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Policy of Agricultural Mechanization and Food Security in Nigeria: Challenges and Prospects

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Abstract. This paper examined agricultural mechanization as strategy for food security in Nigeria. The study adopted a descriptive method of analysis. Data for the study were obtained from secondary sources archival search. The main findings of the research are: There is a relationship between agricultural mechanization and food security in Nigeria. Effective agricultural mechanization facilitates heavy food production in Nigeria. Alleged lack of availability of agricultural mechanization is a threat to food security in Nigeria. Farmers' inability to use agricultural mechanization tools effectively affects food security in Nigeria. The study identified some challenges militating against agricultural mechanization in Nigeria. These challenges are affordability of mechanization, non-availability of mechanization, lack of famer skills and high tariff in machine spare part. The study found out that the rural people are mostly poor and hardly can buy a costly machine individually. Another problem is that a large proportion of rural farming populations are illiterate. This situation stands in the way of improving agricultural production and productivity as well as general levels of farm management. The study concluded with some strategies to enhance agricultural mechanization for food security in Nigeria. The strategies are availability of finance and loans to farmers, capacity building of farmers. Others are development of local organization and the creation of enabling business environment. The study recommended that government should encourage and promote local design and manufacture of farm implements and equipment at low cost. Programmes and policies of the government especially agricultural mechanization and policy on tractorization should be given necessary funding so as to ensure food security.

1. Introduction

Food is one of the basic human needs through the ages. However, food has not always been readily available to a large proportion of the populace in many countries. This situation has caused economic hardship to many nations (Andersen, 2019). Growing concern about the impact of food shortage on the development of nations world over is situated on the need for nations to strategize for improved national development through food security. The issue of food security has been very crucial to national development of countries overtime. For instance, the dearth of bread helped to topple France's centuries-old monarchy in the revolution of 1789 (Andersen, 2019). The wheat crisis of the 1970s put the Soviet Union in a precarious situation. The USA used food as foreign policy instrument to its advantage by refusing to sell wheat to the Soviet Union until it adopted a less aggressive posture in her defense (Roger, 2016).

In simple terms, agricultural mechanization is the replacement of human and animal labour by mechanical devices in farming activities. According to Simalenga (2020), agricultural mechanization should be taken in its broadest sense, embracing the manufacture, distribution and operation of all types of tools, implements, machines and equipment for agricultural land development, farm production and crop harvesting, and primary processing. It is no doubt that agricultural mechanization is considered to hold the key to food security. Nations around the world have succeeded in using agricultural mechanization to boost food security (Ademosun, 2019).

However, for real progress, growth and sustainable advancement to occur in the agricultural industry anywhere, it is essential to apply a trio of technologies comprising the Biochemical, Socio-

Economic and Engineering, Technologies (BSEET) (Ademosun, 2019). The transformation in American agriculture has been attributed to mechanization. Agricultural mechanization in Asia, U.S.A and Europe is geared towards increasing food security. For instance, in USA only about 3 per cent of the entire populations are farmers. Yet, they are able to meet to a reasonable extent the food needs of the United State. The massive production rate is made possible by the use of agricultural mechanization (Choudhury and Musa, 2010).

In Nigeria, the agricultural sector remains the only custodian of food security and employer of labour. The sector employs about 70 percent of the labour force (Abimbola, 2014). Despite this huge number of persons engaged in agriculture, the sector has been unable to meet the food demand of Nigerians. There has been a nineteen-fold increase in food importation. Dependence on food importation could put Nigeria in a precarious state of insecurity. Societies have long been concerned that food supply would lag behind population growth, resulting to famine. It is hopeful that in the future, Nigeria would become the third most populous country in the world. Through better understanding of agricultural mechanization, she will be able to be self-sufficient in food production, or else be a country, pre-dominantly agricultural but not able to produce adequate food for its populace, Abimbola (2014). The need for agricultural mechanization in Nigeria has become more acute in recent years due to the urgent need to accelerate food and fibre production for the teeming urban and rural population. Adama (2015) summarized the primary objective of agricultural mechanization as: to minimize production cost, optimize protect quality, product the environment and minimize farm production flexibility.

Nigeria is blessed with abundant human and agricultural resources. However, majority of its citizens live in hunger and abject poverty. For instance, Nigeria is ranked 91st out of a total of 104 countries in the 2015 Global Hunger Index (Ebo, 2016). The 2012 United Nations Development Programme Human Development Index put Nigeria 153rd out of a total of 187 countries with hunger and poverty (Ebo, 2016). Classifying Nigeria as one of the poorest countries testifies to its failure to secure adequate food for its teaming population. Efforts by the government of Nigeria towards improving food security and access to food to its populace have not been successful (Ebo, 2016). Institutions like the Agricultural Development Project (ADP), River Basin Development Authority (RBDA), and National Food Storage Programme (NFSP) established to boost agricultural development were not successful (Faloyin, 2015).

The largely subsistence agricultural sector has failed to keep up with rapid population growth of between 2.5% and 3% per annum in Nigeria (NISER, 2010). In Nigeria, hunger is pervasive, food price inflation has remained high and a greater proportion of household income is spent on food. The dependency of Nigeria on food importation has made her a food dependent nation, and a junior partner in comity of nations. This has become a threat to national development because without adequate and sustainable food security, people cannot live healthy and active lives (Faloyin, 2015). However, Nigeria's effort towards food sustainability has not been achieved. Food scarcity is caused mostly by the increase in world population. This is associated with the assertion that population increases geometrically while food production grows only arithmetically, if unchecked. Other causes of food scarcity like low level of agricultural mechanization, desertification, flood and erosion, sea pollution and pests menace, inadequate storage and distribution facilities are all hindrances to achievement of food security. A nation is not food secure until all people and each household have both physical and economic access to the basic food they need to work and function normally. Food must be available to everybody in sufficient proportion in the country. In spite of huge amounts invested in the procurement of agricultural machine in Nigeria, the level of agricultural mechanization continues to be very low (Adama, 2015). In respect of the above, Nigerian engineers have made a lot of progress in developing proto types of machines relevant to crops soils and socio-economic condition it is based on the above assertions that this study set out to assess agricultural mechanization as strategy for food security in Nigeria.

1.1 Justification of the Paper

Nigeria is facing a threatening food security crisis with its growing population becoming increasingly dependent on imported foods. The food crises could be attributed to low level of agricultural mechanization in Nigeria. Also, the once dominant subsistence-oriented farm economy is at risk of gradual marginalization. Insecure land tenure, scarcity of funds and credit, labour scarcity despite overall high unemployment and stagnant technology have crippled its further development. Until today, a wide range of mechanization policies have had limited impact in ameliorating the problems of food insecurity (Daramola, 2013).

Previous efforts in mechanization of agricultural productivity by various governments had been through the importation of tractors and implement into Nigeria. This has however not been able to solve the problem of our laggard embrace of mechanization. However over the years, little in term of policy guidelines have been formulated to achieve the objectives of effective agricultural mechanization process in the Country. Notwithstanding, there have been several programmes and projects that have been created to improve agricultural productivity with each having different implementation challenges. As a consequence of this, peasant farmers using primitive tools still constitute the bulk of producers of the food crops consumed in the Country. Nigeria is blessed with 98.3million hectares of arable landmass. 72 per cent of this has cultivation potential but only 35 per cent of the arable land is under actual cultivation (FMA, 2016). Despite the high proportion of cultivated landmass relative to the total available space, food production to feed the teeming populace has remained a mirage. Thus in essence, some questions can be asked.

2. Literature Review

Agricultural mechanization is a very broad field in which numerous factors have to be considered. According to Babajide (2019), agricultural mechanization is the application of tools, implements, and powered machinery as inputs to achieve agricultural production. Furthermore, Babajide reveals that many developing societies are intrinsically poor and lack the ability to take advantage of new technology hence they suffer from food crisis situations. Breeding crops and animals that produce higher yields of better quality but do not adversely affect the ecosystem can be achieved only through agricultural mechanization. He maintained that in response to the food crisis in developing countries, governments, research institutions and donor agencies have come up with a variety of technical, policy and institutional interventions, ranging from refocusing agricultural research and reviewing food security policies to the provision of emergency food aid.

According to Makanjuola (2019) agricultural mechanization embraces the manufacture, distribution and operation of all types of tools, implements, machines and equipment for agricultural land development. This definition is in contrast to the concept of many who erroneously take mechanization to mean the application of engineering principles to crop production only. Makanjuola pointed out that mechanization and intensification levels, fertilizer use and use of other modern technologies have remained low in Africa to date. However, degraded lands are common all over the continent and there are many reasons for this. One of them is the continuous use of the plough (or hand hoe) that leads to soil degradation and loss of fertile top soil. It is astonishing to see how far the reality of soil erosion has progressed in many regions of Africa considering the currently low level of mechanization. Makanjuola further posited that agricultural mechanization covers all levels of technology from the simplest and most basic to the most sophisticated and powerful. To him what is very important is that the technology involved meets the real needs of farmers and can be used efficiently and effectively and is financially viable. He did not view agricultural mechanization as the use of tractors and sophisticated agricultural machinery in agriculture.

According to Kennedy (2019), food security is the availability at all times of adequate food supplies to sustain a steady expansion of food consumption. This definition failed to see food security as a situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food. Kennedy construed as supply of food to meets the dietary needs and food preferences for an active and healthy life by all people at all time. This definition is comprehensive but it did not recognize food security as the success of local livelihoods to guaranteed success to sufficient food at the household level.

Agricultural mechanization is an essential agricultural input which has the potential to facilitate and increase food security. It enables access to input supply chains and integration in downstream value chains. Thus it provide for more income, renewed business opportunities and further value addition. Moreover agricultural mechanization in its broadest sense can contribute significantly to the development of value chains as it has the potential to render postharvest, processing and environmentally friendly.

According to Oni (2018), the world population will reach 9 billion people by 2050. The worldwide call for food will increase for at least another 40 years due to the explosion in the global population. Adequate food security depends on the use of agricultural mechanization in farming activities to the feed the estimated population. It is essential to apply innovative methods in all stages of production, processing, and marketing of food materials. Despite the belief that the reasons for food insecurity are more complicated, some believe that improving the physical performance of agriculture using a set of

new technologies is the main solution. Agriculture has always had a crucial role in the preparation of human needs for food and its development. The importance of agriculture in providing the nutritional requirements for developing populations is undeniable (Oni, 2018). Additionally, several parameters in the agricultural sector are very useful as an indicator for the expression of social identity and cultural promotion of rural communities.

One of the contributing factors to food security is closing the yield gap that not only leads to increased crop production but also increases the efficiency of land use, reduces the production costs, and may result in food security. As a definition, yield gap refers to the difference between realized productivity and the best that can be achieved by using current technologies and management systems (James, 2018). Thus, the use of current and new technologies and management systems in agriculture is one of the ways to reduce the yield gap and food insecurity.

3. Theoretical Framework - Dependency Theory

The Dependency Theory was developed in the late 1950s by the Director of the United Nations Economic Commission for Latin America, Raul Prebisch. Prebisch and his colleagues were concerned with the fact that economic growth in the advanced industrialized countries did not translate to growth in the poorer countries (Apter, 1987). As such, they concluded that economic activity in the richer countries often led to serious economic problems in the poorer countries. Such a possibility was not predicted by neoclassical theory, which had assumed that economic growth was beneficial to all (Pareto optimal) even if the benefits were not always equally shared. Prebisch's explained that poor countries exported primary commodities to the rich countries who then manufactured products out of those commodities and sold them back to the poorer countries. The "Value Added" by manufacturing a usable product always cost more than the primary products used to create those products. Consequently, poorer countries would never be earning enough from their export earnings to pay for their imports.

Prebisch asserted that poorer countries should embark on programmes of import substitution so that they need not purchase the manufactured products from the richer countries (Apter, 1987). The poorer countries would still sell their primary products on the world market, but their foreign exchange reserves would not be used to purchase their manufactures from abroad. However, three issues made this policy difficult to follow. The first is that the internal markets of the poorer countries were not large enough to support the economies of scale used by the richer countries to keep their prices low. The second issue concerned the political will of the poorer countries as to whether a transformation from being primary products producers was possible or desirable. The final issue revolved around the extent to which the poorer countries actually had control of their primary products, particularly in the area of selling those products abroad. These obstacles to the import substitution policy led others to think a little more creatively and historically at the relationship between rich and poor countries (McCracken, 1991).

3.1 Overview of Agricultural Mechanization as Strategy Food Security in Nigeria

The production of food in Africa and especially in Nigeria is generally very labour intensive particularly in smallholder agriculture (Abimbola, 2014). The manual work carried out by farmers and their families is arduous and time consuming and in many countries this is a major constraint to increasing agricultural production. Also, the day to day drudgery of farming is a major contributory factor in the migration of people, particularly young people, from the rural countryside to the prospect of a better life in towns and cities. Agricultural mechanization is a crucial input to agricultural crop production, processing and transport (Abimbola, 2014). It is frequently very capital intensive, compared to other inputs and it has repercussions on the efficiency of input use – including seeds, fertilizer, water, and time/labour. It is also much more complex in its application, requiring not only correct use, but also a service infrastructure for maintenance and repair.

It is essential to embrace the agricultural mechanization sector and raise its efficiency in the context of Sustainable Crop Production Intensification (Kennedy, 2019). Whilst agricultural mechanization is indispensable for agricultural production, it can also have very detrimental effects on the environmental sustainability of farming. However if the correct technologies are applied then sustainable intensification can ensue. Two broad stages of farm mechanization process have been identified viz: Mechanization of power intensive operations (MPIO) e.g. land preparation, threshing etc. which generally precedes the Mechanization of control-intensive operations e.g. weeding, harvesting etc (Kennedy, 2019). A wide range of implements, equipment and power sources can be developed and harnessed in the course of mechanizing agriculture. Mechanization Policy (MP) measure should include

direct and indirect interventions by the government, so as to have impact on decisions made by the farmers. Agriculture contributed 41.84 per cent to Nigeria's GDP in 1989 (NIPC, 2020). Nigerian agriculture is still characterized by overwhelmingly small holdings, farm lands are rain fed, fertilizer use, agricultural activities are manually carried out and improved seed variety not adopted (Akinola, 2019).

This calls for mechanization of agricultural production operations from land clearing, sowing, harvesting, and processing to storage of food. Attempts to minimize drudgery and save time involved in these operations have yielded some results but much is still desired.

The objectives of the agricultural mechanization policy of Nigeria presented in the Agricultural Policy for Nigeria in 1989 are: reduction of the drudgery of agriculture by providing mechanical power to replace some of the labour required in agricultural business and reduction of the high cost of agricultural production which arises from high labour wage rates and the share of labour cost in the total cost of agricultural production. Small-scale farmers are estimated to account for the cultivation of about 90 per cent of the total cultivated land area in Nigeria, producing about 90 percent of the total agricultural output (CTA, 2014). This category of farmers still depends on manual labour to carry out their various farming operations. However, with labour demand at critical crop production stages, high labour cost and food demand for the teaming population of over 140 million with an annual growth rate of 2.5per cent, the introduction of agricultural labour saving devices to Nigerian agriculture is indispensable.

Mrema and Odigboh (2013) reported that about 86 per cent of land preparation operations in Nigeria are carried out with hand tools. The output of a human being is 0.07 kW which is limited by stress at high temperature and humidity conditions in tropical country like Nigeria. Thus, an average peasant farmer in Nigeria owns a farm less than 2ha which is barely enough to produce what is needed to feed his family. There are many factors responsible for this. The major one is lack of appropriate labour-saving agricultural tools and machines.

4. Agriculture Policies in Nigeria

4.1 National Accelerated Food Production Programme

The National Accelerated Food Production Programme (NAFPP) was an agricultural extension programme initiated in 1972 by the Federal Department of Agriculture during General Yakubu Gowon's regime. The programme focused on bringing about a significant increase in the production of maize, cassava, rice and wheat in the northern states through subsistent production within a short period of time. The programme was designed to spread to other states in the country after the pilot stage that was established in Anambra, Imo, Ondo, Oyo, Ogun, Benue, Plateau and Kano states. The NAFPP was designed to encourage food production and food security in an economy that had become increasingly dependent on crude oil. A major highlight of the programme was the encouragement given to ill-prepared universities undergraduates to go to the rural areas to teach peasant farmers modern farming techniques. Many saw (and still see) the NAFPP as an operation meant to fool Nigerians rather than to feed them, because it never yielded the anticipated food security.

4.2 Agricultural Development Projects

The Agricultural Development Projects (ADP) previously known as Integrated Agricultural Development Projects (IADP) was initially established in 1974 in the North East (Funtua), North West (Gusau) and North Central (Gombe) states as pilot schemes. The earlier impressive result of the programme led to its replication in 1989 to the entire then nineteen states of the Federation. This approach to agricultural and rural development was based on collaborative efforts between the federal government, state government and World Bank (Amalu, 1998). The important character of the programme are reliance on the small scale farmers as the main people that will bring about increase in food production and the feedback information mechanism which is a decentralized decision making process that allows farm families/households to give their responses to an innovation/technology, incentive, subsidies etc according to their judgment. The objectives of the programme are to bring about solution to the decrease found in agricultural productivity by sustaining domestic food supply, through massive infusion of World Bank funds, the ADPs were established to provide extension services, technical input support and rural infrastructure (Ayoola, 2011).

4.3 Operation Feed the Nation

This programme was established on 21st May 1976 under the military regime of General Olusegun Obasanjo. The programme was launched with the aim of bringing about increased food production in the entire nation through the active involvement and participation of everybody in every discipline thereby making every person to be capable of partly or wholly feeding him or herself. Under this programme every available piece of land in urban, sub-urban and rural areas was meant to be planted while government provided inputs and subsidies (like agrochemicals, fertilizers, improved variety of seed/seedlings, day olds chicks, matchets, sickle, hoes etc) freely to government establishments. Individuals received these inputs at a subsidized rate. The objectives of the OFN were to:

- Mobilize the nation towards self-sufficiency and self-reliance in food production.
- Encourage the sector of the community relying heavily on food purchase to grow their own food.
- Encourage general pride in agriculture.
- Encourage balanced nutritional feeding and thereby produce a healthy nation.

4.4 River Basin Development Authorities

River Basin Development Decree 25 of 1976 was promulgated in 1976 to establish eleven River Basin Development Authorities (RBDAs) (Ayoola, 2011). The initial intention of the authorities was to foster the economic potentials of the existing water bodies particularly irrigation and fishery with hydroelectric power generation and domestic water supply as secondary objectives. The objective of the programme was later extended to other areas most importantly to production and rural infrastructural development. Problems found in the programme were: a number of the authorities grew out of proportion and the operations of some suffered from intensive political interference. In addition, substantial public funds were wasted to streamline sizes and functions of RBDAs through the disposal of their non-water assets.

The river basins authorities were also expected to bridge the gap between the rural and urban centres by taking development to the grass roots and discourage migration from the rural areas to the urban centres. These objectives were to be achieved through surface impoundment of water by constructing small, medium and large dams, which would enable an all-year round farming activities in the country. The policy was to use the "basins as development modules to bridge the widening gap between rural and urban areas and stem the drift of rural people to overcrowded cities." In furtherance of these objectives, the Federal Department of Fisheries (FDF) was also established in 1976. The Department was to collaborate with the RBDAs to promote fishery development through a number of different kinds of projects that provide financial and technical assistance to promote fisheries in commercial and small-scale fish farming. "The need for the Development in the river basins cannot be overemphasized as it is essential for complementing the production from marine sources (Bamisaye, 1986).

4.5 Green Revolution

GR was a programme inaugurated by Shehu Shagari in April 1980. The programme was aimed at increasing production of food and raw materials in order to ensure food security and self-sufficiency in basic staples. Secondly, it aspired to boost production of livestock and fish in order to meet home and export needs and to expand and diversify the nation's foreign exchange earnings through production and processing of export crops. The Federal Government ensured the success of the programme by providing agrochemicals, improved seeds/seedlings, irrigation system, machine (mechanization), credit facilities, improved marketing and favourable pricing policy for agricultural products. The programme did not achieve its objective of increasing food supply because there was delay in execution of most of the projects involved in the programme. There was also no monitoring and evaluation of the projects for which huge sums of money were spent.

4.6 Directorate for Food Roads and Rural Infrastructure

The Directorate was initiated in Nigeria in January 1986 under General Ibrahim Babangida's administration. It was a kind of home grown social dimensions of adjustment (SDA) that was embarked upon in most sub-Saharan African countries by the World Bank, African Development Bank and the United Nations Development Programme (UNDP). The programme was designed to improve the quality of life (improvement in nutrition, housing, health, employment, road, water, industrialization etc) and standard/level of living of the rural dwellers through the use of many resources that exist in the rural areas and mass participation of the rural people. The poor quality of infrastructures provided by the Directorate probably due to embezzlement/mismanagement of fund made the impact of the programme almost

insignificant. However, the Directorate has been criticized in the past for lack of proper focus and programme accountability (Idachaba, 2014).

4.7 Better Life Programme for Rural Women

Better Life Programme (BLP) for rural women was founded in Nigeria by Mrs Maryam Babangida (wife of the then president of Nigeria) in 1987. The programme aimed at stimulating and motivating rural women towards achieving better living standards and sensitizing the rest of Nigerians to their problems. Others include; to raise consciousness about their rights, the availability of opportunities and facilities, and their social, political and economic responsibilities; encourage recreation and enrich family life; and inculcate the spirit of self-development particularly in the fields of education, business, arts, crafts and agriculture (Obasi and Oguche, 2015).

Over publicity of the programme was criticized by people who thought that the programme might turn into a mere fashion parade. Also, cultural and religious inhibition of the muslims that do not allow easy access to women in 'purdah' reduced level of participation and consequently led to low level of benefit accruing from the programme.

4.8. National Agricultural Land Development Authority

The National Agricultural Land Development Authority (NALDA) was established in 1992 much more lately than the Decree (Land Use Decree, 1978) and Act (Land Use Act 1979). The Authority aimed at giving strategic public support for land development, assisting and promoting better uses of Nigeria's rural land and their resources. Others are boosting profitable employment opportunities for rural dwellers, raising the level/standard of living of rural people, targeting and assisting in achieving food security through self reliance and sufficiency. The land reform act/decree has been criticized most as what highly placed officers used to usurp land that belonged to poor people.

4.9 Family Support Programme

The Family Support Programme (FSP) was inaugurated in 1994, by the wife of the then Head of State of Nigeria Mrs. Maryam Sani Abacha. It was a child of necessity borne out of the need to improve the life and lots of Nigerian masses, especially women in the rural areas. It was to improve the previous experiences of women in development programme by broadening its coverage and sharpening its focus (Aliu, 2011). This programme was a shift of policy thrust on the role of family in national development, particularly as it effects major on social sectors such as health, education and economic empowerment amongst others.

The policy objectives of the FSP are:

- To improve and sustain family cohesion through the promotion of social and economic wellbeing of the Nigerian family for its maximum contribution to national development.
- To promote policies and programmes that strengthens the observance and protection of human rights and the advancement of social justice and human dignity.
- To promote decent health care delivery in reducing material and child mortality and morbidity through improved health care system.
- To sensitize government on the need to provide adequate shelter for all Nigerians.
- Carry out public enlightenment campaigns to sensitize the general public on matters of human decency, civil responsibility and concern for the welfare of the disadvantaged.

5. Level of Agricultural Mechanization in Nigeria

5.1 Hand Tools Technology (HTT)

This is the simplest, and the most basic level of agricultural mechanization in Nigeria. It is the level of technology that has sustained the population through ages. This class of technology has played the leading role among others in the Nigeria context (Sani, 2013). Farming with HTT is tedious, and inefficient, leading to low productivity and small farm holdings. The HTT relies on man as the source of energy for the driving of tools. Currently, well over 90% of farm operations (bush clearing, land preparations etc) are executed through the above means. Some basic hand tools used in Nigeria include Spades, Rakes, Digging Forks, Hoes, and Hand Planters. A greater percentage of land preparation, operations in Africa are still carried out using hand tools powered by the human muscle. A farmer using HTT can cultivate only about one hectare of land. He cannot do more than that for certain scientifically established fact.

5.2 Draught – Animal Technology (DAT)

This class refers to the range of implement, machines and equipment that are powered by animals and have

been found very useful in farming operations. This level of development in mechanization is also referred to in some literature as the introduction of improved hand tools, animals and tractor drawn equipment. Though use is limited to tillage and transportation, the output of these means is far ahead in worth compared with the HTT (Sani, 2014). A major limiting factor in the use of this class of technology is the prevalence of tse-tse fly and lack of local production of animal-drawn equipment. The use of animals as a source of power provides economic gains not only for farmers but also for the local economy. Local businesses benefit from the use of draught animals both on the support side (retailing, manufacturing, and servicing of implements) as well as the processing, marketing and sale of surplus agricultural products. For the national economy, the requirement for foreign currency is generally small or non-existent (Sani, 2014). Animals and trailers also provide local transport facilities in rural areas. Another major economic benefit for farmers who switch to using animal draught is that it releases them and their family to carry out additional, income generating activities.

5.3 Engine Powered Technology (EPT)

The EPT is the modern research and development based method of modern technology in agricultural productivity. This involves the use of tractors, engines, and electricity to power motorized machine for farming operations (Sani, 2014). The vagaries of weather, climatic conditions soil and crop types are important variables in this category. The power sources and their associated implements are available in sizes, power ratings, level of sophistication and technical complexity that vary tremendously. Where the conditions for the use of tractors and large machinery are suitable, investment in agricultural mechanization has proven to be profitable. The main conditions being that the returns gained from using machinery are sufficient to cover investment (Igbeka, 2012). Farmers also need to be sufficiently skilled, both technically and managerially in order to make best use of the technology. This is often not the case in many developing countries, particularly in sub-Saharan Africa, where the introduction and adoption of advanced technologies has been found to be problematic.

Over the last two decades there have been further rapid advances in industrialized countries in the development of agricultural machinery. This has largely been due to the use of electronic and information technologies. The use of these technologies in tractors and combines has become commonplace and has led to the development of precision farming techniques as well as the automation of a large range of other farming operations. It is not uncommon to find systems of automatic feeding of dairy cows with levels of feed based on an individual cow's milk production (Igbeka, 2012). Another example is the use of sprinkler irrigation systems which automatically apply water according to levels of soil moisture but also apply controlled amounts of fertilizer and pesticides.

6. Impacts of Agricultural Mechanization on Food Security in Nigeria

Nigerian agriculture is still characterized by overwhelmingly small holdings. These Holdings are farm lands are rain fed, fertilizer use, agricultural activities are manually carried out and improved seed variety not adopted (Kerr, 2019). This calls for mechanization of agricultural production operations from land clearing, sowing, harvesting, and processing to storage of food. Attempts to minimize drudgery and save time involved in these operations have yielded some results but much is still desired. Small-scale farmers are estimated to account for the cultivation of about 90 per cent of the total cultivated land area in Nigeria, producing about 90 per cent of the total agricultural output. This category of farmers still depends on manual labour to carry out their various farming operations. The direct result of the current reliance on crude and traditional methods is the galloping inflationary trend that is the bane of the nation (McNamara, 2014). Technological solutions in Agriculture would reverse this trend. This would require a huge capital outlay including the cost of importation of capital equipment and the funding of research and development. Mechanization would serve as a means of restoring the glory of the sector as a major source of foreign exchange earnings (Makanjuola, 2019). Mechanization of the agricultural sector needs to be provided for a deserved national priority

Application of machines to farm production Nigeria started about 40 years ago but over the recent 10 years has increased remarkably. Agricultural equipment innovations are relevant in transforming livelihoods in Nigeria and curtail food insecurity. Nigerian Agricultural Engineers have developed many machines and equipment for agricultural operations from tillage to processing (Makanjuola, 2019). Some of these tools are Batch process cassava peeling machine, Proda Cassava peeling machine, Proda Garri Frying machine. Others are Reciprocating Triple – sieve multi- grain separator,

Passive Solar heated Poultry Chick Brooder, Grain Hammer mill, Rotary Power Weeder, Maize planter, Melon Washer and many other agricultural machines and equipment abandoned in workshops of our institutions. These machines are indigenous, readily available, and cost less than imported ones (Mrema, 2015).

7. Food Security and Mechanization Strategies

7.1 Improvement in irrigation facilities

Fundamentally, Nigerian environment is characterized by fair to good soils but poor and unreliable rainfall and low quantity is the case in arid and semi-arid regions. However, technological advancement has given the opportunity to tap the two important natural resources (water and soil) for cultivating the land year around through irrigation (Oriola, 2019). Irrigation projects are therefore designed to help reduce the dependence of crop growth on precipitation which to a large extent is uncontrollable by man (Oriola, 2019). This implies that irrigation is to meet additional requirements of crops during the wet season and supplies water to farmlands during dry aimed at increasing and improving agricultural yield particularly in semi-arid and arid environments (Daniel, 2014). Nwajiuba (2011) observed that irrigation has made higher and reliable yield possible as crops can be planted more than once in a year within the tropics, apart from bigger and reliable yield as against yearly cultivation which is often at the mercy of seasonal rainfall.

7.2 Biotechnology

It is projected that by the year 2025, four fifths of the expected global population of 8.5 billion will be living in developing countries. Currently, it is doubtful whether existing global resources and technologies will satisfy the demands of this growing population for foods and other consumer commodities (Omiti, 2019). The challenge is therefore how to meet these needs mainly production. To avoid damaging environmentally sensitive areas and hence ensure greater food insecurity, new methods need to be utilized to increase farm output on cultivated land. Although global food production is sufficient to meet the needs of every citizen on earth, but the per capita production and availability remains lowest in Africa (FAO, 2016). While Western Europe's food availability stands at 3500 kilocalories per day and those of north America at 3600 kilocalories per day and in sub-Saharan Africa, it stands at only 2100 kilocalories per person per day, the lowest level of per capita food availability in the world (FAO,2016).

Biotechnology programmes in the field of crop improvement are rapidly emerging in Africa. Examples include Kenya's virus resistant transgenic sweet potato project, Egypt's transgenic potato, maize, faba bean and tomato developments, South Africa's new tobacco and cotton varieties with resistance to herbicides. The relevance of genetic modification in producing transgenic crop varieties with resistance to pesticides, insects and diseases cannot be ignored, given the prohibitive costs to farmers of chemicals and input losses (Kerr, 2019). In addition to stimulating food sufficiency, the full-scale adoption of biotechnology is expected to create employment, as a result raising income of households and their purchasing power. This will enhance their ability to afford and consume more nutritional and safer food commodities.

8. The Challenges of Agricultural Mechanization for Food Security in Nigeria

8.1 Lack of Affordability of Mechanization Tools

The rural people are mostly poor and hardly can buy a costly machine individually (Abah, 2010). Some rich farmers having a large quantity of agricultural lands possess some costly machines like, tractors, power tillers, power tiller operated seeders, combines etc. They use these machines in their own lands and also operate them on hiring basis in others' lands and earn a substantial return. But, the number of such farmers is very limited. The importation of used machinery, particularly tractors, combine harvesters and other specialized machinery offers farmers an alternative source of cheaper machinery and offers an additional way to meet demand. However, whether farmers can benefit from this cheap source of machinery depends upon whether the importer is serious in offering a service to farmers including the provision of spare parts and repair services (Abah, 2010). Importation and sale of used machinery occurs mainly in countries where there are technicians who have a relatively high level of skills and knowledge but where the costs of labor are low. As is the case with new machinery, it is often tempting for the public sector to become involved in the importation of used machinery, however, without specialized knowledge of agricultural machinery these schemes usually end up with disastrous consequences.

8.2 Non-Availability and Lack of Quality Machine

Tractors and agricultural machinery can be imported or locally made. Both sources may have a series of problems associated with them. Generally speaking locally made agricultural machinery is of fairly poor quality and high in price. This is due to the underdeveloped nature of the machinery manufacturing industry which in turn is largely due to poor demand (Adebayo, 2015). In addition, supply chains to support tractors and agricultural machinery with spare parts, advice and other services (especially clean fuel) are often underdeveloped and have difficulties in extending to remote rural areas. Due importance was not given to farm mechanization until the beginning of the century. Earlier, only a few manufacturers came up to fabricate simple manually operated machinery like weeder, thresher, winnower etc. With the growing needs for foods, the decision makers got the realization that Nigeria agriculture will have no other alternative than to adopt mechanized cultivation to feed her ever growing population (Adebayo, 2015). This helped grow some agricultural manufacturing workshops in the country. Presently, more than 40,000 small and medium sized local metal working workshops have grown up to manufacture agricultural machinery all over the country.

8.3 Low Knowledge of Mechanization

Although African farmers have a great deal of traditional knowledge and experience accumulated over generations, access to new knowledge remains largely limited. Mostly the level of training for farmers is relatively low and the opportunities for further training are limited (Adekanye, 2010). Public and private extension and training services have limitations in outreach, especially in rural and remote areas, as distances are large and transport can be scarce. Demand for extension and training can also be low and so it is often difficult to economically justify such activities. Another problem is that a large proportion of rural farming populations are illiterate. This situation stands in the way of improving agricultural production and productivity as well as general levels of farm management. For example, land preparation and transportation are carried out by tractors. Other operations such as seeding and harvesting are still mostly carried out manually. This is due to a lack of knowledge by farmers about suitable equipment and a lack of skills in operating such equipment. Where machines are used, the lack of both farmer knowledge and skills leads to misuse and mismanagement of machinery; especially of more sophisticated machines.

8.4 Tariff Difference on Machines and Spare Parts

Low tariff on imported machines and high tariff on spare parts and materials have discouraged the local manufacturers. Since, there is no quality control system of the imported machinery, a huge number of machines are being imported and distributed directly by the local importers to the users. Also, many of the imported low quality machines have already made the farmers reluctant to use them. Once these farmers decide not to use the machines, it becomes hard to convince them for a new machine (Makanjuola, 2019). Further, the high tariff has restricted the imports of spare parts making them unavailable in the local market. Private sector-led input and output markets have not developed as quickly as expected and farmers are constrained by a lack of free competition in these markets, including high prices for agricultural inputs as well as lower farm gate prices than in other regions of the World. The consequent reduction in farm incomes has led to an overall decline in the level of investment in agriculture. At the same time farmer organizations have not generally been effective in assisting smallholders to improve their access to markets and public services.

9. Prospects of Agricultural Mechanization Policy Focus Areas

The philosophy in practice worldwide is that national governments provide the basic conditions and act as catalyst to promote a self-sustaining development of agriculture including the sub-sector of mechanization. Therefore in order to properly position the agricultural sector to confront the daunting challenges of the 21st century, the government should redirect policies and provide strategic assistance to strengthen the growth of agricultural mechanization sub sector in the following main areas:

- Land tenure and reform programs to ensure ready access to mechanizable land.
- Subsidies and Price support for Tractor ownership and management. Even though the extant policy on tractor and equipment use have been towards the establishment of private sector led THUs. In practical terms, it is seldom to see entrepreneurs come quickly forward to fill the gap especially in situation where government has been heavily involved. The development of the private sector to sustain the mechanization efforts, therefore, requires programs, policy incentives and government assistance (Simalenga, 2010).

- Technical assistance especially in categorization and standardization of tools, machinery and technologies to prevent farmers from purchasing unreliable equipment.
- Guidelines and standard for Tractors and equipment safety
- Policy guidelines on equipment for animal husbandry mechanization such as milk collection and processing equipment, egg collection and cleaning, feeders, drinkers and dung cleaners
- Post harvest technologies and on farm storage systems, and
- Advancing policies to support Agriculture led entrepreneurship, that is, small and medium scale agro industrial development.

These measures among others will ensure a proper place for the mechanization subsector to grow in *pari pasu* with other branches of the agricultural sector instead of the current scanty mention it has hitherto received in the extant policies. In addition community driven development (CDD) has now become the acceptable model for sustainable agrarian development, subsequent policies may tap into the ideas of the new paradigm shift through the concept for community farms advocated in Abah (2010).

In other to solve the protracted problem of inadequacy of farm machinery, the Indian approach, which has been yielded considerable result, is recommended for this country. Under this approach, a comprehensive inventory of the existing indigenous tools and implement must be taken. The implements should then be subjected to rigorous testing and improvement in order to increase their efficiency in fields. In this way we would build up a ready-made source of usable indigenous tools to enhance our agricultural activities. However, as noted in Ogunlowo (2019) for any such technology to be adoptable, it must be simple and appropriate for the job, it must be profitable and affordable to the users and it must be environmental friendly.

10. Strategies to enhance agricultural mechanization for food security in Nigeria

10.1 Availability of Finance and Credit Loan to Farmers

Most times farmers are unable to afford the costs of increasing their level of farm power use and mechanization from their own resources. Therefore access to some form of credit is necessary for increasing investment in agricultural mechanization. This could enhance food security in Nigeria. This credit could be made available for all sizes and types of farms and all types of mechanization. Assessment of whether credit should be made available for farmers should be based on a realistic assessment of risk and the potential for increased returns arising out of the investment (Ademosun, 2015).

10.2 Famer's Capacity Building on Mechanization

The profitable use of agricultural machinery and equipment is influenced by how well it is set up, managed, and operated. Bad quality of agricultural operations results in lower levels of production. Wrong selection and use of machinery can lead to a negative impact on the environment and in particular on the soil. Lack of knowledge and ignorance of the technologies used in AM will offset any expected improvements in farm profitability (Akinola, 2019). This can be overcome by suitable and effective training and education. Educating owners and operators of farm machinery and equipment could create an awareness of the opportunities that mechanization provides. This could be achieved by improving the levels of knowledge and understanding of the purpose of using machinery and training on how to operate it efficiently and safely.

10.3 Development of Local Organizations

Encouraging and facilitating the creation of local organizations among small scale famers is a very effective means of disseminating information on mechanization. Farmers' organizations have two main roles to play in assisting individual farmers with agricultural mechanization issues (Akinyele, 2019). First, they could encourage and promote the sharing of machinery among different farm households. They could enable individual households to use machinery and equipment which is beyond each individual's capacity to buy. However, the mechanisms for successful joint use of machinery are often complex. This often relies on the existence of traditions of sharing and assisting in the particular community.

10.4 Creating an Enabling Business Environment

An enabling business environment is an essential requirement for the development and expansion of the mechanization sub-sector. Improving the business environment must cover all stakeholders involved in agricultural mechanization (Adeniran and Babatunde, 2010). It is brought about by putting in place an enabling mix of the different policies that directly or indirectly affect the sub-sector. At farmer level,

improving their income also requires an enabling environment through appropriate taxation and pricing for agricultural products. For the agricultural machinery sub sector, a favorable environment is one which allows the creation of a free market. In this context, improving governance is imperative.

Policies which affect agricultural input prices are one of the most effective means of influencing the direction and pace of agricultural mechanization. For example, where wages are increasing rapidly relative to the prices of other inputs, changes in relative prices can induce labour-saving mechanization (Akinyele, 2019). Governments can influence this process by promoting policies that change the relative cost of labour to mechanization and thus affects the rate of mechanization.

11. Conclusion and Recommendations

This paper asserted that it is essential to embrace the agricultural mechanization sector and raise its efficiency in the context of Sustainable Crop Production Intensification. Whilst agricultural mechanization is indispensable for agricultural production, it can also have very detrimental effects on the environmental sustainability of farming. However if the correct technologies are applied then sustainable intensification can ensue. A wide range of implements, equipment and power sources can be developed and harnessed in the course of mechanizing agriculture. Mechanization policy measure should include direct and indirect interventions by the government, so as to have impact on decisions made by the farmers. The study also opined that Nigeria is facing a threatening food security crisis. Its growing population is increasingly dependent on imported foods. The food crises could be attributed to low level of Agricultural Mechanization in Nigeria. Also, the once dominant subsistence-oriented farm economy is at risk of gradual marginalization. Insecure land tenure, scarcity of funds and credit, labour scarcity despite overall high unemployment and stagnant technology have crippled its further development. Until today, a wide range of mechanization policies have had limited impact in ameliorating the problems of food insecurity.

The study recommended that:

- The Nigeria government should encourage and promote local design and manufacture of farm implements and equipments at low cost.
- Programmes and policies of the government especially agricultural mechanization and policy on tractorization should be given necessary funding so as to ensure food security.
- Subsidies should be provided on agricultural mechanization by the federal, state and local government, and other private organizations.
- Opportunities should be provided for farmers to participate in planning and decision making in agricultural programmes and policies in the state

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