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Special Edition on Mechanization of Agriculture in Nigeria

PROMOTING APPROPRIATE MECHANIZATION TECHNOLOGIES FOR IMPROVED AGRICULTURAL PRODUCTIVITY IN NIGERIA: THE ROLE OF THE NATIONAL CENTRE FOR AGRICULTURAL MECHANIZATION

I. I. Azogu,
National Centre for Agricultural Mechanization (NCAM), P.M.B. 1525, Ilorin,
Kwara State, Nigeria
E-mail:

ABSTRACT

In order to meet with the challenge of ensuring food security, the Federal Government of Nigeria realized that the use of appropriate levels of technology to improve the production of farm works is inevitable. One of those types of technologies is Agricultural Mechanization Technology. In order to facilitate the mechanization of Nigerian agricultural production system, the government established the National Centre for Agricultural Mechanization (NCAM) about two decades ago. This paper presents an overview of the centre and its role in mechanizing Nigerian agriculture.

The Centre has over the years developed technologies that have impacted positively towards the use of land tools, animal traction and engine powered mechanization technology in Nigeria. The machines include: seed treatment dram, manual seed planter, manual seed and fertilizer broadcaster, weeding hoe, cassava lifter, cassava peeler, cassava grater, groundnut digger, groundnut decorticator, paddy parboiler, oil palm fruit processing machines, maize shellers, melon shellers, palm nut crackers, okro slicer, lysimeter, yam chipping machine, threshers and vegetable slicers. The Centre has trained numerous fabricators on how to produce these machines.

The efforts of NCAM needs to be encouraged and sustained in order to ensure a home grown agricultural mechanization agenda for Nigeria.

KEYWORDS: Agricultural mechanization, National Centre for Agricultural Mechanization, animal traction, agricultural productivity.

1. INTRODUCTION

Nigeria is one of the largest countries in Africa, with a total geographical area of 923, 768 square kilometers and an estimated population of about 140 million (2006 estimate). It lies wholly within the tropics along the Gulf of Guinea on the western coast of Africa. Nigeria has a highly diversified agro-ecological condition, which makes possible the production of a wide range of agricultural products. Hence, agriculture constitutes one of the most important sectors of the economy. The sector is particularly important in terms of its employment generation and its contribution to gross domestic product (GDP) and export revenue earnings.

The struggle for food security for Nigeria and other West African countries through the adoption of concerted policies and actions at both national and international levels points to the need for Nigeria and other West African countries to evolve viable agricultural production options that will ensure sustainable production of food and raw materials for human consumption, agro-based industries and export. Production systems involve the conversion of inputs through the application of energy to useful outputs. In agricultural production, this involves a series of operations from production to processing and which invariably necessitates the use of machines and equipment at every stage.

Increased land productivity (greater output/unit area of land) generally depends on the application of higher technology and a higher level of knowledge and management ability. Agricultural mechanization

is an instrument of farm management and as such changes in mechanization level can have a multiplier effect on output per unit of land. Agricultural mechanization has now been accepted as the most crucial input not only to increase agricultural productivity and promote industrialization of the rural sector but also to promote the overall economic development of nations. Historically, increase in productivity can be linked with technological changes. To promote agricultural mechanization, therefore, it is necessary that appropriate levels of agricultural mechanization technology are identified, introduced and managed in each agro-climatic zone.

It was based on the need to develop “home grown” mechanization technologies that the then Federal Ministry of Agriculture and Natural Resources established the National Centre for Agricultural Mechanization (NCAM) in 1974 when it realized that only indigenously developed mechanization technologies manufactured and maintained with our local know-how and facilities could best sustain agricultural development in Nigeria.

The policy on agricultural mechanization was to encourage the development of efficient "home grown" tools, equipment and systems which improve agricultural production and productivity, relieve the continuously increasing labour constraints, enhance farmer's income, reduce food imports, increase food export and save foreign exchange. It was envisaged that NCAM would accomplish these tasks through carrying out, among other functions, the standardization and certification of agricultural tools, machines and equipment in Nigeria, as well as testing and evaluating the suitability of all types of imported and locally developed agricultural tools, machines and equipment already in use and those proposed to be used in Nigeria. Thus, there has been a long felt need in Nigeria by the government, concerned institutions, and individuals to use standardization to promote the evolution of appropriate agricultural mechanization through a rapid development of indigenous agricultural tools, machines and equipment, since it has been realized that standardization represents the fastest vehicle' to integrate agricultural mechanization to technological and economic development of the nation.

Therefore, this paper discusses the role of the National Centre for Agricultural Mechanization (NCAM) in promoting appropriate mechanization technologies for improved agricultural productivity in Nigeria.

2. AGRICULTURAL MECHANIZATION

2.1 The Concept

Agricultural mechanization can be defined as the development, introduction and use of mechanical assistance of all forms and at any level of technological sophistication in agricultural production. It should be noted that agricultural mechanization is not the same as tractorization. Tractorization simply means the use of tractors for farm work.

Odigboh (2000), further defined agricultural mechanization as the use of a machine, any machine to accomplish a task or an operation involved in agricultural production. Such tasks or operation include reduction in human drudgery, improvement of timeliness and efficiency of various agricultural operations, bringing more land under cultivation, preserving the quality of agricultural products, providing better rural living conditions and markedly advancing the economic growth.

Thus, the need for mechanization of agriculture in Nigeria has become more acute in recent years due to, among other reasons, the urgent need to accelerate food and fibre production for the teeming urban and rural population through increasing both labour and land productivity, as well as expanding the existing cultivated area. Also crucial is the need to create the necessary awareness of the immense potentials of agricultural mechanization technology to the economic development of the nation.

The primary objective of agricultural mechanization was summarized by Pellizzi (1992), as minimization of production costs, optimization of product quality, protection of the environment and minimization of farm production flexibility. Benefits of agricultural mechanization include the reduction of farm drudgery, the timely provision of suitable conditions and environment for plant and animal growth, better control of such production functions as seed bed preparations, drainage, cultivation, fertilizer application, planting, weed and pest control, reduction of harvest losses, post harvest quality preservation, storage, processing, distribution and marketing, which in turn contribute to enhanced food security, employment opportunities, better rural living and working conditions and thus reduced poverty.

2.2 Levels of Agricultural Mechanization in Nigeria

Three levels of agricultural mechanization can be identified in Nigeria. These include hand tool technology, draught animal technology and engine powered technology. According to Anazodo et al. (1989), over 90% of farm operations in Nigeria are carried out using simple farm tools. Table 1 indicates the estimates of areas under different power sources in Northern States of Nigeria (Ajav, 2000), while Table 2 presents technologies used in traditional and modern commercial farming in Nigeria (Okigbo, 1989).

Table 1: Estimates of areas under different power sources in Northern States of Nigeria

	Power Source		
	Hoe	Animal power	Tractor
Number of farmers (million)	7.5	0.1	0.015
Area cultivated (ha/farmer/yr)	1.0	5.0	50.0
Total area cultivated annually (million Ha)	7.5	0.5	0.75
Percent of total area (%)	86.0	5.5	8.5

Source: Ajav (2000)

Table 2: Technologies used in traditional and modern commercial farming

Description	Traditional Farming	Modern Commercial Farming
Land Area	Small (1 - 5ha)	Large (10-100ha or more)
Tools/Equipment	Simple: fire, hoe, axe, digging, sticks, matchets	Complex: Tractors and implements, threshers, and other better quality and higher output equipment.
Crops	Many species (5-80) landraces, no genetic improvement, wide genetic base	Few Species (1-3) improved narrow genetic base.
Animals	Several species	Usually 1-2 species
Labour	Manual, human energy or animal power	Mechanical, petroleum fuels, electric energy
Soil fertility maintenance	Follows, ash, organic manures	Inorganic fertilizers, sometimes manure, soil amendments, e.g. Lime, etc.
Pests and Disease management	Physical/cultural	Mainly mechanical/chemical (insecticides, fungicides, etc)
Crop management	Manual	Growth regulators for defoliation control of flowering, fruit drop, etc.
Harvesting	Manual or with simple tools	Mechanical –Tractors, plus implements: threshers, combine harvesters.
Post harvest handling and drying	Simple sun-drying or over fires	Mechanical forced air, artificial drying using petroleum fuels, sometimes refrigeration.

Source: Okigbo 1988

2.3 Traditional Agricultural Mechanization Technologies

These are the simplest and most basic technology for agricultural mechanization in use in Nigeria. These technologies range from the traditional cutlasses and hoes, to the developed stick and stone tools which are the only means to enhanced labour productivity in the pre-historic times. These hand tool technologies use man as a power source; and are inefficient and ineffective. Man is limited to about 0.1hp continuous power output and is therefore, grossly inefficient as a primary source of power. However, in many parts of Nigeria where arable farmers are predominantly peasants, traditional technologies are in use, predominantly.

2.4 Draught Animal Technology

As a step further in the traditional agricultural mechanization technology, animal muscle power is substituted for human power, a process which already started in ancient civilization. A large variety of implements and machines have been developed which use animals as the principal power source. According to Ajav (2000), the current animal traction areas of the country can be classified into four distinct regions, namely:

- Active Animal Traction Region (AATR)
- Semi-Active Animal Traction Region (SAATR)
- Introductory Animal Traction Region (IATR)
- None Animal Tractor Region (NATR)

The following is the overall view of the animal traction technology in Nigerian agriculture (Ajav, 2000).

- Over 2 million Farmers spread across 19 states of the federation are actively involved in the use of animal traction.
- Less than 10% of the 2 million active animal traction farmers exploit the full potentials of animal traction through the use of limited available implements. Most of other farmers are only familiar with the ridging and transport equipment and their operation.
- Most farmers lack animal drawn equipment like ploughs, harrows, planters, weeders and harvesters.
- Animal traction implements/equipment are mostly produced and maintained by local blacksmiths. These blacksmiths are mostly constrained by insufficient patronage, unavailability of raw materials, inadequate workshop facilities and ineffective marketing strategies.

Draught animal technology refers to a range of implements, machines and equipment with animal power as the major energy source; animals such as donkeys, horses, camels, oxen, buffalos are employed for this purpose.

2.5 Engine Powered Machinery Technology

The most sophisticated of the three levels of agricultural technology is the engine powered machinery technology. It involves the use of a range of tractor sizes as the sole prime mover. Engines or motors using petrol or diesel fuel or electricity are used to power machines such as threshers, mills, irrigation pumps, grinders, aircraft for spraying and self-propelled machines for production, harvesting and handling of a wide variety of crops (Onwualu et. al., 2006).

For commercial farming to succeed, agricultural production, processing and utilization must necessarily move from the present subsistence nature to a commercial one through the use of agricultural mechanization technologies which must be environmentally friendly. Efforts are being geared towards the replacement of human operator with mechanical systems including automated ones as human operations are inconsistent and less efficient.

2.6 Appropriate Mechanization Technology in Relation to Level of Development

The term Technology means many things to several people and these depend on the setting or the context. Broadly defined, however, technology implies any practical art which utilizes scientific knowledge. The objective is usually to advance and enhance human society and conditions. Technology is used to harness the forces of nature and transform the resources that nature has bestowed on man, into goods and services for better quality life. Appropriateness of technology refers to the level of mechanization and how it is used in relation to crop production and agricultural processing. Appropriateness can only be determined after a careful consideration of the technical, economical and social characteristics of each situation. New and improved technologies to be adopted for agricultural mechanization in Nigeria must be appropriate and acceptable both in terms of farmers' social economic environment as well as resources and technical suitability of the technologies.

Agricultural mechanization technology in Nigeria can only be said to be appropriate if:

- The machines are compact, light, low powered and multipurpose. Locally available materials must be incorporated in fabricating the machines to reduce cost of manufacturing.
- Small size tractors, mini power tillers, and small farm equipment must meet the need of indigenous commercial farmers; operators' safety and comfort.
- High cost of fossil fuel in Nigeria emphasizes the need to develop energy efficient machines by harnessing non-conventional sources of energy.

3. ROLE OF NCAM IN MECHANIZING NIGERIAN AGRICULTURE

3.1 NCAM Mandate and Attainment of Agricultural Productivity

It was in the realization that self sufficiency in food and fibre production is the major index for assessing a nation's developmental effort, policy makers were convinced that modernization of Nigerian agriculture through the introduction and development of need-based "home grown" agricultural mechanization technology will be the only way out of the log-jam of hunger and want. It was on this premise, that NCAM was established in 1974 following the acceptance of the report of a team of experts set up by the Federal Government to advise her on the possible establishment of an agricultural mechanization institution based on its perceived roles elsewhere. Subsequently, NCAM became a semi-autonomous parastatal under the Federal Ministry of Agriculture and Rural Development by Decree (now Act) No. 35 of 1990.

NCAM by this decree was established with the general objective of accelerating mechanization in the agricultural sector of the economy in order to increase the quantity and quality of agricultural products through the process of agricultural machinery development, testing and standardization; and the dissemination of the knowledge of industrial manufacture, its efficient applications and maintenance capability. Specifically, the functions of NCAM are to:

i. Encourage and engage in adaptive and innovative research towards the development of indigenous machines for farming and processing techniques.
ii. Design and develop simple and low cost equipment which can be manufactured with local materials, skills and facilities.
iii. Standardize and certify in collaboration with the Standards Organization of Nigeria (SON) agricultural machines, equipment and engineering practices in use in Nigeria.
iv. Bring into focus mechanical technologies and equipment developed by various institutions/agencies, or bodies and evaluates their suitability for adoption.
v. Assist in the commercialization of proven machines, equipment, tools and techniques.
vi. Disseminate information on methods and programmes for achieving speedy agricultural mechanization.

vii. Provide training facilities by organizing courses and seminars specially designed to ensure sufficient trained manpower for appropriate mechanization.
viii. Promote cooperation in agricultural mechanization with similar institutions in and outside Nigeria and with international bodies, connected with agricultural mechanization.

3.2 Salient Achievements

In the realization of the above objectives, NCAM have made some salient achievements. So far quite a number of agricultural mechanization technologies have been developed and promoted by NCAM. These include:-

i. NCAM Seed treatment drum – a simple device for chemically treating seeds prior to storage/planting. The output capacity is 20-25-kg/hr, it consists of a cylindrical drum mounted on two bearings supported on an angle iron frame. The device is ready for commercial release.

ii. NCAM Hand seed planter - a simple device for planting seeds such as maize, soya-beans, guinea-corn etc. It consists of a seed tube, seed funnel, a handle, a jaw-type of soil opener and seed spacing adjustment; it can drop one or two seeds from the seed funnels at a time. NCAM Hand seed planter is ready for commercial release.

iii. NCAM Manual Seed and Fertilizer Broadcaster - a multi-purpose low-cost device which can distribute granular materials such as seeds, fertilizers, pesticides, etc., with high degree of uniformity and precision. It comprises of a cylindrical hopper with a conical bottom, a circular distributor disc with fins, a gear drive mechanism, a hand crank, an agitator, a feed control lever and a strap for mounting the broadcaster on the shoulder. The output capacity of this broadcaster is 4 – 5 ha/day. The machine has been mass-produced and distributed to farmers all over the country.

iv. NCAM Improved Long Handle Weeding Hoe - a useful device or tool used for weeding and hoeing in the standing posture. The salient features include blade made of high carbon steel, long or short handle for any desirable posture during work, a rake that can be fitted to the same handle. It was found that a person could weed from 0.02-0.4ha/hr with the hoe; the labour requirement varies from 22 - 40 man – hr/ha depending on the soil, crop and weed condition. Future commercial production will require supply of special materials.

v. NCAM Rotary Hand Push Weeding Hoe – is a push-pull type of weeder which is used for weeding and hoeing for crops sown in line. Its main features include a rim made out of mild steel rods and cone bearings. The wheel hand hoe is meant for weeding and hoeing in the inter-row spaces of the crop planted in lines. It is not convenient to use it for crops planted on ridges. The work out-put of rotary hand push weeding hoe is 0.03 - 0.05 ha/hr.

vi. NCAM Cassava Lifter - is a simple device designed for uprooting cassava tubers. It consists of a frame to which a foot board and an immovable gripping-jaw are attached, a lever (handle) which is hinged to the frame. The work output of this device is about 2000 plants/man-hour under normal condition.

vii. NCAM Improved Cassava Peeling Tool - a tool used for peeling tubers. Its application is less tedious compared with the energy and time expended during the use of traditional tool such as kitchen knife. The main features of this tool are peeling blade and a handle which are made of mild steel. The output capacity of the peeling tool is about 35 kg/hr and its peeling efficiency is as high as 99.6% while tuber loss is less than 0.4%. The tool is ready for commercial release.

viii. NCAM Pedal Operated Cassava Grater - a farm processing equipment fabricated to improve the traditional way of grating peeled cassava tubers into fine mash for further processing in terms of drudgery, timeliness and output capacity. The grater comprises a grating drum, a rectangular hopper and drum housing a gear system and a pedal. The output capacity of the machine depends on the strength and agility of the operators. Two operators can produce 30 kg cassava mash per hour.

ix. NCAM Tractor Mounted Groundnut Digger - is a tractor mounted implement used in uprooting groundnut plants which are ready for harvest on the farm. This implement can be used on large scale or mechanized farm to reduce the intensity of labour during harvesting. It consists of cutting blades, which helps to cut the roots of the groundnut vines and loosens the soil. The average field capacity was found to be 0.53 ha/hr. The machine is currently under test for further improvement.

x. NCAM Groundnut Decorticator - a machine or device used for shelling of groundnut pods after harvest to obtain fine seeds. The main features of the machine include a frame, hopper cylinder cum concave, an oscillating – section and a handle. The output capacity is 40-50 kg/hr. The manually operated decorticator is ready for commercial release while the motorized version is under intensive testing.

xi. NCAM Farm Level Paddy Parboiler - an equipment used in soaking paddy in water and heating as well as steaming it over a period of time. It consists of a 50-gallon oil drum divided into two chambers, the soaking chamber and the steaming chamber. Perforated pipes and drain plugs are also fitted on the parboiler. The output capacity of parboiler is 70 kg of paddy in a batch and the parboiling process last for 3-4 hours. The equipment is ready for commercial release.

xii. NCAM Oil Palm fruit processing equipment - a complete set of labour saving devices for the production of palm oil from palm fruit. The set comprises of:

1) The palm fruit steamer/sterilizer which is made of standard 50-gallon oil drum with upper and lower chambers, perforated circular metal sheet and a drain plug.

2) The palm fruit digester is used to depericarp or macerate the mesocarp and extract the oil from the cooked palm fruits. They are of two types, namely:- vertical and horizontal types. Their essential features include cylindrical housing, the inner perforated cylindrical drum, a shaft, spikes and a handle.

3) The palm oil clarifier is a cylindrical container made from iron sheet. The main features are upper cylindrical section, lower cylindrical section and a drain pipe.

xiii. NCAM Manual Maize Sheller - a very efficient and simple equipment for shelling maize cobs. It consists of galvanized steel and thick plates. It functions well on a small-scale farm (i.e. peasant farm). The output capacity is about 30 kg/hr. The equipment is ready for commercialization.

xiv. The Bench Mounted Maize Sheller - an improvement on the cone type. It consists of a conical shelling unit, a handle and a housing unit. The entire unit is mounted on a bench or table. The output capacity is about 40 kg/hr. The sheller can be used effectively on a large scale farm. The sheller is now perfectly ready for commercialization.

xv. Marumbi Maize Sheller - a manually operated machine which has a capacity of 450 kg/day. It is used for detaching maize grains from the cobs. Its main features are hopper, compression sprayer, a shelling disc and bevel gear. It can be used by small and medium scale entrepreneurs.

xvi. Seed dehuller - is a manually operated equipment with a capacity of 25-30 kg/day. It is used to dehull crops like cowpea and soyabeans. The main features of this machine are screw on a shaft, a pipe, a hopper and a handle. It is affordable for most housewives.

xvii. Manual Melon Washer - has a capacity of 30-40 kg/hr. It is used in washing melon seed after removal from its pod. The main features are perforated cylindrical drum, outer-cylindrical container, hopper, shaft and fibrous brushes. Small and medium scale processors can use it.

xviii. Okra slicer - an equipment which slices Okra into several even slices at once and it is manually operated. It has a capacity of 25 - 30kg/hr. Its main features are stainless blades, cutting unit, aluminum slab, and collecting tray. It can be used by housewives, restaurants, hotels and small scale entrepreneur.

xix. Lysimeter - used to determine the crop evapotranspiration at various growth stages. It consists of the weighting mechanism, the mercury manometer and the calibration unit.

xx. Palmnut Cracker - has a capacity of 155 kg/hr and a cracking efficiency of 94%. It is used in cracking Palmnut and this machine is very adequate and appropriate for the small-medium scale processor in Nigeria. The main features are the hopper, the rotor assembly, strike plate, the supporting frame and the power source (3-5 hp petrol engine).

xxi. Melon Sheller (Motorized) - used in shelling melon; it has a capacity of 1.5ton/day. This machine can be used by large-small scale processors. It's features are the hopper, shelling unit and the power source.

xxii. Manual Yam chipping machine - Is operated manually and has a capacity of 0.4 tonne dice yam (chips)/day. The machine can be used by small-medium scale processors. It's main features are the knife which is attached to the handle, the puncher, and the cube shaped steel sections.

xxiii. Multi-purpose thresher - can be used to thresh maize, rice, cowpea, guinea corn, and other grain crops. It has a capacity of 200 kg/hr (for cowpea). The main features of this equipment are the hopper, the threshing unit which consists of beaters welded onto cylinders and the concave. Medium-large scale entrepreneurs would find this equipment highly versatile.

xxiv. Vegetable Slicer - used in slicing tomatoes, okra and carrot, and other vegetable crops. It has a capacity of 30 kg/hr, 20 kg/hr and 15 kg/hr respectively for tomatoes, okra and carrot. Its main features are presser tray, frame and cutting blades. It can be used by housewives, and small scale processors.

3.3 NCAM's Strategy in the Adoption and Promotion of Appropriate Agricultural Mechanization Technologies

NCAM as well as some Research Institutes and Universities have devoted a great deal of efforts and resources to conducting applied research and development aimed at the design and fabrication of equipment and implements for primary production, processing and preservation of our local crops. These efforts were geared towards tropical crops for which there are no suitable machines for their production and processing that are available from overseas sources. For such crops, all the cultural and processing operations are still performed manually by the producers who are predominantly peasant farmers or subsistent processors. These research and development efforts have yielded many appropriate prototype machines and equipment. NCAM has developed various prototype agricultural equipment which are very appropriate to the need of small-medium scale Nigerian farmers. These equipment and tools as earlier outlined will assist the rural farmers to increase their agricultural production and productivity and thus

help to alleviate rural poverty. To ensure that these technologies are adopted, the Centre over the years has applied the following strategies.

3.3.1 Industrial Liaison between NCAM and Manufacturing Industries

In an effort to promote the adoption of agricultural mechanization technologies in Nigeria, the Centre established a liaison programme to facilitate linkages with Research Institutes, and the Manufacturing Industries. This ensures that prototypes designed by the Research Institutes are manufactured and mass produced by the local and indigenous manufacturing industries that no doubt have more adequate engineering infrastructures for the manufacture and mass production of the prototypes for distribution to end-users. In addition, this arrangement encouraged more entrepreneurs to establish industries for the manufacture of the locally designed equipment or even sponsor research and development works on agricultural equipment development.

On the other hand, the Research Institutes are kept abreast of the latest technologies in the industry. Complaints and suggestions for improving the performance of a particular equipment are fed back by the farmer end-users to the research institutes through the manufacturers. This way, a more appropriate agricultural equipment is developed for the farmers for increased agricultural production and productivity.

3.3.2 *NCAM Field Days*

With a view to ensuring speedy transfer of the know-how and indigenously developed technologies from research to end-users, a close liaison with the industry is essential. Towards this end, NCAM organise field days regularly. The essence of the field days is to create a platform forum for enlightening farmers, field engineers, entrepreneurs and other stakeholders in the development of adoptable appropriate low-cost need- based technology.

3.3.3 *Training of Fabricators on NCAM Developed Technologies*

Towards the promotion and commercialization of these technologies, NCAM conducts series of training for fabricators of agricultural equipment / machines. Some of the training courses and seminars already conducted include:

a) National Training Workshop on Animal Traction for Agricultural Development in Nigeria held 30th June – 4th July, 1997 and sponsored by UNDP.
b) National Training Course on Skill Development in Blacksmithing and Fabrication held 8th-19th September, 1997 and sponsored by UNDP.
c) National Seminar on Establishment of Collaboration and Network for Manufacturers/Suppliers of Agricultural Tools/Equipment and relevant Research Institutes, 11-12 December, 1997 and sponsored by NCAM.
d) National Workshop on Appropriate Agricultural Mechanization for Skills Development in Low-cost Agricultural Mechanization Practices, 26-28 November, 1996, sponsored by UNDP.
e) Training on the use of Universal Testing Machine to determine the Engineering Properties of Agricultural and Industrial Materials (August, 2001).
f) Training on Skills Development in Blacksmith and Fabrication of Simple Implements and Tools (2002).
g) Training Workshop for Fabricators on Cassava Production and Processing Technologies (2004).
h) Training of Fabricators of Agricultural Equipment and Tools under the year 2006 Millennium Development Goals (2006).
i) Training Workshop on Fabrication of Agricultural Equipment and Tools under the 2006 Millennium Development Goals held at NCAM, Ilorin from 1 – 7 July, 2007.

These training courses have been followed up with monitoring and evaluation of the fabricators trained to ensure that the skills acquired by them are being utilized and also employed to train other fabricators so as to create the desired multiplier effect.

4. CONCLUSION

Much has been said and done by various governments, agencies and individuals on what type and level of mechanization should be introduced and how to introduce it into Nigerian agriculture. Mechanization has been widely accepted as an indispensable input to agricultural and rural development. The lack of effective, consistent and clearly defined policies and strategies for agricultural mechanization poses important constraints on increased agricultural production and productivity. Yet, every year that passes, the urgency of the varying issues involved are heightened and refocused more sharply for implementation. However, it is generally agreed that appropriate agricultural mechanization technology for Nigeria must evolve from a gradual development of indigenous technology. The mechanization approach must be an integrated one to include most, if not all, the agricultural production processes and operations and must also be part of and include the essential elements of the overall agricultural and rural development strategies in order to get to the roots of rural poverty.

The roles of the government, financial institutions, the research institutes, the private sector and other interest groups must be carefully and effectively articulated if the dream of developing sustainable agricultural productivity in Nigeria is to be realized.

In order to break the cycle of poverty in Nigeria, the right attitude to work must be developed and sustained. Adoption and promotion of appropriate agricultural mechanization technology offers the developing nations the means to achieve these aims so as to build an efficient and prosperous economy. However, to achieve these, agricultural mechanization technology must be indigenous or home-grown and integrated into the national life and continuously promoted and upgraded to ensure sustainability.

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AGRICULTURAL MACHINERY OPERATORS AND MECHANICS TRAINING IN NIGERIA: AN OVERVIEW OF CONTRIBUTIONS

M. A. Ladeinde., E. O. Atanda., A. J. Ageh., S. O. Idowu and S. O. Olayemi
Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC),
Federal Department of Agriculture, P.M.B 636, Akure, Nigeria
mabayojeladeinde@yahoo.com; olugbenga_atanda@yahoo.com; doyinageh@yahoo.com

ABSTRACT

The paper discusses the need for training as a way of ensuring sustainable development in Nigeria. Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) intervention and its rationale towards agricultural mechanization development in Nigeria is emphasized. Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) objectives, training programmes, training scope and approach to trainings were elucidated. Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) achievements as a mechanization training institution as well as the challenges of training agricultural machinery operators and mechanics in Nigeria were also discussed. The paper noted that with the setting up of the two AMMOTRACs in Akure and Misau, these centres have been addressing the issue of training and retraining of tractor operators and mechanics as well as other farm mechanization training programmes. The Centre has so far trained two thousand five hundred and twenty (2,520) engineers, technical officers, technologists, workshop managers, farm managers, agricultural machinery operators and mechanics in the twenty one (21) already conducted training sessions. The paper finally concluded that farmers, research and educational institutions, organizations/establishments, parastatals and other stakeholders involved in agricultural mechanization in Nigeria should avail themselves of the various training opportunities at the two centres for their overall training needs.

KEYWORDS: Agricultural Machinery Operator, Mechanics, Training, AMMOTRAC, Mechanization

1. INTRODUCTION

The number of people without enough food to eat on a regular basis remains stubbornly high, at over 800 million, and is not falling significantly. Over 60% of the world undernourished people live in Asia, and a quarter in Africa. The proportion of people who are hungry, however, is greater in Africa (33%) than Asia (16%).The latest Food and Agriculture Organization (FAO) figures indicate that there are 22 countries, 16 of which are in Africa (mainly sub-Saharan African), in which the undernourishment prevalence rate is over 35% (FAO, 2008).

The Nigerian Government is confronted with a mission for self-sufficiency in food production with an over 120 million population; there are lots of pressures on the agricultural sector for food production as well as industrial raw materials. The situation is not helped by the fact that the growth of Nigeria's food production has been very low. The country's food production has been growing at a rate of about 2.5 percent per annum while demand for food has been growing at about 3.5 percent (Eneh, 2006). Many policies of successive governments towards self sufficiency in food production which include the establishment of several ad-hoc agricultural development programmes like the Farm Settlement Schemes (FSC) in 1960 to 1970, National Accelerated Food Production Programme (NAFPP) in 1973 to 1977, the Grow More Food Programme (GMFP) in 1970 to 1984, the River Basin Development Authority (RBDA) in 1976 to date, Tractor Hiring Units (THUs) in 1960 to date, Agro–Service Centres (ASC) in 1976 to date, Operation Feed the Nation (OFN) in 1976 to 1979, Green Revolution in 1979 to 1983, Agricultural Development Projects (ADPs) in 1985 to date and so on, have all been introduced to boost

food production in Nigeria. These programmes have made their modest impacts, but the deficit still persists as availability of food and fiber at affordable prices has continued to elude Nigerians.

A number of programmes are being put in place to ensure that Nigeria is food secured. These include the Special Programme on Food Security (SPFS) in conjunction with the Food and Agriculture Organization (FAO). Under this programme, three sites were selected in each state of the federation and one in the Federal Capital Territory (FCT). Necessary production inputs were provided to the farmers in each site with adequate monitoring and supervision. This programme has resulted in bumper harvests for all selected crops. Also, the Federal Ministry of Agriculture and Water Resources has embarked on the accelerated production of five agricultural commodities through the Presidential Initiatives on cassava, rice, oil and vegetables, livestock and fisheries. These initiatives are geared towards addressing the limitations of our farmers with a view to enhancing their productivity and production capacities leading to economic empowerment and poverty alleviation at the grassroots, as critical paths to economic growth.

For these and other agricultural development programmes to succeed, agricultural production, processing and utilization must necessarily move from its present subsistence level to a commercial level (Onwualu and Pawa, 2004). This can only be accomplished through mechanization (Onwualu and Pawa, 2004). In fairness to government, a lot has been done towards agricultural mechanization. Every Ministry of Agriculture has an engineering division; every state has an Agricultural Mechanization Authority or Tractor and Equipment Hiring Unit. Most agricultural research institutes and higher institutions have agricultural engineering departments. To crown it all, government established the National Centre for Agricultural Mechanization (NCAM) at Ilorin in Kwara state.

The farm tractor is a major element of farm mechanization. Its versatility and high efficiency have made it suitable for most field and barnyard operations (Ishola and Adeoti, 2004). The role of tractors in farm mechanization is just to function as a source of power and give propulsion to the attached implements / machinery (Tanveer et al., 2001). The high cost of ownership of farm tractors in Nigeria presently militates against the use of tractors by majority of the farmers (Babatunde, 1996; Akinoso and Mijinyawa, 2001). One policy of the Obasanjo administration in Nigeria is the procurement of agricultural tractors and implements for resale to farmers at 25% subsidy. Consequently in the year 2003, the Federal Government procured and distributed 1,000 units of tractors at very competitive prices to beneficiary states. In the year 2005, the Federal Government set up the machinery for the procurement of additional 1,000 tractors and complete set of implements in order to improve the tractorization density in Nigeria, currently estimated at 0.3hp/hectare as against the Food and Agriculture Organization (FAO) recommendation of 1.5hp/hectare (Bello, 2005). The Federal Government has completed the distribution of these new agricultural tractors and associated implements to each state of the federation including the Federal Capital Territory.

Agricultural Mechanization in Nigeria is still characterized by low competence level of machinery operators and mechanics. This is further compounded by the technological changes in the machinery and equipment that were imported into the country in the past years as most operators and mechanics finds it difficult to operate, maintain and repair some of them . This heavy investment outlay will not achieve its desired result, if these tractors and implements are not well operated and maintained to achieve its useful service life span. It is also important to guard against premature failure or early breakdown right from the time of planning for purchase to the time of usage and storage. Against this background, it becomes necessary for personnel in maintenance and repair to continue to upgrade their knowledge of agricultural machinery trends and innovation. All categories of manpower, operators and mechanics, engineers, technical officers and technologists, are required to periodically attend training courses and workshops. The Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC), located in Akure and Misau in Nigeria, provide such training.

The paper examines the present status of Agricultural Machinery Operators and Mechanics training in Nigeria with an overview of the contribution of AMMOTRAC, Akure in Ondo State. To accomplish this

objective, the paper takes a snapshot on the need for training as a way of ensuring sustainable development in Nigeria , outlines AMMOTRAC intervention and its rationale towards agricultural mechanization development in Nigeria, illustrates the objectives, training programmes, training scope and training approach of AMMOTRAC, identifies achievements of AMMOTRAC at Akure as a mechanization training institution in Nigeria and then highlights some challenges of training agricultural machinery operators and mechanics in Nigeria.

2. NEED FOR TRAINING AS A WAY OF ENSURING SUSTAINABLE DEVELOPMENT IN NIGERIA

Human resource is one of the greatest assets in any endeavour. Thus, the development of human resources is vital in any organization (Beredugo, 2001). In particular, in a rapidly changing technological environment, for instance agricultural machinery and equipment continue to improve in design outlook. New models of equipment are placed on the market, at times, old ones are rendered obsolete, or market forces prevent further production of a particular model. Training is the process of providing knowledge and skills and bringing about desired changes in attitudes in order to improve the competence of people being trained (Youdeowei and Kwarteng, 1995). The goal of training therefore is to improve performance on the job.

Although the importance of highly competent agricultural machinery operators and mechanics to effective mechanization practices cannot be over-emphasized. The non-charlant attitude of some managers of agricultural establishments and other stakeholders involved in mechanization practices in Nigeria towards training and retraining of their operators and mechanics constitutes serious bane to advancement of agricultural mechanization in Nigeria. If agricultural mechanization would develop at a pace that would meet food demand for population explosion in Nigeria, we must change our orientation as well as our attitude towards training. Training, however, may be necessary for many reasons, including (Youdeowei and Kwarteng, 1995):

- When there is a discrepancy between an employee's current performance and the required standard of performance in his/her present position.
- When there are changes in a job description or the addition of new responsibilities in the present position.
- When an employee moves to a new position and acquires a new set of responsibilities.
- When some new way of doing something has been developed.

3. AGRICULTURAL MECHANICS AND MACHINERY OPERATORS TRAINING CENTRE (AMMOTRAC) INTERVENTION AND ITS RATIONALE TOWARDS AGRICULTURAL MECHANIZATION DEVELOPMENT IN NIGERIA

It was in the very late 1970s that it became clear that Nigeria's agriculture could no longer cope without sophisticated mechanization activities. Thus more agricultural machinery and equipment from overseas were introduced into the country's agricultural sector. This increase in agricultural mechanization activities without due consideration and concern for trained personnel to cater for the upkeep and maintenance of such huge investments were leading to huge losses and wastages which became associated with the ownership and management of agricultural tractors/machinery in the country (AMMOTRAC, 2003).

This prompted the engineering division of the Federal Department of Agriculture in the early '80s to come up with the concept of establishing Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC). This move is aimed at achieving maximum profitability of the machinery as well as realizing their full service life span. However, due to some setbacks, Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) could not take off until late 1988 when the centre in Akure took off. This centre initially took care of trainees from all the states of the federation including

the Federal Capital Territory, Abuja. In August 1992, Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC), Misau in Bauchi State was established to take care of trainees from the northern states including the Federal Capital Territory, Abuja while Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) in Akure handles the training programme for trainees from the southern states of the federation (AMMOTRAC, 2003).

4. OBJECTIVES OF THE AGRICULTURAL MECHANICS AND MACHINERY OPERATORS' TRAINING CENTRE (AMMOTRAC)

The objectives of the centre are as follows:

- Train agricultural machinery mechanics and operators on the techniques of operation, maintenance and repair of agricultural machines and equipment.
- Train personnel on the techniques of operation and maintenance of animal traction equipment as well as management of work animals.
- Train agricultural machinery mechanics and operators on the techniques of operation, maintenance and repair of agricultural land development and bush clearing equipment.
- Train personnel on the operation and maintenance of food storage machines and equipment.
- Train personnel on the installation, operation, maintenance and repair of agro-processing machinery for grain crops, root crops, oil crops and so on.
- Train personnel on the installation, operation, maintenance and repair of irrigation equipment.
- Train personnel on the operation, maintenance and repair of livestock and fishery production equipment.

5. TRAINING PROGRAMMES OF THE AGRICULTURAL MECHANICS AND MACHINERY OPERATORS' TRAINING CENTRE (AMMOTRAC)

Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) will realize the above listed objectives through the following training programmes:

- **Short Term Training Programme**
  This will not be more than two weeks duration. The participants will be drawn from States Ministries of Agriculture and Natural Resources, Agricultural Development Projects, River Basin Development Authorities, National Agricultural Land Development Authorities; Private mechanized farms as well as Agricultural Machinery and Equipment Marketing Companies in all the southern states of Nigeria. It is however designed for experienced agricultural machinery operators and mechanics in such establishments.

- **On-the-Spot Training Programme**
  This will be carried out through the use of well-equipped mobile workshop manned by skilled technical personnel. They will visit large mechanized government and private farms where they will conduct on the spot training and correct common mistakes that might be observed during the trip.

- **Train the Trainers Training Programme**
  Trainers for this programme will be drawn from existing agricultural institutions and large scale mechanized government and private farms. The aim of this programme is for the trainers from such institutions to acquire new skills and refresh their knowledge through Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) programme and be able to transfer same skills and knowledge to trainees and personnel in their various places of work.

- **Long Term Training Programme**

This is a programme that will commence when Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) is fully established. It will draw participants from the students with equivalent of at least Junior Secondary School (JSS) certificate holders as well as students with equivalent certificates. It will be organized in separate classes for agricultural machinery operators and mechanics respectively. The duration of the programme will be about eighteen months for operators and twenty-four months for the mechanics. At the completion of the course, the graduates will be awarded Government Grade II and III trade certificates. This is to be worked out in conjunction with the National Board for Technical Education (NBTE).

6. TRAINING SCOPE OF AGRICULTURAL MECHANICS AND MACHINERY OPERATORS' TRAINING CENTRE (AMMOTRAC)

Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) training topics have been specifically packaged in line with her objectives. Each topic has been tailored to meet the demand of participants nominated to attend such training programmes and courses. Some of the centre's training programmes and courses cover the following major topics namely:

- Basic Tractor Operators' Training
- Repair and Management of Farm Machines and Implements
- Hydraulics and Transmission Systems
- Economic Management and Operation of Farm Machinery and Equipment
- Training on Irrigation pump Operation, Maintenance and Repair
- Cassava Mechanization training
- Rice Mechanization tillage training

Besides Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) regular training programmes and courses, the centre has the potential capability to arrange and conduct training programmes and courses even in collaboration with client organizations/ establishments.

7. TRAINING APPROACH OF AGRICULTURAL MECHANICS AND MACHINERY OPERATORS' TRAINING CENTRE (AMMOTRAC)

Knowledge is widely believed to be acquired by training which can be either practical or theoretical. Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) training approach falls into these categories as follows (AMMOTRAC, 2003):

- **Practical:** Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) training programmes are designed to provide practical assistance to all categories of participants and officers involved in agricultural mechanization practices. In addition, 75% of the training duration will be practical in nature.

- **Participation:** The training methods emphasize shared learning experiences, case studies, role-play and syndicate discussions to ensure that course subject matter is applied to what prevails on the field of operation. Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) training approach is enriched by modern training technology, such as audio-visual training aids like overhead projector and slides, computer and resourceful study tours.

- **Responsive**: Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) training programmes have been developed to meet the training needs identified in a systematic survey of client organizations /establishments, and are regularly revised in the light of changing technological demands.

- **Follow-up:** A follow up system has been adopted to help participants apply what they have learned in the classroom to their job situations. In all cases, client organizations/establishments are visited after training, to give further coaching and assistance to participants, and to also measure the impact of the training received from the centre.

8. ACHIEVEMENTS OF AGRICULTURAL MECHANICS AND MACHINERY OPERATORS' TRAINING CENTRE (AMMOTRAC) AT AKURE AS A MECHANIZATION TRAINING INSTITUTION IN NIGERIA

8.1 Training and Manpower Development

Shortage of skilled manpower is a crucial problem that hinders agro-industrial development in Nigeria. For this reason, Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC), Akure attaches considerable importance to training in its annual plans. The centre is also blessed with a team of well experienced Agricultural Engineers and Technical Officers saddled with the responsibilities of impacting knowledge and practical skills on participants during training. The centre has succeeded in conducting series of training programmes in the past, mostly for employees of Federal Ministry of Agriculture and Rural Development (FMARD), State Ministries of Agriculture and Rural Development (MARD), Agricultural Development Projects (ADP), River Basin Development Authorities (RBDAs), Educational and Research Institutions, Local Government Councils (Department of Agriculture) and Private Mechanized farms. The Centre has so far trained two thousand five hundred and twenty (2,520) engineers, technical officers, technologists, workshop managers, farm managers, agricultural machinery operators and mechanics in the twenty one (21) already conducted training sessions. The sponsorship which often covers tuition fees, accommodation, training facilities and materials, local field trips and so on, has all been provided free of charge by the centre while the client organizations/establishments provide transportation cost to and from Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC), Akure for their participants.

8.2 Engineering Consultancy Services

Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) also provide engineering consultancy services to both public and private sector organizations/establishments engaged in the practice of agricultural mechanization. Such consultancy advice and services are based on an in-depth diagnostic study of the client's organization/establishment problems that are in line with its objectives. Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) can provide professional advice in the area of procurement, operation, maintenance and even effect repair on different range of farm machinery and equipment.

9. CHALLENGES OF TRAINING AGRICULTURAL MACHINERY OPERATORS AND MECHANICS IN NIGERIA

At present, there are lots of challenges greatly limiting the performance and output of Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC), Akure. With due consideration to the targets expected to be achieved, the centre has been forging ahead to achieve its set objectives as a centre of maintenance culture for agricultural machinery and equipment in Nigeria. Some of these major challenges are discussed below:

9.1 Capacities

The issue of capacities is pertinent with respect to both the physical and human resources.

9.1.1 ***Physical Resources:*** The provision of enough infrastructures such as dinning/hostel building facilities, lecture rooms, workshops, laboratories, library, office accommodation, senior and junior staff

quarters, will enable Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) successfully carry out other programmes as contained in its mandate.

9.1.2 ***Human Resources:*** Most senior officers who acted as Training Resource persons are not sent on periodical courses and trainings locally or abroad to update and upgrade their knowledge and skills of agricultural machinery trends and innovation.

9.2 Funding

The two training centres since inception have been relying on the statutory allocation from the Federal Ministry of Agriculture and Water Resources, Abuja for its funding. The funding has not been able to meet the required optimum set objectives of the centers. Also funds are not generated internally as the two centres do not charge any money from trainees. Adequate funding in the area of provision of training equipment and machines together with other teaching/practical aids is very necessary to assists in meeting other objectives.

9.3 Quality of Trainees

Some of our trainees are semi-illiterates thereby making it extremely difficult for the Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) Training Resource persons to impact the knowledge and skills during theory and practical sessions effectively. In addition, these categories of trainees may be found to be practically good on the job but the challenge remains that they need to acquire the basic education to be able to fit into future training programmes of Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC). The possession of either the Senior Secondary School Certificate or Technical College Certificate as the entry requirement for future trainings will also ensure better service delivery. The need to embrace adult education by these categories of agricultural machinery operators and mechanics is of paramount importance.

9.4 Networking

Networking is an important aspect in the accelerated growth of an institution. Networking can be with other similar institutions or with industry. In either case, it gives opportunity for sharing of resources and especially information for faster development. Unfortunately, the two AMMOTRACs do not have well developed networks due to the following reasons:

- The existing frame work does not allow sufficient networking with other similar mechanization training institutions around the world.
- There are no funds to enable activities that would make networks meaningful and interesting.

9.5 Quality of AMMOTRAC Certificate

The two training centres merely issue certificates of participation at the end of each training programme. Most trainees complain that Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) certificates could not earn them conversion, for instance from the post of chief tractor operator to the post of technical officer talkless of promotion in their work places, hence the disappointment in coming regularly to attend different Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) training programmes. There is therefore the need for the two centres to liaise with relevant educational authorities like the National Board for Technical Education, College of Technology, School of Agriculture, Universities and even the Federal Ministry of Employment, Labour and Productivity for the purpose of upgrading its certificate.

10. CONCLUSION AND RECOMMENDATION

This paper has identified low competence level of several agricultural machinery operators and mechanics as the major constraint to successful mechanization practice in Nigeria. The two AMMOTRACs have the capabilities for training and retraining agricultural machinery operators and mechanics including the potential to conduct training programmes on mechanization that covers all areas of agricultural activities. The Federal Government should provide adequate institutional support and infrastructures through adequate funding for accelerated development of the two centres at Akure and Misau. It is recommended that farmers, organizations, establishments, parastatals, research and educational institutions and other stakeholders involved in mechanization practices in Nigeria should avail themselves of the various training opportunities available at the two training centres for their overall training needs.

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A PROPOSED COMMUNITY-BASED PARTICIPATORY TECHNOLOGY DEVELOPMENT PROGRAMME (COPATED) FOR MECHANIZATION OF SMALL FARMS IN NIGERIA

J. C. Adama[1], A. P. Onwualu[2], and C. O. Akubuo[3]
[1]Agricultural Engineering Department, Michael Okpara University of Agriculture Umudike, P.M.B 7267, Umuahia, Nigeria adamajoseph@yahoo.com
[2]Raw Materials Research and Development Council, P.M.B 232, Abuja, Nigeria ponwualu@yahoo.com
[3]Agricultural Engineering Department, University of Nigeria, Nsukka, Nigeria

ABSTRACT

This paper describes a proposed Community-Based Participatory Technology Development programme (COPATED) which, if implemented, has high potentials in mechanization of small farms in Nigeria. The programme is based on the establishment of centres for small farm mechanization in viable communities in the country. Membership of each centre is restricted to farmers sharing common farm boundaries. The farmers govern themselves and formulate their policies with respect to the type of machinery and other inputs they need and the production systems to use. The role of governments and their existing agencies is to provide technical and economic assistance and advice to the centres. Technology based Non-Governmental Organizations are to provide necessary organizational and logistics supports. The advantages of the proposed approach over the conventional ones are discussed.

KEYWORDS: Community, participatory, mechanization, small farms.

1. INTRODUCTION

Nigeria is the most populous country in Africa with a population of 140,003,542 on a land mass of 92.4 million hectares out of which 68 million hectares are good cultivable land with lakes and rivers spanning through the ecological zones (FMARD, 2004; Ogumola, 2006; FGN, 2007). Also, the country has diverse vegetation capable of supporting a heavy population of livestock as well as 267.7 billion m^3 of surface water, 57.9 billion m^3 of underground water and reasonably abundant rain fall of between 300mm – 4000mm (FMAWR, 2008).

In the sixties, before the discovery of oil, high level of food production was achieved through the mobilization of millions of small and medium scale farmers across the country. Then, there were abundant food and raw materials which satisfied effective demand without resort to importation (Liman, 1979). Then, over 80% of all foreign exchange earnings came from agriculture (Oguleye, 1992). But oil has since changed that picture. For instance, in 1970, out of ₦220.9 million spent by the government, over ₦176 million came from oil. Between 1979 and 1983, production stood at 2.3 billion barrels a day. Total earnings within that period stood at ₦43.6 billion from oil alone (Chukwuemeka, 1993). This development caused the share of agriculture in Nigeria's exports to decrease from 80% in the sixties to a disappointing 3.7% in 1980 (Odigboh and Onwualu, 1994).

The fortunes from oil notwithstanding, successive governments experimented with different programmes and agencies to rejuvenate the agricultural sector. Some of these programmes and agencies (Table 1) have agricultural mechanization as a cardinal mandate. In addition to these agencies and programmes, the New Partnership for African Development (NEPAD) and Millennium Development Goals (MGD) have interesting programmes aimed at developing African agriculture for poverty eradication (Asika, 2005; FGN, 2006).

Table 1: Some Government Programmes and Agencies with Agricultural Mechanization Related Mandates.

S/N	Programme and Agency	Acronyms	Remarks
1	Farm Settlement	FS	Regional level
2	National Accelerated Food Production Project	NAFPP	Federal level
3	Agricultural Development Project	ADP	State level
4	Nigerian Agricultural Cooperative and Rural Development Bank	NACRDB	Federal level
5	Operation Feed the Nation	OFN	Federal level
6	Commodity Board	CB	Federal level
7	National Agricultural Credit Guarantee Scheme	NACGS	Federal level
8	River Basin Development Authority	RBDA	Federal level
9	Land use Policy	LUP	Federal level
10	Green Revolution	GR	Federal level
11	National Centre for Agricultural Mechanization	NCAM	Federal level
12	Directorate of Foods, Roads and Rural Infrastructure	DFRRI	Federal level
13	National Directorate of Employment	NDE	Federal level
14	Rural Agro Industrial Development Scheme	RAIDS	Federal level
15	Crop Storage Unit	CSU	Federal level
16	Strategic Grains Reserve	SGR	Federal level
17	Rural Artisan Training and Support Unit	RATSU	Federal level
18	Agricultural Machinery Mechanics and Operators Training Centre	AMMOTRAC	Federal level
19	Tractor and Equipment Hiring Units	TEHU	State level
20	National Agricultural Land Development Authority	NALDA	Federal level
21	Departments of Rural Development	DRD	Federal and State levels
22	Family Economic Advancement Programme	FEAP	Federal level
23	National Poverty Eradication Programme	NAPEP	Federal level
24	National Economic Empowerment and Development Strategy	NEEDS	Federal level
25	State Economic Empowerment and Development Strategy	SEEDS	State level
26	Local Economic and Environmental Management Programme	LEEMP	State level
27	National Programme for Food Security	NPFS	Federal level
28	National Food Reserve Agency	NFRA	Federal level
29	Commercial Agriculture Development Programme	CADP	Federal and State levels

Sources: Ajayi, 1974; Kolawole, 1974; Ijere, 1976, 1991; Oranyeli, 1979; Oyaide, 1979; Taylor, 1979; Anazodo, 1987; Aina, 1993; Odigboh and Onwualu, 1994; FMARD, 2004, Onwualu et al, 2006; FMAWR, 2008; Stambler, E. 2010; Adeoti and Umah, 2010.

The concept, formulation, implementation and problems, of these agencies and programmes have been extensively discussed by the above authors. And from the discussions, there are indications that most of these agencies and programmes failed to achieve the cardinal objectives of Nigerian agricultural system which includes: achieving self sufficiency in food and raw materials production, modernization of agricultural production, processing and storage and markedly improving the quality of rural life in Nigeria (FMA, 1988). Some of the reasons identified to have caused the failure of a number of the programmes and agencies are that most of them neglected community structural approach, adopted a top down approach and failed to optimize local resources (Anazodo, 1980; Ijere, 1991; Odigboh and Onwualu, 1994). That is, they were not people oriented and therefore, as soon as the government withdrew its participation, the projects died. It is argued and believed that if the farmers are involved from the

beginning and the programme is taken as theirs, sustainability will be ensured as they would go on even when government support is withdrawn.

The objective of this paper is to present a proposed programme for mechanization of small - scale farms in Nigeria from where over 80% of the agricultural products used in this country come (Anazodo, 1982a; Odigboh, 1988; FMAWR, 2008). This is part of a study which was carried out by a systematic review of past agricultural policies and programmes and a field survey of small - scale farmers in order to identify their mechanization problems and willingness to accept and adopt programmes developed for mechanizing their farms, although the results of this survey had been published elsewhere (Adama, et al; 1998). The present proposal is based on the experiences gained from that survey. Programmes like this have the potential of not only making Nigeria to be self sufficient in food production but to produce enough raw materials to sustain a robust manufacturing sector (Onwualu et al, 2009; Onwualu, 2010).

2. THE PROGRAMME

2.1 Problem Statement

In spite of the stifling economic climate in the country, the government has continued to pursue policies and programmes that would ensure the realization of the national goal to achieve self sufficiency and self reliance in food production and thus meet domestic and industrial demands.

The problems facing the mechanization of small - scale farms in Nigeria have been subject of discussion by a number of researchers (Oyolu, 1976; Anazodo, 1980; Anazodo, 1982a; Anazodo, 1982b; Odigboh, 1988; Ijere, 1991; Odigboh and Onwualu, 1994; FMARD, 2004: FMAWR, 2008). Some of these problems are: land tenure system which has made it difficult for the government or private organizations to acquire land for large scale cultivation especially in the south; lands which are fragmented with odd shape, scattered and with long distances between them – problems which do not lend themselves for economic introduction of tractorized equipment. Other identified problems include: high cost of mechanical inputs such as tractors, implements, etc – problem which has forced the farmer to use hand tools for all tillage and farming operations with only the motive power available being what he and his wife can generate from their aged or aging muscles; neglect of the farmers real problems when formulating agricultural programmes (top down approach) and neglect of agricultural mechanization components in past programmes Also identified are: inadequate supply of other inputs such as fertilizer, agro-chemicals and seeds ; poor extension service; lack of infrastructural facilities such as roads, water, electricity and storage systems; low returns on investment; aging and unorganized farmers; dearth of reliable planning statistics, etc. Another important problem that faces the mechanization of small farms is government interference with the operations of the agencies that are set up to assist in mechanizing the operations. An example is the River Basin Development Authority which was 11 in number by 1976, 18 in 1984, and by Decree No 25 of 1988, the number was reduced to 11. At the same time, the authority has been moved from one Ministry to the other and so are their functions and mandates (Ijere, 1991). Another case in point is the National Agricultural Land Development Authority, NALDA. This agency was involved in mechanized bush clearing and tillage operations, extension services, supply of bio - chemical inputs, etc. It acquired and distributed many tractors and farm implements to states for farm operations (Table 2). The authority was moved from the Presidency to Federal Ministry of Agriculture and Natural Resources, only to be scrapped in January, 2000.

Table 2: List of Tractors and Implements Inherited by Department of Rural Development from Defunct NALDA

S/N	State	Tractor	Implements										
			Disc Plough	Disc Harrow	Disc Ridger	M/B Plough	Bund Former	Ditcher	Tipping Trailer	Rotary Slaher	Stihl C/Saw	PTO Compressor	Water Bowser
1	Abia	1	1	1	1	1	1	1	1	-	3	-	-
2	Adamawa	8	8	7	6	-	2	2	3	1	-	1	1
3	A/Ibom	2	2	2	1	-	2	2	2	1	1	-	-
4	Anambra	2	2	2	2	-	2	2	2	1	-	-	-
5	Bauchi	7	6	5	5	-	1	2	2	-	-	1	1
6	Bayelsa	1	1	1	1	-	1	1	1	1	-	-	-
7	Benue	5	4	4	4	1	2	2	3	1	-	1	1
8	Borno	7	7	6	6	2	2	2	2	-	-	1	1
9	C/River	4	3	3	2	-	2	2	2	1	2	-	-
10	Delta	2	2	2	2	-	2	2	2	1	-	-	-
11	Ebonyi	3	3	3	2	-	2	2	2	1	-	-	-
12	Edo	3	3	3	4	1	2	2	2	1	-	-	-
13	Ekiti	5	4	4	4	1	1	1	1	1	-	-	-
14	Enugu	3	3	3	3	-	1	1	1	1	-	-	-
15	FCT	6	6	6	5	-	2	2	2	1	-	-	1
16	Gombe	7	7	6	6	-	1	1	2	-	-	-	-
17	Imo	3	2	2	2	1	2	2	2	1	-	-	-
18	Jigawa	10	8	9	8	1	2	2	4	-	-	1	1
19	Kaduna	8	8	7	7	1	2	2	3	-	-	1	-
20	Kano	8	8	7	7	1	2	2	3	-	-	1	1
21	Katsina	10	9	8	8	1	32	5	1	-	1	-	1
22	Kebbi	8	8	7	7	1	2	2	2	1	-	1	1
23	Kogi	6	5	5	5	-	2	2	3	1	-	1	1
24	Kwara	7	7	7	8	1	2	2	3	1	2	1	-
25	Lagos	5	4	4	4	-	2	2	2	1	-	-	-
26	Nasarawa	6	6	6	6	1	1	1	1	-	-	-	-
27	Niger	6	6	5	4	1	2	2	3	-	-	1	-
28	Ogun	3	3	2	2	-	2	2	2	1	-	-	-

29	Ondo	4	3	3	3	1	1	1	1	1	1	-	-
30	Osun	3	3	2	2	-	2	2	2	1	-	-	-
31	Oyo	5	4	4	4	1	2	2	2	1	-	-	-
32	Plateau	11	10	10	8	1	1	1	3	1	-	1	1
33	Rivers	2	2	2	1	-	1	1	1	1	4	-	-
34	Sokoto	8	5	7	6	3	1	1	1	-	-	1	1
35	Taraba	8	8	7	6	-	3	2	3	1	-	1	1
36	Yobe	7	5	6	6	-	2	1	2	-	-	1	1
37	Zamfara	7	4	7	6	2	1	1	1	-	-	-	-
	Total in place	201	178	177	164	23	63	62	80	25	14	16	10
		-	-	-	-	13	-	1	-	-	41	-	-
	Total	201	178	177	164	36	63	63	80	25	55	16	11

Source: Elesa, 2003.

A quantitative analysis of these problems was done elsewhere (Adama, et al.; 1998) using agricultural mechanization indices developed by (Anazodo, 1982a). In spite of government efforts, these problems have persisted and therefore call for continuous studies to develop new programmes that would tackle most or all of them.

For increased food and fibre production, agricultural production systems especially at family farm level must be improved by mechanizing the operations. The benefits of agricultural mechanization have been discussed by a number of researchers (Anazodo 1980; Onwualu, et al; 2006). Table 3 presents rates of operation achieved by hand and mechanical powered systems thus providing further justification for agricultural mechanization.

Table 3: Rates of some farm operations using hand and mechanical power systems

S/No	Operation	Hand power (Ha/Man-day)	Mechanical (Ha/h)
1.	Shrub Clearing	0.03*	0.68^{+}
2.	Ploughing	0.02*	0.44*
3.	Harrowing	-	0.64^{+}
4.	Ridging	0.02*	0.56^{+}
5.	Maize Planting	0.08	0.30^{+}
6.	Cassava Harvesting	0.05*	-
7.	Weeding	0.03*	-
8.	Maize Harvesting	0.06^{+}	1.30^{+}
9.	Fertilizer Application	0.05^{+}	0.50^{+}
10.	Mound Making	0.01*	-
11.	Spraying		
a.	Using Knapsack	-	0.43^{+}
b.	Using Boom Sprayer	-	1.30^{+}

Sources: *****Odigboh, 1988, +Anazodo, 1980, - Not available.

2.2 Concept of the Programme

The programme proposed here is based on the establishment of Centres for Community Farms (CCF) at various locations of the country. Membership of each centre will be limited to farmers sharing common boundaries, forming a contiguous farm land so that the scattered, small sized and fragmented land holdings will be pooled together while maintaining the natural boundary between the farms. Each farmer clears and maintains his portion and receives farm inputs in proportion to the size of his farm within the area.

This approach differs from the nucleus centre model proposed by Anazodo (1986) which was based on the concept of group joint ownership of the large - scale farms. The proposed programme emphasizes individual ownership and care within the large scale farm land. It also differs from NALDA programme in that while NALDA has specific crops for states and/or zones called mandate crops which it supported farmers under the proposed programme grow any crop of their choice provided their choice fits into the type of operation carried out in the centre. The components of the programme include: Machinery Resources Management, Land and Infrastructure, Bio-Chemical Inputs and Extension Services, and General Administration.

2.3 Components of the Programme

2.3.1 *Machinery Resources Management Division (MRM)*

Machinery Resources Management Division is the fundamental component of this programme. It includes the management of tractors and implements. Due to the prohibitive cost of tractors compared to the income status of the farmers, it is difficult now for them (the farmers) especially those of them

who operate on small scale to own the machinery either as an individual or on a shared basis. Also, because of the sizes and shapes of the farms which range from a maximum of 4 ha to as small as 0.1 ha across the country (Oyolu, 1976; FMAWR, 2008), and with odd shapes, fragmented and scattered, tractor hiring companies find it uneconomical to work on these farms (Anazodo,1980).

On this component, this programme recommends that equipment should be supplied to each centre by the Federal Government through an established Board. In the centre, the equipment will be supplied to the most viable farmer in form of interest free loan. The loan will be given by the NACRB to be guaranteed by the ACGS. The most viable farmer in a centre will be determined by the Board based on size of holdings in the centre, financial base, experience, etc. The equipment should belong to an individual instead of the group. This will eliminate the problems experienced in the cooperative society approach. The equipment will be used for association members only. The beneficiary (the most viable farmer) will pay for the machines at an interest free cost. Operations will be subsidized by the government through the Board. For instance, if the cost of carrying out ploughing operation in the area is ₦1000 per hectare, the cost for doing the job for a member at 25% subsidy in the centre will be ₦750 per ha and a farmer who has 0.2ha in the pooled area will pay ₦150 for ploughing. This amount is affordable by most rural farmers. The cost of the equipment will be paid gradually from the generated fund.

In addition to Field Production machines, this Division will also take care of machines for processing, storage, handling, distribution, water supply, irrigation, erosion control and other rural infrastructure

With the establishments in various locations, the state governments will then progressively phase out TEHU and convert them into machinery repair and maintenance centres to compliment the two AMMOTRAC centres at Akure and Misau.

2.3.2 *Land and Infrastructure Division*

Past programmes were developed on the assumption that there were abundant land resources for large - scale mechanized farming which could be acquired from the owners and leased out to private individuals by the government as provided for in the land use policy. Because of land tenure system in the country, this assumption did not work especially in the south. Attempts made by the government to acquire land and lease to private individuals are often met with strong petitions and in some cases to destruction of life and property (Ijere, 1991).

In the new programme, the land belongs to the people and it is used by them. That is, the farmers in a centre must be owners of the pooled area either as individuals or as members of the family owning the merged area. This system will guarantee the availability and security of the farm and the equipment there. The pooling of the lands will give an economic size holding for introduction of tractorized machinery and equipment. Because of the dwindling capacity of the government to provide infrastructures this time even in the urban centres, it is recommended in the programme that all the infrastructures needed by the farmers will be built by the farmers using local materials such as bamboo, palm fronts, grasses, earth, tree trunks, etc which could be easily sourced. Such infrastructures include: houses, roads, culverts, wells, drainage systems, ponds, etc. The farmers will also undertake the maintenance while the government supervises.

With the farmers providing the infrastructures and therefore taking them as theirs, vandalization will reduce. As the farm grows in size and output, then the need and resources for the provision of improved infrastructures will be gradually met. The needed resources shall be agreed on by the farmers and managed by them in a Community Based Natural Resources Management System as in the present case of Local Economic and Environmental Management Programme (LEEMP) and International Institute for Tropical Agriculture (IITA) programme on Cassava processing.

2.3.3 Bio-chemical Inputs and Extension Services Division

The cost of bio-chemical inputs is directly affected by the cost of seeds, seedlings, cuttings, fertilizer, spray chemicals, etc. The inputs costs are not to be subsidized. The Board will procure the inputs and deliver them to the centre. Members buy them on cash and carry basis and not cost recovery. Farmers are willing and can afford the cost of the inputs. The problem has been how and where to source for them. The quantity to be sold to a farmer in a centre will depend on the size of his holding. For instance, one hectare of sole maize production requires 25kg of improved hybrid maize seeds and 1kg of maize seed costs ₦60. The total quantity of each input to be supplied to a centre will be worked out and will be determined by the total size of the pooled area. This approach differs from the agro service system (Singh, 1979) where inputs supply is at a particular location in a zone not known to many of the rural farmers. Inputs in the centres are hijacked by business men. In this case, the input goes to the farmers directly in pre-determined quantity – the farm size – which now serves as a holding factor unlike the cooperative society method of the past.

The cost of extension service will be borne by the government. The extension agents should be full time staff of the board, posted to each centre.

2.3.4 General Administration Division

Each CCF is to be managed by a Board of Directors which will be made up of members of the farmers owning the pooled area (Fig 1). This composition will ensure that the machinery beneficiary does not abuse the entire exercise. The activity of the CCF board members will be supervised by a National Board. The administrator of the CCF will utilize the existing systems of organization of communities in Nigeria such as the age grades in the south, the feudal systems of the north, etc. Such existing systems shall be fine tuned into a Community Based National Resources Management System which has to be developed after series of workshops with farmers. The board will from time to time obtain inputs from farmers on issues such as required technologies using the techniques of Participatory Technology Development (PTD).

2.4 National Board for the Mechanization of Small Farms (NBMSF)

It is specifically, recommended in this programme that an agency to be called National Board for Mechanization of Small Farms be established at the federal level to work directly with the Centres for Community Farms in various locations in each state or local government. The board should be placed under National Centre for Agricultural Mechanization (NCAM) and should be funded from the Presidency. The board should be headed by a deputy director who reports to the Executive Director of NCAM. In the states, it should be headed by coordinators. Figure 1 shows the organ gram of how the programme will be operated from the Presidency down to the wards, kindred, family and the farmer.

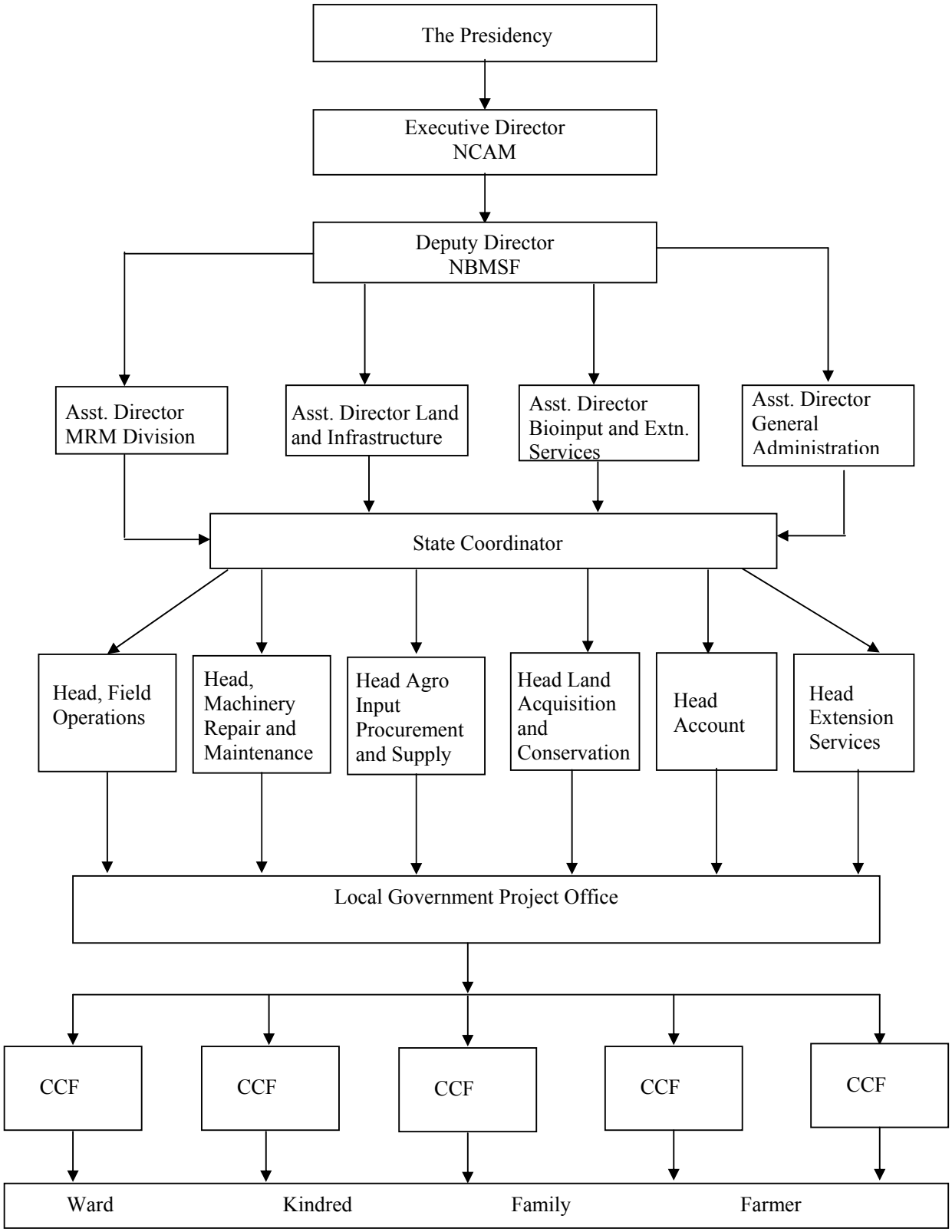
The Presidency
Executive Director NCAM
Deputy Director NBMSF
Asst. Director MRM Division
Asst. Director Land and Infrastructure
Asst. Director Bioinput and Extn. Services
Asst. Director General Administration
State Coordinator
Head, Field Operations
Head, Machinery Repair and Maintenance
Head Agro Input Procurement and Supply
Head Land Acquisition and Conservation
Head Account
Head Extension Services
Local Government Project Office
CCF
CCF
CCF
CCF
CCF
Ward
Kindred
Family
Farmer

Fig. 1. An Organogram for the Proposed Community-Based Programme for Mechanization of Small Farms in Nigeria.

The function of the local government in the programme is to confirm the availability of the land as may be claimed by the group.

Other functions of the board are:

1. Verification or identification of the total size of the farm land in the centre.
2. Determination of the total size of the farm land in the centre and the size of boundaries clearly specified and properly root picked before tractorization.
3. Determination of the most viable farmer in a centre and ensuring that he gets the equipment.
4. Ensuring that the supplied equipment is used appropriately for the members and at approved cost.
5. Procurement of other inputs and making them available to the farmers in good time and in the right quantity.
6. Recommending to government Federal Department of Agriculture, areas for mechanical bush clearing.
7. Ensuring that the machinery beneficiary pays part of the head cost of the equipment at the end of every season.
8. Repair and periodic maintenance of the supplied equipment.

2.5 Interaction with Other Existing Agencies

The Community based programme is not a replacement for other relevant agencies such as NFRA, NPFS, FDA, ADP, FMAWR, etc. Rather, it is an attempt to better harness the government assistance given by those agencies. Figure 2 shows that the CCF will interact with other agencies by harnessing the assistance which the bodies can give especially the banks which can grant them loans with ease as the farmers already have collateral (the pooled land) and therefore, would not need guarantors any more.

Other linkages will be with universities, research institutes and other wider Non Governmental Organizations (NGOs) which will enable them have access to foreign donor organizations e.g. UNDP, FAO, FADU, USAID, etc.

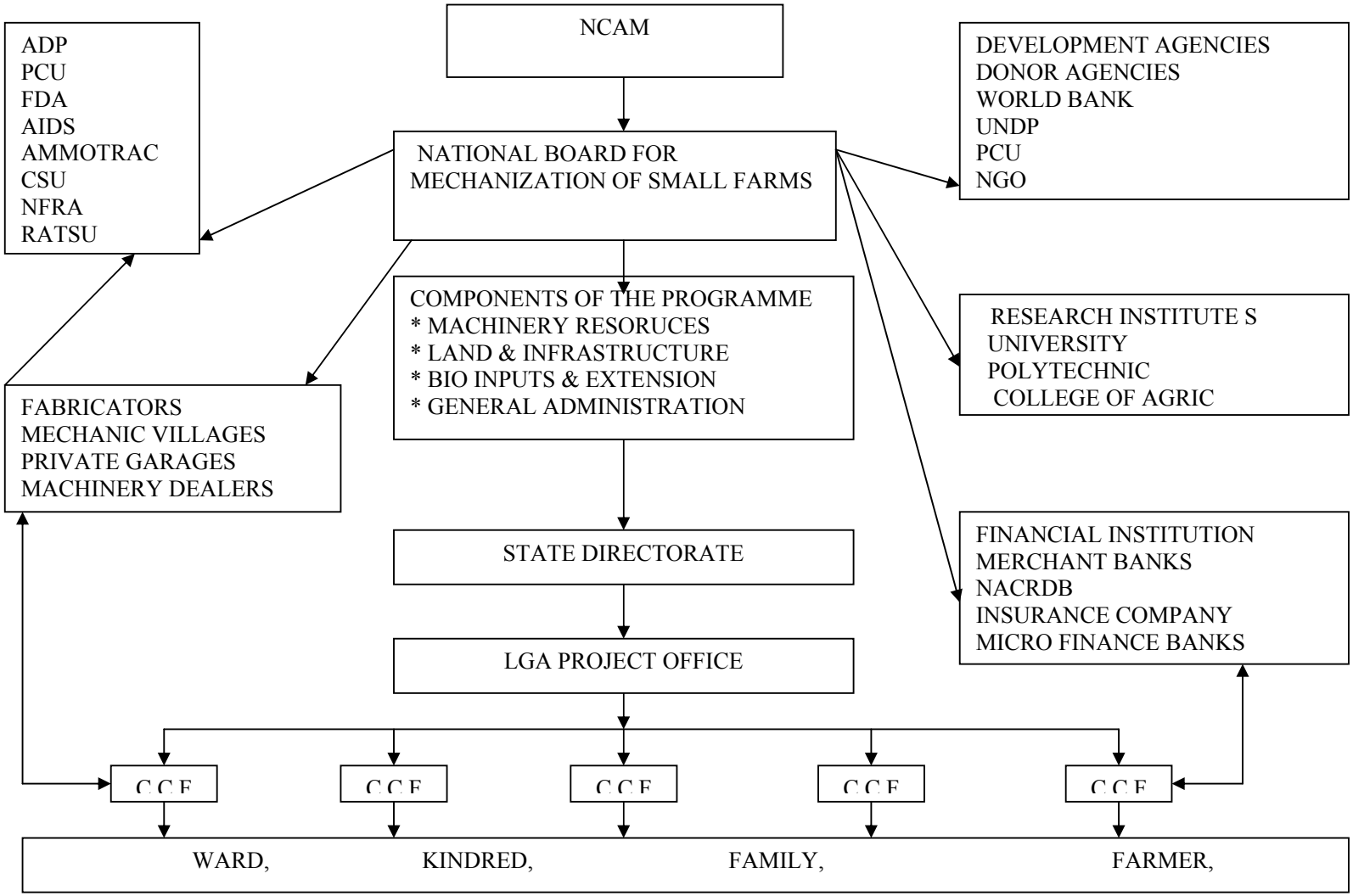

Fig. 2. Interaction between the programmme and other existing agencies

2.6 The Potential Impact of the Programme as a Strategy for Mechanizing Small Farms in Nigeria

It has been often shown that over 80% of the food we eat in this country come from the small scale or family farmers who live in the rural areas poorly served by almost all public amenities (Anazodo, 1980; Odigboh, 1988; Ijere, 1991; FMAWR, 2008).

The implementation of this programme will bring marginal relief to the rural farmers by introducing tractorized equipments, reduce cost of production, increase the quantity and quality of food production, enhance the provision and maintenance of roads, water, electricity and other essential infrastructural facilities and hence cause rural development which will in turn reduce rural urban migration.

A quantitative analysis done elsewhere (Adama, 1997) on a 100 hectare farm after pooling with maize as a sole crop gave a financial efficiency of 301%. Further calculations showed that the farm will require one (1). 36kW tractor, one each, of plough, harrow, ridger, and trailer, 800kg of NPK fertilizer, 2500kg of maize seeds, etc.

3. CONCLUSIONS

A community based programme for mechanization of small scale farms in Nigeria has been proposed. The programme takes into consideration, the land tenure system in Nigeria, the fragmented and small sized land holdings, the dwindling capacity of the government to provide infrastructural facilities needed for mechanizing agriculture especially at a family farm level, the high cost of farm equipment and participation of the rural farmers in the implementation of programmes developed for mechanizing their farms, and enactment of the land use policy.

It differs from other programmes because it seeks to consolidate family farms without attempting to take the land away from the owners. It is also based on the Community Based National Resources Management System embellished with Participation Technology Development Approach.

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FARM TRACTOR UTILIZATION PATTERN FOR VARIOUS AGRICULTURAL OPERATIONS

S. O. Nkakini and B. V. Eguruze
Department of Agricultural and Environmental Engineering,
Rivers State University of Science and Technology, Port Harcourt, Nigeria
nkakini@yahoo.com

ABSTRACT

The level of tractorization in Rivers State in this project is brought under analysis. Information was gathered on tractor utilization pattern in Rivers State, comparing it to existing standard to affirm or highlight problems bothering on mechanized farming in the region. The data obtained from both primary and secondary sources of information were collated and analyzed using descriptive statistics as an index to describe or summarize the characteristics of the observations. The data generated were subjected to Percentage analysis and this reveals that visited farms have sufficient number of hand tools for manual farm operations. Operations such as seedbed preparation, sowing, harvesting and threshing are grossly manually operated, as farms lack implements to mechanize these operations.

By using matching implements, tractors can be put to more use, and other operations that are done manually can be mechanized to boost tractor-hour, more harvest and profitability. It is ideal for the Government of Rivers state to adopt a tractor Utilization scheme to enhance Agricultural development in the present decade and thus will generally ensure a better tractor utilization pattern.

KEYWORD: Farm tractor, utilization pattern, operations, Rivers State.

1. INTRODUCTION

Tractors recently have become the most vital and efficient mechanisms used extensively in agricultural operations. It is the most essential vehicle that does most of the operations in farms, which function covers from land preparation to harvesting and transportation.

Rivers State practiced both subsistence and cash-crop farming and relied solely on human beings as the source of power. However, their productivities were low, according to Lilijedahl et al., (1979) being cited by Nkakini et al., (2006), human beings are limited to less than 0.1kw continuous power output. Eliminating this limitation, the use of tractors for field operation was introduced to boost agricultural productivity and reduce the drudgeries and tedium associated with agricultural operation. Tractor forms the pivot of agricultural mechanization and the basis for the utilization of other machines/equipment for the various agricultural activities such as ploughing, harrowing, ridging, planting, weeding, fertilizer/pesticide application, harvesting and transportation of farm produce. In Rivers State a total of 52 tractors and over 51 units of farms equipment were acquired and distributed to farms in the year 1971. Thus, this government gesture was just for government-owned farms, and the facilities were out of the reach of private agriculturists in the state. Of this number of tractors provided, statistics has shown that 60-65% of the tractors are involved in haulage of agricultural produce while the rest 35-40% are used in the land preparation, operation, ploughing, harrowing, sowing, irrigation and threshing/shelling. Among these various operations, ploughing require more power expenditure, followed by land preparation operation and transportation. The land-preparation operations, namely; tillage and cultivation, break and stir up a soil in readiness for crop planting were predominantly manual operation using universally accepted implements.

The single factor that affects proper utilization of farm tractor is the number of hours the tractors are in use annually. The use of hour meters on farm tractors gives an accurate estimate of the annual use of tractors.

According to experts, a tractor should be used at least 1000 hours in a year. Tractors are not a scale-free technology like seeds and fertilizers. It implies that purchase of a tractor is justified only if there is sufficient work throughout the year, which besides field operations includes transport and stationary work also. Possession of a tractor for small farm holding is quite irrational if viewed from its used pattern. It is for this reason, that tractor in such situation is proving to be a liability rather than an asset due to under utilization. Currently, used tractors are designed for 'all purpose' operations. Operating in a vast range of mounted, semi-mounted and trailed implements and machines, and has hydraulic devices to provide easy and accurate control of the equipment from driver tractor's seat.

In considering the effect of tractors on farming organization, a clear indication has shown that tractors play vital roles for mechanizing agriculture, resulting in the introduction of multiple-cropping, enhancing the total cropping area by developing non-agricultural land into cultivated land. The importance of adequate tractor utilization is not only merely on account of lowering working cost, but also the benefit that arise from relatively improved cultural practices leading to better seedbed preparation for high productivity of crops and its quality.

In Rivers State, tractors and implements are under utilized in all forms of cultural practices in agriculture. Planting and harvesting were predominantly manual operations using universally accepted implements leading to non-use of tractors in these operations. Farmers are used to subsistence farming system and rely mainly on human being as the source of power, hence the application of tractors and implements is restricted due to the farm sizes. In such a case, adoption of tractors for the performance of agricultural operations on a farm like tractive work-seedbed operation, cultivation, harvesting, transportation etc and also stationary work-silage cutting, feed grinding, threshing, winnowing and lifting of irrigation water becomes impossible. Ploughing needs a maximum utilization of tractor followed by land development and transportation; in its full duration of 1000 hours per annum. Therefore, any numbers of hours short of this indicate under utilization of tractor, since the cost of operation per hour decreases with increase in hours of use.

Transporting of agricultural product without adequate loads are good examples of under-utilization of tractor which characterized the attitude of most of the farmers in the state.

The problem of inadequate utilization of tractor may be of two types;
(i) improper utilization of power (ii) improper utilization in terms of duration of use. A tractor with a certain horse power has the capacity to pull certain load, anything short of this, results to underutilization of tractor power.

Nkakini et al., (2006), identified lack of incentive to use of machinery in agricultural practices due to poverty, ignorance, cheap traditional tools which are readily available to the poor farmers. He further re-iterated that resorting to manual labour for agricultural operations has resulted to tractor under utilization in the region.

Various investigations have been carried out on tractor utilization pattern because of its important role in farm mechanization (Pedro and Jenkins 2003). This research on tractor utilization pattern of various agricultural operations is essential to help maximize tractor utilization pattern of mechanized farms in Rivers State. And also, to further mechanize the non-mechanized farm operations for greater productivity and profitability, thereby improving on the income of farmers as well as making food available to the populace. So far no work has been done on tractor utilization pattern in Rivers State.

Due to the vital role tractors play in agricultural mechanization in the tropical rain forests, farmers are able to carry out the various processes involved in land preparation for agricultural purposes - slashing, ploughing, harrowing and ridging over tens and hundreds of hectares of land within a short space of time.

Thus, the study was to explore the existing tractor utilization pattern for various farm operations on farms. This determines the effectiveness in tractor utilization in all field operations and suggests solution for effective pattern of tractor utilization in Rivers State. This research is therefore essential to agricultural mechanization so as to help in projecting mechanization and managing existing tractor utilization pattern.

2. MATERIALS AND METHODS

Rivers State is situated on latitude 05° 21N and longitude 06° 57E (Federal Ministry of Aviation Meteorological Department, 2004). The state has a wide agro-ecological diversity with fishing and farming as the main occupation of the people. Agriculture in the state is predominantly rain fed, with 2369.14mm of average annual rain fall and average minimum and maximum temperatures of 25.1^{o}C and 30.3^{o}C respectively.

Data were collected from several farms both institution and research centers, using both primary and secondary sources. The primary data were obtained from structured questionnaire, personal contacts, oral interview and some inspections were also carried out.

The use of secondary sources also played a vital role in this research. It was through this method that relevant information such as standard tractor hour, tractorization intensity (TI), government policy, agricultural operation standards etc were obtained from agricultural documents such as bulletins, workshop/seminar papers.

For the purpose of this research, the average working hour of tractors and their engagements in various farms as collated from the structured questionnaire and with these, annual tractor working hour was projected and compared to standards on the basis of agricultural practices. The aspects covered, that yielded the needed information for the research includes; farm type and size, number of tractors available in a source location, type of condition (serviceable/broken down), type of farm implements available, type of operations by tractors, seasons and hours of tractor use in a year, equipment hire services, maintenance practices and schedules which were collected from various farms in the state.

The data obtained from both primary and secondary sources of information were collated and analyzed using descriptive statistics as an index to describe or summarize the characteristics of the observations. The data generated were subjected to percentage analysis. Also, the statistical methods of developing effective field capacity (EFC), theoretical filed capacity (TFC) and field efficiency were employed as appropriate (Hanna, 2002).

The effective field capacity of a machine in the field was easily calculated by dividing the acres completed by the hours of actual field time.

$$EF = \frac{A}{Tp + T1} \quad \text{..... 1}$$

Where

EF = effective field capacity, ha/hr
A = area covered, ha
TP = productive time, hr
T1 = non productive time, hr (Time lost for turning, loading and adjustments excluding refueling and machine trouble).

Theoretical field capacity (TFC), depends relatively on the full operating width of the machine and the average travel speed in the field. It can be calculated as:

$$TFC\ (Ah) = \frac{width\ \ x\ \ speed}{8.25},\ m/s \text{.....}(2)$$

Field Efficiency is the ratio of actual or effective field capacity (EFC) to theoretical field capacity (TFC). It is calculated as:

$$EF = \frac{Effective\ field\ capacity}{Theoritical\ field\ capacity} \text{.....}(3)$$

Where

$EF = \ field\ efficiencey\ \%$

3. RESULT AND DISCUSSION

3.1 Characteristics of the Farms

The names of establishment/organization and types of farms visited with their area distribution are given in tables 1 and 2.

In table 1, NDDC main crops cultivation are cassava and rice, IITA Onne, research project mainly on cassava, plantain and banana. However, yam and beans are also grown in rainy season, agro-forestry (agboo tree, cherry and oil crops are mono cropped). Shell farm in Bori yam demonstration farm, pineapple and cassava, with teleflora and plantain are grown. RSUST, university demonstration farm and private small scale farm, but has major crops grown as cassava, vegetable and maize. However, pineapple, pear, guava, orange and plantain are also grown. ADP's demonstration farm concentrated on rice, cassava, yam and maize cultivations also grown are orange, yam, plantain/banana. And RIART had research/commercial project. Legumes and local pears are the major crops grown, while others grown include cereals, root, crops, citrus and mango.

From Table 2, it was clear that all the six farms have on the average 68.26% of their total area for agricultural use, about 31.74% of these croppable areas are unused. From Table 2 NDDC, of the 340ha, 97.1% is developed into cultivable fields, 2.94% is building area. The whole area is rainfed and there is a borehole for irrigation used mainly during dry season, especially for the rice.

From Table 2, IITA farm, of the 100ha, 95% is developed into agricultural, grassland, animal husbandry and forestry and 0.04% is used for building, while 0.01% for road network.

From Table 2, Shell farm, of the 13ha of the total area, 96.2% is developed into cultivable fields, 5.8% area is under building, and 0.03% is for horticulture.
From the table, showing RSUST farm, of the 129.6ha, 45.2% is developed into cultivable fields, 3.4% area is under building while 1.85% for horticulture.

From Table 2, ADP farm of the 30ha, 57.3% is developed into cultivable fields, 16.7% area is under building and 1.67% is for horticulture.
RIART farm, of the 158ha, 8.1% is developed into cultivable fields and only 4.19% area is under horticulture and 18.9% is for building. The whole area is rainfed.

Table 1: Names of establishment/organization and type of farms

Establishment/Organization	Type of Farms
Niger Delta Developmental Commission (NDDC)	Cassava and rice farms
International Institute of Tropical Agriculture (IITA) Onne	Research work and project -Cassava, Plantain/Banana projects, yam, Beans, Oil Crops.
Agriculture Resource and Training Centre (Shell	Yam demonstration farm - Pineapple and Cassava

farm) Bori	Teleflora and Plantain.
Agricultural Engineering Workshop R.S.U.S.T	University demonstration farm and private small-scale farm - Cassava, vegetable, maize.
Rivers State Agriculture Development Project (ADP)	Demonstration farm - Cassava, major crops yam, maize, rice, orange, Plantain/Banana.
Rivers State Institute of Agriculture Research and Training Onne (RIART)	Research/commercial projects – legumes, local pear, major crops, root-crops, citrus, pea, plantain and Mango.

Table 2: Area distribution of the visited farms

Classification	Area (ha)					
	NDDC	IITA	SHELL	R.S.U.S.T	ADP	RIART
Total Area	340	100	13	129.6	30	158
Building area	10	4	0.75	4.40	5	30
Horticulture	-	-	0.025	2.41	0.5	6.5
Area left for agriculture, grass land, animal husbandry and forestry.	330	95	12.5	58.57	17.2	12.8
Road Network	-	-	-	-	-	-

3.2. Availability of Farm Machinery and Implements

Table 3, showed the available farm machinery and power at the visited farms. The farms have sufficient number of hand tools for manual farm operations. From the table, numbers of tractors are relatively sufficient for the farms, although they are inadequately utilized. By using matching implements, tractors can be put to more use, and other operations that are done manually can be mechanized to boost tractor-hour, more harvest and profitability, thus reduce equipment cost. This will generally ensure a better tractor utilization pattern.

Table 3: Farm machinery availability at visited farms

Implements	Visited farm/number						
	NDDC	IITA	SHELL	R.S.U.S.T	ADP	RIART	TOTAL
Hand Tools	-	-	-	-	-	-	-
Spade	-	20	20	2	10	10	62
Hand Plough	-	-	-	-	-	1	1
Sprayer	2	10	5	-	-	1	18
Watering Can	-	-	5	-	-	-	5
Cutlasses	-	50	-	-	-	-	1
Tractor Drawn							
Cultivator	15	-	-	1	-	2	18
Disc Plough	15	1	2	5	3	2	28
Disc Harrow	15	1	1	5	2	2	26
Ridger	-	1	-	3	1	-	5
Mould Board Plough	-	-	-	1	-	-	1
Planter	-	-	-	1	-	-	1
Rotivator	-	-	1	3	-	-	4
Slashed	15	-	-	4	1	-	20
Thresher (mini)	-	1	-	-	-	-	1
Prime Mover							
Tractor	15	4	1	5	2	3	30
Miscellaneous							
Trailer	-	-	-	5	-	-	5
Bucket	15	-	-	-	-	-	15

3.3 Engagement of Tractors and Equipment

The engagement of tractors at the farms is given in Table 4 a-f of which the 4985.9hrs (NDDC), 6446.2hrs (IITA), 804.8hrs (SHELL), 2760.9hrs (R.S.U.S.T), 1801.0hrs (ADP) and 191.1hrs (RIART) of tractor utilization for the year 2005-2006 respectively. From Table 4a, in NDDC, 23.22% hours were used in transportation, 21.92% in ploughing, 21.92% in harrowing, 21.92% in ridging, 11.23% in slashing. The peak demand for tractor is for transportation operation which is almost constant throughout the year i.e. (January – December). The demand for tractors for ploughing, harrowing and ridging i.e. June – July 2005 for cultivation and November – December 2005 for harvesting and also February – March 2006 for cultivation was almost constant. The demand for tractors in slashing operation is mostly during land preparation i.e. June – July 2005 and February – March 2006.

Table 4a showed that fifteen tractors were constantly engaged throughout the year except in the months of August, September, October, January, April and May in NDDC, which is evidenced from slashing records and the reduction in number of hours in those mentioned months which may be due to continuous wet days and high rainfall characterized to our deltic region. It is also observed from the table that these tractors were engaged mainly for transportation and land preparation operations.

In IITA, 40.24% hours were used in ridging, 20.48% transportation, 17% in ploughing and harrowing, 15.48% in fertilizer application and 7.94% in slashing operations.

The peak demand for tractor is for ridging February and March – April 2006. The demand for tractors for transportation work is constant throughout the year as well. The demand for tractors in ploughing, harrowing and fertilizer application; is from June – July, and November, 2005 for harvesting, January – February and March – April for cultivation.

The Table also showed that tractors were constantly engaged throughout the year except in these months of August, September, October, and December, 2005 and May 2006. Low utilization of tractors in these months may be due to continues wet days and high rainfall which is characterized to deltic terrine. It was also observed from the table that these tractors were engaged mainly for transportation and land preparation operations. The total average tractor engaged throughout the year were forty.

In Shell, 46.67% hours were used in transportation, 23.96% in harrowing, 21.48% in ploughing and 3.85% in slashing work. The peak demand for tractor is for transportation work which is almost contact throughout the year i.e. (January – December). The demand for tractors for harrowing is mostly during planting and harvesting seasons June – July 2005, and April, 2006 respectively. The demand for tractors for ploughing and harrowing during the planting seasons and slashing period.

The table also showed that one tractor is constantly engaged throughout the year, bringing the total average tractors engaged to be twelve. It was also observed from the table that the tractor was engaged mainly for transportations, harrowing and ploughing works.

In R.S.U.S.T, 51.29% hours were in transportation, 12.28% in slashing, 12.14% in ploughing and harrowing respectively. The peak demand for tractors is for transportation work. The demand for tractor for slashing is basically during cultivation and harvesting seasons i.e. June, 2005, February and March 2006. The demand of tractor for ploughing, harrowing and ridging is from June – July for cultivation, November –December for harvesting and February – March for cultivation. The table also showed that four tractors were engaged in June – July 2005 and February – March, 2006. The total average tractors engage during the periods were thirty-five. It was also observed from table that these tractors were engaged mainly for transportation work.

In ADP, 38.87% hours were used in slashing, 26.71% in transportation, 16.14% in ridging, 9.99% in ploughing and 7.77% in harrowing work. The peak demand for tractor is for slashing i.e. July – January 2005, April and May, 2006. The demand for tractor in respect of transportation work is higher during cultivation and harvesting seasons i.e. January – April 2006. The table also showed that two tractors were constantly engaged throughout the year except July – September, December and January, bringing the average tractor engaged to seventeen. It is also observed from table that these tractors were engaged mainly for slashing, transportation and ridging works.

In RIART, 61.54% hours were used in ploughing, 15.38% in harrowing, 15.38% in threshing and 7.69% in weeding work. The peak demand for tractor is for ploughing i.e. January 2006. The table showed threshing operation was done only in month of November and weeding in May, 2006. It was observed from table that average tractors engaged throughout the year were four.

Table 4a: Average monthly use of tractor at visited farm for different operations 2005 - 2006

NDDC FARM							
Month	Average working hour	VARIOUS FARM OPERATIONS					Average Tractor Engage
		Slashing	Ploughing	Harrowing	Ridging	Transpor-tation	
June	710.8	140.0	140.0	140.0	140.0	150.8	15.0
July	710.8	140.0	140.0	140.0	140.0	150.8	15.0
August	301.6	-	75.4	75.4	75.4	75.4	5.0
September	377.0	-	75.4	75.4	75.4	150.8	6.0
October	301.6	-	75.4	75.4	75.4	75.4	5.0
November	570.8	-	140.0	140.0	140.0	150.8	15.0
December	428.9	-	140.0	140.0	140.0	8.9	15.0
January	93.2	-	8.9	8.9	8.9	75.4	5.0
February	710.8	140.0	140.0	140.0	140.0	150.8	15.0
March	710.8	140.0	140.0	140.0	140.0	150.8	15.0
April	35.6	-	8.9	8.9	8.9	8.9	5.0
May	35.6	-	8.9	8.9	8.9	8.9	5.0
Total	4985.9	560.0	1092.9	1092.9	1092.9	1157.7	121.0
Av. working hour/month	415.49	46.67	91.08	91.08	91.08	96.48	10.08

Table 4b: Average monthly use of tractor at visited farm for different operations 2005-2006

IITA FARM								
Month	Average working hour	VARIOUS FARM OPERATIONS						Average Tractor Engage
		Slashing	Ploughing	Harrowing	Ridging	Ferti. Applica	Transpor-tation.	
June	415.8	83.1	49.9	49.9	133.0	49.9	50.0	4.0
July	415.8	83.1	49.9	49.9	133.0	49.9	50.0	4.0
August	27.6	24.6	-	-	-	-	3.0	2.0
September	250.6	24.6	-	-	-	-	266.0	4.0
October	13.0	10.0	-	-	-	-	3.0	2.0
November	460.0	100.0	100.0	100.0	100.0	-	160.0	3.0
December	14.3	10.0	-	-	-	-	133.0	3.0
January	2527.0	-	399.0	399.0	1064.0	399.0	266.0	4.0
February	660.0	100.0	100.0	100.0	100.0	100.0	160.0	4.0
March	1346.6	83.1	199.5	199.5	532.0	199.5	133.0	4.0
April	1346.0	83.1	199.5	199.5	532.0	199.5	133.0	4.0
May	13.0	10.0	-	-	-	-	3.0	2.0
Total	6446.2	511.6	1097.8	1097.8	2594.0	997.8	1320.0	40.0
Av. Working	537.18	42.63	91.48	91.48	216.17	78.98	110.0	3.3

hour/month								

Table 4c: Average monthly use of tractor at visited farm for different operations 2005 – 2006

	SHELL FARM					
Month	Average working hour	VARIOUS FARM OPERATIONS				Average Tractor Engagement
		Slashing	Ploughing	Harrowing	Transportation	
June	103.9	3.9	32.0	32.0	36.0	1.0
July	103.9	3.9	32.0	32.0	36.0	1.0
August	52.1	3.9	12.1	12.1	24.0	1.0
September	64.1	3.9	12.1	12.1	36.0	1.0
October	54.1	3.9	12.1	12.1	26.0	1.0
November	64.1	3.9	12.1	12.1	36.0	1.0
December	60.2	-	12.1	12.1	36.0	1.0
January	48.2	-	12.1	12.1	24.0	1.0
February	60.2	-	12.1	12.1	36.0	1.0
March	60.2	-	12.1	12.1	13.6	1.0
April	93.9	3.9	12.1	32.0	36.0	1.0
May	39.9	3.9	-	-	36.0	1.0
Total	804.8	31.2	172.9	192.8	375.6	12.0
Average Working hour/month	67.07	2.6	14.41	16.07	31.3	1.0

Table 4d: Average monthly use of tractor at visited farm for different operations 2005 - 2006

	R.S.U.S.T FARM						
Month	Average working hour	VARIOUS FARM OPERATIONS					Average Tractor Engage
		Slashing	Ploughing	Harrowing	Ridging	Transpor-tation	
June	367.7	79.3	59.5	59.5	59.5	109.9	4.0
July	402.4	-	79.3	79.3	79.3	164.5	4.0
August	79.8	16.0	-	-	-	63.8	2.0
September	79.9	16.0	-	-	-	63.9	2.0
October	79.8	16.0	-	-	-	63.8	2.0
November	278.0	-	49.1	49.1	49.1	130.7	3.0
December	278.0	-	49.1	49.1	49.1	130.7	3.0
January	79.8	16.0	-	-	-	63.8	2.0
February	472.2	65.5	49.1	49.1	49.1	259.4	4.0
March	472.2	65.5	49.1	49.1	49.1	259.4	4.0
April	58.5	16.0	-	-	-	42.5	2.0
May	112.6	48.8	-	-	-	63.8	3.0
Total	2760.9	339.1	335.2	335.2	335.2	1416.2	35.0
Average Working hour/month	230.1	28.3	27.9	27.9	27.9	118.0	2.9

Table 4e: Average monthly use of tractor at visited farm for different operations 2005 - 2006

	ADP FARM						
Month	Average working hour	VARIOUS FARM OPERATIONS					Average Tractor Engage
		Slashing	Ploughing	Harrowing	Ridging	Transpor-tation	
June	64.0	-	-	-	-	9.0	2.0
July	74.0	64.0	-	-	-	10.0	1.0
August	82.0	64.0	-	-	-	18.0	1.0
September	73.0	64.0	-	-	-	9.0	1.0
October	94.0	64.0	-	-	-	30.0	2.0
November	109.0	64.0	-	-	-	45.0	2.0
December	94.0	64.0	-	-	-	30.0	1.0
January	94.0	64.0	-	-	-	30.0	1.0
February	340.0	30.0	60.0	40.0	120.0	90.0	2.0
March	340.0	30.0	60.0	40.0	120.0	90.0	2.0
April	334.0	64.0	60.0	60.0	60.0	90.0	2.0
May	94.0	64.0	-	-	-	30.0	1.0
Total	1801.0	700.0	180.0	140.0	300.0	481.0	17.0
Average Working hour/month	150.1	58.3	15.0	11.7	25.0	40.1	1.4

Table 4f: Average monthly use of tractor at visited farm for different operations 2005 - 2006

	RIART FARM							
Month	Average working hour	VARIOUS FARM OPERATIONS						Average Tractor Engage
		Slashing	Ploughing	Harrowing	Threshing	Weeding	Transpor-tation	
June	-	-	-	-	-	-	-	-
July	-	-	-	-	-	-	-	-
August	-	-	-	-	-	-	-	-
September	-	-	-	-	-	-	-	-
October	-	-	-	-	-	-	-	-
November	29.4	-	-	-	29.4	-	-	1.0
December	-	-	-	-	-	-	-	-
January	14.7	-	117.6	29.4	-	-	-	2.0
February	-	-	-	-	-	-	-	-
March	-	-	-	-	-	-	-	-
April	-	-	-	-	-	-	-	-
May	14.7	-	-	-	-	14.7	-	1.0
Total	191.1	-	117.6	29.4	29.4	14.7	-	4.0
Average Working hour/month	15.9	-	9.8	2.5	2.5	1.2	-	0.3

3.4 FARM TRACTOR AND IMPLEMENTS UTILIZATION

Several factors were identified as barriers in tractor utilization in the investigation. It was found generally, that none of the farms has a log book. Data realized were largely presumed; and the greatest cause of low tractor usage was partial mechanization, followed by break down of farm machinery, and farm size. However, the greatest reasons for low tractor usage are the breakdown of farm machinery, partial mechanization and farm size which is common in private farms.

However, lack of marching implements is also identified as another cause of partial mechanization. Additional hours of work annually would have been realized if there were other farm operations like planting and threshing on which the tractors could be applied, which would have reduced the cost per hour for the tractor.

Farm machine capacity was influenced by the prescribed field operations, the cropping system and equipment performance (Witney and Eradat 1982. The desired hours of use of different implements and tractors for particular crop and operations was calculated using field capacity of different tractor drawn implements. The effective field capacity of implements depends on their sizes.

Table 5: Effective field capacity of machine for various operations in different farms

Visited farms	Slashing	Ploughing	Harrowing	Ridging	Weeding	Threshing	Fertilizer application	Effective field capacity
NDDC	0.589	0.302	0.302	0.302	-	-	-	0.213
IITA	0.186	0.087	0.087	0.037	-	-	0.095	0.070
Shell	0.401	0.072	0.065	-	-	-	-	0.076
RSUST	0.173	0.175	0.175	0.175	-	-	-	0.099
ADP	0.025	0.095	0.123	0.057	-	-	-	0.043
RIART	-	0.109	0.435	-	0.871	0.435	-	0.264

From table 5 the effective field capacity of machine for various field operations in different visited farms were depicted. The average effective field capacity of machine for various operations are 0.213, 0.070, 0.076, 0.099, 0.043 and 0.264 for NDDC, 11TA, Shell, RSUST, ADP and RIART respectively.

Table 6, showed the Theoretical Field Capacity (TFC) of implements such as disc harrow, disc plough and slasher, as 0.198, 0.215 and 0.173 respectively.

Table 7, showed the field efficiency (%) for different operations for ploughing, harrowing and slashing operations in all the visited farms.

Table 6: Theoretical Field Capacity (TFC)

Implements	Disc Harrow	Disc Plough	Slasher
TCF (ha/hr) Theoretical field capacity	0.198	0.215	0.173

Table 7: Field efficiency (%) for various operations and implements in different farms

Visited Farms	Field Efficiency (%) for Different Operations		
	Field efficiency (%) for different operation	Harrowing	Slashing
NDDC	40	55	40
IITA	40	44	53
Shall	33	30	32
RSUST	81	88	80
ADP	44	62	41
RIART	51	219	-

4. CONCLUSION

The conclusion drawn from the results of analysis of the collected data and other information showed that the farm tractor utilization level in the state was low and was caused mainly by the breakdown of tractors, size of farm and manual methods of operations which was ineffective and inefficient. Quite agreeably, manual methods of operations are cheap, simple and easily available to the farmer, but they are time and energy consuming. Presently, only limited farm activities of bush clearing, tillage and transportation of farm inputs and products are undertaken by tractors in the state.

Most of the farmers still adapt to a fixed cropping pattern like cassava and maize and for this reason the number of working hours of tractor per year are too small.

By proper utilization of tractor, a farmer can reduce cost of operation per working hour of tractor and increase his profitability.

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SUSTAINABILITY AND COST OF AGRICULTURAL MECHANIZATION IN NIGERIA AS AFFECTED BY MACRO-ECONOMIC POLICIES

B. O. Ugwuishiwu[1] and A. P. Onwualu[2]
[1]Agricultural Engineering and Bioresources Department
University of Nigeria, Nsukka, Nigeria
ugwuishiwubo@yahoo.co.uk
[2]Raw Materials Research and Development Council (RMRDC) Abuja, Nigeria
ponwualu@yahoo.com

ABSTRACT

There is no doubt that laudable agricultural development projects have been formulated and implemented by different governments in Nigeria. What is loudly in doubt is their sustainability. The sub-sector where this is most glaring is agricultural mechanization. Although machines have been introduced to our agricultural production in the past, farmers continue to toil with hand tools.

In this paper, linkages are established between macro-economic policies include trade liberalization, currency exchange, subsidy, privatization and commercialization, and financial system reforms. Data are provided to show that the policies resulted in high cost and low demand of agricultural machines and spare parts, low research and decrease in local fabrication, low capacity utilization and folding of farm machinery manufacturing plants and agro-industries.

To create an enabling environment for sustainable agricultural mechanization, exchange rate should be reviewed. Subsidies reintroduced, privatization and commercialization reviewed, local equipment manufacturers and dealers encouraged, and community development associations organized for joint procurement and use of agricultural machinery. Government role in these areas should be restricted to creating the enabling environment, monitoring and evaluation.

KEYWORDS: Sustainability, agricultural mechanization, macro-economic policy, agricultural development

1. INTRODUCTION

Towards the middle of 1986, the Federal Government initiated a reform programme called Structural Adjustment Programme (SAP). The salient features of SAP included, inter alia, the adoption of market controlled exchange rate for the naira. Liberalization of interest rates, trade liberalization through removal of price controls and import licensing, privatization and commercialization of public utilities and removal of subsidies and fiscal and monetary restraints to arrest the inflationary tendency of the economy (Jayaramn, 1994; CNB/NISER, 1991). Ten years into the implementation of SAP (1986-1996) statistics show mixed results for the agricultural sector of the economy. For instance, SAP redressed the problems of price distortions and the balance of payment disequilibrium. However, these gains have been accompanied by many problems such as sharp rise in cost of production, hike in interest rate, decline in real income and fuel. In particular, it became impossible for the farmers to own and operate agricultural machinery. The cost of tractors rose by more than 2000 percent in the last 10 years while the cost of implements rose by over 1000 percent, with corresponding increase in the cost of spare parts. (CNB/NISER, 1991)

The National Agricultural Policy (1981-1985) has its objective as the reduction of drudgery in agriculture by providing mechanization. However, it appears that the sustainability of these programmes in general and agricultural mechanization in particular is being adversely affected by the undesirable impacts of SAP presented above. After a decade of implementation of SAP, it is relevant

to take stock in order to recommend how the policies can be restructured in order to eliminate the undesirable effects especially in key sectors of the economy such as agriculture.

The principal objective, of this study was to investigate the extent to which agricultural mechanization is affected by the key policy instruments embodied in the Structural Adjustment Programme (SAP). The specific objectives were to:

(a) study the present status of agricultural mechanization in Nigeria;
(b) review macro-economic policies and environment in Nigeria
(c) Examine the effects of macro-economic environment on cost, availability and use of farm machinery, equipment and spare parts; and
(d) develop a medium and long term strategy towards adjusting the policies to ensure sustainability of agricultural mechanization.

2. METHODOLOGY

The first part of the research involved a survey and detailed study of the macro-economic environment in Nigeria since1986 in order to have detailed information of the formulation and implementation of the various policies by government. This involved study of reports of selected Federal Establishments including Federal Ministry of Finance, Central Bank of Nigeria (CBN), Nigerian Institute of Social and Economic Research (NISER), Federal Office Statistics (FOS) as well as relevant books and literature. Information collected includes the objectives of various SAP policies and reforms, types of agricultural policies and currency exchange rates in Nigeria.

The second part of the work involved data collection from dealers of farm machinery, equipment and spare parts. Some of the dealers consulted include BEWAC, Tractor and Equipment, Holt Engineering, UTC, and Allens. Data were also obtained from relevant institutions such as Project Development Institute (PRODA), Universities, ADPs, NALDA, Tractor and Equipment Hiring Units and Engineering Divisions of some states Ministries of Agriculture.

The third part of the data collection exercise was from dealers and users of agricultural machinery. Most of the farmers were reached through extension agents in some state ADPs. This is part of an on-going exercise towards the collection of relevant management data from farmers. The data and observations reported in the paper represent average values from several sources rather than from a specific source.

3. AGRICULTURAL MECHANIZATION STATUS IN NIGERIA

Agricultural mechanization is the application of engineering principles and technology in the design, development, manufacture, selection, testing, adoption, operation and maintenance of tools, implements, machines, structures and other technological systems and gadgets. The aims are to reduce human drudgery, improve timeliness and efficiency of farm operations, bring more land under cultivation, increase the quality and extend the storage life of agricultural products, provide better living conditions and markedly advance the economic growth of rural sector (Anazodo, 1980).

Agricultural mechanization in Nigeria can be classified into three levels of technology: Hand-Tool Technology, (HIT) Draught Animal Technology (DAT) and Engine-powered Technology (EPT) (Odigboh and Onwualu, 1994). Hand-tool technology is the simplest and more basic level of agricultural mechanization where human beings are the power source. This make use of such tools and implements as machetes, cutlasses, hoes, diggers, axe, spades, shovels, trowels, rakes, forks, mattocks and shears. It is the lowest, oldest and the most primitive level of agricultural mechanization. About 86 percent of the cultivated area in Nigeria is tilled and farmed using these tools and this is the highest in Africa shown in Table 1.

Table 1: Sources of power for various primary land preparation in various countries

Country	Percentage of total cultivated land		
	Human energy	Draught animal	Mechanical power
Nigeria	86	4	10
Botswana	20	40	40
Zimbabwe	15	30	55
Tanzania	80	14	6
Kenya	84	12	4
Ethiopia	10	80	10
Zambia	55	15	30
Switzerland	15	35	50
Uganda	70	20	10
China	22	26	52
India	18	21	61

Source: Odigboh and Onwualu, 1994

Draught-Animal Technology is the next level of agricultural mechanization and refers to a wide range of implements, machines and equipments which are powered by such animals as mules, oxen, horses, buffaloes, camels and donkeys. It is used to a great extent by farmers in the northern part of Nigeria where it provides some marginal relief for the drudgery inherent in field operations such as tillage. Some of the problems limiting the use of this technology in Nigeria include: high incidence of tsetse fly, stress suffered by the animal due to high temperature and relative humidity condition in the tropics, high cost of maintaining the animals.

Engine-Power Technology is the highest and most modern level of agricultural mechanization. It refers to a very wide range of implements, machines and equipment powered by a similarly wide range of mobile or stationary motive sources (engines and motors), using petroleum fuels, or electricity, power sources and their associated implements are available in size, power rating, level of sophistication and technical complexity that vary tremendously.

The most common and best known power source in agriculture today is the tractor which comes in a wide range of types, makes, size, power rating and capabilities. The level engine power technology use in Nigeria agricultural is relatively low (Table 1). Report by Anazodo (1988) showed that tractorisation intensity for Nigeria was 0.24h/ha as against the recommended figure of 1.5h/ha. Thus the level of machinery used in agricultural is still low. The danger is that this is even on the decline.

This situation can be set against the background of the numerous agricultural development programmes at various stages of implementation in the country. These programmes include farm Settlement Scheme, National Accelerated Food Production Projects. Rural Agro-Industrial Development Scheme Directorate of Foods, Roads and Rural Infrastructure, River Basin Development Authorities, National Land Development Authority, National Centre for Agricultural Mechanization, Family Economic Advancement Programme, Agricultural Mechanics and Machinery Operators Training Centre (AMMOTRAC) etc. The contributions and potential impacts of these other agencies towards agricultural mechanization have been reviewed by many authors (Ijere, 1991; Odigboh and Onwualu, 1994; Anazodo *et al.,* 1987; Makanjuola *et al* 1991; Onwualu, 1998; Ajibola, 1997; Oni, 1994; Adama *et al.,* 1997; Odigboh, 1997).

These reviewers have shown that although these programmes have and are making significant progress towards introducing machines in agriculture, getting the farmers to acquire and use the machines on a sustainable basis is still a mirage. The hypothesis of the present paper is that unless the economic environment is adjusted to encourage the sustainable use of these machines, agricultural mechanization will continue to be a dream rather than a reality.

4. MACRO-ECONOMIC POLICIES IN NIGERIA

Since the onset of SAP in 1986, Nigeria has embarked upon macro economic reforms which combine short-term stabilization policies designed to alter the structure of production and consumption and put the economy on a path of sustainable development.

The implementation of the economic policies was based mostly on the recommendation of the World Bank and International Monetary Fund (IMF). The two Financial Institutions believed that most of the economic problems emanate from over-valued exchange rate, too many controls on the economy, over-bloated public service, government involvement in production sector, ineffective tax policy formulation and implementation, unwarranted over protection of local manufacturing enterprise by import tariffs and deregulation of the financial industry (CBN/NISER, 1991). The implementation of SAP in Nigeria resulted in mixed reactions with respect to its implications for the manufacturing industries and agricultural development. The major focus of the policies is the promotion of efficiency and self-reliance. The implemented reforms can be discussed under the following categories

(a) Currency exchange rate policies,
(b) Price control and trade liberalization policies,
(c) Privatization and commercialization of public utilities policies,
(d) Subsidy policies
(e) Wages and civil services reforms and
(f) Reforms of financial system.

4.1 Currency Exchange Rate Policies

With the introduction of SAP, foreign exchange allocation and import licensing procedure were abolished and new foreign exchange policy – Foreign Exchange Market (FEM) was introduced. The exchange rate varied from a position of about one US Dollar to one Naira in 1986 to the current value of one Dollar to ₦125. The new exchange policy has helped to remove the over-valuation problems like alteration in competitiveness and profitability of farming in favour of other activities especially trading. With regard to imports, exchange rate over-valuation helped to cheapen imports of competing food items as well as agro-based industrial raw materials CBN/NISER, 1991). In principle, the sharp depreciation of the Naira boosted export earning and producer price of export crops.

4.2 Price Control and Trade Liberalization Policies

In the past, marketing of most cash crops, especially those meant for export was handled on behalf of government by commodity boards. These boards were hardly given any competition by the private sector excerpt when traded commodities were not meant for export. The main stands of marketing and pricing policy were that these boards fix prices for agricultural commodities and handled exclusively export trade. The activities of commodity boards in Nigeria, prior to their abolition in 1986 were major sources of disincentives to farming. Evidence showed that farmers faced many implicit taxes, apart from the conventional trade tariff and protection bias, as a result of the pricing policies adopted by the marketing boards.

Since SAP, the commodity boards had been abolished and free-market pricing has been introduced in line with trade liberalization policy. This has helped to eliminate the excessive implicit taxation in farm incomes which were inherent in the operation of the commodity board system. The prices, have not only converged with world market prices but are further boosted by the sharp depreciation in the value of local currency. Farmers are therefore able to compete effectively both in product and factor market including the market for labour. In addition, farmer exporters were allowed to retain the foreign exchange proceeds from exports trade. Unfortunately, the new arrangement has not provided

the desired stability to cushion farmers against periods of sharp prices fluctuation (CBN/NISER. 1991).

4.3 Privatization and Commercialization of Public Utilities

The principal measure of privatization and commercialization was divesture of government ownership of productive enterprises. This policy was effectively implemented through the establishment of government committee on privatization and commercialization. Most public utilities which hitherto were subsidized are now commercialized (Adeboye *et al*., 1995).

The range of ownership included manufacturing enterprises, banking, generation and distribution of electricity, water, communication and there are talks of commercializing the building and maintenance of roads. These have resulted in general increase in the cost of the affected corporations. For example, electricity bill, water rate and even road tools have increase considerably since the privatization and commercialization of public utilities. The central objective of this policy is to reduce the government involvement in the productive sector. Although the establishment posted higher profits, the effect on the economy was inflationary as producers and users increased prices of the goods and services.

4.4 Subsidy Policies

Most of the special programmes for boasting food production in Nigeria prior to SAP policies relied heavily on farm input subsidies as the main channel of providing incentives to farmers. Such subsidies were extended to a range of services such as clearing, irrigation, farm credit and extension, fertilizer, agro-chemicals and machinery. This was partly intended to offset the bias against agriculture and rural life caused by the heavy implicit taxation of farm incomes as a result of existing produce pricing and marketing and partly to improve the competitiveness and productivity of farming enterprise.

Apart from the financial burden on government, accessibility of input subsidies has the potential of changing the cost of farming enterprise an adversely changing the choice of crops and farming techniques. With the SAP policy reforms, subsidies on inputs like fertilizer, fuel, etc. were gradually reduced and ultimately eliminated. The hope is that the adoption on appropriate exchange rate policy and trade liberalization will provide the needed price incentive to farmers.

4.5 Wages and Civil Service Reform

Prior to the introduction of SAP, the public sector was the prime mover of the economy and major employer of labour. The organized private sector comprising industrial services and construction industry also played a vital role in the provision of employment to both skilled and unskilled. The major focus of wage policy was to guarantee a minimum wage income for the employee of both the public and formal private sectors. Owing the predominance of the informal sector in rural areas there was nothing within the framework of wage policy for stimulating and guaranteeing rural areas, there was nothing within the framework of wage policy for simulating and guaranteeing rural wages incomes. Also, the rural wages were irregular due to disguised nature and seasonality of rural employment. This resulted in a wide divergence between rural wages and statutorily determined wages of the urban, formal public private sector.

Civil Societies reform in Nigeria has not been systematic. What has happened has been embargo on employment and retrenchment and currently (1996), the embargo has been lifted. The effect on the economy is that the number of public servant s decreased as a result of embargo on employment and retrenchment. The salary of the civil servants increased over the years but the rural incomes for farm enterprise did not reflect such increase.

With policy reform, urban wages have declined substantially due mainly to inflation and sharp depreciation of the Naira. On the contrary, rural wages have improved relatively due to enhanced producers prices of a number of farming enterprises (CBN/NISER, 1991).

4.6 Reform of Financial System

The deregulation of the financial system (banks) makes it possible for people to obtain foreign exchange with relative ease. This was so because banks interest rate was low and loans were easily obtained. In addition, it initially prompted the establishment of a large number of private banks of different forms including merchant banks, community banks, etc. Lending rate have been deregulated although there is still some government control.

Unfortunately, the gains from the deregulation were short lived. By 1995, there was distress in the financial system and many of the banks collapsed due to sharp practices by the operators. Many industrial establishments and individuals got their money trapped in the distressed banks.

There were other financial reforms like Minimum Capitalization of banks; 'operating target' interest rate etc formulated to cushion the effects of inflation that over took Nigeria economy as a result of high exchange rate and impact of increase in oil price (Adedipe, 2004).

5. IMPACT OF SAP ON AGRICULTURAL MECHANIZATION

5.1 Cost of Agricultural Machinery and Spare Parts

High inflation rates resulting from sharp depreciation of the Naira has given rise to dramatic increase in the cost of imported farm inputs such as tractors, ploughs, harrows, ridgers and spare parts. Price and trade liberalization policies did not provide farmers the resilience to absorb the sharp price fluctuation that graced the policies. In the same frame, privatization and commercialization of public utilities and subsidy policies, in spite of the intended purpose did not improve the Naira cost of farm machinery and spare parts. In the same capacity, the wages and civil services, and financial system reforms did not actually increase the income of farmers but reduced their earning capacity.

The trends of relationship of increased in the cost of farm machinery are shown in Tables 2 to 7. The tables show astronomical rise in the cost of farm tractors, other machinery and spare parts, making cost of these goods out of reach of many farmers. With this disposition, new investments on commercial agriculture is discourage while maintenance and rehabilitation of existing equipment also poses serious financial strain on agricultural mechanization.

Table 2. Average purchase price for 50kw tractor in Nigeria 1980-2008 (₦' 1000)

Tractor Make	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008
Steyr	44.0	53.0	50.0	114.0	267.0	680.0	1100.0	2410.0	2610.0	2610.0	12006.0	14094	15660.0	13833.0	15529.5
I. H. Case	23.0	28.0	26.0	60.0	140.0	280.0	510.0	2400.0	2500.0	2500.0	11500.0	13500	1500.0	13250.0	14875.0
Masey Furguson	31.0	37.0	35.0	80.0	187.0	390.0	810.0	1660.0	2600.0	2600.0	11960.0	14040	16500.0	13780.0	15470.0
Ford	36.0	43.0	40.0	91.0	213.0	510.0	740.0	2100.0	2440.0	2440.0	11224.0	13176	14640.0	12932.0	14518.0
Fait	36.0	43.0	40.0	91.0	213.0	500.0	770.0	1900.0	2490.0	2490.0	11454.0	13446	14940.0	13197.0	14815.5
Average	34.0	40.8	38.2	87.0	204.0	472.0	786.0	2094.0	2528.0	2528.0	11528.8	13651.2	15168.0	13398.4	15041.6
Percentage Average Increase in Prices From 1980	-	20.0	12.0	156.0	500.0	1288.0	2212.0	6059.0	7335.0	7335.0	33741.0	39609	44010.0	38875.5	43643.25

Table 3. Average purchase price for disc plough in Nigeria 1980-2008 (₦' 1000)

Tractor Make	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008
Steyr	5.0	6.0	6.0	13.0	31.0	55.0	140.0	189.0	241.0	241.0	1108.6	1301.4	1446.0	1277.3	1433.95
I. H. Case	3.0	3.5	3.4	8.0	18.0	31.0	94.0	185.0	230.0	230.0	1058.0	1242.00	1380.0	1219.0	1368.5
Masey Furguson	3.5	4.0	4.0	9.0	21.0	39.0	70.0	190.0	431.2	431.2	1983.52	2328.48	2757.2	22.85	2565.64
Ford	3.2	4.0	4.0	8.5	20.0	33.0	69.0	120.0	300.0	300.0	1380.0	1620.0	18.00.0	1590.5	1785.0
Fait	3.0	3.8	3.5	8.0	19.0	30.0	82.0	180.0	285.0	285.0	1311.0	1539.0	1710.0	1510.5	1695.75
Permitter	3.0	4.0	4.0	9.0	20.0	36.0	79.0	125.0	270.0	270.0	1242.0	1458.0	1620.0	1431.0	1606.5
Average	3.5	4.2	4.2	9.3	21.5	37.0	89.0	164.8	293.0	293.0	1341.8	1582.2	1758.0	1552.9	1743.35
Percentage Average Increase in Prices From 1980	-	20.0	20.0	166.0	514.0	957.0	2443.0	4609.0	8271.0	8271.0	38046.6	4466.0	49626.0	43836.3	49212.45

Table 4. Average Purchase Price for Disc Harrow in Nigeria 1980-2008 (₦' 1000)

Tractor Make	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008
Steyr	4.8	5.0	5.4	12.4	29.0	60.0	120.0	170.0	265.5	265.5	1221.3	1433.7	1593.0	1407.15	1579.72
I. H. Case	3.0	3.5	4.0	9.0	20.0	34.0	86.0	150.0	270.0	270.0	1242.0	1458.0	1620.0	1431.0	1606.5
Masey Furguson	5.3	6.0	6.0	14.0	32.0	65.0	115.0	310.0	490.2	490.2	2254.92	2647.08	2940.0	2597.0	2916.69
Ford	2.0	2.4	3.0	6.0	14.0	21.0	76.0	215.0	241.0	241.0	1108.0	1301.4	1446.0	1277.3	1433.95
Fait	2.0	2.2	2.5	5.4	13.0	23.0	79.0	200.0	315.0	315.0	1449.0	1701.0	1890.0	1669.5	1874.25
Permitter	2.2	2.4	2.5	6.0	18.0	23.0	88.0	165.0	260.0	260.0	1196.0	1404.0	1560.0	1378.0	1547.0
Average	3.6	4.0	3.9	8.8	20.0	37.7	94.0	201.7	306.9	306.9	1411.74	1657.26	1841.4	1626.57	1826.1
Percentage Average Increase in Prices From 1980	-.	14.0	08.0	144.0	456.0	947.0	2511.0	5503.0	8425.0	8425.0	38755.0	45495.0	50550.0	44652.5	50128.75

Table 5. Average purchase price for ridge in Nigeria 1980-2008 (₦' 1000)

Tractor Make	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008
Steyr	3.7	4.2	4.1	9.5	22.0	46.0	130.0	191.0	282.0	282.0	1297.2	1522.8	1692.0	1494.6	1677.9
I. H. Case	2.2	2.5	2.5	6.0	14.0	23.0	86.0	145.0	260.0	260.0	1196.0	1404.0	1560.0	1378.0	1547.0
Masey Furguson	2.5	3.0	3.0	7.0	15.0	25.0	69.0	141.0	250.2	250.2	115092	1351.08	1501.2	1326.1	1488.7
Ford	2.1	2.6	2.5	6.0	14.0	23.0	68.0	138.0	248.0	248.0	1140.8	1339.2	1488.8	1314.4	1475.6
Fait	2.0	2.5	2.2	5.5	13.0	22.4	71.0	145.0	246.0	246.0	1131.6	1328.4	1476.0	1303.8	1463.7
Permitter	2.0	2.5	2.0	5.5	13.0	21.0	88.0	165.0	270.0	270.0	1242.0	1458.0	1620.0	1431.0	1606.5
Average	2.1	2.9	2.7	6.6	15.2	26.0	85.3	154.2	259.3	259.3	1192.78	1400.2	1555.8	1374.3	1542.8
Percentage Average Increase in Prices From 1980	-	38.0	29.0	214.0	624.0	25.0	4014.0	7243.0	12248.0	12248.0	56340.8	66139.2	73488.0	64914.4	72875.6

Table 6. Average purchase price of other implements in Nigeria (₦' 1000)

Implements	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008
Tipping Trailer (4 tons)	4.5	5.4	70.0	13.0	27.0	46.0	95.0	150.0	340.0	340.0	1565.0	1836.0	2040.0	1802.0	2023.0
Boom Sprayer (400 Lt)	7.5	9.0	12.0	21.0	45.0	75.0	144.0	195.0	260.0	260.0	1196.0	1404.0	1560.0	1378.0	1547.0
Multipurpose	4.0	5.0	6.0	11.0	25.0	39.0	80.0	120.0	260.0	260.0	119.6	1404.0	1560.0	1378.0	1547.0
Seed Drill Master	1.0	1.3	2.0	3.0	7.0	14.0	31.4	45.0	111.2	111.2	511.52	606.48	667.2	589.4	661.6
Planter/Fertilizer (4row)	8.5	10.0	14.0	26.0	52.0	88.0	245.0	390.0	610.0	610.0	2806.0	32.94.0	3660.0	3233.0	3629.5

Table 7. Average purchase for fast selling spare parts in Nigeria 1980-2008 (₦' 1000)

Spare Parts	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008
Metal Main Baring	95.0	113.0	115.0	260.0	570.0	1100.0	1450.0	1600.0	2600.0	2600.0	11960.0	14040.0	15600.0	13780.0	15470.0
Bake Lining	13.0	16.0	22.0	38.0	80.0	150.0	190.0	200.0	340.0	340.0	1564.0	1836.0	2040.0	1802.0	1921.0
Water Pump Kit	78.0	92.0	127.0	225.0	475.0	850.0	1000.0	1200.0	1500.0	1500.0	6900.0	8100.0	9000.0	7955.0	8925.0
Oil Filter	16.0	19.0	25.0	44.0	95.0	150.0	220.0	340.0	450.0	450.0	2070.0	2430.0	2700.0	2385.0	2677.5
Pivot Pin	20.0	24.0	33.0	57.0	120.0	195.0	410.0	650.0	1030.0	1030.0	4738.0	5562.0	6180.0	5459.0	6128.5
Clutch Plate	39.0	47.0	64.0	110.0	240.0	450.0	780.0	1100.0	1870.0	1870.0	8602.0	10098.0	11220.0	9911.0	46826.0
Cylinder Gasket	22.0	27.0	36.0	63.0	135.0	240.0	350.0	560.0	890.0	890.0	2714.0	3186.0	3540.0	3127.0	3510.0
Coupling Assey	21.0	23.0	32.0	56.0	115.0	200.0	300.0	420.0	580.0	580.0	2668.0	3132.0	3486.0	3074.0	3451.0
Brake Pad	24.0	29.0	39.0	70.0	140.0	320.0	370.0	500.0	840.0	840.0	2484.0	2916.0	3240.0	2862.0	3213.0
Gas Filter	8.0	11.0	15.0	28.0	50.0	100.0	150.0	180.0	330.0	330.0	1518.0	1782.0	1980.0	1749.0	1963.0
Oil Seal	11.0	13.0	18.0	32.0	70.0	140.0	220.0	430.0	590.0	590.0	2714.0	3186.0	3360.0	3127.0	3510.0
Clutch Cover	33.0	40.0	55.0	95.0	200.0	380.0	520.0	650.0	1100.0	1100.0	5060.0	5940.0	6600.0	5830.0	6545.0
Fan Belt	7.0	11.0	14.5	26.0	50.0	100.0	160.0	190.0	280.0	280.0	1288.0	1512.0	6680.0	1484.0	1666.0
Bottom O/H Gasket	61.0	73.0	98.0	175.0	380.0	700.0	1200.0	1400.0	1900.0	1900.0	6740.0	10260.0	11400.0	10070.0	11305.0

Bearing Set	53.0	64.0	87.0	155.0	320.0	540.0	710.0	800.0	1430.0	1430.0	6578.0	7722.0	8580.0	7579.0	8508.5
Piston	130.0	160.0	218.0	380.0	800.0	1600.0	2400.0	3200.0	4100.0	4100.0	18860.0	22140.0	24600.0	2173.0	24395.0
Control Box	30.0	37.0	50.0	88.0	190.0	320.0	540.0	600.0	900.0	900.0	4140.0	4860.0	5400.0	4770.0	5355.0
Seal Kit	11.0	13.0	18.0	32.0	65.0	120.0	180.0	190.0	350.0	350.0	1610.0	1890.0	2100.0	1855.0	2082.5
Over Hauling	53.0	65.0	78.0	150.0	330.0	510.0	750.0	1100.0	288.0	2880.0	13248.0	1552.0	17280.0	15264.0	17136.5

5.2 Availability of Agricultural Machinery and Spare Parts

The availability of agricultural machinery and spare parts is linked directly with the prevailing economic environment. Under the market which rocked prices of imports, individual farmers, co-operative societies and agro-based industries do not have the financial capacity to procure new farm implement. This led to a situation where dealers and fabricators produced and stock implements only on demand. The effect of this is increase in fabrication, low import volume, low research output and the folding up of tractor assembly plants and dealers all these in torn result in non availability of agricultural machinery and spare parts.

5.3 Low Demand of Machinery, Equipment and Spare Parts

The demand of agricultural machinery, equipment and spare parts is function of such parameters as affordability, availability, cost/benefit analysis and adoption rate. Low demand for the agricultural machinery, reduced incomes of the farmers, resulting in low savings hence reduced purchasing power of the farmers.

SAP policies and reforms succeeded in discouraging imports and encouraged exports hence low volume of imports. It led to general increase in the cost of products since most manufacturing outfits depend largely on imports. Consequences of deregulation of financial system in Nigeria, and the resulted distress of some bank, huge amount of money trapped in the distressed bank is enough to deprive farmers of their demand of agricultural inputs.

5.4 Low Capacity Utilization of Agro-based Industries

With low volume of imports, low research output, scarcity of basic raw materials, high cost of necessary inputs, most industries have been producing far below their installed capacity. Coupled to this problem is the low demand of products of these agro-based industries. This even the little that is produced is not immediately sold, forcing the industries to further reduce the volume of production. Of course of this has led to the retrenchment of staff and in some cases outright folding of the industries. It is therefore clear to see that in the near future, even what aspects are produced locally will now be imported as it is cheaper, and easier.

5.5 Sustainability of Agricultural Mechanization

Sustainable agriculture mechanization can be the introduction and use of machinery in agricultural production in such a way that it is progressive. In other words, once machinery is introduced, it should be useful over a reasonable period of time and should be a progressive increased in demand mechanization programmes. But this study has shown abundantly that the culprits are the macro-economic policies implemented for the past ten years.

6. MAKING AGRICULTURAL MECHANIZATION PROGRAMMES SUSTAINABLE

For s long as the basic problems identified above are not addressed. Nigerian agricultural mechanization effort will continue to be unsuitable. Expensive machinery will continue to be abandoned a few months after they are introduced to farmers. Since the macro-economic policies have been identified as the fundamental problems, they must be restructured. The following recommendations have the potential of channeling agricultural mechanization towards the path of sustainable development:

a) Re-introduction of subsidies in key agricultural inputs such as fertilizer, machinery, spare parts, fuels, etc.
b) Since the government still operates a dual exchange policy, importers of agricultural machinery and spare parts should be given foreign exchange at the government rate of ₦20 to $1 rather than the open market price of more than ₦80.

c) Government should take a second look at commercialization of public utilities especially electricity, water, etc.
d) The financial assistance given to farmers in form of loan facilities through banks should be more closely monitored to avoid the situation where a farmer is required to provide collateral which he does not have.
e) Setting up of model workshop and spare parts depots for agricultural machinery.
f) Facilitate the formation of more cooperative societies, community Development Associations and other NGOs and assisting then in acquiring machinery.
g) Introducing more incentives to machinery manufacturers and dealers.

7. CONCLUSIONS

A review of the impact of the Structural Adjustment Programme (SAP) and other macroeconomic policies embarked upon by the Federal Government since 1986 shows that it has adversely affected agricultural mechanization. It has resulted in too high cost of agricultural machinery, low capacity utilization of agro-based industries, and a general decrease in the ability of farmers to own and use machinery. Unfortunately, existing data from the study suggest that the macroeconomic environment created by macroeconomic policies were not agricultural sector friendly. In line with Eyo, 2008, macroeconomic environment has not been able to support operators of agricultural sector to acquire high pay-off input that are invaluable in improving the capital base of the agricultural sector.

It is recommended that government should review the economic policies and ensure an enabling environment for formation and operation of cooperatives and Community Development Associations towards ownership and operation of machinery in agriculture.

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INSTITUTIONAL FRAME WORK FOR MECHANIZATION OF AGRICULTURE IN NIGERIA: A CASE STUDY OF RIVER BASIN AUTHORITIES

A. Bosso, A. A. Fagge and A. Gambo
Department of Agricultural Engineering, Kaduna Polytechnic, Kaduna, Nigeria
aafagge@yahoo.com; balamaliky@yahoo.com

ABSTRACT

The ever-increasing food shortage in Nigeria calls for consistency in government policy on Agriculture and Water Resources Development. The setting-up of twelve (12) River Basin Development Authorities by decree No 87 of 1978 throughout the six geo-political zone of this country was certainly a milestone in reducing food shortage and unemployment in Nigeria. The need to revisit the decrees establishing all River Basins Authorities to allow them function effectively, so as to make agricultural activities look more attractive and profitable by provision of farm machineries, other farm inputs and extension services to participating farmers cannot be over emphasized.

KEY WORDS: Mechanization, agriculture, river basins, water resources.

1. INTRODUCTION

The River Basin Development concept is neither unique nor new to Nigeria. The concept dated back to ancient development in the Wile valley. However, the first modern River Basin Development Authority is the Tennessee Valley Authority (T.V.A) initiated in United States of America (USA) in 1933. Since then several valley authorities have been established in many countries similar to the Tennessee Valley Authority (Musa, 1990).

Nigeria has a total land area of 92, 377,000 hectare (Fagoyinbo, 1997), 26% which is arable. Nigeria is however endowed with a network of rivers and streams with an estimated total length of 8051 kilometers with a surface area of about 11,300,000 hectares, (Fagoyinbo, 1977).

In Nigeria, the first River Authority was Niger Delta Development Board which came into existence in 1960 and was charged with the physical and economic development of the Delta area. This was followed in 1963 with a study of land and water resources of Sokoto Rima Basin; in 1964 the formation of Chad Basin Commission with the responsibility of conducting and implementing studies needed for the development of the Basin. In 1968, following the study of Kano River Basin by the Bureau of Reclamation of the United State Department of Interior, Kano State Government established Kano River Project (Musa, 1990).

According to Musa (1990), the Federal Government formerly established two River Basins, namely Chad Basin Development Authority by Decree No.32 and the Sokoto Rima Basin Development Authority by Decree No.33 both of 1973. Three years later, the entire country was divided into eleven "River Basins", with ten established by Decree No.25 of June 1976, while the eleventh (11th) the Niger Delta Basin Development Authority was established by Decree No.37 of August, 1976. The existence of those River Basins was further re-confirmed by Decree No.87 of September, 1978. The established River Basins Development Authorities as shown in Table 1.

Table 1: List of River Basin Authorities in Nigeria and their areas of coverage

S/N	Name of River Basin	Basin Head quarters	Areas of Coverage (States)
1.	Anambra-Imo	Owerri	Anambra, Imo, Abia, Enugu and Ebonyi
2.	Benin-Owena	Benin	Ondo, Ekiti, Benin and Delta
3.	Chad Basin	Maiduguri	Borno, Yobe and parts of Adamawa
4.	Cross-River	Calabar	Cross-Rivers and Akwa Ibom
5.	Hadejia-Jama'are	Kano	Kano, Jigawa and parts of Bauchi
6.	Lower Benue	Makurdi	Benue, Plateau, Nassarawa and parts of Kogi
7.	Lower Niger	Ilorin	Kwara and Kogi
8.	Niger Delta	Port Harcourt	Rivers, Bayelsa and parts of Delta
9.	Ogun-Oshun	Abeokuta	Ogun, Oyo, Osun and Lagos
10.	Sokoto-Rima	Sokoto	Sokoto, Kebbi, Zamfara and Katsina
11.	Upper Benue	Yola	Taraba, Gombe and parts of Adamawa and Bauchi
12.	Upper Niger	Minna	Kaduna, Niger and FCT

Source: Federal Ministry of Water Resources, Abuja (FMWR) (1984)

FMWR Newsletter, (1984) mentioned that, the River Basins were further divided to coincide with political boundaries of each state with the exception of Lagos, each getting a River Basin and Rural Development Authority, this was however short-lived. In 1986 the earlier River Basin Development Authorities re-emerged but with strict and limited scope of operation, i.e. that of water resources development as contained in Decree No. 35 of 1st October 1986.

However, in 1984 the Niger River Basin Development Authority was split into what was known as the Upper Niger Basin, Lower Niger Basin and Kaduna- Karaduwa River Basin and Rural Development Authorities.

Furthermore, in 1986, Decree No.35 returned the number of the authorities to the former number of eleven (11) removing the aspect of Rural Development from all the authorities. This Decree drastically reduced the functions of the authorities.

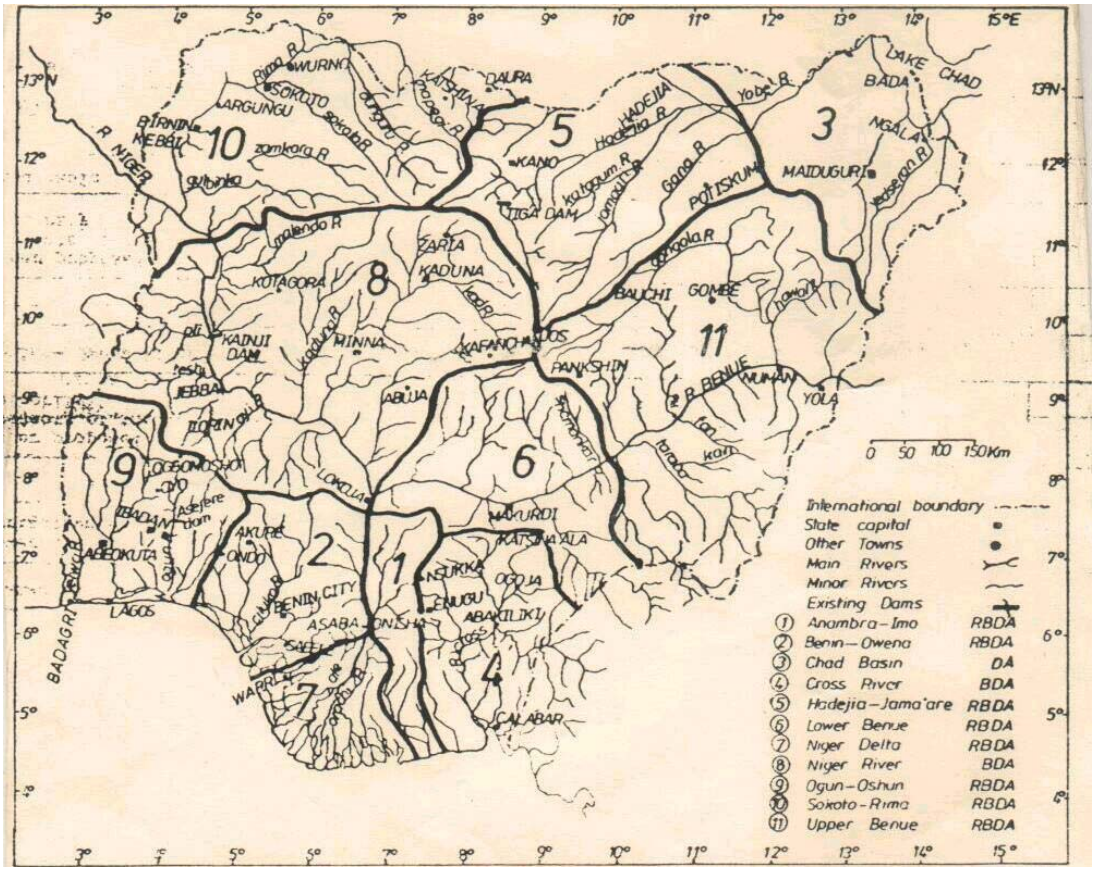

Fig.1 Surface water sources and River Basin Development Authorities (R.B.D.A) of Nigeria

2. INITIAL OPERATIONAL GUIDELINES AND OBJECTIVES OF THE RIVER BASINS

Since the initial inception of River Basin Authorities, they are under the supervision of the Federal Ministry of Agriculture and Rural Development. The River Basins, which are Federal Government Agricultural Agencies, were meant to provide essential agriculture services at the door steps of farmers living in the rural areas. In a bid to effectively accomplish the task ahead of them, the following departments were put in place.

2.1 Organizational Structure of River Basin Authorities

- Department of Agriculture
- Department of Livestock and Fisheries
- Department of Engineering
- Department of Finance and Administration

All the Basin authorities were headed by General Mangers and assisted by Assistant General Managers, as shown in figure 2.

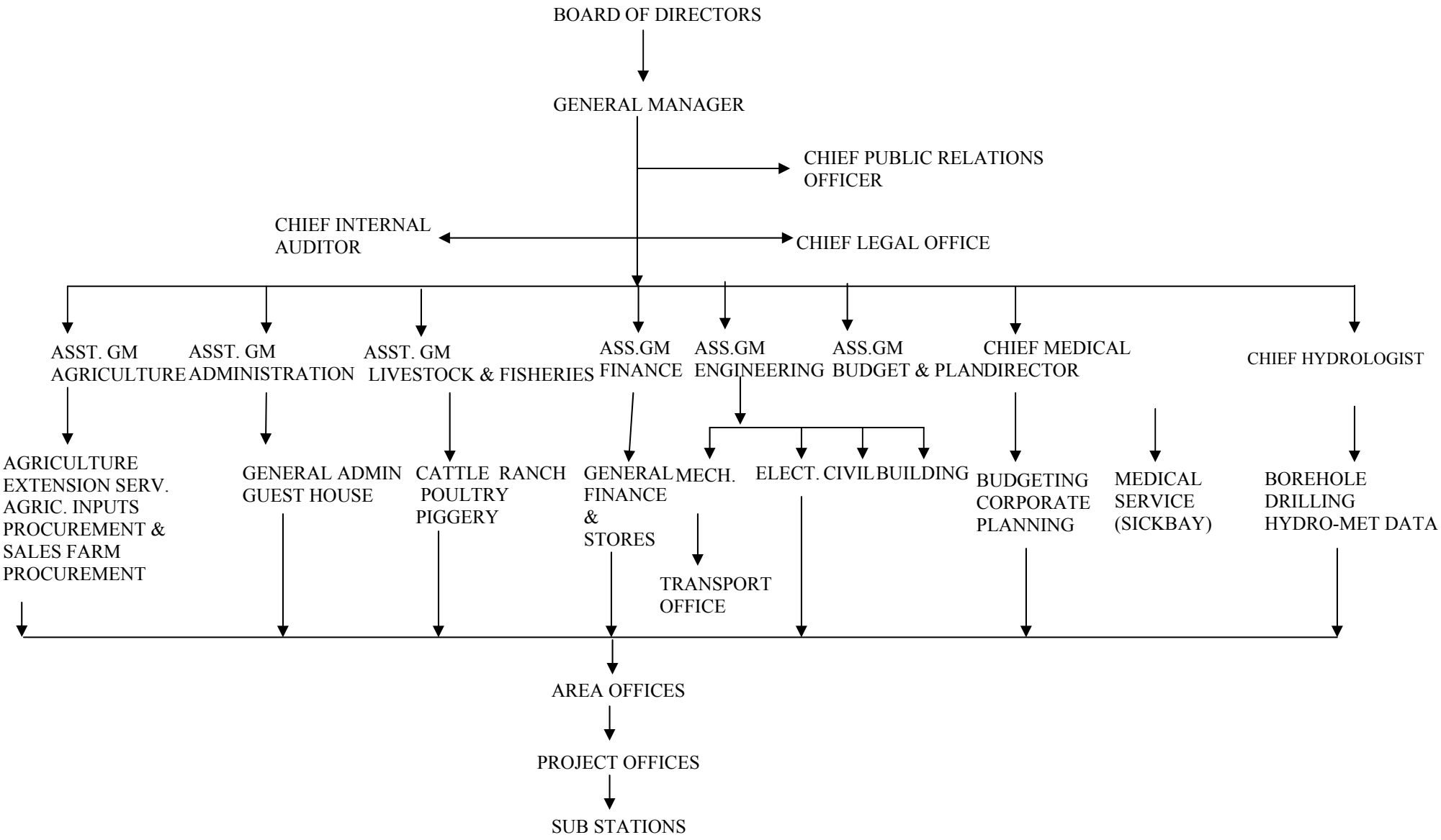

Fig.2: Organization of River Basin Authorities from Inception (1979-1989)

2.2 Agriculture Department

The Agriculture department is headed by an Assistant General Manager under which he has the Chief Agricultural Officers, Assistant Chiefs Agricultural Officer, Principal Agricultural Officers, Senior Agricultural Officers, Agriculture Officers and their counterparts in the superintendents' cadre. The agriculture department is to provide farm inputs (fertilizers, Agro-chemicals, improved seeds and land) to all participating farmers within its area of coverage at a highly subsidized rate.

The agriculture department has the inventory of all participating farmers, acquire farm lands for the authorities from the farmers within their locality and arrange for the payment of compensation to farmers and assist in the acquisition of loan from the Agriculture and Cooperative Bank, Commercial Banks etc for the farmers; to serve as an incentive.

2.3 Livestock and Fisheries Department

This department is headed by an Assistant General Manager, under which he has Chief Livestock officer Chief Fisheries Officer, Assistant Chief Livestock Officer, Assistant Chief Fisheries Officer and their like. This department operate by organizing fishermen into cooperatives in areas within their area of operation and provide fishing inputs at a highly subsidized rate. In the area of livestock production, the authorities establish hatcheries, incubators, feed mills and livestock pen houses/battery cages in areas of coverage to provide birds to the community living within such locality as a package.

The livestock section/poultry are manned by livestock officers. The whole idea is to provide a balanced died to the teaming population of this country at an affordable rate.

2.4 Engineering Department

This department is headed by an Assistant General Manager under which all arms of the engineering profession is available to provide all the necessary engineering support that is required to make the authority achieve a huge success. The arms engineering include, Mechanical, Electrical, Civil, Building, Survey, Irrigation, and Hydrology.

2.4.1 *Civil Engineering Section*

This section deals with the supervision of dam construction, rural road and provision of irrigation facilities on irrigation schemes.

2.4.2 *Electrical Section*

This section is responsible for the provision of electricity and electrical installation in buildings, offices, poultry store and project buildings and the processing of payment of electricity bills.

2.4.3 *Mechanical Section*

This section is responsible for the provision of automobiles, tractors and equipment, articulate trucks and trailers earth moving equipment, fuel tankers, generators and water pumps for use on project sites and for transportation purpose and the general maintenance of such.

2.4.4 *Building Section*

This section deals with the supervision of the authority's building in the area and project sites and the process of settling building contractors. The carpenter and building technicians are also responsible for the maintenance and rehabilitation of the authority's building structure when the need arises.

2.4.5 *Survey Section*

The staff here are responsible for all survey work on the farm, roads and irrigation schemes and the recommendation and settlement of compensation on acquired farm and dam sites.

2.4.6 *Irrigation section*

The staff in this section deal with the operation and maintenance of all irrigation structure and equipment on farm and project sites. They design irrigation schemes based on availability of water for the authority.

2.4.7 *Hydrology Section*

This section maintains all the hydrometer stations, keep daily weather, temperature and rainfall data for the purpose of planning. They are directly responsible for the selection and drilling of tube wells and boreholes on the authority's resident and farm sites.

2.5 Finance and Administration Department

This section is headed by an Assistant General Manager (Administration) and assisted by a chief finance officer. This department is responsible for the keeping of all financial transaction and records of events, staff disposition, staff promotion, staff positing and correspondences coming in and going out of the organization.

The day to day running of the guest houses, residential quarters and office allocation etc is conducted in addition to other functions, mentioned above.

The staffing arrangement in area and project offices is a replica of what obtains in the headquarters for the smooth running of all the activities of the authority. In view of the former structure and objectives of the authorities, it is pertinent to consider the number category, professionals involved in the running of these organizations as means of employment opportunity.

3. POLICY CHANGES IN RIVER BASINS

In 1988, the Federal Ministry of Agriculture which was separated from a newly created Federal Ministry of Water Resources came up with restructuring the activities of all River Basins based on its new objectives and guideline. In the view dispensation, all aspect of agriculture was removed from the Basin Authorities and transferred to other Federal Government agencies such as National Agricultural Land Development Authority (NALDA), Directorate of Foods Roads and Rural Infrastructure (DIFRRI) and the Agricultural Development Projects (ADPs).

As a matter of fact, the new dispensation under the Federal Ministry of Water Resources ushered in staff rationalization, affecting all the agriculture, livestock and fisheries staff, creating artificial unemployment.

In April 1992, the process of partial commercialization of the River Basin was introduced with the sole aim of making them generate substantial revenue to take care of their recurrent expenditure. Under this new approach more technical staff were retrenched to cut-down recurrent cost.

In April 1994, the Bureau of Public Enterprises (previously called Technical Committee on Privatization and Commercialization, TCPC) categorized the River Basins into three (A,B,C) depending on the largeness, facilities and assets available in each of the authorities. Under commercialization drive, the organogram of the River Basins was also restructured into two main departments which are Operations and Finance Administration. Under the managing Director's office there are four (4) units, viz: corporate affairs, legal secretary and internal audit units. The two main departments are headed by Executive

Directors and they report directly to the Managing Director/Chief Executive of the Authority as shown in figure 3. A seven (7) man member's board of directors was appointed to direct issues on policy and contract awards for all the River Basins (BPE, 1994).

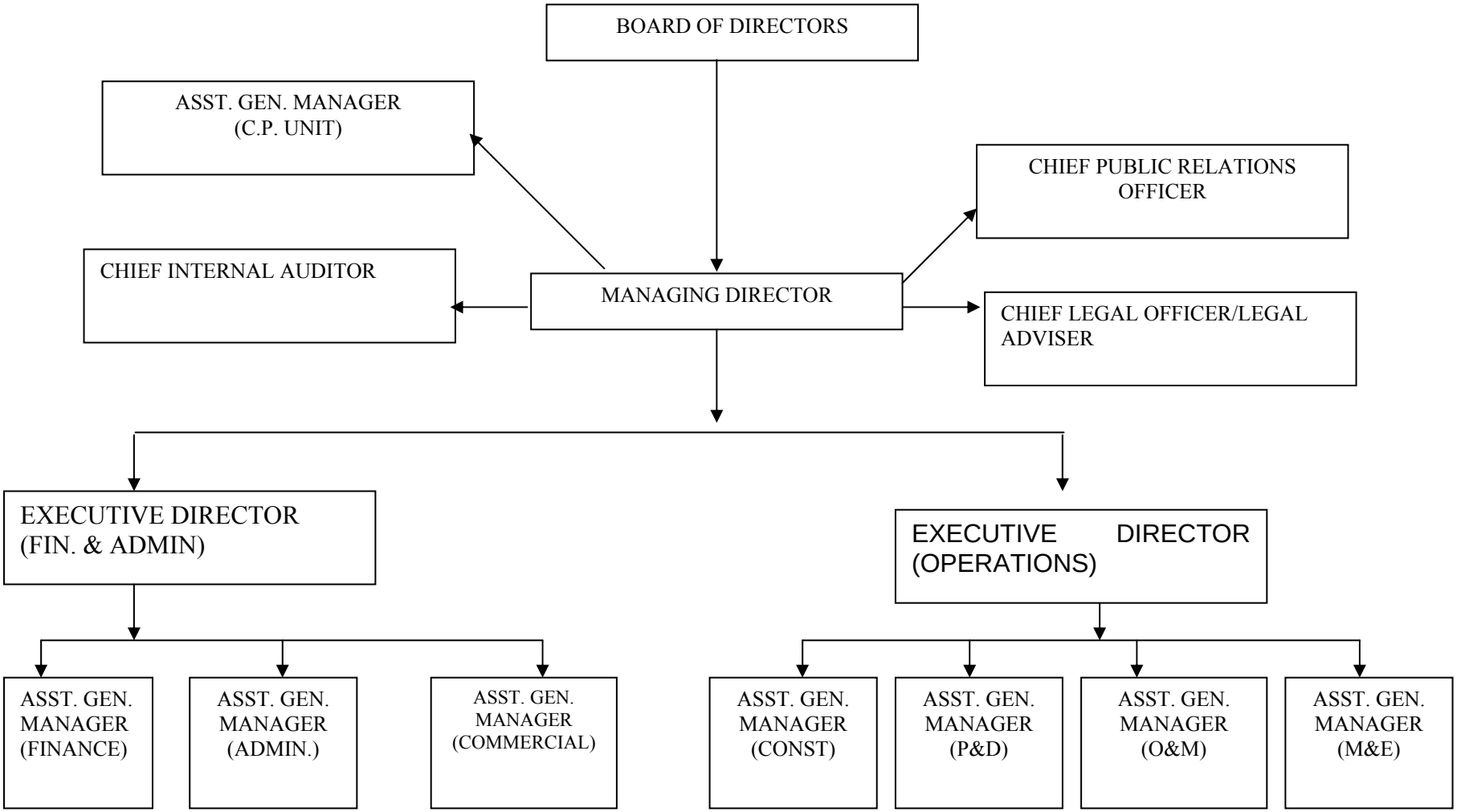

Fig.3: Oraganogram of River Basin Authorities from 1990-Date

3.1 New Operational Objectives of the River Basin under the Commercialization Programme

In view of the new commercialization drive the corporate objectives of the River Basins were spelt out as follows:

- To undertake comprehensive development of surface and underground water resources for multipurpose use with particular emphasis on the provision of irrigation infrastructure and control of floods and for watershed management.
- To construct, operate and maintain dams, dykes, wells, polders, boreholes, irrigation and drainage system and other works necessary for the achievement of the authority's function and handover all land, to be cultivated under the irrigation schemes to farmers.
- To supply water from the authority's completed storage schemes to all was for a free to be determined by the authorities which such facilities.
- To construct, operate and maintain infrastructure service such as roads and bridges linking project sites, provided such infrastructure service are included and form an integral part of the list of approval projects.
- To develop and keep up-date comprehensive water resources master plan, collection and collations of water resources, water use socio-economic and environmental data of the River Basins (UNRBDA 2002)

3.2 Commercialization of River Basins

In view of the commercialization of River Basins most of the authorities' assets where disposed off or auctioned to individuals, organisation and private corporations. The idea is to cut-down operational cost, reduce area of coverage, reduce the boredom of maintaining buildings, vehicles, agricultural machinery and equipment, rainfed schemes, provision of farm inputs, agricultural loans, and payment of huge salary bills etc.

Under the commercialization drive, it is expected that large scale farmers, corporate bodies or cooperative farmers, shall acquire large hectares of land on irrigation schemes within the River Basin area of coverage to generate enough revenue for the authorities to offsets their recurrent expenditure.

However, the funding of all capital projects still remains the responsibility of the Federal Ministry of Water Resources. The drilling of boreholes for communities, individuals, local government councils and organizations is suppose to be another source of revenue generation for the River Basins.

4. PRESENT ASSESSMENT OF AGRICULTURAL MECHANIZATION IN RIVER BASINS

Bosso et al. (2004) stated that at the instance of the creation of the eleven (11) Basin Authorities in 1979, the objective was to develop agriculture and water resources activities and to provide essential agricultural services at a highly subsidized rate to farmers within the area of coverage of each River Basin as a package. The services include, land clearing, land tillage, Crop Management, and harvesting of their farm produce. The provision of those essential ingredients by the River Basins in the past for crop production under rainfed and irrigation farming and subsequent marketing outlet made farming a very attractive, lucrative and profitable occupation.

The present level of agricultural mechanization in River Basin Authorities has drastically dropped to about 10% compared to the past where it stood at 90%. (Bosso et al. 2004). The reasons for the low level of mechanization includes changes in policy and objective of River Basins, the abandonment of all rainfed schemes, the sales of farm machinery and equipment used for the tilling of land for the farmers, the non-provision of fertilizers, Agro-chemicals, market out let, non-existence of extension services and new farming techniques etc. Under the present commercialization drive, there is inadequate attention paid

to agricultural mechanization activities in River Basins. The absence of farm tractors, processing machines, seeder drillers, fertilizer and sprayers etc is very apparent.

5. MACHINERY AND LAND DEVELOPMENT IN RIVER BASINS

Agricultural mechanization is defined as maximizing the energy of power to increase production efficient, output and quality of farm products by the use of modern machinery, techniques and improved inputs (Culpin, 1975).

Therefore, in view of the New River Basin's dispensation, most functional agricultural machinery and equipment, earthmoving and road construction equipment, water pumps electrical generators, drilling rigs etc have been disposed-off to reduce operational cost to the barest minimum, thereby affecting their level of mechanization (UNRBDA, 2008).

The few farm machinery and implements available are used for land preparation and the prepared lands are later shared to only the farmers participating on such schemes as a source of revenue generation for the River Basins Authorities. (Table 2)

Table 2: List of large irrigation dams/major schemes and crops produced in River Basin Authorities

S/N	Name of River Basin	Name of Dam	Name of Irrigation Scheme	Area of Coverage (Ha)	Crops Grown
1.	Upper Benue	Dadin Kowa Kiri Dam	Dadin Kowa Kiri Project	25,000 12,000	Sugarcane, Rice Vegetables
2.	Lower Niger	River Niger Omi	Tada-Shonga Kamps	2,568 4,100	Rice, maize, Vegetable
3.	Sokoto Rima	Bakalori Goronyo Zobe	Bakalori Goronyo Zobe	25,000 15,000 10,000	Rice Wheat Vegetables, Maize
4.	Hadeija Jama'are	Tiga Challawa Gorge	Kura	30,000 20,000	Rice Maize, Vegetables
5.	Cross-River	Nkari Ijegu	Nkari Yala multipurpose	1,000 2,500	Rice, Cassava Vegetables
6.	Benin-Owena	Llushi Ukhun	Ega Erho	5,000 1,000	Rice Cassava, Vegetable, Fruits
7.	Chad Basin	South Chad Bega	South Chad Kirinowa	67,000 20,000	Rice Wheat, Vegetables, g/nut
8.	Anambra-Imo	Lower-Anambra Ibu-River	Omor Ibu	1,562	Rice, Cassava Vegetables
9.	Ogun-Oshun	Oyan Ikere Gorge Oyan Sepeteri	Lower Ogun Middle Ogun Obafemi/Owode Sepeteri	12,000 3,000 3,000 2,000	Rice Maize Vegetable Melon, Okro
10.	Lower Benue	Benue Mada Mada	Benue Nassarawa Plateau	2,000 3,000 1,500	Rice Cassava Vegetable, Potatoes
11.	Niger Delta	Delta Polders Otamiri Ekpo	ISampon Otamiri Ekporo	2,000 1,000 1,000	Rive, Okro Fruits Vegetable

		Lowdand Drainage	Loko	1,000	Oil palm
12.	Upper Niger	Tunga Kawo Kubli Galma	Tungan Kawo Swashi Zaira	1,000 2,900 2,500	Rice, Maize Vegetable, Okro Wheat

Source: Federal Ministry of Water Resources, Abuja FMWR (1984)

In extreme cases, most farmers participating on the River Basin Schemes/Project are compelled to source for farm tractors and other inputs to cultivate their farmland, on such projects to meet-up with their targets, thus, causing untold hardship and increasing the cost of production on the side of the farmers participating on the River Basin Project sites. This approach of partial mechanization by the River Basins has discourage most farmers from participating in crop production on the River Basin Schemes, despite the huge investment on the provision of large dams and irrigation facilities over time. The participating farmers are force to reduce their hectrage of land because of non-availability of complete package of farm inputs. The only services provided by the River Basins presently, include the construction of weirs, dykes, irrigation structure and other head works across the streams, and provision of water for domestics use.

6. FACTORS AFFECTING AGRICULTURAL MECHANIZATION IN RIVER BASINS

The greatest evil that has befallen agricultural mechanization in River Basins is the absence of continuity in government programmes and policy. Every policy had always been centered around government functionaries rather than on nation well-being (Alatise 1996). Other reasons include the following:

i. High production cost
ii. Lack of appropriate machinery for some operations
iii. Inadequate extension service and new farming techniques
iv. Lack of agricultural inputs (hybrid seeds, fertilizers and agro-chemicals)

7. CURRENT TRENDS AND FUTURE PROSPECT OF AGRICULTURAL MECHANIZATION IN RIVER BASINS

Aba (1998) mentioned that, the role played and still being played by the government in the agricultural mechanization in Nigeria cannot be overlooked. The government has set up a number of development authorities, agencies and projects, whose activities encompass all farming activities including mechanization. The River Basins are one of the Federal Government Authorities established to enhance agriculture mechanization through the provision of essential agro-services to farmers for food production to our teaming population. There are also department of Agricultural Engineering in several Universities, Polytechnics and Colleges of Agriculture in Nigeria whose graduates are underutilized as a result of massive retrenchment and unemployment who would have contributed immensely in the provision of expertise knowledge and experience to enhance agricultural mechanization in government organisation and establishments.

The government has also established, a National Centre for Agricultural Mechanization at Ilorin, whose functions include testing, developing and fabricating agricultural machines and equipment suitable to Nigerian conditions to reduce cost of importation. More tractor and equipment assembly plants can be established.

8. CONCLUSION AND RECOMMENDATION

The trends in agricultural mechanization in the River Basin Authorities in Nigeria so far and the various factors affecting proper implementation of suitable mechanization system had been discussed. The need to revisit the decrees establishing all River Basins and subsequent amendments is necessary to allow them

revert back to their original functions, so as to make agricultural activities look more attractive and profitable to all participating and other interested farmers, by the direct provision of farm inputs, extension services and market outlets for their produce after harvest. The continuous survival of the River Basins Authorities could provide enough employment opportunities to agriculture and related disciplines graduates.

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FARM MECHANIZATION CHALLENGES AND PROSPECTS IN AKWA IBOM STATE OF NIGERIA

E. U. U. Ituen
Department of Agricultural and Food Engineering,
University of Uyo, Uyo, Nigeria
dreuuituen@yahoo.com

ABSTRACT

Mechanization of Agriculture started with the establishment of government model farms in the late 1960s and early 1970s. Farm tractors and accessories, crop processing machines, high yielding seeds, fertilizers and other farm chemicals were introduced in the farms which acted as demonstration centres to farmers too. Farmers studied and adopted the new farming technology in their small farm holdings. By early 1980s, the Cross River Basin and Rural Development Authority established many more farms, introduced more farm machinery and inputs and made them available to more farmers. Some farmers started medium scale farms of 5 to 10 hectares, mechanized the land preparation and planted mainly maize and cassava. Many got into trouble with maize because they suffered losses as they could not dry them after harvest in the peak of rainy season. They were discouraged and pulled out of the business. In the late 1980s, cassava Mossaic Disease (CMD) ravaged cassava in the land and there was serious hunger. Improved and disease-resistant varieties were introduced and more farmers, including civil servants, came in to plant to survive, making use of the abandoned government model farms and cross River Basin farms. They employed machinery from land preparation to weed control and the demand for fertilizer rose sharply and fertilizer was scare by mid 1990s. Recently, the Nigeria Delta Development Commission (NDDC) has also made farm tractors available to farmers. Inspite of these attempts, many farmers do not have access to these facilities in time. Fertilizers are very scarce. Other farm chemicals are costly and scarce too. Credit facilities are not easy to come by. Mechanized farming is not encouraged. There is hunger in the land. The solution to the hunger problem lies in serious farm mechanization, high yielding varieties of seeds and the availability of fertilizers, pesticides and other farm inputs.

KEYWORDS: Farm mechanization, farm machinery, high yielding seeds, fertilizers, pesticides.

1. INTRODUCTION

Farm mechanization has been seen as the pivot to agricultural revolution in many parts of the world, and has contributed greatly to increased output of food crops and other agricultural products to meet the demands of the ever increasing world population. Through farm mechanization, many industrial raw materials are produced for the rapidly expanding world industries.

Mechanization of agriculture has solved food scarcity problems in many countries. Only about 3 percent of the American population is engaged in farming now, and one American farmer produces enough food to feed 60 people and also a family can manage up to 1200 hectares of farmland (Snivastava et al, 2006) India was once hit by severe famine due to the menace of droughts and floods and this created a precarious situation. Through concerted efforts by the Indian government, strategies were evolved in research in Universities and agricultural institutions to develop experimental plot machines and high yielding varieties of crops and associated production and protection technologies which brought about green Revolution (Yadav & Gupta, 1988).

In Punjab state, the outcome of Green Revolution was phenomenal and substantial because of the following reasons (Mittal and Bhatia, 1988).

(i) Favourable physical condition for crop growth
(ii) Enterprising human element responsive to innovation.
(iii) Land reforms policy conducive to higher production
(iv) Almost cent percent consolidation of holdings
(v) Efficient system of services to support agricultural development.
(vi) Good net-work of cooperative societies for short term crop loans and supply of fertilizers and other inputs.

Today, India is self sufficient in food production. Mechanization of agriculture is therefore a key factor to increased agricultural production and food security.

The objectives of this paper are to identify and discuss the challenges and prospects of agricultural mechanization in Akwa Ibom Stat, Nigeria.

2. AGRICULTURAL PRODUCTION IN AKWA IBOM STATE OF NIGERIA

2.1 Background Information

Akwa Ibom State has an area of 7,081sq.km (708,100 hectares) and lies along the south-Eastern plains bordered by Cross River, Rivers and Abia States. It has an extensive shoreline of 129km long. Its climate is typically tropical, hot and humid. The state is densely populated. Farming is mainly subsistence with an average farm size of below one hectare. Many farmers still allow fallow periods. The main crops grown are cassava, maize, plantain, cocoyam, okra, fluted pumpkin, rice, oil palm, rubber, cocoa and raffia palm.

The state is a flat-lying sandy coastal area prone to erosion. It has a bimodal rainfall pattern with the rains lasting on the average for eight to nine months, followed by a short dry season. The rains are heavy and range from 2,200mm in the Northern areas to 3,500mm in the Southern coastal areas (AK-Seeds, 2004). The rains begin in March and end in November, with the peaks in July and September. The state has typical rain forest and mangrove vegetation and the weather can support crops all round the year. The main soil type is deep porous sandy loam and is acidic.

2.2 Early Agricultural Development and Farm Mechanization

Akwa Ibom State was created out of Cross River State in 1987. Before then, it was called the mainland part of Cross River State. In the mainland part of Cross River State as well as other parts of that state, agricultural development was solely the responsibilities of government agencies and parastatals. One agency was the Agricultural development corporation (ADC), which was responsible for tree crops plantation development. Many oil palm plantations were established and large scale mechanized oil palm mills built. The processing of the oil palm fruits were completely mechanized. Rubber plantations with facilities of mechanized processing of the products were also established.

Apart from the tree crops, government through the ministry of Agriculture and Natural Resources, established food crops farms which were called model farms. They acted as demonstration farms in which new technologies in Agriculture were introduced. Farm tractors were used to prepare the land for planting. Improved varieties of crops, were introduced. Crops processing equipment such as rice threshers and hullers, maize shellers, cassava processing machines, oil palm processing machines, etc, were introduced in these farms. Farmers obtained improved seeds and other inputs from these farms, bought processing machines at subsidized prices and even hired the farm tractors to prepare their farm lands for planting.

From the mid 1970s to the mid 1980s, some farmers acquired medium scale farm lands of 5 to 15 hectares and began to practice mechanized farming, hiring farm tractors to till the soil. The major crops they planted were cassava and maize and the planting period was March to April. However, the maize farmers

soon ran into trouble for they harvested their crops in June and July, the peak of rains. There was no means of drying and the maize rot away, bringing heavy losses to them. There were nobody to buy the wet maize. After this incidence farmers declined to plant maize on a large scale and tractor hiring also reduced. Cassava planting was more costly as they had to weed more than 2 times before harvest. Thus there was no encouragement in farm mechanization during this period because farmers did gain in their business.

Later on, government disengaged from direct farming and handed over the model farms to cooperatives formed by farmers. Inputs in the form of machinery, seeds, fertilizer and farm chemicals were made available to them at subsidized rates.

During this period too, the Cross River Basin and Rural Development authority established many farms which also performed the functions of the government model farms. These farms produced food crops such as rice, cassava, maize etc. They also acted as demonstrated farms in which there were extensive mechanization of the farming processes. Later on, the Basin Authority also pulled out from direct food production and also gave the farms to cooperative bodies formed by farmers. These cooperative farmers are tenants on these farms as well as on government model farms till today. However, activities in these farms are almost at zero points because these are no functional farm tractors, no credit facilities and no fertilizers for the farmers.

2.3 Recent Agricultural Development and Farm Mechanization

After the creation of Akwa Ibom State, there was a severe outbreak of cassava Mosaic disease (CMD) which devastated cassava, one of the major staples of the state. As at 1988, this epidemic had reached its peak, wiping out all indigenous species of cassava as well as improved non-resistant varieties. People were hungry. About 90 percent of gari that came into the state were brought in from other states, notably, Cross River, Edo and Delta, and the price of the commodity was very high, above the reach of the ordinary citizen.

This situation led to active intervention by the state government through the ministry of Agriculture and Akwa Ibom Agricultural Development Programme (AKADEP) which introduced virus-resistant cassava varieties for use by farmers. Improved cassava cultivars such as TMS 30555. TMS 30572, among others, were already in circulation by 1990 to 1991 (AKADEP, 1992). Very many people were engaged in farming, planting cassava for survival. On week-ends, civil servants traveled to the villages to farm. There was scarcity of labour. Tractor hiring was the next alterative. The ministry of Agriculture, Akwa Ibom Agricultural Development Programme, Cross River Basin Development Authority, had few tractors and they were in high demand. Farmers became used to hiring tractors although they had small holdings to farm. Today, farmers hire tractors for land preparation in preference to the costly labour that delay their work or disappoint and frustrate them. The Niger Delta Development Commission (NDDC) has recently sold farm tractors and the accessories at affordable costs to farming cooperatives and recognized farmers. This has enabled more farmers have access to tractors to help mechanize their farms.

3. CHALLENGES TO AGRICULTURAL MECHANIZATION IN AKWA IBOM STATE

There are many constraints to successful farm mechanization in Akwa Ibom State and they include fragmentation of farmlands or small land holdings, land tenure system, poor capital base, scarcity of farm machinery and equipment, insufficient farm inputs, poor infrastructural facilities, land degradation, poor social and economic structures.

3.1 Fragmented Farmlands

The state is densely populated. The fallow lands between villages, which are meant for farming are limited. Consequently, many farmers have small land holdings which are scattered in different locations

in the village. Proceeds from these small landholdings will not meet the expenses on machinery, and other farm inputs. Ali El Hossay (1988) confirmed that land fragmentation with numerous canals and drainage ditches, narrow access roads to individual farm plots, seriously restrict the use of mechanized equipment. Olayide (1980) stated that the small farmers production problems are intensive labour needs (60 percent of total production cost), poor technology, low operating capital, fixed capital investment and poor management.

3.2 Land Tenure System

In many communities, land is inherited. Outright sale is forbidden. Communal lands are not sold too. Investors may not be able to buy enough land to start large scale farms which can be mechanized. Women constitute about 75 percent of peasant farmers and since land is invested in men, these women can do little or nothing to change land tenure system such as merging their individual little plots to favour farm mechanization.

Men should therefore be drawn into Agriculture through incentives.

3.3 Poor Capital Base

About 90 percent of the farmers are peasants, operating at subsistence level. Most of them have no capital to invest in farming. At harvests, they sell their farm products and make use of the money. During the next planting season, they have no more money to hire machinery and buy farm inputs. Many of them have no collaterals for credit facilities.

3.4 Scarcity of Farm Machinery and Equipment

Since farming requires timeliness of operations, farmers rush to plant within the first one month of the first rains. Crops planted during this period perform well because there is little or no leaching. Farm tractors and other equipment for land preparation are scare at this time such that many farmers resort to manual labour to prepare their farmlands. Labour is costly and many farmers cannot afford for it. This brings about poor performance by farmers.

3.5 Insufficient Farm Inputs

Farm inputs as used here refer to seeds; fertilizer and the pesticides (insecticides & herbicides). A farmer with a very poor harvest is not happy and he will not have money to invest again. In Akwa Ibom State rainfall is very heavy, leaching to leading and washing away of farmlands. The soil needs amendments to restore its fertility. But fertilizer is not always forthcoming. It is a very rare commodity and as such farmers suffer because of poor productivity.

High yielding varieties may not be available always. Sometimes, the seeds may not be viable aid some may not be able to resist diseases. Thirdly, the farmers need herbicides to control weeds which grow luxuriantly on account of high rainfall. Using herbicides costs far less than using manual labour to weed. Insecticides and fungicides are needed to protect the crops because the humid environment breads insects and diseases.

3.6 Poor Infrastructural Facilities

Infrastructural facilities considered include roads, electricity and water. Rural roads in Akwa Ibom State are very bad especially in the rainy season because of severe erosion. Many roads are rendered impassable. There are many slippery hills with deep-seated clay which hinder even the cyclists from passing. Such communities are cut-off from the rest of the state during the rainy season. Farm inputs are not taken in and products are not evacuated. Unfortunately; these are the areas with large expanse of

farmlands, very fertile and suitable for large scale mechanized farms. Big-time farmers cannot go to invest because of bad roads.

Electricity is needed to process crops using an electric motor to run farm machinery is cheaper than using an internal combustion engine which needs regular servicing and fueling as well as contributing to environmental pollution. If rural farmers process their crops and add value to them, they earn higher income than when they sell them raw. Electricity in the rural farming communities means more comfort to them and will help reduce migration of the youths who are needed more on the farms to urban centres.

Good water supply is an essential utility to the rural farmers. Poor water supply is a health hazard. It brings sickness and sometimes death. Consequently, the productivity of the farmers is low and farm mechanization cannot create any positive impact on the community.

3.7 Land Degradation

Due to heavy rainfall, there is serious erosion which washes away top soil. The soil is generally acidic and the fertility is low. The farmer will spend heavily to remedy the low soil fertility if he is to invest and make gain in mechanized farming.

Gully erosion is a common feature and rural roads are destroyed. Sometimes there are landslides which take away farmlands, cut off roads entirely and restrict movements.

In many instances, floods submerge farmlands and destroy crops completely. Farmers incur irreparable losses especially as they do not have farm insurance. In the coastal areas, there are often, cases of oil spill which destroy hectares of farms and bring heavy losses to farmers. The oil spill also has long term effect on the soil and can render such soils unfit for cropping. Again, because of gas flaring, the rains which fall are acidic and this adversely affects the soil fertility too.

3.8 Poor Social and Economic Structures

Farmers in the rural areas are generally poor and cannot as individuals afford for farm machinery to mechanize their farms. At the same time, they do not like to come together to form cooperatives and put their resources to invest. Because of their individualistic approach, they are unable to have access to credit facilities from commercial houses or government. The Punjab state experience (Mittal and Bhatia, 1988) has shown the importance of cooperative societies in agricultural revolution for these cooperatives had huge successes in Agricultural production.

4. PROSPECTS OF FARM MECHANIZATION IN AKWA IBOM STATE

Although the challenges to farm mechanization in Akwa Ibom State are many, it is imperative that there should be food security for the people. For this to be achieved, farm mechanization is the answer. This becomes very necessary because a lot of young farm labour is migrating to cities especially Uyo the State capital, for other jobs in the phase of present industrialization, leaving only the aged peasants on the farms. The following strategies may be adopted to encourage farm mechanization in the state:

4.1 The Establishment of Land Bank by the Government

Government should handover abandoned government model farms and Cross River Basin farms which run into thousands of hectares of farmlands to constituted private investors willing to embark on large scale farming and farm mechanization. Some of these farms run into hundreds of hectares of land and many are left fallow while some are used by the host communities to plant some crops. Many hundreds of hectares of rice farms are left unutilized today. Effective utilization of these abandoned farmlands through farm mechanization arrangement will greatly boost food production in the state.

4.2 Formation of Farmers' Cooperatives

Farmers should be encouraged to come together and form cooperatives so as to attract incentives for farming. Such incentives include credit facilities and farm inputs. Such registered cooperative bodies will enjoy government's protection in their business. The cooperatives will be able to acquire farm equipment for mechanized farm, which an individual would not be able to achieve.

4.3 Availability of Farm Equipment and Inputs

Farm tractors and the accessories should be readily available for farmers to hire at subsidized rates. Government and its agencies such as AKADEP, NDDC and Cross River Basin Development Authority, should introduce tractor hiring services in the local government headquarters so as to bring the services nearer to the rural areas.

Other farm inputs such as fertilizer and farm chemicals should be made available to farmers too. Fertilizers are needed to remedy the highly degraded soils created by leaching and erosion. For mechanized farms which may entail large scale farming, manual weeding is difficult. The weeds are controlled by herbicides. Also the crops are protected by insecticides and fungicides.

4.4 Construction of Rural Feeder Roads

The rural areas with large expanse of land for large farms are characterized by poor earth roads damaged by erosion. During rainy seasons, vehicles and sometimes motorcycles do not pass through these roads. Investors will not go to where they will not have access to at certain periods of the years. Building these roads is very necessary. Some can be tarred.

4.5 Opening of Closed Waterways

Nearly all the rice fields are in the flood plains of the Northern part of the State. Every year, the flood increases in height and expanse and submerges rice and other crops. Farmers suffer untold hardship because of the losses they incur. In 2004, one government rice farm of 400 hectares had only 40 hectares cropped. The rest was covered with high floods. But when the water channels in which the farm was drained into was cleared down to the nearby river, 100% of the farmland was free for cropping. Such water channels should be cleared for easy flow of water from time to time.

4.6 Post Harvest Handling of Crops

Some major crops, especially cereals, are harvested in the peak of rains. Maize is harvested in June and July and rice in August and September. Maize rots away, if harvested in large quantities because of lack of dryers. Rice also suffers because after parboiling, there is no adequate sunshine to dry the parboiled paddy. These crops, especially maize which is so susceptible to bad weather, can be bought by government or other stake holders to dry mechanically and store.

4.7 Reviving Some Abandoned Strategic Agricultural Projects

There are some strategic government projects, which if completed, will revolutionize agriculture in Akwa Ibom State. Unfortunat4ely, they have been abandoned for decades. A typical example is the Nkari irrigation dam project in Ini Local Government Area. It was started in the early 19080s under the regime of Alhaji Shehu Shagari up through the Cross River Basin and Rural Development Authority. Under Obasanjo, the project was on-going and up till now, it is not completed. This dam is said to be the largest

in South-South. This project, if completed will really boost agricultural production from fruits and vegetables to cereals. This dam is sited in a flood plain of more than 4,000 hectares.

5. CONCLUSION

Akwa Ibom State has a small land mass and the population density is high. The people are hungry because agricultural production is low. The labour on the farm is scarce since the youths have migrated to cities to look for jobs, leaving the aged behind. Being in the tropical rain forest region, the weeds grow very rapidly and pose threats to crops.

For the state to be self sufficient in food production, the only option is to embark on intensive agricultural mechanization. The abandoned government farmlands, those of Cross River Basin and Rural Development Authority, can be constituted into large scale farms for the private sector participation. High yielding seeds, fertilizer and farm chemicals, are integral parts of the successful farm mechanization scheme.

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MECHANIZATION OF AGRICULTURE IN THE NORTHEAST SEMI ARID REGION OF NIGERIA

I. Audu[1], M. A. Haque[1] and H. Ahmad[2]
[1]Department of Agricultural & Environmental Resources Engineering,
University of Maiduguri, Maiduguri, Nigeria.
[1]Department of Agricultural Engineering, Bayero University, Kano, Nigeria.

ABSTRACT

A review of mechanization of agriculture in the northeast semi-arid region of Nigeria is presented. It focuses on food production problems and ways of ameliorating the problem through mechanization efforts. The basic agricultural practice predominating in the area is upland rain-fed cultivation and irrigation in the low lying fadama areas along side rivers, streams and lakes. The main crops grown in the region include millet and sorghum for the rain-fed whereas wheat, onions and other vegetables are cultivated in the fadamas. In Borno state, only about 1,388,720 hectares of land is estimated to be under cultivation with about 4,452,200 hectares available for expansion. Government interventions to boost crop production to match growing population over the years did not yield the desired results principally due to lack of adequate mechanization and bad policy implementation. The specific tractor population density in the region is very low and this is further aggravated by lack of maintenance resulting to high number of non-functional machines. It was also found out that the dominant tasks performed by tractors in this technologically limited region are seedbed preparation, threshing and transportation. Recommendations for improvement include: establishing new subsidised supply chain for agricultural machinery, promoting establishment of local manufacturing capability for agricultural machinery, more attention to post harvest systems and more pragmatic credit facilities to farmers.

KEYWORDS: Agricultural mechanization, semi arid region, irrigation, processing.

1. INTRODUCTION

Global population has been increasing over the years and this implies that more food is required in order to feed this growing population. The world population has increased from about 5.5 billion in 1990 to nearly 7 billion in 2010. The growth of food production has not been commensurate to the population growth globally. For example, the world cereal production has increased from just below 2500 million tonnes in 1999 to just above 2500 million tonnes in 2006 (Mrema, 2008). Even as these figures point to a serious problem, there are wide variations of the problem in different parts of the world, with some regions completely overcoming it while others struggling to solve it.

Agricultural productivity in Africa remains largely stagnant with yields of maize and other staple cereals typically remaining the same at about 1000 kg/ha which is about a third of the average achieved in Asia and Latin America (FAO, 2008). In the Sub-Saharan Africa (SSA), the population has more than doubled from about 330 million in 1980 to nearly 800 million in 2010, while food production only increased marginally. This indicates a bleak situation in SSA in terms of food self-sufficiency. Many factors are responsible for these imbalances and these include among others, lack of mechanization and other technology based inputs, climate, conflicts and illiteracy.

Agricultural mechanization is often considered a key factor for sufficient food production (Haque et al., 2003; Mrema et al., 2008). Mechanization not only allows previously unutilized land to be brought under

cultivation, but also results in timelier field operations and reduction in drudgery associated with farm work. During the middle of the last century, draught animals and tractors were introduced in many communities in the SSA to accelerate cash crop production and to increase the area under cultivation. In some instances, both the government and the private sector promoted tractor use by offering tractor-hire services. It was also during this time that governments in sub-Saharan countries attempted to intervene by engaging in comparatively large-scale agricultural mechanization projects (FAO, 2008). As a result, agricultural production increased but that did not last due to factors such as reduction/withdrawal of agricultural subsidy, tractor-hire services and disruption of produce markets (Bishop-Sambrook, 2005). Progress in agricultural mechanization stalled in much of sub-Saharan countries and in some cases even retrogressed. Land preparation then relied completely on human muscle power on about 80 percent of the cultivated land, with draught animals and tractors being used on only 15 percent and 5 percent, respectively (FAO, 2008). In Europe, North America and some parts of Asia, they have succeeded in addressing the problem of production and this is due principally to mechanization (number of tractors, new implements). They have not only mechanized land preparation tasks, but also many harvesting and post harvest operations.

In its effort to boost agricultural development, Nigerian government, and sometimes in collaboration with some international organizations like the World Bank, Food and Agriculture Organization (FAO) and African Development Bank (ADB), has severally introduced various developmental programmes across the country. They include programmes such as Operation Feed the Nation, Green Revolution, National Economic Empowerment and Development Strategy (NEEDS), ADPs and RBDAs. In Nigeria, mechanization is often linked to the use of tractors. The Nigerian farmer sometimes, due to scarce tractor services, uses draught animal power as an alternative source of power for agricultural development (Ajav, 2000). As at 1996, the total area cultivated in Nigeria was about 8.75 million hectares out of which 86, 5.5 and 8.5% were cultivated with hoe, animal power and tractor respectively (Ladeinde, 1996). There is a slight improvement (65, 25 and 10%) in about a decade, as evidenced by an FAO (2008) report for SSA. Recent investigations (Haque et al., 2003; Audu et al., 2008) still show a very low level of agricultural mechanization in the semi-arid region (SAR) of Nigeria.

This paper presents a review of the information available on the level of agricultural mechanization in the north-eastern SAR of Nigeria with suggestions on how to improve the situation.

2. THE NORTHEAST SEMI-ARID REGION (SAR) OF NIGERIA

The SAR of Nigeria in general falls within the Sudano-Sahelian zone (SSZ) of sub-Saharan Africa and it covers a vast area with Sokoto state in the west and Borno in the east and is strategically located at the gateway between Nigeria and three other African countries; sharing borders with the Republics of Niger to the north, Chad to the north east, and Cameroon to the east.
In the north-eastern part of this semi-arid area are Borno and Yobe states and this is where the main focus of this write-up lies. The landscape of this area is developed on the young sedimentary rocks of the Chad formation and it is an extensive plain that contains no prominent hills with an average elevation of 300 m above sea level, sloping towards the Lake Chad. The soils in the semi-arid region vary from sandy loam to clay, with sand size fraction dominating the top soils from the northeast (Rayar, 1987; Chiroma et al., 2010).

There are three main climatic seasons in the area- cool dry (harmattan) season, which lasts from October to March; the hot dry season that lasts from April to May, with peak temperatures reaching between 39 and 45 degrees under the shade; and the rainy season, which varies from place to place and normally lasts from June to September with a range of 300-700 mm (Audu et al., 2008).

The major occupation of the people, especially in the rural areas, is agricultural production and pastoralism (NPC, 1998). The basic agriculture of the area is upland rain-fed cultivation, based on millet and sorghum. Rain-fed crop farming in the upland areas and *fadama* (or flood plain) irrigation farming

constitute the major occupation in most rural communities of the region. In Borno state, only about 1,388,720 hectares of land is estimated to be under cultivation with about 4,452,200 hectares available for expansion (MARD, 2001).
Situated on the edge of the Sahara Desert, the semi-arid region of Nigeria is ecologically vulnerable and therefore subject to all the vagaries of climatic changes including drought, floods, river desiccation and desertification. Lake Chad is the major wetland in the semi-arid Sahel corridor, supporting some 11 million people, who directly depend on the Lake and its hinterland for survival (FAO, 2004). Lake Chad, because of its unique position in the midst of arid and semi-arid zones, must have been a focal point for the intermixture of peoples, cultures and various occupational groups for centuries (Tijani, 1980). It was described as a 'big commercial zone' and at the same time providing 'considerable pasture grounds during the dry and the rainy season to support large nomadic populations of Kanembu, Shuwa and the Fulani' (Alkali, 1978).

3. AGRICULTURAL DEVELOPMENT IN THE SEMI-ARID REGION

3.1 Status

According to an FAO report, African countries have an economy strongly dominated by the agriculture sector. Agriculture generates up to 50 percent of gross domestic product (GDP), contributing more than 80 percent of trade in value and more than 50 percent of raw materials to industries (FAO, 2008). The Nigerian situation is not far from the African picture. In the 1960s, the agricultural sector was the most important in terms of contributions to domestic production, employment and foreign exchange earnings. As at 2009, Nigeria's (per capita) GDP stood at $2,400 with agriculture contributing about 33.4% (Index Mundi, 2010) with crops accounting for 80%, livestock 13%, forestry 3% and fishery 4% (IMF, 2010). Agriculture in the SAR as indeed in the rest of the country provides employment for the majority of people. Smallholder farmers constitute 80% of all farm holdings and their production system is inefficient. Although, more number of farmers have access to agricultural inputs such as tractor and fertilizer today than 40-50 years ago, still this is only a minor fraction of the total number of farmers in the region. It is only very few actual farmers that have access to the tractor hiring services and fertilizers provided by the government with majority of the beneficiaries involved in racketeering. At the end of the day, the farmers are left with the option of either paying very high prices for these inputs or to go along with their age-long ways of using the traditional tools or draught animal power. This experience leaves the agriculture sector of the economy virtually stagnant and underdeveloped and in some cases even deteriorated. Owing to poor and inefficient post harvest handling, storage and processing methods, 30 – 40 per cent of agricultural product is lost (FAO, 2008). In terms of yield, it was reported that Africa remained stagnant with only about one tonne per hectare for maize and other cereals and it also foresees a bleaker future when global warming is taken into consideration.

The low level of engineering technology inputs in agriculture has been cited as one of the main constraints hindering the modernization of agriculture and food production systems in Africa.

3.2 Institutional Support

Many institutional programmes in agriculture have been undertaken by the Government (both Federal and State) and sometimes in collaboration with international organizations since independence to develop agriculture in Nigeria. Some of these that are visibly available in this semi-arid region include:

i. River Basin Development Authority Programme (RBDA)
ii. Rural Integrated Agricultural Development Programme (ADP)
iii. Agro Service Centre Programme (ASC)
iv. National and State Food Production Companies
v. Research Institute

vi. National Economic Empowerment Development Strategy (NEEDS).

Many of these interventions were not successful due to obstacles on the way to development. Notably are: lack of fine-tuning of agricultural sector policies to meet the needs of farmers and investors in agriculture, inadequacy of rain-fed agriculture, soil infertility and erosion (both wind and water). Some of the measures to be taken to achieve development in the agricultural sector will include among others:

- Control of the importation of food, especially those with local substitutes. Local food production should be encouraged by making agricultural inputs available, supporting adequate storage and processing facilities and providing market facilities for their produce.
- Support for *fadama* development and management,
- Promoting the use of organic matter and good agronomic practices, planting of trees, especially those with economic value.

4. STATUS OF AGRICULTURAL MECHANIZATION IN THE NORTHEAST SEMI-ARID REGION

4.1 Production Infrastructure

Agricultural mechanization is largely linked to the availability of tractors in an area. The density of tractors in an area usually defines its level of mechanization. It was reported that the use of tractors in the SSA is generally low compared to Brazil, China and India (see Figure 1). In their comparative analysis of the use of tractors, Haque et al. (2003) reported that the specific tractor population density (STPD) in Borno State (now Borno and Yobe states) is not only very low, but also declined from 0.28 in 1984 to 0.22 in 1998 (see Table 1). During this period, the major tasks performed with the tractor were disc harrowing, disc ploughing, threshing and transportation, with the first two dominating. In another study in the semi-arid region of Nigeria, Haque et al. (1999) reported that on average 65.92% of the annual tractor operational time was spent on harrowing, while 14.24% was spent on ploughing. Farmers plough and/or harrow their lands prior to planting. As the upland soils in northern Borno are mostly sandy, the farmers in that area might be aware of the limited benefits of ploughing and/or harrowing and therefore only few use these methods. Ploughing and/or harrowing are mostly applied to prepare lands in southern part of Borno State (Table 2).

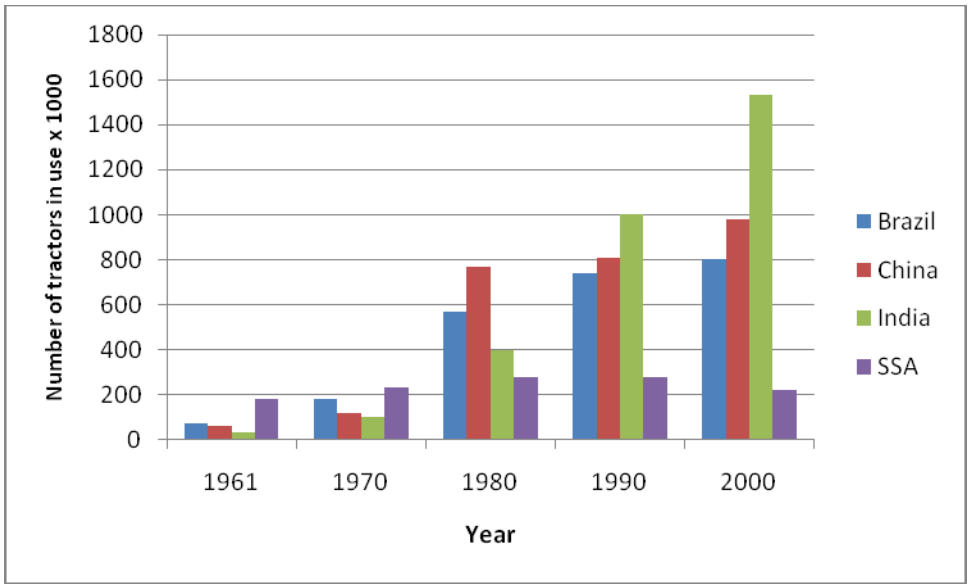

Figure 1: Tractors in use in sub-Saharan Africa compared to other developing Countries

SSA = Sub Saharan Africa
Source: FAO (2004)

Table 1: Tractor statistics and uses in Borno State (now Borno and Yobe)

Item	1984 (former Borno)	1998 (present Borno)
Total number of tractors	1311	610
Number of tractor makes	12	16
Number of tractor models	31	61
Functional tractors (% of total)	39	65
Private tractors (% of total)	41	52
Public tractors (% of total)	59	48
Specific tractor population density	0.28	0.22
Specific tractor wattage	9	12
Major operations performed in order of decreasing importance	Disc harrowing, disc ploughing, threshing, transportation	Disc harrowing, disc ploughing, threshing, transportation

Source: Haque et al. (2003)

Table 2: Percentage of farmers applying various methods of land preparation in the 10 Local Government Areas of Borno State

Local Government Area	Methods Applied				
	Land Clearing	Burning Crop Residue	Ploughing	Harrowing	Ridging
Abadam	90.0	36.7	26.7	16.7	0.0
Bama	80.0	80.0	6.7	43.3	0.0
Bayo	100.0	100.0	6.9	0.0	0.0
Damboa	96.7	93.3	96.7	53.3	76.7
Hawul	46.7	60.0	53.3	3.3	0.0
Jere	57.1	50.0	28.6	42.9	17.9
Konduga	100.0	96.2	92.3	61.5	0.0
Mobbar	82.8	93.1	89.7	86.2	0.0
Monguno	63.3	63.3	10.0	50.0	3.3
Ngala	100.0	96.4	3.6	60.7	0.0
Average	81.7	76.9	41.4	41.8	9.8

Source: Audu et al. (2008)

The use of machinery in crop production is very limited in this area (Haque et al., 2001; Audu et al. 2008). Machines such as combine harvesters, planters, threshers, etc are rarely used by the farmers and even a quarter of those that are widely used are non-functional (Table 3). More than half of the total tractors available in Borno (now Borno and Yobe) were non-functional (Haque et al., 2001). Farmers still use the traditional hand tools such as sickles and cutlasses for harvesting their crops. Combine harvesters, fishing boat and fishing gears are employed only to a limited extent (Table 4). With only few machines used and coupled with the high number of non functional ones, it is difficult to make a breakthrough in mechanization in this region.

Table 3: Number and conditions of various types of agricultural machinery in Borno State

Type	Number		
	F*	NF	T
Tractor	395	215	610

Disc plough	132	14	177
Mouldboard plough	4	1	5
Chisel plough	3	0	3
Disc harrow	253	38	291
Land leveller	11	0	11
Disc ridger	30	5	35
Mouldboard ridger	2	0	2
Seed planter	9	2	11
Seed drill	3	5	8
Boom sprayer	6	1	7
Cereal thresher	10	1	11
Rotary slasher	5	1	6
Bailer	0	1	1
Combine harvester	22	9	31
Trailer	144	24	168
Total	1029	348	1377
Per cent	75	25	100

*F =Functional, NF = Non-functional, T = Total
Source: Haque et al. (2001)

Table 4: Percentage of usage of different harvesting methods in 10 Local Government Areas of Borno State

	Harvesting Method			
LGA	Combine Harvester	Fishing Boat	Hand Tools	Fishing Gears
Abadam	16.7	23.3	93.3	20.0
Bama	0.0	0.0	80.0	3.3
Bayo	0.0	0.0	100.0	0.0
Damboa	0.0	0.0	96.7	0.0
Hawul	6.7	0.0	93.3	0.0
Jere	42.9	7.1	53.6	0.0
Konduga	0.0	0.0	100.0	0.0
Mobbar	0.0	6.9	96.6	27.6
Monguno	0.0	13.3	70.0	6.7
Ngala	0.0	25.0	100.0	7.1
Average	6.6	7.6	88.3	6.5

Source: Audu et al. (2008)

In their bid to improve agricultural mechanization, Borno and Yobe states have established Agricultural Mechanization Authority (BOSAMA & YOSAMA) principally to provide tractor hire and other agricultural mechanization services in their areas. These authorities started well at the beginning but their services are increasingly proving difficult to get by the farmers. This is due to competition and corruption. Tractors are given to supposedly farmers on hire basis at the beginning of the rainy season to perform mainly seedbed preparation and to a lesser extent threshing at the end of the rainy season. In a recent study of tractor use in BOSAMA, Maikafi (2010) found out that the 57% functional tractors were mainly used for seedbed preparation and threshing and with about 880 hours of annual use. Ali (2010) also reported similar result in his study on the use of tractors in YOSAMA.

Farmers in this region use fertilizers, agrochemicals and insecticides. The use of these inputs is gaining acceptance among the farmers in recent times compared to the low usage in 1988 (FAO, 1990). As a result of shortage of organic manure, the use of inorganic fertilizer is on the increase. According to FAO (1990), the average consumption of fertilizers was estimated at 10 kg/ha and this is usually limited to

maize, rice, groundnut and cotton. Although the government tries to make fertilizer available to the farmers, it is almost invariably beyond the reach of the farmers. The farmers mostly get their fertilizers from the open market and at high costs. Fertilizers should be applied in relation to the existing soil fertility. The use of chemicals (fungicides) can give effective control of many diseases, but their costs are generally high and place them out of the reach of small-scale farmers. This may explain the low usage of this input in crop production. New seed varieties are increasingly being used by the farmers and often obtained from the open market and sometimes from ADP/MANR.
The most common processing facilities used in the communities include open air sun drying, power mill, vegetable grinder and rice mill. The storage facilities widely used by the farmers in the SAR region are the stores and the granaries.

4.2 Irrigation

Irrigation in this region is normally practiced during the dry season in the fadama areas and along the shores of Lakes Chad and Alau. The flood plain cropping involves planting in depressions seasonally inundated by flood from nearby rivers and lakes. Earth bunds are constructed to retain or exclude water as required. Also, water is diverted from the river, stream or lake and distributed along canals or ditches by gravity to where it is needed (Plate 1). Surface irrigation in its various forms (basins, borders and furrows) is the dominant water application method over most of the residual floodplains *fadama*. Most of the farmers now use small motorized pumps to directly lift water from the river, stream or lake. It was also observed that in areas far from rivers, streams and lakes, the farmers sink wash bores and dig wells and use motorized pumps to lift water to irrigate their farms. Most of the irrigation facilities are maintained by the individual farmers and sometimes group of farmers. Government's involvement is limited as revealed in Table 5.

Plate 1: An irrigation setup in Ngala LGA, near Lake Chad
Source: Audu et al. (2008)

Table 5: Organ responsible for maintaining irrigation facilities in 10 LGAs of Borno State

	Organ maintaining irrigation facilities		
LGA	Individuals	Group	Government
Abadam	80.0	56.7	3.3
Bama	66.7	0.0	0.0
Bayo	96.6	3.4	0.0
Damboa	53.3	0.0	0.0
Hawul	43.3	43.3	0.0
Jere	50.0	32.1	14.3
Konduga	61.5	0.0	0.0
Mobbar	86.2	0.0	24.1
Monguno	63.3	0.0	0.0
Ngala	0.0	42.9	25.0
Average	60.1	17.8	6.7

Source: Audu et al. (2008)

5. CHALLENGES OF AGRICULTURAL MECHANIZATION IN THE NORTHEAST SAR

- Lack of transparency by hire service managers and deep corruption in the system has stagnated or even reduced the area under cultivation because tractors are not utilized efficiently
- Difficulty accessing spare parts
- High service and repair costs
- Generally low level of education, with 63.7% being illiterates as reflected in the 1991 census. This has serious negative implications for agricultural production, particularly the receptiveness of farmers to extension services and the adoption of innovations.
- Apart from low power input, there is lack of investment in irrigation especially when compared with other developing nations like India.

6. SUGGESTIONS ON HOW TO MECHANIZE AGRICULTURE IN THE NORTHEAST SAR

Mechanization will remain an important input in agricultural production and development. Lack of clearly defined strategies on agricultural mechanization is an important constraint to increased agricultural production and efficiency in the country as whole. Government should give priority attention to establishing reliable and low-cost supplies of tractors and related equipment, as well as other machines. For the immediate solution, government might consider establishing new supply chains for cheaper agricultural machinery and spare parts from Asia. Borno and Yobe states have already started going in this direction but care should be taken not to import sub-standard machines. The People's Republic of China and India produce and export tractors and implements at prices that are a small fraction of prevailing prices of the equipment imported from developed countries. Procuring machinery from such countries will go a long way towards accelerating agricultural mechanization in this area. This will also promote farm power use by making more functional tractors available.

Development of local industry for manufacturing machinery and equipment (small diesel engines, threshing machines, fodder-choppers as well as a range of animal powered equipment) as recommended by Haque et al. (2003) will also go a long way in the mechanization of agriculture in this region. This also has the added advantage of generating alternative employment, reducing dependence on imports, saving foreign exchange and facilitating the supply of parts and services.

Government should provide more support for water management systems in the *fadama* areas so that farming activities can go on, particularly in the dry season. This will involve provision of infrastructure like access road in *fadama* areas, and promotion of institutional organization of *fadama* users.

In order to add more value to produce from the farm and promote shell life, government and/or the private entrepreneurs should provide models of farm storage facilities at the ADPs for farmers to see, and then arrange to produce them. Government should subsequently and perhaps simultaneously provide credit facilities to both the farmers and the investors. Also, more studies on processing of staple foods should be undertaken to improve their form and acceptability.

7. CONCLUSION

From the review of mechanization of agriculture in the northeast semi-arid region of Nigeria, the following conclusions can be drawn:

The rate of crop production in the northeast SAR does not match the rate of population increase. Many factors are responsible for these imbalances and the most important amongst these are very low level of mechanization and climate.

Agricultural mechanization challenges in the northeast SAR include: Lack of transparency by hire service managers and deep corruption in the system, difficulty accessing spare parts, high service and repair costs. Agricultural mechanization service delivery should have a standard format of reporting in the ADPs, Ministries and Agricultural Mechanization Authorities as found in other service deliveries such as oil refineries (NNPC) and Power Holding Company (PHCN). The possibility of development of local industry for the manufacture of machinery and equipment as well as a range of animal powered equipment should be looked into immediately. This will not only increase the level of mechanization of agriculture in the region but will also generate alternative employment, reduce dependency on imports, save foreign exchange and facilitate the supply of parts and services. There is also the problem of poor storage and processing facilities in the region and therefore the need for attention in this regard too.

The semi-arid region of Nigeria is situated on the edge of the Sahara Desert, which is ecologically vulnerable and therefore subject to all the vagaries of climatic changes including drought, floods, river desiccation and desertification. Government should provide support for water management systems especially in the *fadama* areas so that farming activities can go on, particularly in the dry season. This will involve provision of infrastructure like access roads and promotion of institutional organization of *fadama* users.

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STATUS, CHALLENGES AND PROSPECTS OF AGRICULTURAL MECHANIZATION IN NORTH WEST AGRO-ECOLOGICAL ZONE OF NIGERIA

S. Z. Abubakar
Agricultural Engineering Department
National Agricultural Extension and Research Liaison Services (NAERLS)
Ahmadu Bello University, PMB 1067, Zaria, Nigeria
szabubakar@yahoo.co.uk

ABSTRACT

The north western agro-ecological zone of Nigeria comprising of seven states is one of the poorest parts of the country with the lowest per capita Gross National Product (GNP). Agricultural production and other value addition activities associated with crops, livestock, fisheries, forestry etc commodities are the major occupation of the inhabitants time immemorial. The region played principal role in the promotion of cash crops exported to European countries for the industrial revolution witnessed in Europe. The growth and development of the agric sector since the discovery of petrol in the country not only staled but declined drastically. The ancient farm tools used for production and to a small extend simple machines used for value addition activities still characterized the level of mechanization in the country. This slow progress has affected production and processing capacities of the key actors in the value chain of all agricultural commodities resulting in low productivity, income, food insecurity, poverty, massive rural urban migration, unemployment, insecurity, etc.

The irony of deprivation in abundance amongst Nigerians is partly due to inability to mechanize our agriculture to improve its efficiency, cost effectiveness, diversity and competitiveness. The paper highlights major factors responsible for the present situation and proffer strategies to overcome same. Basic concept of value chain approach and its strong relationship with ability to mechanize agriculture as well as principal technological requirements to drive modern agriculture were elaborated. Institutional framework, policies and strategies for the acceleration of dissemination and promotion of appropriate technologies for enhanced uptake by target users and eventual adoption were also suggested.

KEYWORDS: Agro-ecological zones, per capita, gross national product, industrial revolution, value chain approach,

1. INTRODUCTION

The importance of agriculture in the Nigerian economy cannot be overemphasized. It is a major occupation providing employment for about 70 percent of the people. Despite this, Nigeria is unable to produce enough food and fibre to meet her demand. This could be attributed among others, to the fact that majority of Nigerian farmers are subsistence small holder farmers who cultivate between 1-2 hectares, which is usually scattered over a wide area. It is the small – holder farmers that account for about 94% of the agricultural output while large commercial farms produce a paltry 6% of the total agricultural output (CNF, 1995).

In general terms, the Nigerian farmer is often described as the "hand – hoe farmer" because nearly all of his farm operations are still carried out manually using the inefficient hoe and cutlass. It has been reported (Mijindadi et all, 1994) that less than 2% of the agricultural production in Nigeria is mechanized in the real sense, leaving 98% of the production in the hands of traditional producers. The effect of this dependence on hand tool technology is low output and the technology cannot transform agriculture.

As no society can afford not to have a vibrant agricultural sector, urgent measures have to be taken to redress the situation in Nigeria. One of the most effective is to eliminate or, at least, minimize the drudgery involved and attempt to increase the use of sophisticated mechanization inputs such as tractors, combine harvesters, silos, etc. This has been the attempt by most past and present Nigerian governments. Their high initial running costs, incompatibility with farmers' environment and their crops, cropping techniques and high technical requirement for their operation and maintenance make such sophisticated mechanization inputs to be beyond the rich of farmers (Mijindadi et al, 1994; Lawal and Yiljep, 1996; and Yiljep et al, 1996).

The situation can be improved upon if farmers are assisted with simple mechanization inputs which are more efficient than the hoe and cutlass but which are economically compatible with farmers' practices. A number of such mechanization inputs have been developed by Research and Development Centres (R&DCs) but are laying "in-siitu". They need to be extended to beneficiaries (rural farmers). This paper highlights the extension approaches needed to introduce simple mechanization technologies for boosting food production in Nigeria.

2. CONCEPT OF FARM MECHANIZATION

Farm mechanization has been defined as the process of development and introduction of mechanized assistance of all forms and at any level of technological sophistication in agricultural production in order to reduce human drudgery, improve timeliness and efficiency of various farm operations, bring more land under cultivation, preserve the quality of produce, improve living condition and markedly advance the economic growth of the rural sector (Anazodo, 1986; Mijindadi et al., 1994; and Abubakar, 2010d). This simply means that farm mechanization encompasses in its widest sense hand-tool technology, draught animal technology and mechanical – power technology. Rijk (1989) gave the following phases or levels of agricultural mechanization: Hand Tool Technology, Draught Animal Technology and Mechanical Power Technology.

2.1 Hand Tool Technology (HT)

This is the use of tools and simple implements powered by human muscle and are the simplest and most basic level of agricultural mechanization. Hand tool technology is ineffective in transforming agriculture.

2.2 Draught Animal Technology (DAT)

This refers to a wide range of implements, machines, and equipment used in agriculture which are powered by animals, mostly buffalo, oxen, horses, mules, donkeys and camels. DAT is limited in scope and output.

2.3 Mechanical Power Technology (MPT)

MPT is the highest level of mechanization "commonly" used in agriculture. It takes many forms: a wide range of tractor sizes which are used as mobile power for field operations and transport, and as stationary power for various machines; engines or motors using petrol or diesel fuel or electricity to power threshers, mills, irrigation pumps, grinders and other stationary machines; aircraft for distributing crop protection materials and fertilizers; and self – propelled machines for the production, harvesting and handling of crops (Anazodo et al, 1986).

2.4 Challenges of Agricultural Mechanization

As indicated earlier, the successful development and application of improved agricultural mechanization technology is limited in Nigeria. Several factors, which may be socio-economic, cultural and technical in nature, have been discussed extensively by many researchers (Odigboh, 1976; Makanjuola, 1978 and

Yiljep and Gwarzo, 1986) and summarized by Anazodo et al. (1986). These factors are reproduced below.

i. Fragmented holdings which hinder efficient use of machinery;

ii. Current agronomic practices (in particular multi – cropping) which limit the scope and efficiency of machinery to be employed;

iii. Lack of classified data and information on the suitability, adaptability and performance of commercially available agricultural equipment as related to the types and conditions of soils and crops;

iv. Inadequate repair and maintenance facilities as well as difficulties in obtaining spare parts for machines and equipment;

v. Lack of trained machinery operators and mechanics;

vi. Poor credit facilities;

vii. Inadequate research and demonstration facilities;

viii. Inadequacy of needed farm equipment

ix. Absence of incentives for indigenous design and manufacture of needed farm equipment;

x. Inadequate infrastructural facilities such as roads, water supply, electricity, and

3. INSTITUTIONAL LINKAGES IN AGRICULTURAL EQUIPMENT RESEARCH AND EXTENSION

Principally, Institutions executing research work in agricultural mechanization in Nigeria are National Centre for Agricultural Mechanization (NCAM); 16 Universities with Departments of Agricultural Engineering (DAE); some Polytechnics, Raw Materials Research and Development Council (RMRDC), Federal Institute of Industrial Research Oshodi (FIIRO), National Stored Production Research Institute (NSPRI), Projects Development Agency (PRODA) and other relevant research institutes. Research orientations are in basic, applied and recently in the area of On-Farm Adaptive Research (OFAR) by the Agricultural development Projects (ADPs).

The new Institutional set up in farm equipment transfer in Nigeria provides at the apex the Agricultural Research Council of Nigeria (ARCN) who in turn coordinates and supervises the entire National Agricultural Research System (NARS) with 16 NARIs, FCAs, etc. Central to the identification, selection, packaging and promotion of viable technologies addressing clear market needs or demands are National Agricultural Extension and Research Liaison Services (NAERLS) and RMRDC. Other supporting organizations include: the National Food Reserve Agency (NFRA), PRODA. The Federal Colleges of Agriculture (FCAs), supported by ADPs working in collaboration with appropriate Research Institutes in the National Agricultural Research System (NARS) for play complimentary roles in the development, adaptation and dissemination of proven and relevant agricultural mechanization technologies (ARCN, 2007).

The mandate of NAERLS includes: Research on processes and approaches for extension delivery, development, collation, evaluation and dissemination of appropriate agricultural technologies; monitoring

of agricultural technology development and its dissemination. Technology dissemination is carried out through print and electronic media production as well as training of field extension workers nationwide, working in collaboration with relevant Institutes and ADPs.

The ADPs in all the States and Federal capital Territory are responsible for grass-root technology delivery. NAERLS supports the ADPs with capacity building or the production of audio-visual packages and print/electronic media programmes production on a number of improved technologies for promotion. Manpower training for the mechanization sub sector has been regarded as adequate (Lawal et al; 1996). The position is that the 16 universities DAE train high-level manpower, a number of polytechnics and colleges of agriculture turn out middle and senior level technical staff, and a number of farm training centers of states Ministries of Agriculture offering training to the lower cadre mechanization staff. There also exist two special centers for the training of agricultural mechanics and machinery operators. The only problem as pointed out by Lawal et al (1996) is that since agriculture has remained in the hands of peasant farmers, the main avenues of employment for this trained manpower have been in government extension services, in research institutes and sometimes in teaching rather than in farm mechanization itself.

4. STATE OF ADOPTION OF FARM MECHANIZATION TECHNOLOGIES

Despite the efforts being made by numerous Research and Development Centres (R&DCs), Extension Agencies and other related organizations, the adoption of farm mechanization technologies by Nigerians farmers is very low (Jibril et al, 1995). It has been shown that no realistic change in the Nigerian Agriculture can be expected with the present level of drudgery. This will remain so until the farmer finds an alternative to the hoe and cutlass technique of production (FMI, 12971). Mijindadi (1989) asserted that the adoption of mechanization technologies is not only low but also several public agencies expected to promote their usage are yet to realize their indispensable nature.

4.1 Causes of Low Adoption of Agricultural Mechanization Technologies

The low level of farm mechanization technology adoption by farmers can be attributed to a number of factors some of which are:

i. Non-availability of the technology where and when needed;

ii. Relatively high cost of the technologies/machines where available;

iii. Lack of farmer finance to purchase the machines even if possibilities exist for their profitable utilization;

iv. Lack of awareness of the existence of the technologies by farmers;

v. Lack of skilled village level artisans to service and repair the equipment when they break down;

vi. Lack of suitability of several of the equipment to meet farmers' exact requirement and production environment;

vii. Lack of support for farm mechanization technologies and treating it as a separate and major issue in Nigeria's agricultural policy. It has always been relegated to the background and considered merely as a support service (Yiljep et al; 1994), and

viii. Reluctance on the side of R & D Centres to release information on their equipment.

As shown by Pinstrup-Anderson (1982), the most critical of the factors enumerated above is unsuitability. Very often, equipment development does not start from the farmer's field and production environment. As a result, some of the mechanization technologies do not address the farmers' needs. That is why the adoption of new technologies has been slow and limited to a relatively small number of farmers.

More often than not, where the equipment conforms to farmer's needs and environment, extensive efforts is often inadequate to let the farmers know of its existence. Farmers are often skeptical of new ideas and technologies, and would frequently require ample information and proofs to show that the innovation is worth expending their resources on. The need for a vigorous extension effort to popularize new mechanization technologies is, therefore, very essential.

Local artisans (blacksmiths and welders) are the closest equipment producers to the majority of Nigerian farmers, being mostly rural dwellers themselves. These groups of manufactures need to be made aware of available improved mechanization technologies and be provided with information and skill on how to produce and market them.

4.2 Technology Requirement to Drive Nigerian Agriculture

Land is still available for cultivation but doing so would reduce biodiversity and further deplete natural resources. We need to grow more food from existing resources, which are past diminishing. We also need to grow more from less, i.e. intensification strategies such as irrigation, fertigation, greenhouse, rainwater harvesting, etc. We must strive to add value to most agric. commodities to be able to compete in the global market.
This critical challenge of ensuring food security in the face of the continuing growth in demand coupled with the scarcity of natural resources means that the role of technology in agriculture has never been more critical.

The following are summary of the technology requirement for the nation to mechanize the agricultural sector to become competitive in both regional and global cycle (Abubakar, 2009 and 2010c):

- Development and use of f**arm power** to provide the n**eeded energy,**
- Development and use of f**arm tools & machineries** matching the available Farm Power for **higher output**
- Development and use of **farm infrastructure** to support the production, processing, preservation, packaging, handling and marketing of crops, trees, animals, poultry, fisheries, forestry products for **competitive marketing**
- Development and use of **improved techniques and practices for improved productivity and efficiency**
- Development and use of techniques and practices to **conserve environment, natural resources and biodiversity for sustainability**

Our effort to mechanize agriculture in Nigeria must be realigned with the global best practices/approach of value chain concept where critical points for intervention must be identified along the value chain with definite and specific solution which would bring immediate and tangible results/output. The achievement forms the basis for the next level/layer of intervention looking at higher standards set by other markets/nations. This cyclic and continuous approach that is need based and problem solving has no alternative if the nation is to mechanize this critical sector of our economy. Figures 1 to 3 show the different perspectives of the value chain concept applied to agriculture.

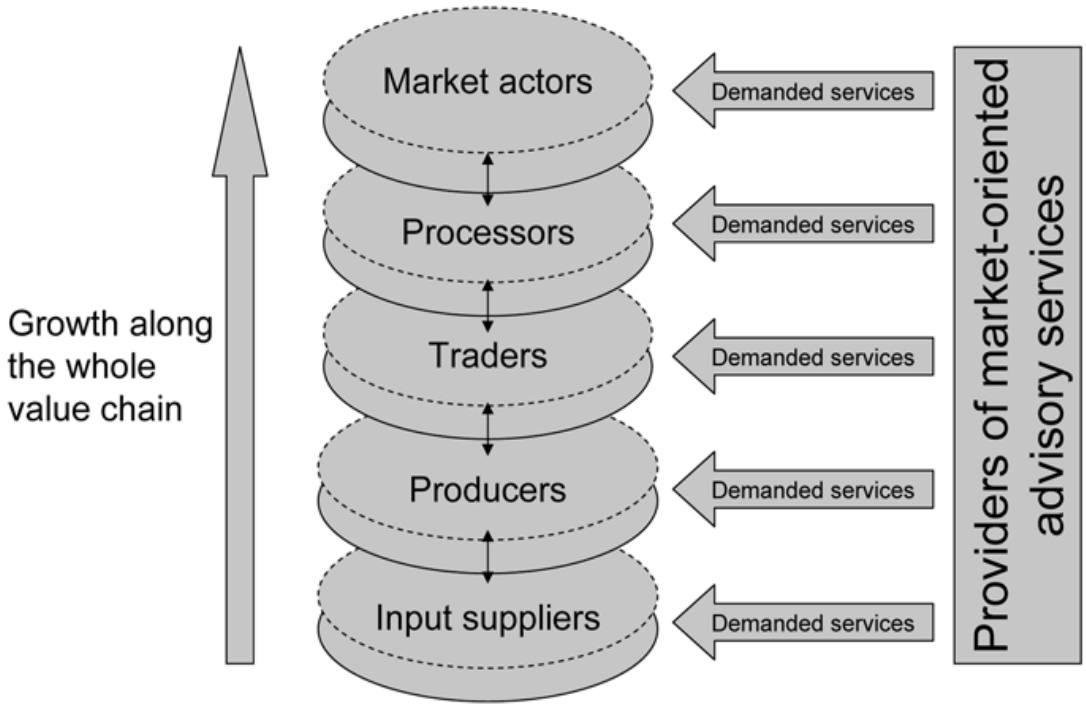

Figure 1: Value Chain Concept for Agric Engineers to adopt

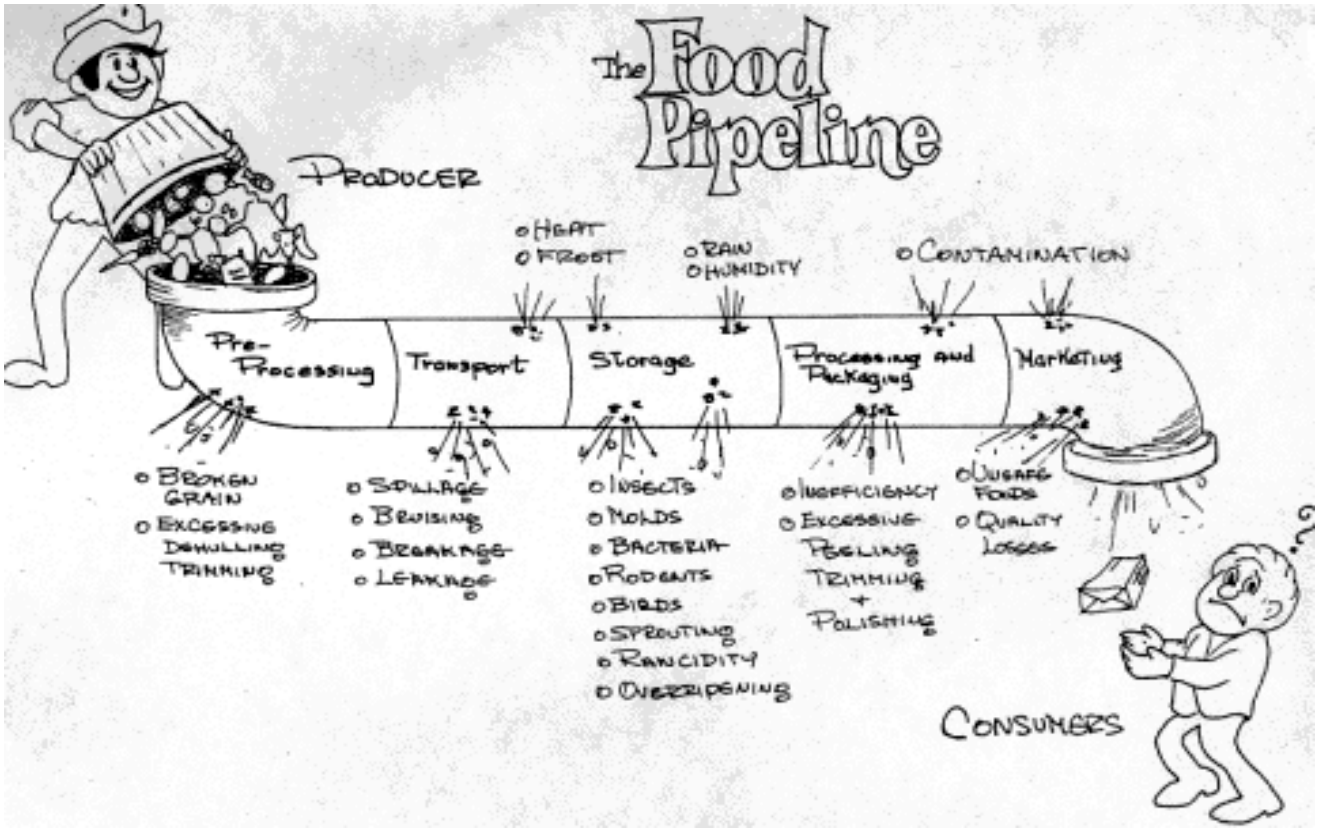

Figure 2: Value Chain System Approach with clear and identifiable points for Interventions

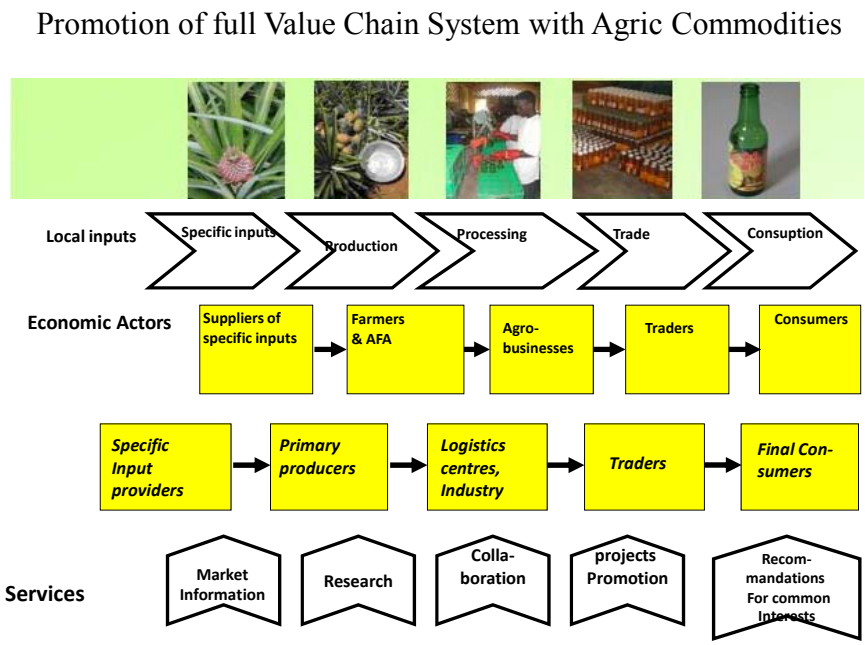

Figure 3: Typical example of Value Chain Approach applied to Agric Commodity

4.3 The Role of Extension and Promotion

The extension organizations in the country have a major role to play in overcoming the problem of low adoption and usage of farm mechanization technologies by Nigerian farmers. As evident from the factors listed as affecting the adoption by farmers, low adoption arose principally from lack of sufficient extension liaison between research and development Centers (developing or manufacturing the equipment) and farmers (end users of the equipment). Thus, the role or main task of extension is to act as an effective link between the two groups. Hence the need to mobilize ADPs, NGOs and the like for effective participation is more critical now.

In this regard, Mijindadi (1989), Abubakar (2008, 2010a) stated that it is the responsibility of extension organizations to assist the farmers to learn about and take advantage of new opportunities that can increase their agricultural practices. It is worth noting that it also the responsibility of extension units to bring to the researcher's attention accurate information pertaining to the farmers' conditions and needs such that agricultural mechanization technologies or interventions can fit their specific needs. Jibril et al. (1995) and Abubakar (2009) stated that the extension units today have a onerous task of engineering greater Researcher-Farmer interaction in order to stimulate the development of appropriate technologies and ensuring that farmers use them. Thus, the success of the introduction of farm mechanization technologies depends largely on their popularization among the small-holder farmers.

5. STRATEGIES FOR ACCELERATING THE DISSEMINATION AND ADOPTION OF FARM MECHANIZATION TECHNOLOGIES

Some suggested strategies through the extension linkage programmes (namely, through the participation of farm mechanization Subject Matter Specialists, SMSs, in farmers seasonal planning meeting for problem identification and possible solutions, development of action plans and mobilization of resources for the implementation of the plans under the platform of farmers associations/unions needed to be carried

out in order to accelerate the rate of adoption of improved farm mechanization technologies by small – holder farmers and they include (Abubakar, 2008b):

i. Identification of promising local artisans (blacksmiths and fabricators) to participate in training programmes on the fabrication and maintenance of suitable simple farm mechanization technologies. Emphasis is to be given to welders since they have been identified as the most suitable. Financial and other logistic support can be negotiated with financial organizations to be agreed upon (initiative in progress at NCAM).

ii. Research and Development Centres/Institutes and other relevant organizations should provide comprehensive information and demonstration on their development farm technologies. They should liaise with extension organizations to effectively execute this. They should also be willing to release information on their equipment.

iii. Providing assistance to farmers to meet their agricultural equipment needs by sourcing information on proven relevant technologies suitable for their use and extending such technologies to them. Information can be sourced from both within and outside the country. The sources of information include Research Institutes, Universities, polytechnics, other organizations, journals, newsletters, conferences, workshops, fairs, etc.

iv. Identifying farmers' specific problems and equipment needs and feeding the information to Research and Development Centres and Institutions. Problems can be identified during exercises such as the annual cropping season evaluation surveys conducted by NAERLS and Project Coordinating Unit (PCU) in collaboration with ADPs or other periodic diagnostic surveys. Such information can b passed to the R & D Centres/Organisation such as during the annual zonal OFAR and workshops at the Zonal Coordinating NARLs and at National Conferences, seminars, workshops and other similar fora. Better still a participatory approach to Research, equipment development and extension delivery will make new technologies and improved practices in Agricultural Mechanization more relevant and appropriate.

v. Linking potential equipment fabricators and manufactures with centers having technologies ready for commercialization. Sustained pressures should be mounted on appropriate government agencies to give necessary support to such entrepreneurs.

vi. Continuous monitoring and evaluation of farm mechanizations technologies under development at R & D Centres and those in use by farmers and relate information arising from such exercise to both the R & D Centres and farmers directly or through the ADPs.

vii. Encouragement of States to liaise with such bodies as NAERLS on the production of extension media packages both electronic and print (Radio and TV programmes, computer slides, training manuals, bulletins, guides, posters, etc) to popularize proven relevant agricultural equipment and technologies.

viii. Also in collaboration with NAERLS and other extension organizations, there is the need to conduct research in areas of equipment and technology dissemination using farmers group or community-based organization facilitated by farmers' leaders so as to

determine the most effective strategies for agricultural equipment and technology dissemination.

ix. NAERLS, ADPs and other extension agencies such as NGOs, CBOs, etc. in the country to monitor and review the extension services were rendered to farmers with the aim of establishing whether their farm mechanization needs are addressed. Extension Agencies/Organizations should be mobilized to provide assistance to the National Centre for Agricultural Mechanization in the establishment and sustenance of a comprehensive data bank on agricultural mechanization information and research findings.

x. The network of information and implementation modalities between local artisans, the small-holder farmers, relevant national agricultural research institutes, relevant extension organization, the National Center for Agricultural Mechanization and financing agencies (Financial Institutions, donor agencies, recommended for implementation.

6. CONCLUSION

The low rate of adoption and utilization of appropriate mechanization technologies has remained one of the major factors militating against agricultural production in Nigeria. There exist in the country a number of improved appropriate technologies that could be adopted by farmers, processors, marketers, industrialists and other actors along the value chain of various agric commodities. There is the need to bridge the adoption gap through an effective Research Extension and Promotion/Campaign Linkage Programme. The need for the agricultural engineers to key in the new paradigm shift of value chain approach where they identify specific points of interventions that are problem solving. Specialization and deeper efforts are indeed expected from the agricultural engineers who are to naturally lead in the mechanization of the Nigerians agriculture. This, it is hoped will significantly improve the production capacity of key actors operating along the value chain of most agricultural commodities in Nigerian and hence address the issue of food security, poverty and unemployment of active work force at both family, community, state and national levels.

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