in research institutes have developed improved varieties of different local crops of cowpea, soybean, cassava, plantain/banana, rice, using a lot of engineered tools and equipment. The increased production of most crops in the northern part Nigeria is due mainly to improved varieties and increased engineering input including irrigation facilities. The Fadama projects are also contributing a lot of technical inputs into Nigeria's agriculture by using lowlands for increased agricultural productivity targeted at the resource-poor farmer.

The Cassava Enterprises Development Project (CEDP) goal is to diversify and strengthen rural economy in selected geo-political zones in Nigeria using cassava as the engine of growth. This CEDP is administered by the International Institute of Tropical Agriculture (IITA). It is targeted at resource-poor producers, micro- and small-scale processors, most of who are women as well as fabricators, traders, agribusiness entrepreneurs and consumers, as secondary beneficiaries. The Cassava Initiative (CI) has shown encouraging statistics: production rose to 40m T of tuber in 2005. In the same year garri (processed cassava) was exported to Sierra Leone and first 40 MT of cassava chips to China (Opara, 2006). With the mechanization of the CI it is expected that production will reach 150m T of tubers by 2008.

The Rice Initiative (RI) is being facilitated by the National Cereals Research Institute (NCRI) in collaboration with the West African Rice Development Association (WARDA) with the objective of attaining an output of 9m T of milled rice in 2007.

The Vegetable Oil Initiative (VIO) aims at developing large hectares of oil palm, groundnuts, cotton seed, soybean, sheanut, castor oil, melon, sunflower,

beniseed, with the attendant mechanization for increased production and increasing the Nation's capacity for edible oil production. With the ban on the importation of vegetable oil, the organized private sector in Nigeria has taken the challenge and has sustained local consumption.

For the Tree Crops Initiative (TCI) Government's objective is the rapid multiplication and distribution of high yielding, disease resistant and early maturing planting seeds, seedlings and plantlets to farmers at subsidized rates. These trees are meant to mitigate the devastating effects of deforestation, improve wood and timber resources as well as non-timber forest products (NTFP): fruits, leaves, bark, fuelwood, bush meat and medicinal plants (Spore, 2006).

The Livestock and Fisheries Initiative (LFI) aims at increasing production and enhancing the animal protein intake of Nigerians. The 2006 bird's flu menace in Nigeria was a litmus test to this LFI and Government showed great leadership by promptly evolving appropriate control and eradication measures. This curbed the spread of the virus.

Koinyan (1987) enumerated some agricultural engineering inputs to Nigeria rural development through the DFRRI. These include:
• Design and publication of the technical specifications for the manufacture of simple equipment and devices e.g. ruwatsan (water) pump and accessories for shallow wells; hand and tractor pulled road rollers; plastic screen slotting machine. • Provision of infrastructural facilities of roads, water and electrification.
• Improved rural housing
• Farm mechanization
• Agricultural products storage, processing and marketing.

All these facilities and equipment requirement, equipment use and maintenance are direct engineering activities, which involve design, construction, supervision and management. Agricultural engineers, scientists and technologists are actively engaged in providing the required inputs into these activities that have increased and improved agricultural productivity in Nigeria. These technocrats have developed interest in producing their own

raw materials locally, in investing in agricultural production and in processing, employing their own engineering and scientific experience in the process. In spite of all these a substantial percentage of food consumed in Nigeria is still been imported due to the inadequate domestic production and preservation which is what the various interventions and initiatives are presently addressing. In large part, the previous drop in agricultural production in Nigeria resulted from the small percentage of machine power invested in agricultural production, processing, storage and marketing. The steep rise in prices of tractors and other farm machines and comparatively little growth of agricultural income, with attendant high food cost, have lowered the purchasing power for farm machines by rural farmers. The problem of high cost of farm machines and implements can only be tackled through appropriate government policy on local machinery production/manufacture.

World agriculture is being greatly influenced by information technology (IT). Agriculture is building its computerized plants and animal factories as well as precision farming (Sigrimis et al., 1999).

RECOMMENDATIONS

This section aims at enumerating what agricultural engineers expect from themselves, other scientists/professionals, farmers and governments:

• Agricultural engineers have to get involved in the training of the needed manpower or experts in agricultural sciences and engineering including IT to develop and execute a sustainable agricultural production system in Nigeria; be actively involved in funding and promoting Seminars and Workshops for disseminating knowledge in agricultural production technology. The experienced staff with good background in different aspects of engineering and agriculture will be required to manage resources that will improve agricultural production and at the same time be environmentally friendly.

• Agricultural engineers and scientists who are familiar and experienced in the production technology, biotechnology and information and communications technology (ICT) required by agro-industrialists are needed in the area of industrial extension services to provide detailed information on capital investment, type of plant and machinery, source of equipment and materials, skills required for the production of intended goods to be produced.

• To achieve integrated rural development, the various activities involved that have lots of science and engineering content, would require the services and expertise of engineers and scientists. Therefore, there must be co-operation with each other and other stakeholders (including the rural farmers) to make the agricultural programme of Nigeria successful.

• There is no gainsaying the fact that local machinery manufacture is the lasting solution to making agricultural development and the development of local maintenance capability available. Government should enunciate policies that would encourage engineers, technicians, technologists, and fabricators to engage in local manufacture of agricultural machines and implements. And encourage local manufacturers through organization of exhibitions, recognition and awards for useful inventions and manufactured products.

• The nation's ADP's, RBDAs', DFRRI, NARP, FEAP, NEEDS, RAIDS, CEDP, and other initiatives must know that the national research system is supposed to provide the technological back-up and support for the success of their programmes. Linkages with the Universities, Research Institutes and Polytechnics as well as Industrialists, Manufacturers, Fabricators and NASENI and its Development Centers will close the technological gap existing between these Institutions and the farmers.

• Engineers and scientists should be involved in policy formulation at all levels. Agricultural engineers and scientists should make contributions on agricultural production policies and help to formulate clear and well conceived policies and directives which are basic to the successful implementation of any agricultural programme for increased productivity.

• There should be an urgent policy initiative relating to agricultural machinery and equipment development and manufacture. Government must endeavor to protect local manufacturers of agricultural machinery and equipment from foreign imports. Government should also ensure solid technological base for self-sustaining local fabrication and mass production of tested prototypes by (a) initiating and promoting the rapid and wide-spread development of foundries and associated refractory materials. (b) initiating and accelerating the pace of development of materials science and engineering, including steel mills, heavy engineering plants, alloy metals and special steels as areas of focus, and (c) by initiating development and copy-creativity activities in the area of machineries, tools and spare-parts.

• Government should advance a policy that makes it compulsory for importers of machineries for agriculture and allied industries to establish assembly plants as well as factories to produce or assemble spare parts locally in the country.
• Agricultural engineers and environmentalists should be ready to embrace the influence of IT in agriculture and the environment which are thought by some as the growing giant consumers of information and communication and electronic technologies.
• Agricultural engineers should exploit the full potentials of information and communication services and applications for the social, cultural and economic benefits of everybody.
• Agriculture, being a big potential market for new IT products, challenges agricultural engineers to develop innovative applications and innovative solutions that are "use inspired" and "user-fruitful" for the promotion of agricultural mechanization and production in Nigeria.
• Agricultural engineers should lead and guide developments in agro-bio-technological evolution leading to better understanding of biological processes and properties of biological materials to coincide with technological developments in the field of electronics, computers, communications, materials science and machinery (Sigrimis et al., 1999).
• Traditional agricultural engineering training is too limited and should be expanded to include new areas such as emerging technologies, information and communication technologies.
• Agricultural engineers must cooperate with designers, costumers and farmers to get the right and successful ideas for the development of agricultural machines which are characterized by very high and complex technological standards, a strong pressure on cost, a simplicity in construction and a permanent demand for innovations (Harns, 2003). There is the need for team work.

CONCLUSIONS

Agricultural scientists and engineers should make haste to transform Nigeria's agriculture through the development of technologies that are appropriate and acceptable to a majority of farmers, the sort of technologies that ensure, among other things, improved varieties and species of plants and animals, provision of appropriate types and quantities of agrochemicals,

provision of adequate and sustainable sources of irrigation water, the speedy completion of farm operations, safe processing and storage of farm products, enhanced job satisfaction to the farmers, increasing their income base and ensuring their comfort which will generally preserve the human muscle power.

Nigeria's agricultural engineers need to mechanize food production and processing to catch up with increasing population; empower the farmers with mechanization (improved inputs including IT) in order to produce the required results. Since the world is shifting emphasis from the traditional nut and bolt technology in agriculture to a wider spectrum through information technology, Nigerian agricultural engineers and environmentalists should brace up and get involved in the new technologies for the best interest of the farmer and his environment. To exploit the full potentials of the information and communications technologies, agricultural engineers and environmentalists must develop innovative applications and solutions for the farmer, and lead and guide developments in agro-bio-technological evolution This is important because of the many demands on agriculture by the society. However, the most difficult aspect in promoting farm mechanization in Nigeria is how to promote it where the farmer's purchasing power is not only low but weak.

Agricultural scientists and engineers and the government must find the mechanization technologies suitable and relevant to Nigeria's ecological zones, and fund their spread through granting credits to the farmers. Designers of products, processes and machines should make them from local materials so that they may be readily available, adaptable, reliable and affordable as well as being manageable and environment-friendly.
Without this approach, it will be difficult, if not impossible, to solve Nigeria's food problems through agricultural mechanization and environmental management.

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