

Mechanization for Rural Development: A Review of Farm mechanization in Borno State

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Abstract

Agriculture is known to be the predominant economic engagement of the majority of the people in Borno State providing livelihoods for over 80% of the population. Integrate agricultural mechanization into agricultural value chains to improve adoption and adaptation. The current focus on the development of agricultural value chains offers real opportunities for accelerating agricultural mechanization. Evaluation of tractor maintenance and Servicing culture in Borno, stated by Washara et.al. (2023) concluded that the major constraint with machinery and mechanization in the state is the poor access of farmers to mechanization. This is as a result of the high cost of mechanization inputs, the low purchasing power of the majority of farmers to acquire them, and the poor access to loans by farmers. To achieve this goal, it is now widely recognized in the region that agriculture should be promoted as a business and not just for subsistence. This calls for the development of medium to large-scale farmers who will need a lot of agricultural engineering technologies to improve their effectiveness and be profitable. In order to enhance agricultural mechanization in Borno State and Nigeria in particular, the way forward is that the government should intervene to counteract the conflicting issues of high prices, low demand, low supply, and high prices. For this to happen, demand must be encouraged through the concealment of professional medium to large-scale farmers. The elaboration of an agricultural mechanization strategic {AMS} would provide an opportunity to identify the various factors that result in the high cost of agricultural machinery in the country. This will then be followed by providing incentives to stimulate demand for agricultural machinery as well as local production.

Keywords: Borno State, Mechanization, AMS, Agricultural Machineries

INTRODUCTION

Agriculture is known to be the predominant economic engagement of the majority of the people in Borno State providing livelihoods for over 80% of the population. This has made Borno one of the major sources of food production in the Country. Despite its unchallenging contribution to the national food reserve, the agricultural sector in the state is still developed because most of the modern techniques are not yet popular with 98% of the populace in human power. Mechanization is accorded its rightful place.

Agricultural mechanization is a decisive input to agricultural production. It is often merely capital intensive, compared to other farm inputs (usually annual) and it has an aftereffect on the efficiency of all other inputs used in crop production, including seeds for planting, fertilizer for application, water, and time/labour. It is also much more intricate in its application, requiring not only correct use but also a service infrastructure for maintenance, servicing, and repair. For this reason, the Ministry of Agriculture Plant Production and Protection Division needs to embrace the agricultural mechanization sector in the context of Sustainable Crop Production Intensification.

Agricultural mechanization can also have very harmful effects on the environmental sustainability of farming (soil compaction, erosion, tillage, pollution). Nevertheless, if the right technologies are applied, for example: climate smart agriculture like conservation agriculture; harmless and efficient administration of insecticides and pesticides; precision application of fertilizers; soil compaction management; efficient harvesting techniques; and natural resource conservation, then sustainable intensification can guarantee. As an input necessity, mechanization can change Agricultural family economies by facilitating increased output and reducing the drudgery in farm production. Mechanization, when carefully practiced and right to the task, is also capable of protecting natural capital and the environment whilst increasing food production.

'Agricultural Engineering and Technology: a crucial discipline furnishing agriculture to deliver global food security' but what we sooner realized is that Agricultural Engineering and Technology departments in the Borno State Agricultural Mechanization Authority (BOSAMA), State Owned the Ramat Polytechnic, University of Maiduguri and the research center have been coiled down, weak and the availability of creative and world-class undergraduate training is also in serious decline. However, following the current food scarcity and price hike and the succeeding financial crisis with the higher explosion in prices for food stocks such as maize, Beans, and Soya the attention of the people returned to a realization of the crucial role of agricultural Mechanization.

Literature Review

Mechanization simply deals with the act of changing from working at a large scale, exclusively by hand or with animals to the use of machines (Mabayoje, 2017). Agricultural mechanization is defined as the application of tools, implements, and machines powered by man, animal, and engines as inputs for agricultural production (Clarke and Simalenga, 1997). This includes manufacturing, distribution, use, and maintenance (both on-farm and off-farm) of all types of tools,

implements, equipment, and machinery, for agricultural activities (such as land clearing and leveling, tillage activities, planting and Irrigation, harvesting, and processing activities). The agricultural mechanization devices may be powered by human energy (hand tools) animals' draught (animal traction) or mechanical devices or a combination of any of those.

Agricultural mechanization is the harnessing, controlling and organizing all inputs of production such as land, capital, labour, as well as research, education, communication/information, and engineering/technology in agricultural practices (Asoegwu and Asoegwu, 2007). It embraces the use of tools, implements, and machines for agricultural land development, crop production, harvesting, preparation for storage, storage, and on-farm processing. This includes three main power sources: human, animal, and mechanical.

Borno State has comparatively the most abundant land resources; Nevertheless, the State has the lowest farm power base with less than 15 percent of mechanization services provided by engine-powered sources "Washara et.al., (2023). At the same instance approximately 30 percent of farm power is provided by draught animals and over 65 percent comes from people's power. This people's power source often only has undeveloped tools and equipment at its disposal for soil preparation, crop protection, transport of goods, and bucket-type irrigation.

The 2009 high-level FAO expert forum already referred to has made it very clear what the challenge ahead is: how to feed approximately 9 billion people in the year 2050. We have learned lessons and now we must take care that the past mistakes of trying to achieve intensification only through mechanization are adapted to ensure its sustainability.

Investing in farm mechanization for Development in Borno State

According to Tribune Newspaper published February–14–2018: Borno State Commissioner for Agriculture, Mohammed Dili said that since 2012–2018, the State Government had procured farm mechanization equipment worth over N40 billion for agriculture development in the state. He added by saying that the major constraint for the deployment of the farm machines is the continued attacks from the Boko Haram terrorist group.

Explaining further, the Agriculture Commissioner said “We have 1600 Planters which can plant Maize, groundnut, rice and wheat. We have more than 1000, tractors, and the essence of these tractors is to give to our communities, we are just waiting for peace to return, we have created a way of getting these things to our farmers, we have made it possible for us now. We have the combined Harvesters, of the 100 combined Harvesters in this country, we have 50 of them in Borno, and this was meant for the Chad Basin area where we have 7000 hectares of land for wheat and rice production.

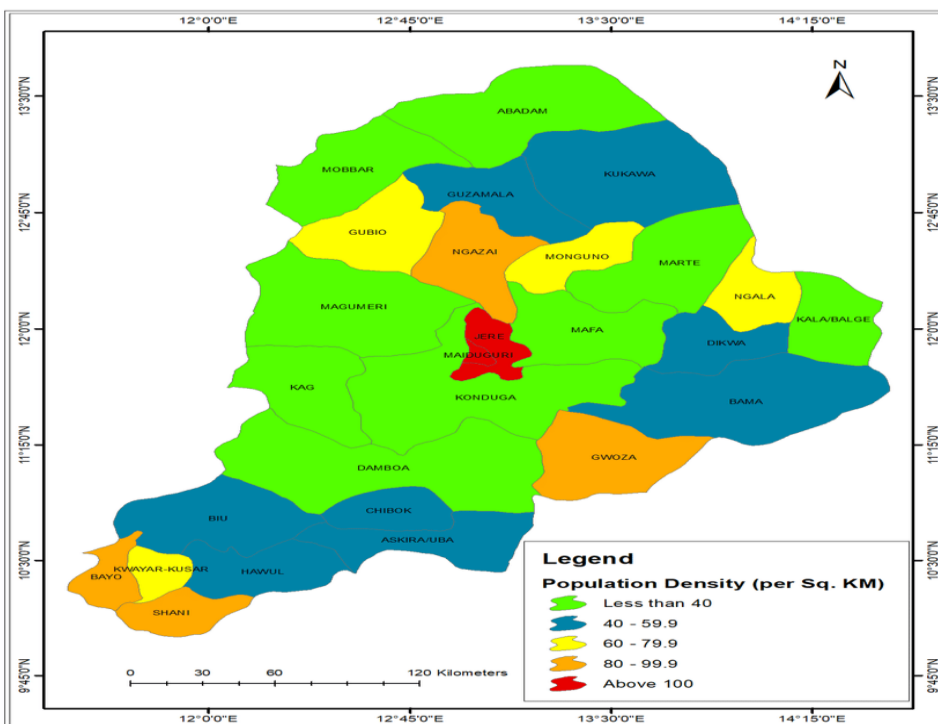
This statement above was challenged by a field survey in 2021 according to "Wahara et.al., 2022" in "Evaluation of Tractor Maintenance and Servicing Culture in Borno State".

Importance of Agricultural Mechanization The need for sustainable agricultural mechanization practices in Nigeria is imperative because hoe and cutlass agriculture cannot support the food and economic needs of the nation. Some of the need for mechanization is highlighted as follows:

a) Geometric increase in population

Borno 6,111,500 Population [2022] – Projection 72,152 km² Area 84.70/km² Population Density [2022] 2.4% Annual Population Change [2006 → 2022]. Considering the population density annual change there's a need for a paradigm shift to be able to feed the state in the years coming. This poses a major threat to people's survival and well-being. Consequently, there is an expectation for geometric growth in food in the State which can only be achieved through sustainable farm mechanization practices.

Fig.1 shows the population density per sq. KM



b) Diversification of the economy

The economy of Borno State is largely agrarian with livestock husbandry, crop husbandry and fishing on the lake Chad dominating the economic activities. But this pride had fallen due to the Boko Haram insurgency. Hence, the unemployment rate is increasing, productivity is low, and consequently, many people live in poverty but better compared to other states of the federation. A sustained agricultural mechanization practice would restore the agricultural sector and ultimately

the state economy. Diversification of the State's economy through agricultural mechanization is the only viable way to save the state from the economic downturn.

C) Food security in the face of environmental degradation

Traditional farming practices are nature-dependent. The degradation of soil fertility, rainfall, and drying of products are exclusively and naturally facilitated, thereby making the farm business a dangerous one. Today, man's activities have tortured natural phenomena such as drought, desertification and soil erosion. Climate change is a universal threat to human survival. It's a fact that global warming will reduce agricultural yield by some percentage yearly. However, mechanizing agricultural activities will go a long way to mitigate the effects of climate change.

d) Increased farmers' earning

In Borno State and Nigeria in particular, traditional farming activities are characterized by poor earnings. Poor Peasant farmers are naturally the poorest set of people in society. This unsuccessful phenomenon makes farm activities less attractive to young, energetic and educated youths. Through mechanizing the Agricultural processes, just as in the US, farmers' income, the standard of living and reputation would be promoted, thus, making agricultural activities attractive to our educated youths.

e) Agro-Industrial Revolution

Commercial agricultural production through mechanization would make raw materials readily available for agro-allied industries. This can revolutionize local productions, reduce post-harvest losses and create economic opportunities down the value chains. Therefore, to achieve food security in Sub-Saharan African nations, e.g., Nigeria, Pawlak et al., (2002) opined that there must be significant progress in plant and animal breeding matched with appropriate mechanization that would play a key role in the development of the agricultural sector.

Functionality of farm machinery in Borno State

According to "Haque, et.al (2020). The state had 16 types of machinery with a total of 1,377, as at 1998. Out of this number, 75% were functional. The private sector possessed a higher number of agricultural types of machinery, both total and functional. The total number of machines in the sector was 778, out of which 83% were functional. In the public sector, 599 machines were identified, out of which 64% were functional.

According to a field survey conducted in 2021 by "Washara et.al. (2023) they found that there are a total number of ninety-six (96) tractors in the farm center fifty two (52) are functional and thirty-one (31) are non-functional while percentage analysis shows that 54.16% are functional and 32.29% are non-functional; there is a total number of four (4) tractors in Bui and all are functional with a percentage analysis of 100%; Hawul with a total number of ten (10) tractors, five (5) are functional and five (5) are nonfunctional and with a percentage analysis of 50% functional and 50% non-functional; Bayo with a total number of five (5), two (2) are functional and (3) are non-functional

with a percentage analysis of 40% functional and 60% non-functional; Kwaya-kusar with a total number of five (5) tractors and all are functional the percentage analysis is 100%.

According to the above results, there's a need for the increase in functionality of the tractors through proper maintenance and Servicing.

Brief History of Agricultural Mechanization in Nigeria

Generally, primitive agriculture was a matter of human sweat and draft animal labour. Using oxen and horses to pull plough was the earliest form of mechanization. The remaining of farm activities were backbreaking manual operations such as seed planting, weeding, reaping, collecting, bundling, threshing, loading, and transportation of agricultural products. The invention of internal combustion engines caused a dramatic change that placed tractors at the center of agricultural mechanization; this had a profound effect on farm productivity and human society [NAS 2018]. In Nigeria, the earliest tractor unit farm was established in Agege, Lagos state in 1925 while Tractor Hiring Unit (THU) services started in 1956 in the Northern parts (Aboaba, 1977; and Nwosu, 1989). There appears to have been a consensus that THUs provide a viable strategy for promoting mechanization in developing countries, yet the agriculture of these countries has yet to receive meaningful mechanization (Utaku, 2005). There is now a significant number of THUs all over the different parts of the country.

According to Iheanacho et al., (2003), the machines used for agricultural production in Nigeria include hand tools, animal implements, two-wheel, and four-wheel drive tractors, motorized or mechanically driven post-harvest handling and processing machines, crop storage equipment and pumps for irrigation. Nigeria has no single production plant for tractors and machinery; some assembly plants that existed are either moribund or closed down; few indigenous local fabricators attempt to fabricate simple farm tools, machines and other equipment that are used for various activities on the farm to meet the need of small-scale farmers. Most of these types of machinery cannot compete in the international market due to lack of production capacity and equipment. The country largely depends on imported types of machinery.

Levels of Mechanization in Borno State

According to data obtained by (Washara et.al., 2023) and rephrasing them, the following machines are used for agricultural production in Borno State: hand tools, the animal is drawn implements, two-wheel and four-wheel-driven tractors, motorized or mechanically driven post-harvest handling and processing machines, crop storage equipment and pumps for irrigation. Therefore, agricultural mechanization practices in Borno State can be classified into three levels of technology: animal draught (AD); hand-tool (HT), and engine-powered (EP).

a) **HandTool (HT)**. HT level of agricultural mechanization involves the use of tools and implements which are powered by humans. HT is the oldest and the most primitive level of agricultural mechanization (Enaboifo and Anerua-Yakubu, 2014). The hand – tools used mostly in Borno State include machetes, cutlasses, hoes, diggers, axes, spades, shovels, trowels, rakes, forks, mattocks and shears, knapsack sprayers, jab planters, water cans, etc. Agricultural

productivity in Nigeria by the use of HTT is highly limited since humans can only develop about 0.08kw of energy depending on environmental conditions and food intake (Kaul and Egbo, 1992).

b) Draught-Animal (AD). Animal-drawn is predominantly practiced in the Sahel and Sudan savannah ecological zone of Nigeria (North) where soil particles are loosely packed to facilitate animal traction for tillage and transport operations. The use of animals (Bulls, Donkeys, etc.) for planting, and operating stationary machines such as water pumps, threshing machines, winnowers, chaff cutters, and grinders is highly limited even if it exists (Musa, 1988).

c) Engine-Powered (EP) EP level of agricultural mechanization is the most advanced, sophisticated and efficient one. It involves a very wide range of implements, machines, and equipment powered by diesel/ gasoline engines and electric motors. This equipment used in Nigeria includes bulldozers, 4-wheel tractors, 2-wheel tractors, boom sprayers, ridge ploughs, disc ploughs, harrow ploughs, mechanized grain threshers, mechanized milling machines, mechanized garri graters and fryers, mechanized rice harvester, mechanized winnowers, mechanized driers, cassava planting machine, etc. There is no statistical information on the level of EPT use in Nigerian agriculture, but it is observed to be relatively low. The tractorization density of Nigeria is just 0.27 horsepower per hectare which is far below FAO's recommended density of 1.5 horsepower per hectare (Sahel, 2017).

Challenges from the current status of farm mechanization

Recent hikes in world food prices due to environmental disasters, and the increasing use of food crops and agricultural land for the production of biofuels leading to the resulting food riots in many developing nations, have led many policymakers to start thinking of food sovereignty and not just food security. This calls for increasing the productivity of farmers. Furthermore, the state Governor (Engr. B.G. zulum) has now lamented that to stimulate growth and reduce poverty, the business environment needs to be improved for agriculture-led growth. Borno State and Nigeria in particular now have state and national development policies which call for mechanizing or intensifying agricultural production, as well as using agricultural products as raw materials for industries.

According to Washara et.al., (2023), some of the challenges of mechanizing Borno State's agricultural sector include:

a) Funding of Research Activities

Research activities which are a major source contributing to an increase in farm productivity in the agricultural sector of the state have not been funded adequately by the previous government compared to the recent administration. Most research findings originating from the government-established Universities and Research Institutions in the state have not been properly coordinated and disseminated to farmers who are meant to be the sole beneficiaries of the findings.

b) Poor Ratio between Extension Agent and Farmer

No serious attention was paid to the extension services by both federal and state governments. The retired ones are not replaced, and the less available ones are not motivated. This has affected many research successes getting to the end of farmers who need them.

C) Weak Synergy existing between Financial Institutions and Research Institutions

In developed countries, there exists a strong synergy between financial institutions and research institutes in agricultural-related activities. The situation in Borno State and Nigeria in particular is different because most financial institutions believe in businesses that could bring quick profit returns on investment than research work that might take years to achieve its aims and objectives. Most time, financial institutions do not welcome such innovative research work that can bring benefits to farmers and the community.

e) Lack of Synergy between Stakeholders

This also has greatly slowed down the development of agricultural machinery research in the state. Academic and research institutions, financial institutions, farmers, investors and other stakeholders in the sector have weak connections and working relationships. This has resulted in the poor dissemination of breakthroughs in research to the farmers; lack of adequate information to access loan facilities, etc. This should be tackled through various seminars, conferences between relevant stakeholders and exhibitions/farmers' field days in the sector and also put into action.

f) Fragmented Farming

Most farmers in the state are smallholder farmers who are managing a few hectares of land for the farming operation. As a result, the average farm size of a smallholder farmer in the state ranges from 0.7 to 2.2 hectares. Fragmented land holdings usually make it pernicious to use mechanization and cause inefficiencies in agricultural production. The farm output is low resulting from low return on investment. Most of these farmers are used to the traditional way of farming which involves the use of hoes and cutlasses. This has made it tedious for farmers in the state to cope with the use of agricultural machinery in boosting their farm produce which is expected to lead to a high return on investment.

g) Local Knowledge

A lack of access to information regarding mechanization limits stakeholders across the agricultural sector from adopting mechanization. To explain more on this, the extension delivery system is inefficient; as a result, extension agents with information on mechanization opportunities are typically unable to transfer this information.

h) High Cost of Machines

The cost of mechanization input for crop production and processing is very high due to the surge in foreign exchange. Furthermore, it is difficult for farmers and processors to sustain the recurring costs of operating equipment. Poor access to finance is a major constraint to the adoption of

mechanization as it makes it difficult for scaling service providers and new entries to access the capital required to procure equipment.

I) Poor Access to Maintenance Services and Spare Parts

A lack of local expertise for the repair and maintenance of types of machinery is a major constraint to the sustainable use of mechanization in the state. Currently, there are not enough technicians trained to deal with the types and brands of machines available. The poor quality of maintenance services for agricultural machinery is governed by a lack of awareness of the benefits of maintaining machines, the lack of commitment to maintenance culture, the high cost of maintenance, and poor user habits.

j) Poor Status of the Local Agricultural Equipment Fabrication Industry

The majority of agricultural technologies fabricated in the state cannot compete with a foreign counterpart. Therefore, it deprives fabricators of the opportunity for exportation which could earn them more income from foreign exchange and add to the state revenue.

Need for the increase in farm mechanization

Agriculture is particularly important in Borno State because it is the backbone of most of their economies. As the population continues to increase and as the trend of rural departure continues due to the drudgery and low productivity of agriculture in the state, the rate of urbanization will continue to be high. The consequence is that the percentage of the workforce employed in agriculture will continue to decrease.

Enabling Environment for farm mechanization

FAO and UNIDO (2008) concluded that one of the major reasons for the dissatisfying performance and low contribution of mechanization to agricultural development in Africa has been the fragmented approach to mechanization issues. This was attributed to poor planning by government agencies and over-reliance on unpredictable or unsuitable, one-off, aid-in-kind, or other external mechanization inputs. Lack of teamwork or coordination within and between government departments and inherent competition with private sector business initiatives in mechanization services have not helped the situation. Formulation of national agricultural mechanization strategic (AMS) and implementation plans are now seen as the solution, where a holistic approach is used and specifically includes private sector involvement, economic profitability, and creation of an enabling environment with clear roles for both public and private sector stakeholders.

Nigeria has done much to create an enabling environment for agricultural mechanization although it does not have an AMS. The various actions carried out will be used to illustrate the thinking of many states in the region on actions required to enhance agricultural mechanization. According to Asoegwu & Asoegwu (2007) between 1999-2007, the Nigerian government implemented several strategic reforms in the area of privatization, commercialization, deregulation, anti-corruption, and reduction in financial crimes. The resulting initiatives and programs contributed

to creating an enabling environment to enhance agricultural mechanization. In 2001, a new agricultural policy and the National Integrated Rural Development Policy and Strategy were initiated. These two policies were implemented within the framework of the National Economic Empowerment and Development Strategy. As concerns agricultural mechanization, the relevant highlights of the 2001 Agricultural Policy are that it defined the role of the state to be the creation of an enabling environment, while investments should be by the private sector. Agriculture was also recognized to be a business and not just a way of life. To complement the agricultural policy, several programs were launched. According to Asoegwu and Asoegwu (2007) and ICARRD (2006), these were the Presidential initiative in Agriculture (PIA) 2004; Nigerian Market Information System 2004; National Special Food Security program (NSFSP) 2005; FADAMA II program 2005; Recapitalization of the Nigerian Agricultural Cooperative and Rural Development Bank

Recommendations

1. Integrate agricultural mechanization into agricultural value chains to improve adoption and adaptation. The current focus on the development of agricultural value chains offers real opportunities for accelerating agricultural mechanization. As the experiences with grain milling, and recently shelling have shown, a key entry point for mechanization in a particular value chain would be in post-harvest handling and value addition processing. Once these processes are fully mechanized, a profit-driven pull is created for mechanizing field operations.
2. Make agricultural development and food security policies, strategies, and programs “mechanization smart”. Efforts are required to convince public and private sectors of the value proposition of agricultural mechanization so that they can make their current and planned agricultural programs and business plans ‘mechanization smart’—that is to include appropriate mechanization along the value chain the start. The opportunities that mechanization could open for the private sector – including primary producers and their associations, suppliers, financial services providers, and post-harvest handling and marketing agribusinesses – are not currently apparent. This situation needs to be changed through public research and business development services on agricultural mechanization. Furthermore, private mechanization service providers using small tractors and equipment should be emphasized since outright ownership of equipment is out of reach for most smallholders.
3. Establish a comprehensive assessment of mechanization to update obsolete data. There is a serious paucity of up-to-date data and information about agricultural mechanization to guide serious planning and business development. There is therefore a need for an intensive and extensive assessment of the current state of agricultural mechanization supply and utilization. This should be followed by projections of the levels of agricultural mechanization that would be required in the future concerning changing demographics, and demand for agricultural commodities and products.

To enhance agricultural mechanization in Borno State and Nigeria in particular, the way forward is that the government should intervene to counteract the conflicting issues of high prices, low

demand, low supply, and high prices. For this to happen, demand must be encouraged through the concealment of professional medium to large-scale farmers. The elaboration of an AMS would provide an opportunity to identify the various factors that result in the high cost of agricultural machinery in the country. This will then be followed by providing incentives to stimulate demand for agricultural machinery as well as local production.

Discussion

Evaluation of tractor maintenance and Servicing culture in Borno, stated by Washara et.al. (2023) concluded that the major constraint with machinery and mechanization in the state is the poor access of farmers to mechanization. This is a result of the high cost of mechanization inputs, the low purchasing power of the majority of farmers to acquire them, and the poor access to loans by farmers. Other studies in Cameroon (MINADER & FAO-AGS, 2010a) and analysis of the situation in Nigeria by Asoegwu and Asoegwu, (2007), and ICARRD (2006), suggest that this is in general the major constraint in the two regions. The above results in a vicious circle because the high costs of mechanization limit the demand by farmers and hence the supply is consequently very low and does not allow for economies of scale to reduce prices. This leads to little competition because of very few suppliers. In addition, the turnover period is very long. Illustrates the cost of acquiring tractors and tractor hire services in some countries in West and Central Africa {FAO}. With the high costs of tractors in Cameroon for example, only major corporations, timber companies, airports, and state-funded projects can afford to pay for tractors sold locally. Small to medium-scale farmers usually go for imported used equipment.

many states in Nigeria have now concluded that to stimulate growth and reduce poverty, the business environment needs to be integrated for agriculture-led growth. Nigeria has national development policies that call for mechanizing or intensifying agricultural production, as well as using agricultural products as raw materials for industries.

To achieve this goal, it is now widely recognized in the region that agriculture should be promoted as a business and not just for subsistence. This calls for the development of medium to large-scale farmers who will need a lot of agricultural engineering technologies to improve their effectiveness and be profitable. It is also recognized that agricultural mechanization will not be sustainable if it is not developed within a broad framework of national development in which accompanying measures such as improved infrastructure, provision of credits, and access to markets are provided. It is with this in mind that several countries like Nigeria have developed strategies to create an enabling environment to increase private investment in the sector. Because of the low productivity of farmers in the region, the low level of mechanization, the desire to ensure food sovereignty and intensify agricultural production to stimulate economic growth and development, there is a very high potential for expansion of the agricultural sector at all levels

Fig. 2. Some Borno State Agricultural Machineries





REFERENCES

- FAO's recent Diversification Booklet 19: Hire services by farmers for farmers.
<http://www.fao.org/docrep/015/i2475e/i2475e00.pdf>
- <https://tribuneonlineng.com/orno-govt-spent-n40bn-farm-mechanization-7-years-commissioner/>
- Haque, M., Umar, B., & Zamdai, B. (2020). Availability and conditions of agricultural machinery in Borno State, Nigeria. ARID ZONE JOURNAL OF ENGINEERING, TECHNOLOGY AND ENVIRONMENT, 1, 1-6. Retrieved from <https://www.azojete.com.ng/index.php/azojete/article/view/291>
- Washara Ester Y, Usman M.I, Kachalla A.S, Abdullahi A.M, Yunus Hassan and Muhammed Isah Muhammed (2023). Evaluation of tractor maintenance and Servicing Culture in Borno State, Nigeria. International Journal of Agriculture and Earth Science (IJAES) 2695-1894 Vol 9. No. 7
- Mabayoje, L. (2017). Mechanization in Nigeria: Yesterday, Today and the Future. Pp.1-8.
- Clarke, L.J. and T. Simalenga (1997). Farm Mechanisation and Strategy Formulation in East and Southern Africa in Proceedings of FAO/FARMESA Regional Workshop, 30 September. Retrieved December 3, 2006.
- Pawlak, J., D. Pellizzi, and M. Fiala (2002). On the Development of Agricultural Mechanization to Ensure a Long-Term World Food Supply. Agricultural Engineering International: the CIGR Journal of Scientific Research and Development. Invited Overview Paper. Vol. IV.

- Asoegwu S. and A. Asoegwu (2007). “An Overview of Agricultural Mechanization and Its Environmental Management in Nigeria”. *Agricultural Engineering International: the CIGR Ejournal*. Invited Overview No. 6. Vol. IX, pp1.
- NAS. (2018). *Agricultural Mechanization – History Part 1*. Available online: www.greatachievements.org/?id=3783. Retrieved 20th June, 2017.
- Aboaba, F. O. (1977). *Engineering in the Production of Food*. Inaugural Lecture Delivered at the University of Ibadan. 11th June. University of Ibadan Press, Ibadan.
- Nwosu, A. C. (1989). *Agricultural Mechanization in Nigeria. Assessing the Strategies and Technologies for Land Preparation*. Nigerian Institute of Social and Economic Research Monograph Series No. 2. pp.5.
- Utaku, A. C. (2005). A Survey of Mechanization Problem of the Small-Scale Farmers in a CrossSection of Nigeria. *Proceedings of the Nigerian Institution of Agricultural Engineers (NIAE)*. Yenogoa, Vol. 27:400-403.
- World Bank group, (2012). *Fadama Project Turns Nigerian Farmers into Agropreneurs*. Available online on www.worldbank.org. Retrieved 10th March, 2014.
- Iheanacho, A. C., Olukosi, J. O. and A. O. Ogungbile (2003). Economic efficiency of resource use in millet-based cropping systems in Borno State of Nigeria, *Nigerian Journal of Tropical Agriculture*. 2: 33 - 42.
- Enaboifo, M. A. and J. O. Anerua-Yakubu (2014). Mechanization Strategies for Increased Agricultural Production in Edo State Nigeria: A Review. *Nigerian Journal of Agriculture, Food and Environment*. 10(1):41-43.
- Kaul, R. N. and C. O. Egbo (1992). *Introduction to Agric Mechanization*. Published by the Macmillan Press Ltd. London.
- Musa, H. T. (1988). *Animal power utilization in Nigeria*. A paper presented at the pastoralism Conference. National Animal Research Institute. Ahmadu Bello University, Zaria.
- Sahel, (2017). *Nigeria’s Mechanisation Landscape*. Vol. 17. Pp 1-9.
- MINADER & FAO-AGS, 2010a. Appui a la formulation d’une stratégie nationale de mécanisation agricole, TCP/CMR/3204. Rapport de diagnostic: Analyse économique de la mécanisation agricole et des systèmes de transformation primaires (Draft). Rome: FAO-AGS, 109 pp.
- ICARRD. 2006. *Nigeria-national report*. International conference on agrarian reform and rural development. Porto Alegre, 7-10 March. Accessed from www.icarrd.org/en/icard_doc_down/national_Nigeria.doc on September 5, 2010.

The World Bank Group. 2010. World Development Indicators-2010. Available from <http://data.worldbank.org/data-catalog/world-development-indicators/wdi-2010>. Accessed September 12, 2010.

FAO & UNIDO. 2008. Agricultural mechanization in Africa. Time for action: planning investment for enhanced agricultural productivity. Report of an expert group meeting jointly held by FAO and UNIDO in Vienna on 29–30 November 2007. Rome, FAO. 26 pp.