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Mechanization and Skill Development for Productivity Growth, Employment and Value Addition: Insight from Nigeria

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Materials in this paper have been sourced and referenced to the best of our knowledge. Effort have been made to ensure that the originality of the sources of the copyright materials have been provided in the text. Finally, we thank all stakeholders who provided data and information contained in this report and those who in one way or the other provided support during the research.

Executive Summary

Mechanization in African agriculture has returned strongly to the development agenda, owing to the need to up-scale agricultural production and productivity. Its place in African agricultural transformation is being recognized and the focus now is to increase agricultural efficiency and reduce drudgery. Developing countries like Nigeria now aim at informed support for agricultural mechanization. This study was conducted to identify opportunities for mechanization policies and investments to increase productivity, incomes, and employment opportunities and add value to African produce. In particular, the research addressed four specific research objectives:

i. Compare different institutional options for mechanization, including state-led procurement and distribution of machinery and private sector activities.
ii. Assess opinions and policy beliefs with regard to policy instruments and effects related to mechanization, youth and digitalization.
iii. Assess the state of skills development for mechanization.
iv. Assess the effects of agricultural mechanization on rural communities.

The study (which was conducted in three states: Kaduna, Niger and Oyo) highlighted the active role that the private sector plays in mechanization, as most of the tractors in this study were sourced through private vendors. Most of the tractors were owned and managed by male, indicating that at the time of this study, there was little involvement of women in the use of tractors to drive the farm mechanization process. The major crops grown in the study area were maize, rice and cassava, among others. There was still a disproportionately high observation of the absence of competition by nearly a quarter of the respondents. These observations were much higher in Kaduna and Niger states, thus highlighting the need for the promotion of mechanized farming in these locations. The availability of post-purchase service packs was still minimal; however, the study revealed that more than a tenth of the respondents maintained their cars at home, thus indicating a willingness of the farmers to engage in repairs and leverage on potential profits along the value chain. Sources of gaps in knowledge in agricultural mechanization were identified, as approximately three-quarters of the tractor owners did not receive any training prior to and post-acquisition of tractors. The major reasons for the non-receipt of training were lack of awareness, as reported by more than half of the respondents, and high cost of training, reported by nearly a quarter of the respondents. The resultant vulnerability of the non-receipt of training could threaten the participation in tractor use and agricultural mechanization all together. The PID revealed that tractor mechanization is a development that enhances agricultural productivity, increases income and encourages Good Agricultural Practices.

Study 1: Agricultural Mechanization in Nigeria

Daudu, C. K., N. Yarama, F. O. Issa,O. Ojeleye, J. O. Owolabi and O. Fatunbi

Introduction

In rural Nigeria, many households still use human power technologies for crop and livestock production and primary processing operations. Over 60% of farm power is still provided by people's muscles, mostly from women, the elderly and children. Only 25% of farm power is provided by drudge animals and less than 20% of mechanization services are provided by engine power. A man with the hoe, to a great extent, still remains the description of the Nigerian farmer today in spite of decades of significant investments in the sector by the government and international agencies. Statistics also show that Nigeria is one of the least mechanized farming countries in the world, at 0.27hp/hectare, which is far below the Food and Agriculture Organisation's (FAO) recommendation of 1.5hp/hectare. With over 70% of her population involved in agriculture, Nigeria is unable to generate enough for export due to a very low percentage of the agricultural production being mechanized, among other issues.

Country Background on Mechanization

Nigeria is the most populous country in Africa, seventh most populous in the world and this population will be close to 450m by Year 2050. Nigeria is divided into six is geo-political zones, which are North East, North West, North Central, South West, South East and South-South. Three zones were selected from these six zones, based on distribution of the institutions with agricultural engineering programme and practices of mechanized farming in the zones. The selected zones are North West, North Central and South west. Out of these, purposive technique was used to select one state each from the selected zones. The chosen states were Kaduna from North West, Niger from North Central and Oyo from South West.

The importance of agricultural mechanization in Africa in the agricultural transformation was recognized in the Comprehensive Africa Agriculture Development Programme (CAADP) and the Malabo Declaration (FAO and AUC, 2018). Further, agricultural mechanization was regarded as an urgent matter to attain zero hunger and as an essential input to smallholder farming in sub-Saharan Africa. Governments were also urged to prioritize mechanization along the entire food value chain and increase investment in advancing mechanization, with more emphasis on post-harvest and processing technologies (Malabo Montpellier Panel Report, 2018).

Studies by IFPRI (2016) also indicated that the demand for mechanization emerged in some parts of Africa due to economic structural changes in many countries, leading to scarcity of rural labour and diversification into non-farm income activities; although, this created an additional opportunity cost for family farm labour. The studies also suggested that private-sector-driven supply models were better positioned to meet this demand than direct government involvement and certain types of subsidized programmes.

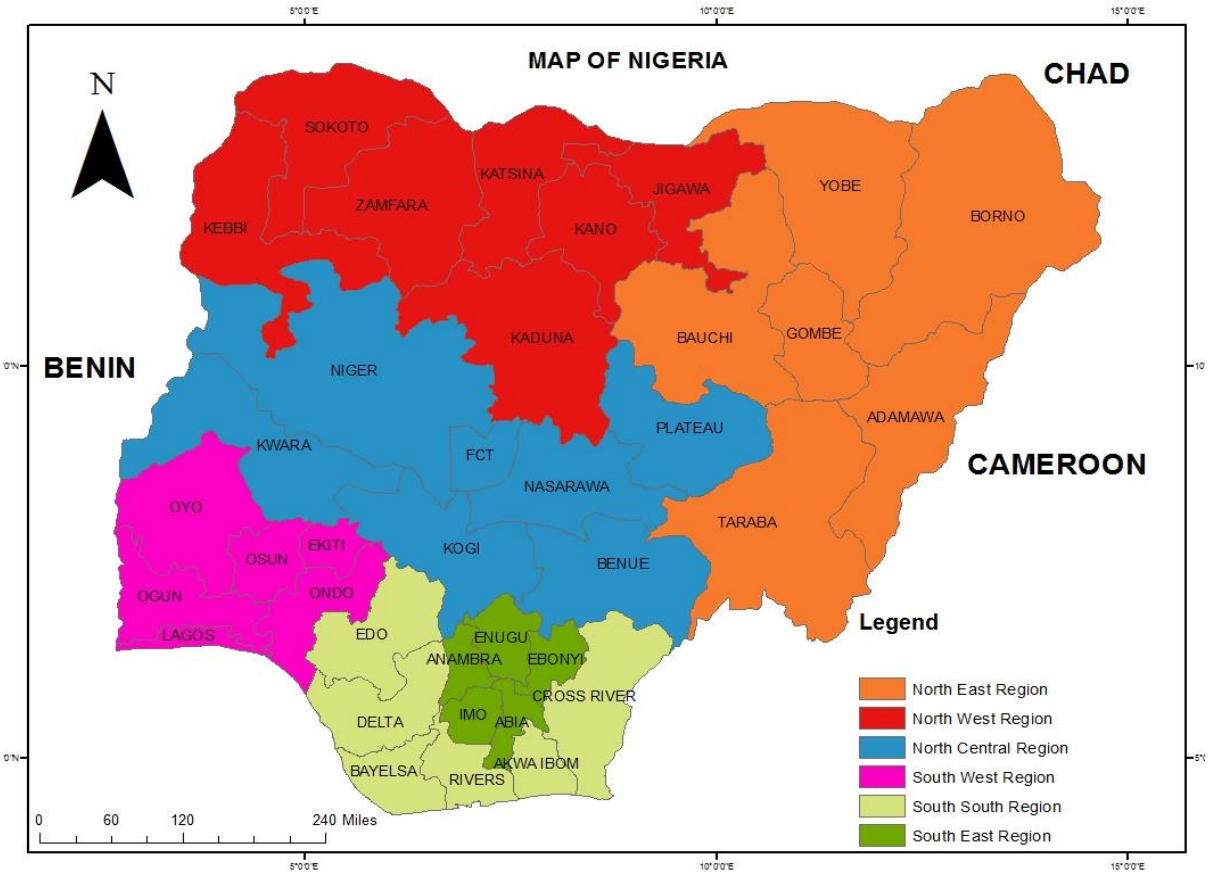

Figure 1: Map of Nigeria by Zone (Region)

According to FAOSTAT (2016), the most challenges faced by mechanization initiatives are: inadequate machinery, staff (operators and mechanics), mechanization extension, access to mechanization technology, after-sales service and resources; lack of credit and finance for farmers and contractors; decreasing farm holding sizes; and aged farming citizens.

In Nigeria, the demand for mechanization is determined by various factors, including farming systems, population density or labour wages (Pingali, 2007 and Issa, 2017a). Due to the heterogeneity in the agro-ecological environments and socio-economic characteristics of farm households in sub-Saharan Africa (SSA), farm mechanization plays diverse roles. For example, farm mechanization may be more effective in reducing labour costs rather than expanding areas cultivated. In such a case, the goal of effective mechanization policies may be to raise the income of smallholder farm households through reduced production costs, rather than growing large-scale farmers. Generally, mechanization aims at any or a combination of these: reduction of drudgery in farm work, increasing in agricultural output per man-hour, improvement in and timeliness of farm operations, reduction in spoilage, waste and other losses of farm produce/ products, preservation and proper processing of farm products and food supplies, maximization of yields by improved agricultural farm operations, enablement of production of more or additional food products, improvement in water supplies and water control systems, reclamation of land abandoned because of primitive operations or inadequate power,

development of new land for agriculture by clearing obstructions or draining, levelling or other reclamation operations and creation of a greater measure of wellbeing for farm families.

The market for mechanization services is underdeveloped in Nigeria, with uneven supply across locations (Takeshima et al., 2013). Most tractor services in Nigeria are provided by the government through either subsidized direct sales or public tractor hiring services (Prop Com, 2011), though private owner-operators are emerging. While commercial markets exist in Nigeria, where imported tractors are sold, effective demand may be small and limited to private owner-operators who have managed to accumulate adequate capital through business expansion after first acquiring subsidized tractors. Due to the low operational capacity and poor maintenance of equipment among public service providers, sub-optimal distribution of subsidized tractors, and high fixed costs, current adoption of mechanization may be highly constrained by the lack of supply, leaving potential demand unmet for the majority of smallholder farmers.

The use of mechanization is associated with distinctive production characteristics (Takeshima et al., 2013 and FAO, 2016). The level of agricultural mechanization in the country has remained low, with non-mechanized practices, such as the "hand-hoe" dominating the farming system. Besides, mechanization involves employment of machine technology in the process of development; in this case, powering agricultural operations do not work in isolation. It requires a conducive environment in terms of various traits, appropriate cropping systems, crop arrangement, land area under cultivation, constant and affordable power, etc. (Oyewole and Oyewole, 2016). With crop production in Nigeria dominated by smallholders engaged mainly in multiple cropping (over 75% of the cropped land), mechanization is constrained. The situation is increasingly compounded by a declining agricultural labour force caused by rural to urban migration, ageing farmer/producer population, as well as the HIV/AIDS and malaria pandemics (Propcom 2009). There is no doubt that agricultural mechanization for the multitude of smallholder farmers in sub-Saharan Africa (SSA) has been a neglected issue for too long. The application of farm power to appropriate tools, implements and machines – "farm mechanization" – is an essential agricultural input with the potential to transform rural livelihoods by facilitating increased output of higher value products while eliminating the drudgery associated with human muscle-powered agricultural production. Such an improved situation for smallholder farmers can improve supply chains in modern food systems.

For the records, the Nigeria's attempt at a coherent agricultural mechanization policy became clear in the early 1970s in view of an increasing shortage of agricultural labour that necessitated the substitution of some appropriate forms of mechanical power for human labour (Issa, 2017a). Consequently, agricultural mechanization policy was structured to achieving the following objectives:

i. The operation of tractor hire units by states.
ii. Liberalized import policy in respect of tractors and agricultural equipment.
iii. Massive assistance programme to farmers on land clearing through cost subsidies

iv. The launching of a machinery ownership scheme in 1980 through which the Federal Government provided half of the purchase cost of farm machinery to be owned and used by farming cooperatives or group farms (Manyong et al., 2005; Issa 2017b)).

Over the years, however, the objective of mechanization policy has been reframed to reducing the drudgery of agriculture by providing mechanical power to replace some of the labour required in agricultural business and reduce the high cost of agricultural production which arises largely from high labour wage rates and the high share of labour in the total cost of agricultural production (FMARD, 2001).

Strategies adopted to actualize the objectives included:

i) Land clearing for agricultural purposes and the regulation of the activities of all land clearing and development agencies.

ii) Provision of subsidy for agricultural land clearing.

iii) Support and assistance for entrepreneurs to receive bank loans to set up private agricultural mechanization enterprises and/or tractor hiring units (THUs) and repair workshops.

iv) Provision of training to a tractor and land clearing operators on the proper use of equipment to prevent soil loss and reduce soil erosion.

v) Intensified use of small motorized farm machines and ox-drawn equipment (animal traction), and promotion of the local manufacture of medium and large farm machinery for land preparation, crop cultivation, harvesting, processing, and storage on large-scale farms.

vi) Acceleration of the development of the National Centre for Agricultural Mechanization; aimed at performing the function of standardization of farm machinery and equipment, alongside the promotion and production of locally designed prototypes.

vii) Partnerships with universities, polytechnics and research institutes in accelerating the development and local fabrication of suitable equipment for use by intermediate and small-scale farmers.

viii) Promotion of private sector participation in the commercialization of prototypes.

Status of Agricultural Mechanization Nigeria

Agriculture in Nigeria is dominated by subsistence and semi-subsistence households cultivating less than 3ha. These smallholder farmers account for over 90% of the nation's agricultural outputs. The land is cultivated mostly by hand and employing low, inadequate levels of agricultural technologies, techniques, and inputs. The aspiration for Nigeria to develop and grow into one of the world's largest economies in the near future cannot be realized until there is a significant and deliberate shift in favour of increased investments in the country's productive sectors, including agriculture. In effect, hand-hoe and cutlass cannot earn Nigeria a place at the table of the 20 largest economies.

Table 2: Mechanized activities in Oyo State

Activities mechanized	Percent of responses (n=186)
Ploughing	64.0
Harrowing	25.3
Planting	3.2
Carrying/transportation	2.2
Milling	1.6
Harvesting	0.5
Pumping water	0.5
Providing electric power	0.5
Hatching eggs	0.5
Fishing	0.5
Total	

Source: ASDSP, 2014

The Trend of Tractorization in Nigeria

The effect of mechanization policy in Nigeria can be viewed from the trend and timeline of tractor population and usage in the country. Figures 1 to 3 show the total number of tractor units from 1970 to 2009, tractor units per 100 square km of arable land from the 1970 to 2009, and agricultural machinery import trade value in $1000 from 1970 to 2011. With an average of 4.36 tractor units per 100 square kilometres over the years, mechanization, as a reflection of tractorization of farm operations, is very low. When further compared with countries like Morocco (49.02), South Africa (64.23), and Egypt (400.1), the level of mechanization in the country leaves much to be desired, despite the country's vast potentials.

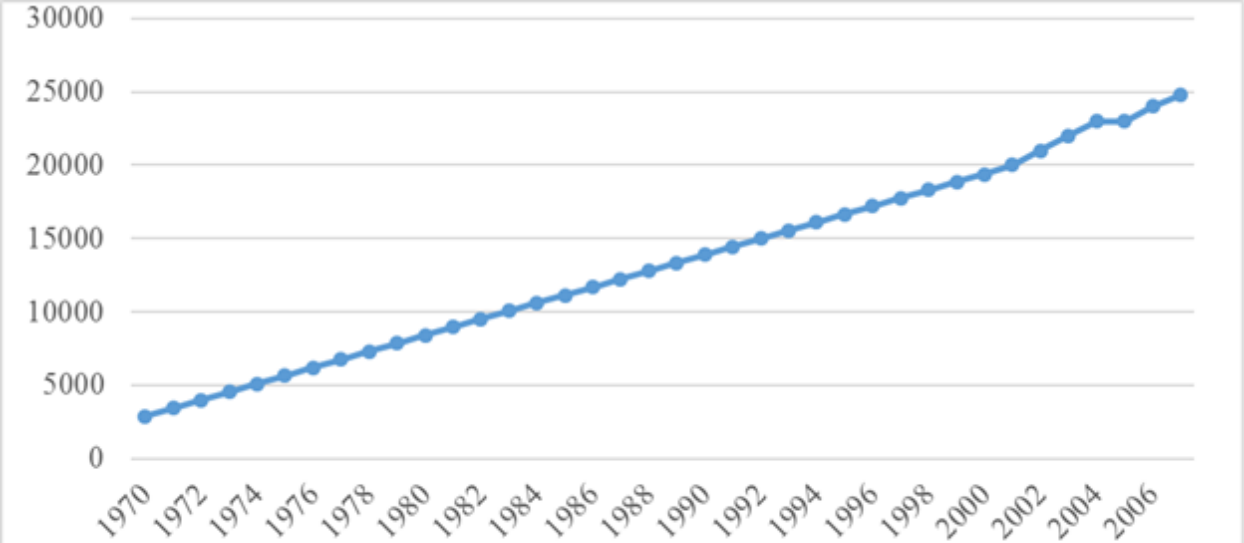

Figure 1. Number of tractor unit per year

Source: FAOSTAT 2019

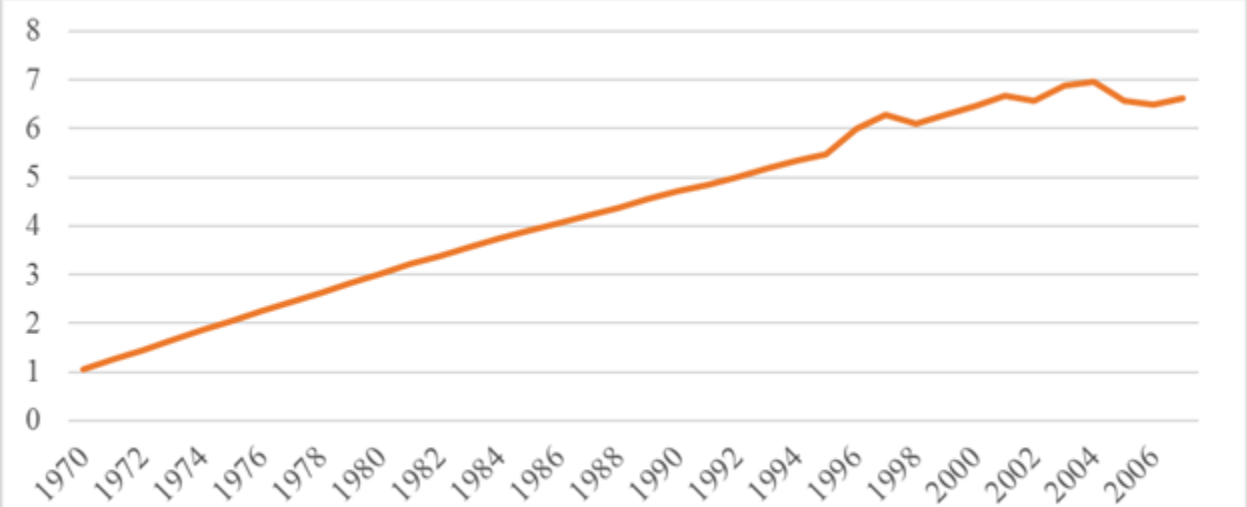

Figure 2: Number of tractor units per 100 Km2of arable land

Source: FAOSTAT 2019

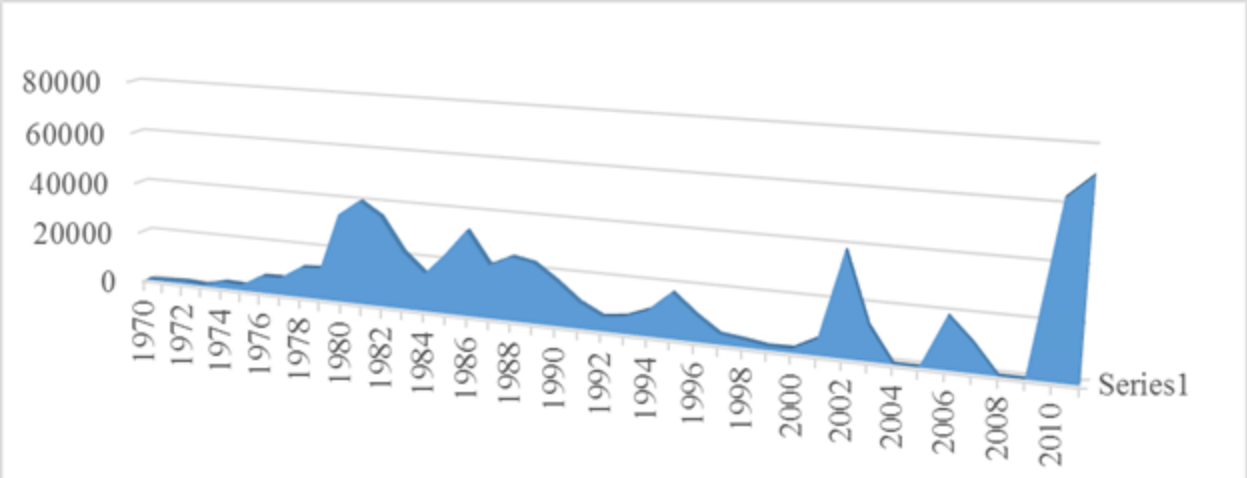

Figure 3: Agricultural machinery import trade value USD (X1000)

Source: FAOSTAT 2019

The peculiarity of low mechanization in Nigeria hinges on small-scale farming. Large-scale farming requires huge investments and mechanization; incidentally, this is not within the reach of most farmers. Besides, the Nigerian cropping system is such that multiple cropping is preferred to sole cropping because of its benefits. It has been established that multiple cropping allows the farmer to grow various crops on a piece of land without necessarily preparing another land, and an insurance against total crop failure, helping in the control of erosion, pests and diseases; it also provides the farmer a variety of crops, thus improving his dietary intake (Steiner, 1982; Langdale et al., 1992; Oyewole and Oyewole 2016). This system, however, impedes mechanization.

Moreover, constraints to the achievement of agricultural mechanization in Nigeria and the policy thrust are such as are common with other agricultural policies in the country. Issues with policy instability, inconsistency in policies and direction, narrow base policy formulation and articulation, poor implementation of policies, and weak institutional framework for policy coordination have been the bane of agricultural policies over the years.

The mechanization of African agriculture is, however, gaining interest in the development agenda, owing to the need to up-scale agricultural production and productivity, the place of mechanization is now being recognized. Developing countries like Nigeria now aim at informed support for agricultural mechanization. This study was conducted to identify opportunities for mechanization policies and investments to increase productivity, incomes, employment opportunities and add value to Nigerian produce.

STATUS OF ANIMAL TRACTION TECHNOLOGY IN NIGERIA

The use of animal traction (AT) in Nigeria for agricultural production is dated to 1920s. The first demonstration of oxen as a source of power took place in 1922 in northern Nigeria under the initiative of the British government. The technology was primarily introduced to improve cash crop production for export and also to improve the diet and income of people living in the

northern region (Garba *et al*., 2012). Also, the need to increase power in Nigerian agriculture to supplement and replace human (manual) labour has long been recognized. As such, animal traction technology appeared to provide the answer in this regard. In Nigeria, just like in any other developing country, the most viable option to the use of mechanical power is animal power, supplied by oxen, camels, donkeys and horses (NAERLS, 2008; Bawa and Bolorunduro, 2008; Omotayo, 2010; Abubakar and Ahmad, 2010: Garba *et al*., 2012 and Owolabi, 2019).

The introduction of AT in Nigerian smallholder systems has brought considerable benefits to agricultural production. AT increased crop yields through better and timely cultivation and planting; reduced labour requirement per unit area and allowed an increase in the area under cultivation. It also helped resolve bottlenecks in weeding, and reduced the drudgery of manual labour. However, despite the potentials of AT to alleviate seasonal labour shortages, which, together with capital shortages are widely considered as the primary production constraint in sub-Saharan African farming systems, less than 10% of the total cultivated area is cropped using animals. Most of the literature consulted on animal traction utilization showed that animal traction in Nigeria has been largely neglected and farmers have not taken full advantage of using work animals for the various possible operations on the farm. This situation prevails, despite considerable efforts by the World Bank-sponsored agricultural development projects (ADPs) aimed at promoting increased use of AT (Ajav, 1989). It is in the face of these and other constraints that it becomes necessary to explore the use and spread of animal traction in Nigeria and look for viable alternatives for enhancing agricultural production through increased use of AT.

Animals Used for Traction in Nigeria

The distribution of work animals and implements used in Nigeria is presented in Tables 1 and 2. These animals include Oxen (77.9%), Cow (72.9%), Camel (12.9%) and Donkey (12.1%). The dominant use of Oxen and Cow could be attributed to their size and strength to carry out farming activities (Owolabi, 2019). The data in Table 2 further reveal various implements used for animal traction to include plough, harrow, ridger, weeder, cart, sprayer, cultivator, crusher and lifter. The pooled result reveal that majority of the respondents used plough (86.4%), harrow (84.3%), ridger (90.7%) and cart (85.0%), making them the mostly used animal traction implements in the selected states.

Table 1: Distribution of work animals used in Nigeria

Animal	Kaduna State *Freq (%)	Kano State *Freq (%)	Zamfara State *Freq (%)	Pooled *Freq (%)
Oxen	23 (50.0)	67 (90.5)	19 (95.0)	109 (77.9)
Cow	18 (39.1)	65 (87.8)	19 (95.0)	102 (72.9)
Camel	12 (26.1)	5 (6.8)	1 (5.0)	18 (12.9)
Donkey	13 (26.1)	3 (4.1)	1 (5.0)	17 (12.1)

Source: Owolabi, 2019 ***multiple response**

Table 2: Distribution of animal traction implements/instrument used in Nigeria

ATT	Frequency*	Percentages	Decision

Ox-drawn plough	137	97.86	Very high
Ox-drawn harrow	129	92.14	Very high
Ox-drawn ridger	108	77.14	Very high
Ox-drawn carts	75	53.57	High
Ox-drawn cultivator	24	17.14	Low
Ox-drawn crusher	20	14.29	Low
Ox-drawn weeder	14	10.00	Low
Ox-drawn lifter	10	7.14	Low
Ox-drawn sprayer	7	5.00	Low

Source: Owolabi, 2019 *Multiple Responses

3.2 Development Operations of Animal Traction in Nigeria

The result in Tables 3 and 4 summarized the operations carried out using animal traction in various parts of the country. Omotayo (2010) also asserted that a man and his family with a pair of work bulls can cultivate as much as 4 to 5 times the area of hand-cultivated farm land.

Table 3: Distribution of animal farmers based on various farm operations across the country

Activity	Independent Users Freq.	%	Dependent Users Freq.	%
Ploughing	10	18.2	3	5.5
Ridging	55	100	55	100
Weeding	38	69.1	12	43.5
Carting or transport	22	40.0	8	14.5
Groundnut harvesting	3	5.5	0	0

Source: Omotayo, 1995

Table 4: Estimates of areas under different power sources in northern states of Nigeria

	Power Source		
	Hoe	Animal	Tractor
Number of farmers (million)	7.5	0.1	0.015
Area cultivated (ha/farmer/year)	1.0	0.5	50.0
Total area cultivated annually (million Ha)	7.5	5.5	0.75
Percent of total area (%)	86.0	100	8.5

Source: Ladeinde 1996

Challenges to Full Adoption and Promotion of Animal Traction in Nigeria

The major constraints to AT usage include inadequate capital/ low accessibility to credit, inadequate implements and high cost of animal. The constraints to animal power development in Nigeria have been described as psychological and social, rather than technical and economic. Rural and urban decision-makers and educators do not consider animal power as a modern development option. There is the need to counteract existing negative and outmoded media coverage if people are to continue to consider animal power as a realistic option. According to

Bello *et al*. (2012), animal power issues need to be taught in schools and discussed in national media. Work animals should be seen as ecologically and economically appropriate in rural areas and should be seen as coexisting effectively with motorized systems to enhance the quality of community life. While motorized power is well accepted, animal power should be portrayed as modern and environmentally acceptable. Positive, realistic and relevant images need to be portrayed though radio, television, magazines and books (Umarua *et al*., 2013).

Animal traction has greater appeal now than ever before for agricultural development in Nigeria. It is an appropriate, relatively affordable and sustainable technology. Its numerous benefits include the provision of vital power for land tillage and transport to smallholder farmers; marketing and trading are made easier; and relieving for women the burden of transporting water, farm inputs and produce by hand, head or wheelbarrow. It is also capable of providing employment and transport, and promoting improved food production and security, thereby leading to higher incomes, better standard of living and the much-needed improvement in arming generally. Inadequate capital and credit, inadequate implement and high cost of animals are among major constraints to the adoption of animal traction across Nigeria.

Ways Forward Towards Animal Traction Promotion

Some options for increasing adoption of animal traction (AT) in Nigeria are:

1. Dynamic and innovative adaptation of AT to farmer conditions
2. Increased research efforts, especially with respect to utilization of animals, harnessing and implements.
3. Extension and promotional efforts to encourage utilization of animal traction in Nigeria through radio, television, and the Internet, as well as development of skills of farmers.

Study 2: Institutional Options for Mechanization, Including State-Led Procurement and Distribution of Machinery & Private Sector Activities

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Abstract

The importance of agricultural mechanization in the agricultural transformation of Africa was recognized in the Comprehensive Africa Agriculture Development Programme (CAADP) and the Malabo Declaration. Further, agricultural mechanization was regarded as an urgent matter in attaining zero hunger and as an essential input to smallholder farming in sub-Saharan Africa. Agriculture in Nigeria is dominated by subsistence and semi-subsistence households cultivating less than 3ha. These smallholder farmers account for over 90% of the nation's agricultural outputs. The land is cultivated mostly by hand and employing low levels of agricultural technologies, techniques and inputs. The level of agricultural mechanization in the country is low, with the hand-hoe dominating the farming system. The situation is increasingly compounded by the declining agricultural labour force, caused by rural - urban migration, ageing farmer/producer population, and malaria pandemics. It is on this premise that this study compared state-led procurement and distribution of machinery and private sector activities. A pre-survey was carried out across the 36 states and the FCT of the six geo-political zones to identify state-imported and privately purchased machinery operators. The survey population was estimated from data of Tractor Owners Hiring Facilities Association of Nigeria (TOHFAN), Tractor Owners Operators Association of Nigeria (TOOAN) and Federal Ministry of Agriculture and Rural Development (FMARD) to generate a list estimating the available tractors in Nigeria. The generated list was used to purposively select three states based on tractor density and geopolitical zones representation. A well-structured questionnaire was developed, uploaded online and administered electronically using Computer Assisted Personalized Information (CAPI). Personnel were deployed to the field to electronically administer the questionnaire to tractor owners, and desk study, mobile contacts were done to complements field work. Purposive sampling technique was used to select tractor owners in the study states (Oyo, Kaduna and Niger) and 100 respondents were randomly sampled in each state for state-imported and privately purchased tractor operators. The snowball technique was also utilized in states where the listing did not have an adequate number of tractors. A total of 259 tractor owners were surveyed (45 state-imported tractors and 214 privately purchased tractors). Data was cleaned and analysed using descriptive statistics. Results of the study revealed that both state-imported and privately purchased tractor owners were educated, though state-imported operators had more tertiary education. Tractor owners were commoners in their communities, belonged to a cooperative group, sourced their income to purchase tractors from farming operations and tractor hiring services, motivated to buy tractors because of the strength/horse power, preferred Merssey Fergusson brand of tractor with capacity greater than 70hp for both state-imported and privately purchased tractor operators. Major operational problems encountered by state-imported tractor operators were fuel supply/ignition and transmission systems, while those of the privately purchased was tyre problem. Major repairs were observed to be done in mechanic workshop for both state-imported and privately purchased tractor

operators. Preferred machineries were tractor, ploughs and harrows. Operations carried out with these tractors were majorly ploughing, harrowing, ridging and transport with the use of hired labours by both state-imported and privately purchased operators. Moreover, state-imported tractor operators out-performed the privately purchased tractor operators in terms of trainings received, duration of trainings, satisfaction of trainings received and knowledge of machineries operated. Most of the tractor constraints encountered were surmounted by the state-imported tractor operators. The income and social aspirations of the operators were found to be significant for both state-imported and privately purchased tractor operators. It was generally observed from the study that state-imported tractor operators were better managed than the privately purchased tractor operators, with regard to the provision of enabling working environments, resources and level of freedom provided to civil servants.

Overview of Tractor Market Actors (Tractor Dealers (Retailers), Manufacturers, Service Providers) in Nigeria

The tractor is at the centre of agricultural mechanization. Nigeria's agricultural mechanization technology has continued to be import-oriented. Agricultural machines and equipment are imported into the country to support the various governments' mechanization policies. At present, there are many different brands and models of tractors in the country. These models were imported by various dealers or machinery vendors. There are many vendors of tractor and machinery, who are strategic partners in agricultural-mechanization activities in Nigeria, as they provide their brands of tractors and equipment to hiring service providers and farmers. Prominent vendors in Nigeria include SCOA, Springfield Agro, Pan African Equipment Nigeria Limited, Dizengoff Nigeria Limited and TATA Africa Services (Nigeria) Limited: Springfield Agro (Mahindra), TATA (John Deere), SCOA (New Holland), Dizengoff Nigeria Limited (Massey Ferguson), Pan African Equipment Nigeria Limited (Valtra). The commonest status maintained by all the dealers is sole distributorship, while the business relationship is that of buyer-seller type. In some cases, the relationship is such that the manufacturer consigns the machine to the dealer who pays after sales of such a machine. Generally, averages of about 100 units of tractors are sold by each dealer per annum. While most dealers sell combined harvesters, only a few sell power tillers. Most of the tractors used in Nigeria are manufactured in Brazil and India. All tractor dealers prefer to import them as semi-knocked down; however, some dealers import tractors in the complete knocked-down form. Sales stores located in strategic parts of the country are used to distribute tractors to customers.

Most tractor dealers maintain uniform prices for each brand, but transport and logistics account for the differences in prices to different customers. Dizengoff Nig. Ltd bears the delivery cost for most of its customers. Private buyers remain the biggest customers to most of the dealers, while service providers mostly constitute the final consumer of tractors sold by most dealers.

Implements are mostly imported from India, Brazil and Turkey. Unavailability of local fabricators, poor quality, as well as high costs are the major reasons dealers do not obtain implements in Nigeria. All the dealers have one form of after-sales service or the other.

Provision of training, the establishment of repair and maintenance workshops, and operation of mobile repair systems are some of the after-sales strategies employed by the dealers.
Most dealers obtain NCAM certification for all their brands of machines. However, the duration of time used to process the certification varies. Most of them obtain certification for sales to federal and state governments, since it is a major condition for securing such contracts. Most dealers have no difficulty in obtaining NCAM certification; some transport and give out one machine of each brand to NCAM for testing, which is the most difficult part of the certification process.

Farm Machinery Hire Service Providers
There are 2 major associations that provide tractor hiring services in Nigeria:

i. Tractor Owners and Operators Association of Nigeria (TOOAN) and
ii. Tractor Owners and Hiring Facilities Association of Nigeria (TOHFAN)

The Tractor Owners and Operators Association of Nigeria (TOOAN)
The Tractor Owners and Operators Association of Nigeria (TOOAN) is a registered cooperative group with the original objective of coordinating the provision of tractor hiring services to Nigerian farmers on a sustainable basis. The association was registered with the Corporate Affairs Commission in July 1997 after operating informally as a pilot scheme since 1983. TOOAN was founded in Sawanjo Farm Settlement, Yewa North LGA, Ogun State. The National Headquarters is located at the National Agricultural Show Ground, KM 28, Abuja-Keffi Road, Nasarawa State. TOOAN has a standing executive committee that represents the association at the national and state levels. There are over 1,500 TOOAN members nationwide.
TOOAN provides the following services:

i. Represents one national voice on behalf of members
ii. Facilitates business opportunities nationwide
iii. Creates connection points for members to financial institutions, vendors and spare parts dealers
iv. Raises the living standard of members and the general farming community
v. Improves the output of Nigeria's farmland by imparting modern skills for land preparation and tractor operation

Tractor Owners and Hiring Facilities Association of Nigeria (TOHFAN)
Tractor Owners and Hiring Facilities Association of Nigeria (TOHFAN) was established in 2003 with 9 tractors and 36 members to provide tractor hiring services to farmers on a commercial basis. By February 2016, the association operated in 18 states across the country, with 187 tractors and 509 members. TOHFAN is managed by a team of executive members from the head office in Zaria, Kaduna State comprising of Chairman, Vice-Chairman, Secretary, Assistant Secretary, Treasurer and Public Relations Officer. At the state level, the association is managed by an executive committee that has similar positions as the head office. A member of TOHFAN can be a tractor owner, tractor mechanic, tractor operator, tractor hiring agent or a tractor booking agent. Some members have more than 1 tractor. TOHFAN as an association does not own a tractor but receives a day work service by every tractor per year or the payment equivalent to ₦20,000/year. Monthly due (₦2000) is also a source of revenue to TOHFAN. Also,

one-third of the revenue accrued from the state chapter is remitted to the national body. A state chapter is granted/inaugurated when there are a minimum of 3 tractor owners (and by implication, 3 tractors), 3 operators and at least 1 hiring agent/booking agent/ mechanic.

Models for Tractor Hiring Service in TOHFAN

As a real-time business-oriented association, TOHFAN operates in unique ways. There are four (4) different models of tractor hiring services:

i. A model involving Hiring agent: In this model, the tractor hiring agent is the centre point. He hires machine from the owner for a specified fee and provides services to farmers who pay him.

ii. A model involving booking agent: In this case, the booking agent finds farmers who need tractor hiring services, and link such farmers with the tractor owner who provides the services and deducts agreed 10% commission from the fee paid by farmers. He is a commission agent, who does not have the money to hire a tractor.

iii. A model involving no hiring/booking agent: Sometimes, the tractor owner gets farmers who need tractor services directly.

iv. A model involving TOHFAN as booking agent: In order to ensure continuous business operation, TOHFAN provides hiring services to large corporate farms by deploying tractors belonging to members of TOHFAN to work in such farms, thereby acting as booking agent (i.e. gets commission on each tractor working on such farms according to laid down rules).

Types of Tractor Hiring Services in Nigeria

i. Owner as operator: A few cases exist where tractor owners double up as operators. In such cases, however, assistant operators are usually on standby should the owner be indisposed.

ii. The owner rents the tractor to the operator and operator provides the service to the farmers: There are also cases of absentee owners who are not directly involved in the management of the tractors. The operator takes all responsibilities about the tractor except for major repairs that are transferred to the owner. Most of these owners can be described as operating tractor hiring services on a part-time basis, since they have their major occupations, such as civil service, or they are engaged in other businesses, which provide the bulk of their annual income. In most cases, these types of owners get their tractor from government sources at a subsidized price.

iii. The owner hires the operator and pays him from the income from the farmers: Most tractor owners interviewed in this survey fell under this category. A higher percentage of their annual income (50 – 75%) comes from tractor hire. Major responsibilities are shared between the owner and the operator. Operators are usually paid 10% of the income accrued from the operation.

Federal Government Efforts to Promote Mechanization

Despite huge amounts invested in the procurement of agricultural machines in Nigeria, the level of agricultural mechanization continues to be very low (Comsec, 1990). The recent Agricultural Transformation Agenda (ATA) recognizes that for it to achieve any level of success, farm mechanization must play a fundamental role. Sequel to this, ATA identified the provision

of mechanization services as crucial to complement the implementation strategy of the various crops under the Agenda. The need to feed over 300 million people by year 2050 (FMARD, 2012) underscores the need to attain self-sufficiency and keep pace with increases in population growth and consumption patterns of the teeming population through agricultural mechanization.

The Federal Government of Nigeria (FGN) approved the implementation of Community Cooperative Tractor Hiring Scheme and the payment of ₦3,153,500,000.00 as 25% Federal Government's equity contribution to the participating companies under the Scheme (Tractorization Programme) through the Public-Private Partnership Model to make available 1,950 units of various tractors and implements (FGN, 2008).

State governments, including that of the Federal Capital Territory (FCT), supported the initiative by providing money for the procurement of tractors and other implements that would be sold to various farmer groups in line with the Federal Government of Nigeria's (FGN) mechanization policy under private sector-led demand-driven community cooperative of the public-private partnership (PPP) initiative. The tractors are expected to generate between ₦25,000 and ₦30,000 daily to pay for these tractors over a period of three to four years. Various state tractor hiring schemes (THSs) invested a lot of resources in procuring tractors and implements to alleviate the problem of mechanization of the small and medium-scale farmers and ensure food security (Alabadan and Yusuf, 2013).

State Government Efforts to Promote Mechanization

Kaduna State Ministry of Agriculture (KSMOA)

The Engineering Department of KSMOA has the responsibility to advise government on policies relating to agricultural mechanization, and in the selection and procurement of machines and equipment. The Department operates under 3 Units: Tractor Hiring Services, Land Clearing, and Mechanical Workshop Development (for tractor repairs and training of mechanics). The 47 units of (Massey Ferguson) tractors in the approved 2014 budget (and rolled over to 2015) were not purchased as at 2015. The State does not have a policy on agricultural mechanization but has plans for one.

Presently, KSMOA does not provide tractor hiring services. Having considered that most farmers are poor with small landholdings, the 2016 budget planned to purchase power tillers and distribute to farmers at a subsidized price. "No objection" was received from the State Governor on this initiative, which was advertised. Conditions for bidding for government procurement included registration with Corporate Affairs Commission, evidence of tax payment, NCAM certification, and evidence of similar procurement in the past. Major challenges of agricultural mechanization in Kaduna State are absence of mechanization policy, and non-procurement of machines, as well as inadequate monitoring of machines.

Niger State

The Niger State Rice Investment Consortium (NSRIC) is a complete rice value chain solution in the State. The vision is to transform Niger State into one of the top three state economies in Nigeria by 2020 by being a model and leader in agro-based industrialization, where there is

employment and wealth creation opportunities for all in the atmosphere of peace. NSRIC is managed under a public-private partnership (PPP) arrangement between RHA Consulting Ltd and Niger State Government, along the rice value chain: land preparation, input acquisition, and distribution, production, marketing, milling through off-taking. RHA was expected to manage NSRIC for 5 years, after which it (NSRIC) would stand on its own as a consortium of the value chain actors (farmers, input dealers, aggregators, marketers and millers). Established in 2013, NSRIC started with 25 tractors and complete implements obtained from Niger State Government (acquired through Commercial Agricultural Credit Guarantee Scheme). NSRIC has the mandate to coordinate all stakeholders and carry out capacity building activities.

The four service providers (located across the state) under the NSRIC were:

1. Zaworo Investment Ltd (Mambe) (10 tractors)
2. Sanusiyyah Ventures (Jima) (5 tractors)
3. Niger Resources (Doko) (5 tractors), and
4. NSRIC (Gaba) (5 tractors).

NSRIC also had power tillers (Chinese brands), reapers, threshers, water pumps, and machinery sheds located at Sheshinbikum village in Lavun LGA. Currently, NSRIC has 30 units of tractors in its management fleet: The remaining 5 tractors were acquired through AEHEs arrangement by the FMARD (through G Consulting). Additional service providers (Seed First MPCS Ltd) were engaged in 2015 to manage the additional 5 units of tractors.

- Under the tractor acquisition arrangement, the service provider made a down payment of 20% of the cost of each tractor, while the balance of 80% is expected to be paid on instalment for 5 years. NSRIC monitors the activities of the service providers to pay to the Niger State Government on schedule. Constraints to agricultural machinery service provision have to do with the high initial cost of tractor and the inability of farmers to pay for tractor services during the season.
- NSRIC has also facilitated contract milling as a measure to encourage post-harvest activities.
- In the NSRIC PPP arrangement, the state government pays the consulting outfit for its services.

Policy Debate on State-Led Versus Market-Led Mechanization

The level of involvement of government in the provision of efficient mechanization has been a major policy debate. In the past, the government was heavily involved in the production, sales and importation of farm tools and equipment, a situation that discouraged private sector participation. The government decided on the types and levels of mechanization, instead of allowing the sub-sector to be largely self-sustaining. Recently, involvement of the private sector (farmers, retailers and wholesalers, manufacturers, and importers) to lead the mechanization market was realized and, hence, space was liberalized to bring about a balanced development in the mechanization sector.

A fundamental requirement is that the mechanization business, as performed by each category of the private sector, must be profitable. If farmers are not making money, they will not be able

to purchase inputs; if retailers cannot sell items at profit, they will not stock them; and if manufacturers are not fabricating tools and machines at a price that can be afforded by the farmer, their business is unsustainable. Hence, the absence of a thriving agricultural machine and tool manufacturing, importing, and retailing sub-sector can be traced to the lack of profit in one of these groups. Therefore, a major development goal must be the creation of the linkages between each group and addressing issues that affect the profitability of one or more of these groups (Clarke, 2000).

African farm systems are the least mechanized of all continents (Sheahan & Barrett, 2018). This is a concern since low levels of mechanization are associated with low levels of labour productivity, a key determinant of farmers' incomes (Fuglie & Rada, 2013). However, with the re-emergence of agriculture on Africa's development agenda, there is now renewed interest in agricultural mechanization (FAO, 2016; Kirui & von Braun, 2018; Malabo Montpellier Panel, 2018). Governments aim to overcome "hoe and cutlass" types of farming to make agriculture attractive to the youth (Birner & Mockshell, 2015); donors increasingly fund mechanization-related projects, and machinery companies have discovered Africa as an emerging market (Daum & Birner, 2017; FAO 2016; Oluwole & Odogola, 2018).

The renewed interest in agricultural mechanization has been fuelled by the increasing evidence that the lack of access to labour limits development for many smallholder farmers (Baudron *et al.,* 2019; Diao *et al.,* 2014; Nin-Pratt & McBride, 2014). Indeed, studies suggest that once mechanized, farmers would benefit from agricultural enterprises, being able to increase farm incomes (Adu-Baffour *et al.,* 2019; Kirui, 2019). But issues relating to agricultural mechanization in Africa are still largely neglected by scholars. This leaves policymakers and practitioners ill-equipped to design good policies and programmes and open for the discussion the questions: What are the best options for the mechanization of smallholder production and processing systems from economic and institutional perspectives? What is the role of the private sector and which role should the state play? Which knowledge and skills are needed to promote mechanization? What are the effects of mechanization on rural employment?

To answer these questions, and thereby scientifically accompany the recent mechanization efforts, the Program of Accompanying Research for Agricultural Innovation (PARI) has identified "mechanization and skill development for productivity growth, employment and value addition" as one of its top priorities. PARI is led by the Center of Development Research (ZEF) and funded by the German Federal Ministry for Economic Cooperation and Development as part of 'One World, No Hunger' Initiative (SEWOH). PARI's research cluster on mechanization is led by University of Hohenheim, the Forum for Agricultural Research in Africa (FARA) and ZEF and jointly implemented with the Institut National des Recherches Agricoles du Bénin (INRAB), Kenya Agricultural and Livestock Research Organization (KALRO), Agricultural Research Council of Nigeria (ARCN), and Institut d'Economie Rurale (IER).

The overall objective of this research is to identify opportunities for mechanization policy and investments to increase productivity, incomes and employment opportunities and add value to African produce. In particular, the research cluster addresses four research objectives:

1. Compare different institutional options for mechanization, including state-led procurement and distribution of machinery and private sector activities. The objective was formulated because of the renewed efforts of many African governments to import

and distribute machinery to farmers, despite that tractors are private goods and the bad track records of such state-led approaches (Daum & Birner, 2017; Pingali, 2007).

2. **To assess opinions and beliefs with regard to policy instruments and effects related to mechanization, youth and digitalization.** The objective was formulated as agricultural development trajectories, including those related to mechanization, youth and digitalization are contested. For example, domestic policymakers and donors often have different opinions and beliefs about the best policies; understanding these differences is key to enabling more fruitful policy dialogues (Mockshell and Birner, 2015).
3. **To assess the state of skills development for mechanization.** The objective was formulated because research and experience have shown that successful agricultural development and mechanization requires knowledge and skills development (Daum *et al*., 2018; Daum and Birner, 2017; Kirui and Kozicka, 2018). The research component analyzes the extent in which existing formal and informal training programs provide the knowledge and skills needed for successful mechanization; this helps guide future knowledge and skills development efforts.
4. **To assess the effects of agricultural mechanization on rural communities.** This objective was as a result of the fact that effects of agricultural mechanization have been subject to a controversial discussion.

State-led and private efforts to promote mechanization

Overview of tractor market actors (types of brands and number of tractors sold)

The market actors include:

i. Retailers
ii. Equipment manufacturers
iii. Farm machinery hires service providers
iv. State institutions
v. Donations of agricultural machinery
vi. Importation of used equipment
vii. Farming community

METHODOLOGY

Study Sites, Sampling and Data Collection

Study Sites

The mechanization study was conducted in some selected states of three of six geo-political zones. The selection criteria were mainly on the estimated number of tractors in the zone, as a fraction of the number in the county (Table 3 and Figure 3).

Table 3: States sampled, mechanized crops and agro-ecological zones

State	Crop	Agro ecological Zone
Kaduna	Rice/Maize	North-Western
Niger	Rice/Maize	North-Central
Oyo	Cassava/maize	South-Western

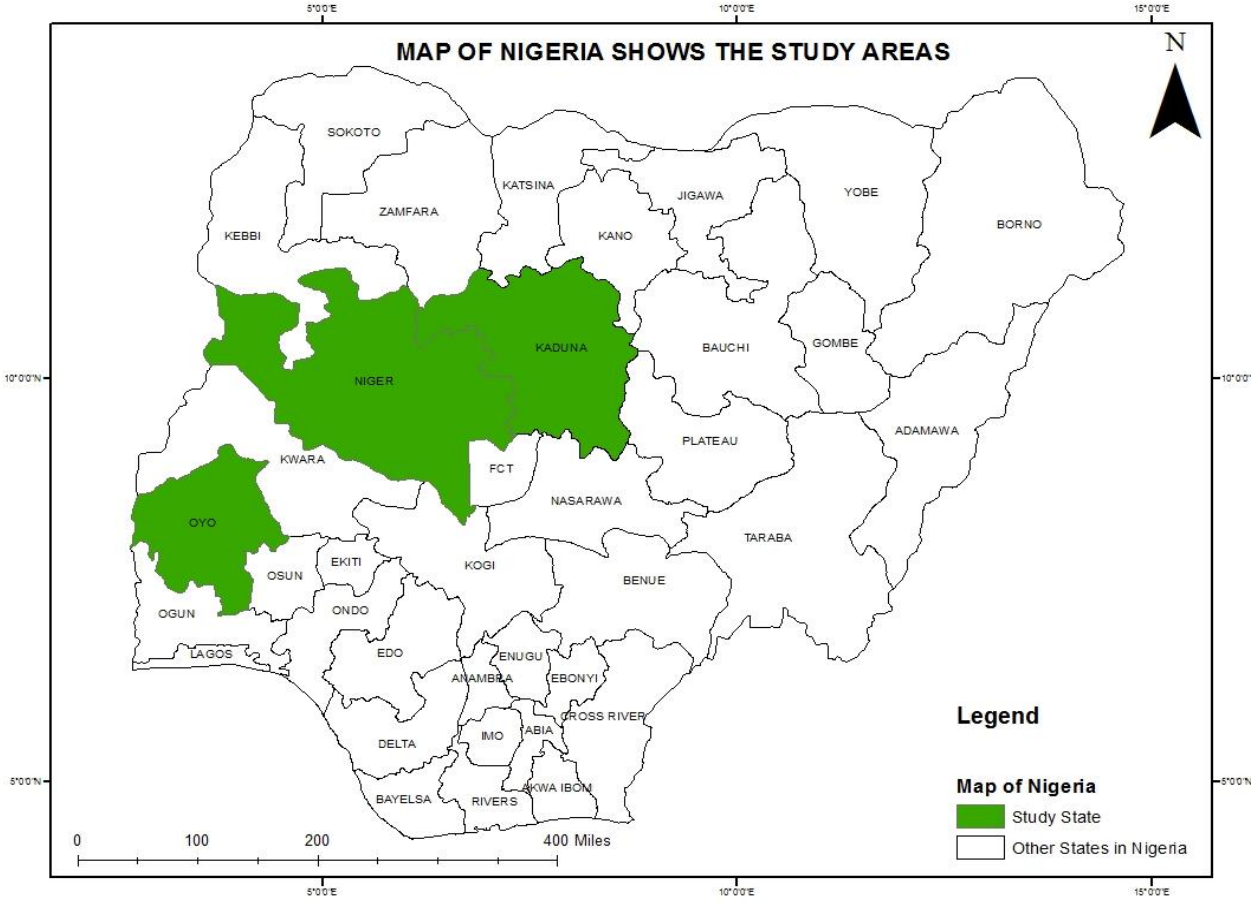

Figure 4: Map of Nigeria showing the study states

The study area for this survey comprised three states from three geo-political zones of Nigeria. These are Kaduna State in North West geo-political zone, Niger State in the North Central geo-political zone and Oyo State in the South West geo-political zone. A preliminary survey across the thirty-six states and the FCT was conducted in conjunction with organizations like Tractor Owners Hiring Facilities Association of Nigeria (TOHFAN) and Tractor Owners and Operators Association of Nigeria (TOOAN) to acquire the lists of private tractor owners, while a department of the Federal Ministry of Agriculture and Rural Development (FMARD) was contacted to provide the lists of Public tractor owners. This data was used to select states for the study. Three states (Kaduna, Niger, and Oyo) were purposively selected, based on tractor density and representation of geo-political zones. Specific lists of private and public tractor owners were subsequently drawn from each state. Private tractor owners in each state were drawn from each senatorial zone and relevant data collected using a questionnaire in the electronic form (Computer-Assisted Personalized Information (CAPI)). Tractor owners were visited to administer the questionnaires. The study also undertook field visits, complemented with intensive use of telephone and desk reviews during for additional information and data.
The survey was conducted during the rainy season. Purposive sampling technique was used to select tractor owners in the study states (see Figure 1). Three hundred (300) tractor owners

were selected in all the states, 100 respondents per state. PID was also conducted to identify the impact of mechanization in communities where tractors were normally used.

Sampling

The proposed methodology was to randomly sample 150 respondents for privately and publicly procured tractors. Selected tractor owner respondents were to have purchased their tractors not earlier than 2014 (i.e., a maximum of five year before the survey). The pre-sampling survey, however, indicated that there were limited numbers of public owned tractors within such sampling frame/ period. Discussions with lead partners allowed for sampling of more respondents from the private sector respondents to make up for the inadequacy in publicly-facilitated acquisition. The snowball technique was also utilized in some states where the listing had inadequate number of tractors.

Data Collection

Copies of the questionnaire were prepared and reviewed by partners from FARA, Germany and African countries participating in the mechanization survey at a joint meeting. Further individual country review was undertaken after pre-testing the instruments in Nigeria. A total of 259 tractor owner respondents were surveyed (45 government-facilitated owners and 214 privately facilitated tractor owners). Data was cleaned and analysed using descriptive statistics.

Results and Discussion

Socioeconomic Characteristics of the Respondents

Educational Level

The result indicates that most of the respondents were educated up to the tertiary level (Figure 4.1). State respondents had the highest level of education; but they were also government-employed. Some private tractor owners had only Arabic rather than modern education.

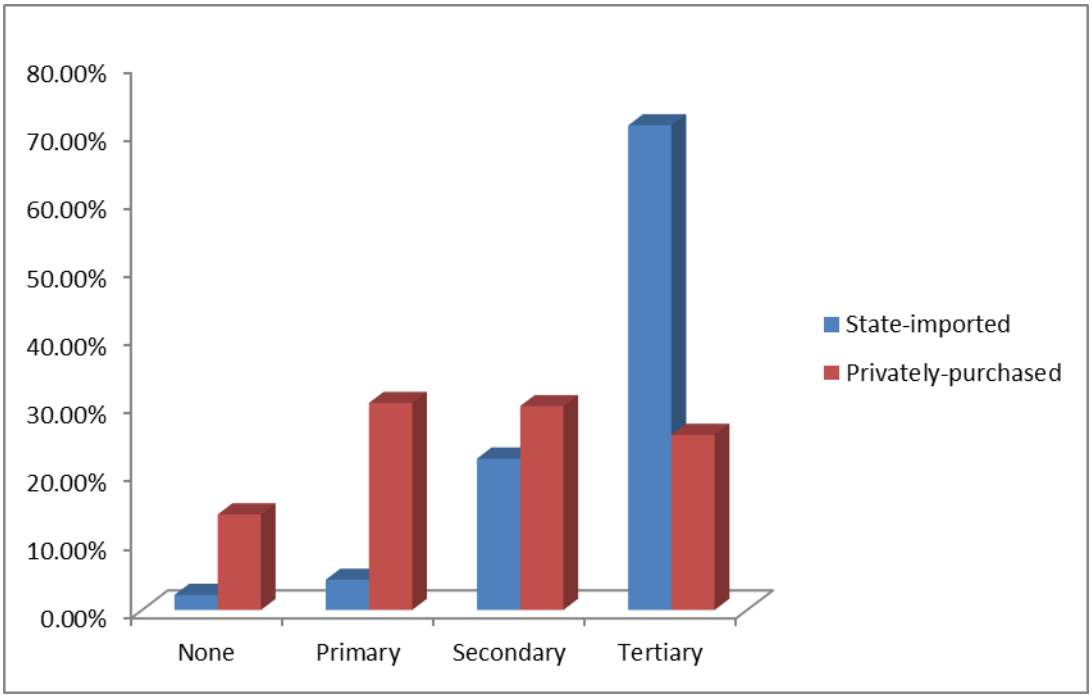

Fig 4.1: Educational level of the respondents

Role of the respondents in the Community

Most of the respondents, especially private tractor owners, did not play any serious role in their communities (Figure 4.2). State-facilitated tractor owners (STOs) were either village head, chairperson, religious leader or chief farmers; a few, however, were health workers. This shows that private tractors owners (PTOs) were more concerned with their tractor businesses than in community service.

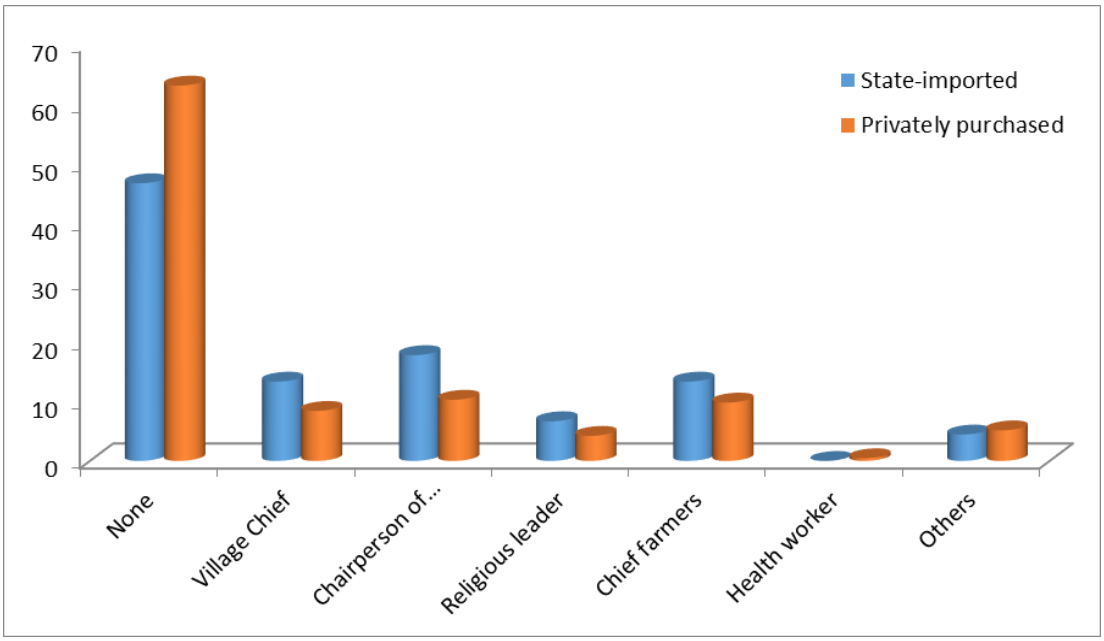

Fig 4.2: Participation in community development of the responded

Group participation

The respondents were involved in different group activities. Most of the STOs participated in faith organizations or block farms, while PTOs were mostly in farm organizations or cooperatives.

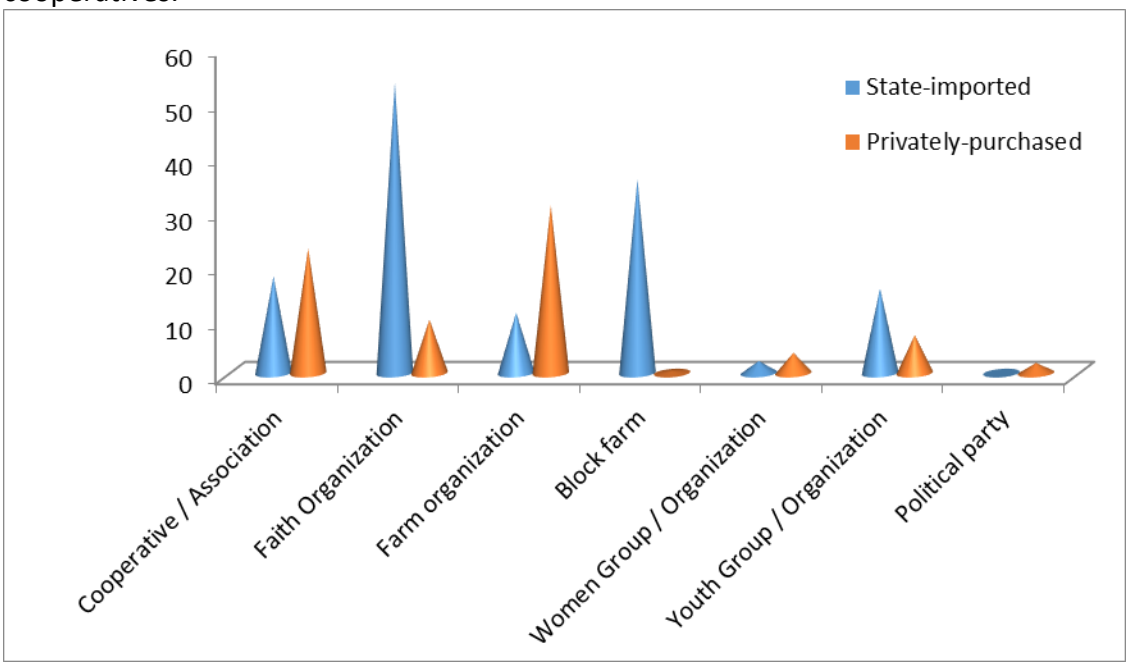

Fig 4.3: Group participation of the respondent

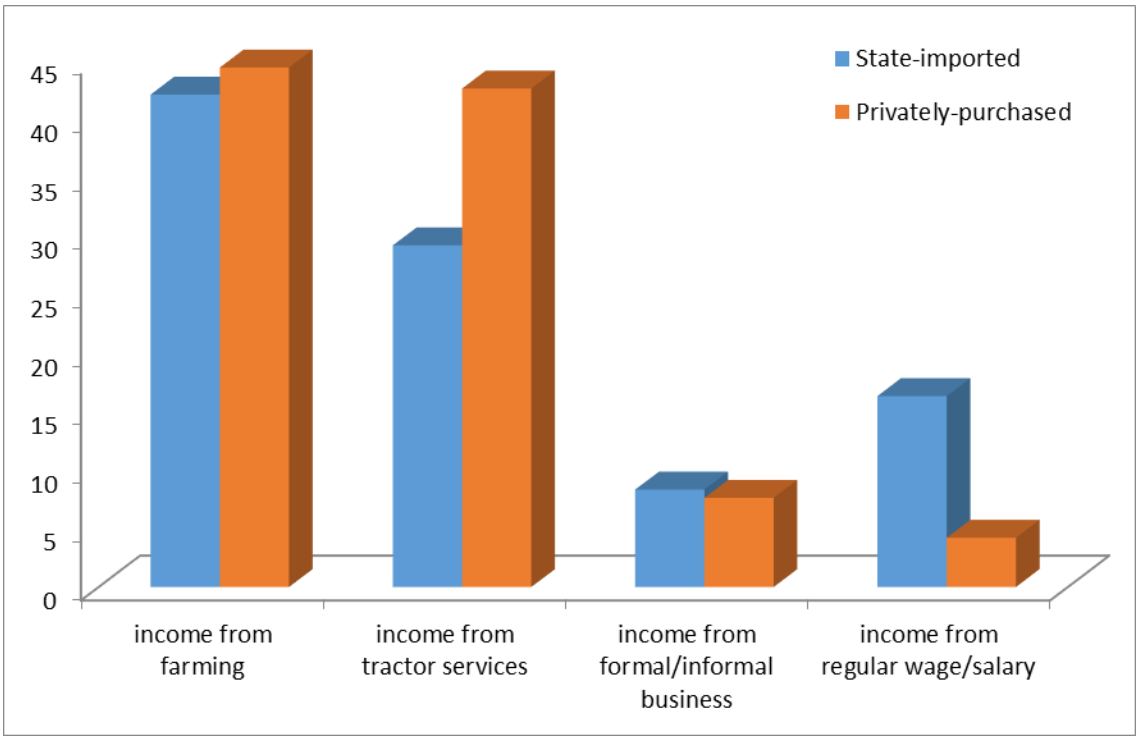

Fig 4.4: Source of income

Source of income

Figure 4.4 contains the information on sources of income of the respondents. Most of incomes of both groups came from either farming or tractor hiring services. Although, some STOs got their income from regular wages and informal businesses, which they carried out after their work hours.

Land Ownership by the Respondents

Both group of tractors owners had large hectares in the last season, and not before the season. However, not all the lands were cultivated; some remained unutilized, perhaps be due to the low mechanization level or lack of motivation in agricultural work.

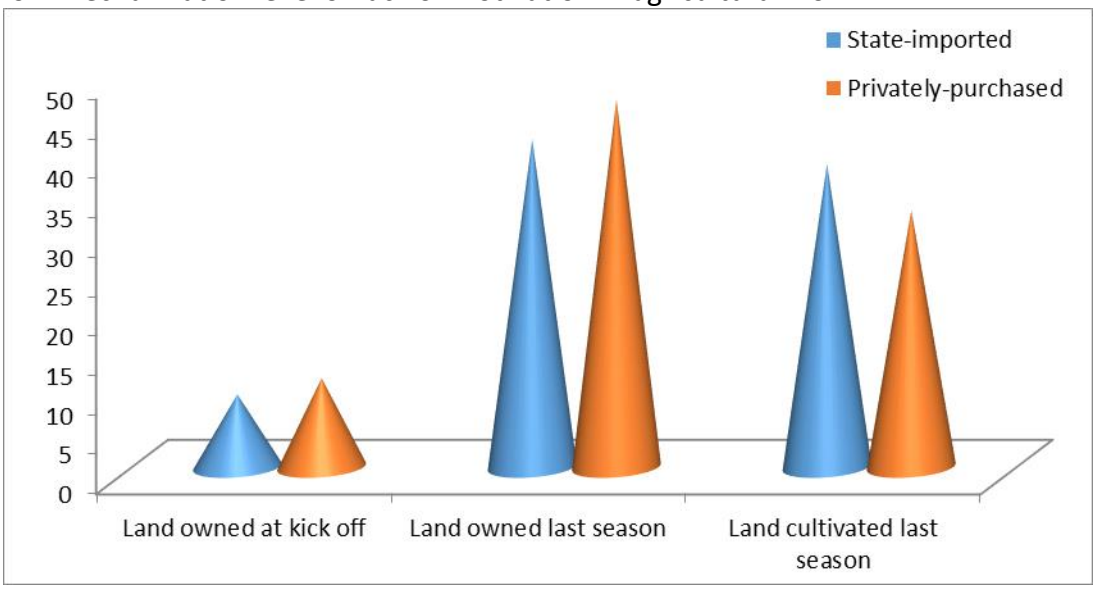

Fig 4.5: Land owned by respondents

Sources of Information and Rationale for selecting Tractor

The main reasons for tractor ownership by both groups were 'to provide tractor hiring service' and to 'upscale production'. Another reason was to provide timely operations in agricultural production. Most of STOs used government as their main source of information in selecting tractors, while PTOs got most of their information from tractor dealers and other farmers (Table 2).

Table 2: Sources of information and Reasons for purchasing the tractor

State-imported				Privately-purchased			
Reasons to buy tractors (%)		Source of choosing tractors (%)		Reasons to buy tractors (%)		Source of choosing tractors (%)	
To Scale up	44.44	Government	68.89	To Scale up	72.22	Government	8.88
Timely farming	31.11	Local Manufacturer	2.22	Timely farming	33.64	Local Manufacturers	1.40
Provide hiring services	82.22	New tractor dealer	2.22	Provide hiring services	89.72	New tractor dealer	9.35
Replace old one	13.33	Used tractor dealer	2.22	Replace old one	5.09	Used tractor dealer	50.47
Other	8.88	Other farmers	20.00	Other	0.93	Other farmers	50.47

Motivation for selecting tractor

Different things motivated the respondents in selecting a particular tractor (Figure 6). STOs chose their machines mostly if they had after-sales service value, high horsepower and quality. PTOs chose their tractors based on strength, brand, quality and price. Massey Ferguson, Mahindra and other brands were the major tractor brands used by all the respondents (Figure 4.6).

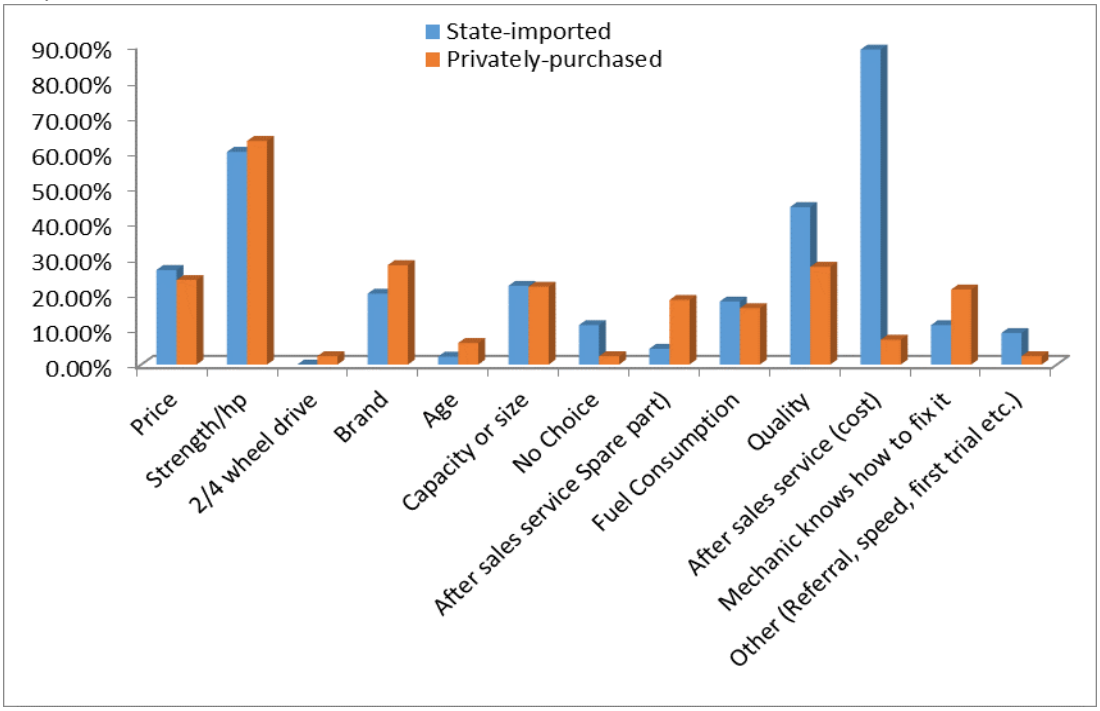

Fig 4.6: Motivation for purchasing a tractor

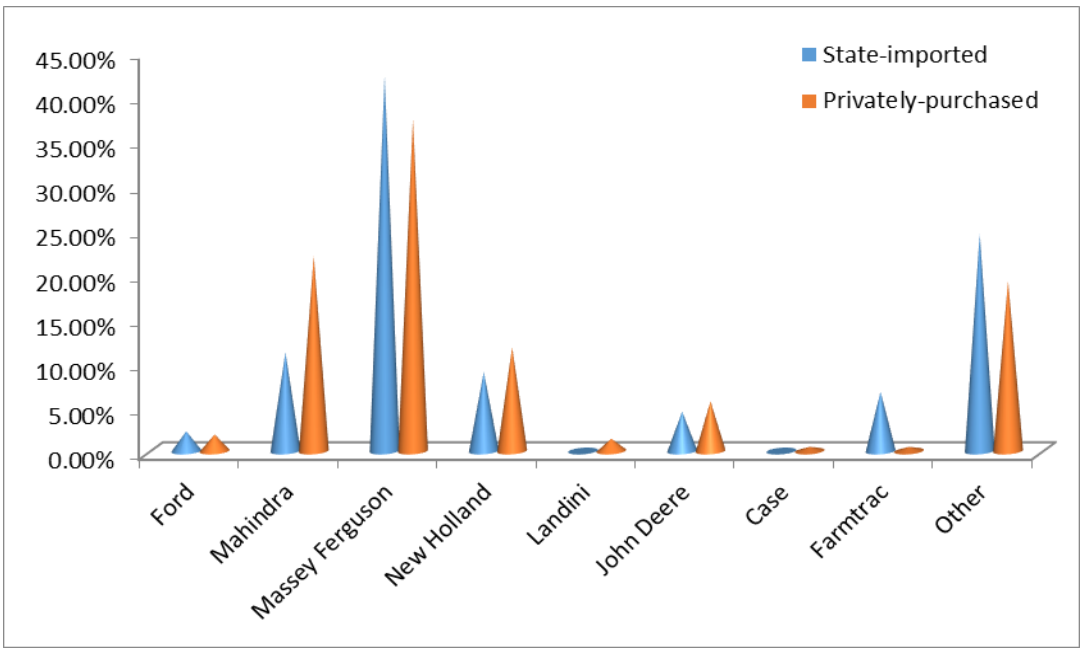

Fig 4.7: Tractor Brand

4.6 Tractor capacity

Most of the respondents had tractors above 70 horsepower (hp). However, some had tractors that were within the range of 60-70hp. The data show that more than 50% of PTOs had tractors with capacity below 40hp.

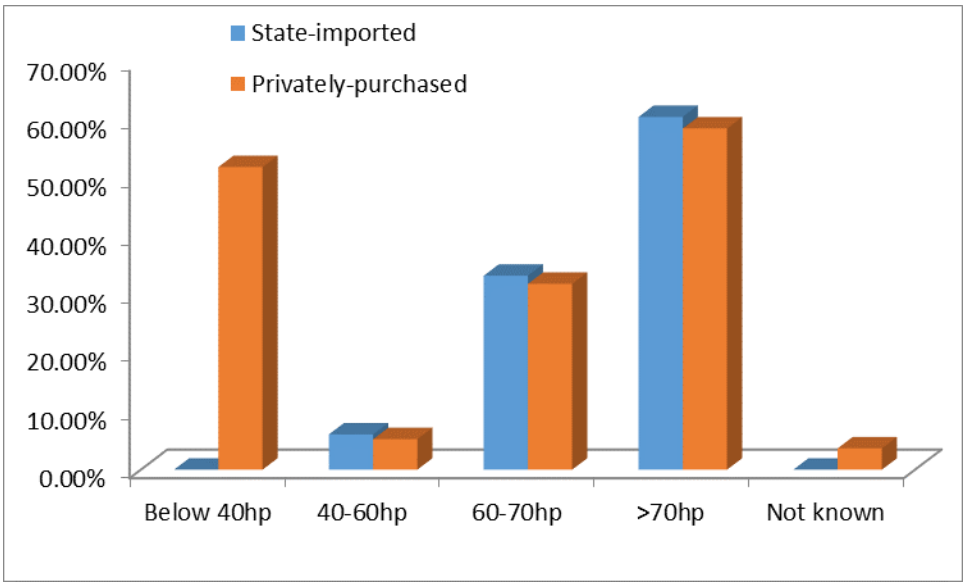

Fig 4.8: Tractor capacity

Major Problem observed during operation

Figure 4.9 indicates the major problems during tillage operation of different tractor systems. Fuel supply, transmission and bearing were the major problems reported by STOs and PTOs.

Hydraulic, tyre and cooling systems also had responses above 20%. STOs had more challenges than PTOs in all the tractor sub-systems, perhaps due to having different tractor brands, service and maintenance schedules.

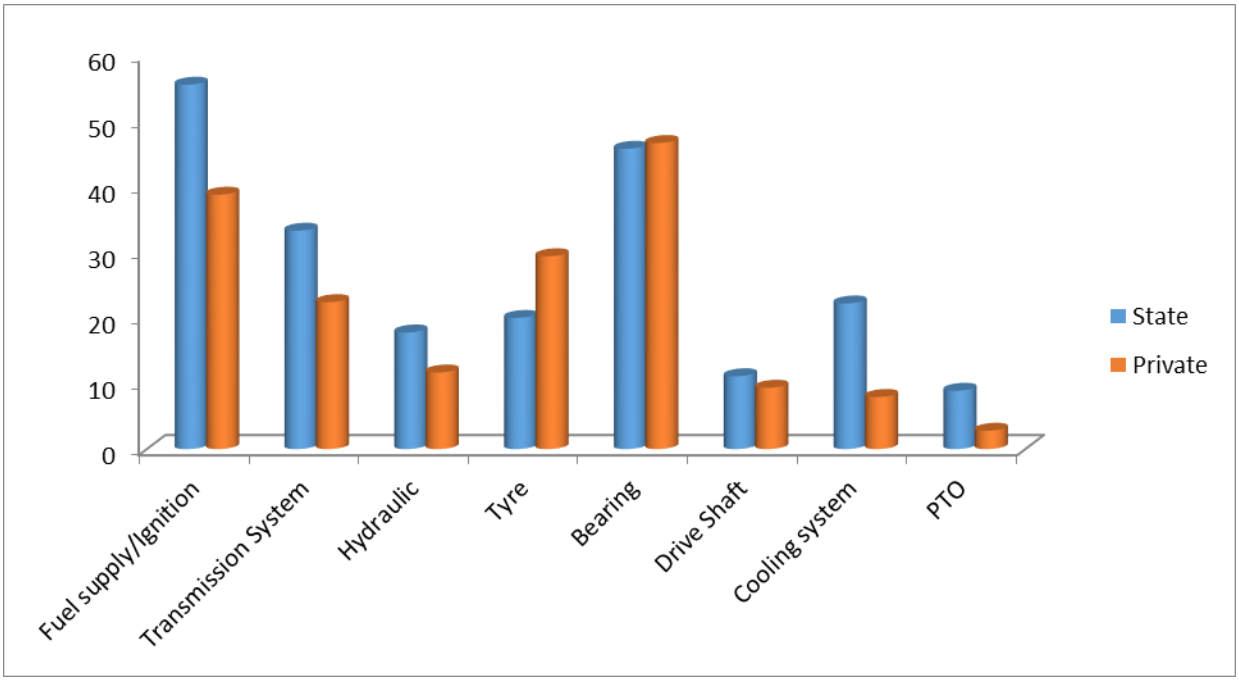

Fig 4.9: Major Problems observed during operation

Major Repairs in Tractors

Tractor repairs information are presented in Table 3. Both groups repaired their tractors in mechanic workshops. The data show that 35.56 and 31.31% STOs and PTOs respectively used mechanic workshops in the repair of tractor engines, while 46.67% and 61.21% respectively did not repair their engines. Some of the respondents reported that they repaired their tractor engines either by themselves or by engaging tractor dealers. The reasons most of them patronized mechanics for engine repair might be the high skills required for engine repairs. Bearing repair was mostly done by mechanics, 20% (STOs) and 23.83% (PTOs). However, some owners repaired their bearing problems themselves or by engaging tractors dealers. Most of the respondents reported no problem with fuel supply/ ignition problems (68.89% and 78.5% for STOs and PTOs respectively). Although 22.22% STOs and 20.60% PTOs addressed their fuel supply/ignition problems at the mechanic workshop, a few used tractor dealers or self-repair. For the repair of the drive shaft, only 8.89 of STOs and 9.35% of PTOs experienced a breakdown; repair was by mechanics. Breakdown of transmission and cooling systems was not common, as over 80% of both respondents had no problem with it. Those that have this problem mostly use mechanics. Hydraulic system and PTO problems were not common, and where they were present, tractor mechanics repaired. Tyre problems were mostly addressed by mechanics, although more than 50% had no tyre problems. The data also showed that most of the mechanics attended to repairs requiring special tools and equipment, especially those not present with tractor owners or operators.

Table 3: Major repairs of tractor

Engine	State (%)	Private (%)	Bearing	State (%)	Private (%)
Owner	13.3	6.07	Owner	4.44	3.27
Dealer	4.4	1.4	Dealer	4.44	0.47
Mechanic	35.56	31.31	Mechanic	20	23.83
None	46.67	61.21	None	71.11	72.43
Fuel supply/Ignition			**Drive Shaft**		
Owner	2.20	0.93	Owner	0	0
Dealer	6.67	0	Dealer	0	0
Mechanic	22.22	20.60	Mechanic	8.89	9.35
None	68.89	78.5	None	91.11	90.65
Transmission System			**Cooling system**		
Owner	0	0.93	Owner	0	0
Dealer	0	0.93	Dealer	6.67	0.93
Mechanic	15.56	9.81	Mechanic	13.30	7.01
None	84.44	88.32	None	80	92.06
Hydraulic			**PTO**		
Owner	0	2.80	Owner	2.22	0
Dealer	0	0.93	Dealer	0	0
Mechanic	17.78	25.70	Mechanic	4.44	2.80
None	82.20	70.56	None	93.33	97.2
Tyre					
Owner	0	1.87			
Dealer	6.67	1.4			
Mechanic	37.78	42.52			
None	55.56	54.21			

Table 4: PTO problems

	State-imported	Privately-purchased	Statistical difference
			X^2_value
Did you PTO (No. yes)	8.89% (n=45)	2.80% (n=214)	0.638
Who did repair Percentage of own, mechanic, dealer…	n=45 Own = 2.22 Dealer = 0 Mechanic=4.44% n/a = 93.33	n=214 Own = 0 Dealer = 0 Mechanic = 2.8% n/a = 97.20	0.97
Satisfaction with maintenance and services Very much Yes Somehow Not really n/a	**n-45** 0 2.22 4.44 0 93.33	**n=214** 0.93% 1.87% 0% 0% 97.20	0.74
			P_value
How often last year	0.3 (0.18)	0.08 (0.05)	0.15
How long broken down last time (days)?	0.2 (0.17)	0.2 (0.18)	0.49
Total cost to repair machine last time?	1822.3 (1670.3)	3995.3 (1987.2)	0.79
How many days does it take to repair?	0.16 (0.10)	0.98 (0.71)	0.32

Legend: (..) = Standard errors *= 10% significant level; ** = 5% significant level; *** = 1% significant level

Most of the respondents surveyed reported less use of PTO (Table 4). The percentage of state-facilitated tractor drivers that used PTO was 8.89 and those of privately purchased tractor owners was 2.8%. Repair of PTO faults was mainly carried out by mechanic for both groups. Among state-facilitated tractor owners, 2.22% fixed their PTO problems themselves; none of the privately purchased tractor owners did this themselves. Conversely, 4.44% of the state-imported machinery operators fixed PTO problems at the mechanics, while 2.8% of the privately purchased owner respondents patronized mechanic workshops. On the degree of satisfaction in fixing PTO faults, 2.2% and 4.4%of state-imported machinery operators were barely satisfied and somehow satisfied respectively. On the other hand, 0.93% and 1.87% of the privately purchased machinery operators were very much satisfied and just satisfied, respectively.

The use of PTO was more effective for the privately purchased machinery operators than state-imported tractor operators. This variation could be due to inadequate knowledge on the significance of PTO, absence of machines that can operate with PTO, fear of PTO splines mismatch between tractors and equipment they operate with among the respondents.

The data on type of machineries preferred by operators are presented in Table 5.

Table 5: Preferences for machinery

Machinery/ Equipment	State imported		Privately purchased		All	
	Number	Percent	Number	Percent	Number	Percent
Tractor	44	29.5	214	37.8	258	36.1
Power tiller/ two wheeled tractor	4	2.7	3	0.5	7	1.0
Generator	0	0.0	1	0.2	1	0.1
Combine-harvester	1	0.7	0	0.0	1	0.1
Sheller (stand-alone)	1	0.7	5	0.9	6	0.8
Thresher (stand-alone)	6	4.0	7	1.2	13	1.8
Water pump	2	1.3	3	0.5	5	0.7
Mill (stand-alone)	0	0.0	1	0.2	1	0.1
Plough	38	25.5	177	31.3	215	30.1
Harrow	28	18.8	93	16.4	121	16.9
Ripper	0	0.0	4	0.7	4	0.6
Boom sprayer	3	2.0	4	0.7	7	1.0
Planter	4	2.7	11	1.9	15	2.1
Fertilizer dispenser	0	0.0	0	0.0	0	0.0
Cart/trailer	10	6.7	27	4.8	37	5.2
Bailer	0	0.0	0	0.0	0	0.0
Mower	0	0.0	0	2.8	0	0.0
Other	8	5.4	16	2.8	24	3.4
Total	**19**	**100.0**	**566**	**100.0**	**715**	**100.0**

The results in Table 5 reveal that preferences were measured for such machines as tractors, power tillers, shellers, threshers, water pumps, ploughs, harrows, boom sprayers, planters and cart/trailers.

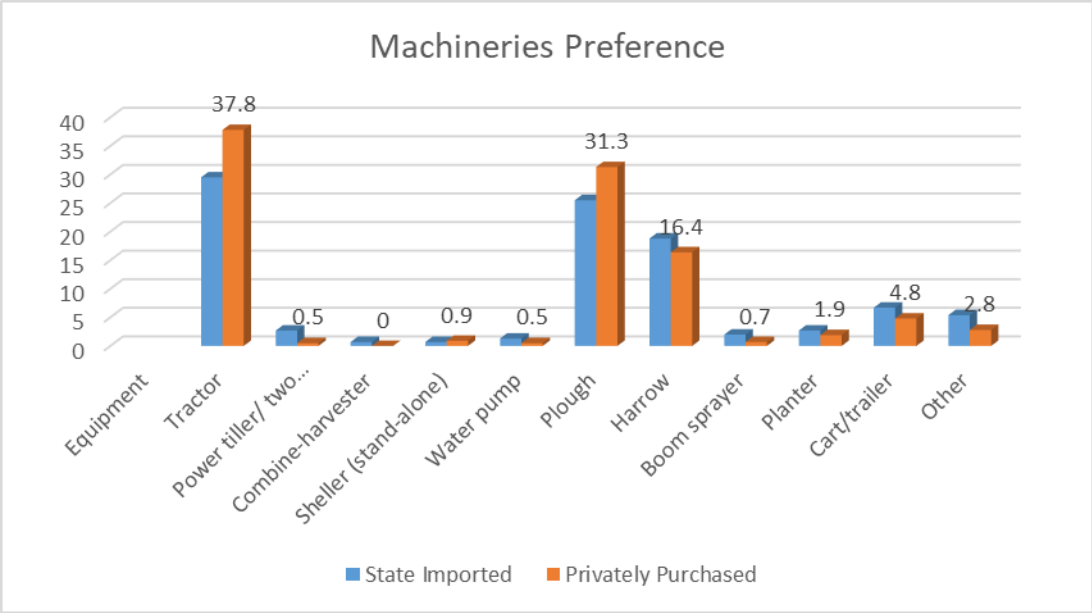

Figure 4.10: Preference for machineries

Figure 4.10 shows that 29.5%, 25.5%, 18.8%, and 6.7% of state-imported machinery operators preferred tractors, ploughs, harrows and cart/trailers, respectively. For the privately purchased machinery operators, 37.8%, 31.3%, 16.4% and 4.8% preferred tractors, plough, harrows and cart/trailer, respectively. As presented in Figure 4.10, combine harvesters, shellers, water pumps and boom sprayers were less preferred by all the respondents.

The percentage of preferences could be due to the types of farm operations carried out by the respondents. The fact that threshing and shelling machines, boom sprayers, and water pumps were less preferred to other machineries could be because the machineries were not commonly used. Also, the high preference for tractors, power tillers, ploughs and harrows implies that tillage and haulage operations were prominent farm operations in the study area.

Machine Utilization and Service Provision

The machines used, the services provided by such machines, and the seasons they are used were also studied. Usually, in Nigeria, these machines are highly utilized during the wet season.

Major season

Major season in Nigeria is the period when rain-fed farming is practised. The season varies from one agro-ecological zone to another. In the north, it is usually between the months of April and August; in the west, it falls between March and September; the east experiences it between March and November. This variation in season greatly influences the type of machineries used and the nature and duration of services provided (Table 6).

Table 6: Machine Utilization during Major Season

	State-imported	Privately-purchased	Statistical difference	
Farming operation mechanized (%)	n=39	n=202	Chi Test χ^2	P Value
i. Land clearing	10.25	5.94		
ii. Ploughing	82.05	88.12		
iii. Ridging	43.59	14.85		
iv. Harrowing	56.41	46.04		
v. Planting	7.69	3.96		
vi. Fertilizing	0.0	1.49		
vii. Weeding	0.0	1.0		
viii. Irrigation	0.0	0.0		
ix. Harvesting	2.56	0.50		
x. Shelling	0.0	1.0		
xi. Spraying	12.82	1.49		
xii. Threshing	2.52	1.0		
xiii. Milling	0.0	0.50		
xiv. Transport	15.38	8.42		
xv. Bailing	0.0	0.0		
xvi. Other	0.0	0.0		
	n=28	n=181	Chi Test χ^2	P Value
% who provided services last main season	71.80	67.96	20.074	<0.001***
			T-test	P-Value
For how many days did you use your machine last main season?	15.68 (2.19)	12.23 (1.79)	0.638	0.524
What is the area (acre) that you needed for own operations on your own farm last main season?	343.5 (149.4)	57.0 (8.7)	1.914	0.080*
What is the total area (acre) that you serviced for other farmers for this operation last main season?	611.6 (264.5)	187.7 (32.9)	1.59	0.162
	n=14	n=244	Chi Test χ^2	P Value
Did you meet all your customer requests last season?	42.857	76.639	8.02	.005**
Did you provide more services last compared to previous season?	42.86	51.03	7.05	0.029**.
How many customers did you provide services to the last main season?	308 (209)	58.98 (13.73)	1.18	0.257
How many customers did you provide services to last main season? (below 2ha)	139.64 (74.46)	54.5 (24.01)	1.05	0.311

	State-imported	Privately-purchased	Statistical difference	
What is the average distance (km) of the customers	168.36 (141.03)	19.68 (3.37)	-0.048	0.96
How many of the customers were female?	55.57 (36.04)	25.82 (9.07)	0.767	0.44
What was the service charge/fee per acre?	2966.9 (382.4)	3671.3 (387.2)	-0.422	0.674
How long (minutes) do you need per acre?	76.3 (15.1)	82.5 (5.1)	-0.279	0.78
How many litres of fuel do you need per acre?	18.0 (4.3)	10.4 (1.2)	-0.424	0.673

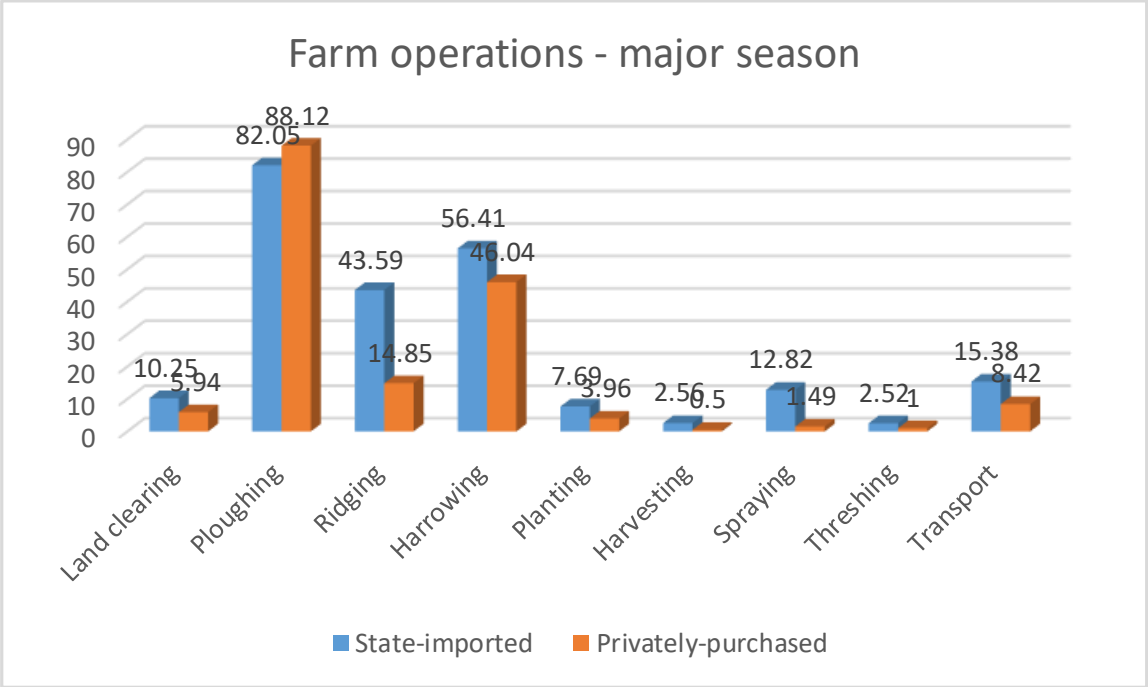

Figure 4.11: Major season's farm operations

Data on the major farm operations during the major farming season are presented in Figure 4.11. The data show that 88.12% of ploughing operation was done by the privately purchased tractors, compared to 82.1% of state-purchased tractors. More so, harrowing and ridging for state-imported tractors had 56.4% and 14.9% respectively, as against 46% and 43.6% for the privately purchased tractors.

Furthermore, state-imported machinery operators carried out more farm operations than the privately purchased operators, with regard to number of days machines were operated, total area serviced, number of customers serviced, and number of customers' requests met. For the privately purchased machinery operators, there was low patronage (Table 8). The litres of fuel used and amount of land serviced by customers were more for state-facilitated operators. The

variation in the patronage received by state-imported machinery operators over privately purchased machinery operators could be associated with the low service charges, extended service hours, the fewness of hours spent on farm operations, servicing of customers with fragmented lands and those distanced away.

Additional service provision

Table 7: Additional service provision

Services provided	State-imported	Privately-purchased	Statistical difference	
Why do you provide hiring services to others? (%) (Repeat for all reasons)	n=28	n=166	Chi Test	P-Value
i. To source operating capital for own farm	25.00	37.95	5.2524	0.262
ii. Business	89.29	95.78		
iii. Help neighbours	17.86	8.43		
iv. Others (Fund education etc.)	3.57	0.00		
How do you plan in which order customers are served? (Repeat for all options)	n=28	n=166	Chi Test (10.94)	P Value (0.534)
First come first served	96.43	89.76		
According to locations	17.86	27.11		
Family/friends first	7.14	9.04		
Priority to regular clients	21.43	15.66		
High demand in the area	10.71	13.25		
Largest farmers first	0.00	16.27		
Other	0.00	0.00		
Have you refused farmers asking for your service last season?	n=28	n=166		
Yes	7.23	40.96		
What kind of credit scheme do you mostly provide to customers? (Repeat for all option)	(n=28)	n=166	Chi Test (0.30)	P-Value (0.90)
i. Does not provide credit (full payment upfront)	60.71	49.40		
ii. Full credit (full payment after harvest)	0.00	5.42		
iii. Partial credit (partial payment upfront)	35.71	42.17		
iv. Others	3.57	3.01		
Do you have other competing mechanization service providers in your service area?	82.14	82.53		
If yes, How many of your competitors are based on your service area?	17.27(206.75)	23.01 (121.34)		
If yes, How many of your competitors are coming from other areas outside your service area?	16.55(206.53)	26.38 (85432.29)		
	n=29	n=50	Chi Test χ^2	P Value
Are there government-led/supported mechanization service providers in your service area?	55.17	100	2.2406	0.326
	n=16	n=50	Chi Test χ^2	P Value

Are they competition for you?	62.5	90.00	0.09	0.95
Did you migrate to provide services in other rainfall zones/countries/ other areas last season?	62.07	47.31		
If yes, for how many days did you migrate?	28(19.15)	37.06 (262.52)		
If yes, what are the average daily extra costs by staying in other rainfall zones/countries/ other areas? (e.g. for hotels)	6623.47(10700.36)	16924.08(38423.81)		

The results on reasons for providing tractor hiring services revealed that 38% and 96% of private tractor owners (PTOs), and 25% and 89% of state-imported tractor owners (STOs), respectively, operated machineries to source capital and business. Also, the services provided were planned based on first come first served, customer location, family and friends, and regular clients. PTOs gave priorities to customers based on location, high demand area and farm sizes (27.1%, 13.25% and 16.3% respectively). STOs planned their operations based on first come first served (96%), and regular clients (21.4%).

PTOs mostly declined customers' requests, probably due to debt on previous services. The credit facilities were more given to customers among PTOs (42.2%) than STOs (35.7%) and there was more demand on full payment before operation among STOs (60.7%) than PTOs (49.4%). Also, STOs thrived well with full payment than PTOs, who accepted credit facilities. Moreover, 82% competitors were reported to be available for both groups of operators. However, these competitors posed more threat to PTOs than STOs. The results further revealed that 23% of the 82% competitors of PTOs were within the same location of operation, while 26% operated outside their service area.

Both groups of respondents migrated from their zones to provide services in neighbouring towns; 62.1% of STOs and 47.1% of PTOs migrated to other zones. However, PTOs stayed longer in a zone they migrate to than STOs.

	State-imported (n=43)	**Privately-purchased (n=211)**	**Statistical difference**	
Relationship with owner (Repeat for all options) (%)			Chi Test χ^2	P Value
i.Hired labour	79.07	67.30	33.8208	0.027
ii.Owner	2.33	10.43		
iii.Owner's son/daughter	4.65	8.53		
iv.Relatives	2.33	12.32		
v.Others	11.63	1.42		
What kind of prior driving experience/certificate does he/she have? (Repeat for all options)	n=42	n=189		
i. Tractor driving experience/certificate	64.27	62.96		
ii. Car driving experience/certificate	16.67	5.82		

iii. None	16.67	31.22		
iv. Others	2.38	0.00		
Has he/she received training on machine use/ maintenance? (Repeat for all options)	n=42	n=189		
i. Formal	33.33	7.94		
ii. Informal	30.95	52.38		
iii. Trained by owners/existing operators	33.33	29.63		
iv. None	2.38	10.05		
			T-test	p-value
How many days?	95.14 (173.17)	160.67(234.20)	6.2981	0.0000
How long did you need to find a suitable operator?	25.71 (83.67)	16.61 (35.91)		
How satisfied are you with the knowledge and skills?	n=42	n=189	Chi Test χ^2	P-Value
i. Not really	0.00	0.53	20.0000	0.220
ii. Somehow	7.14	6.35		
iii. Very much	45.24	44.44		
iv. Yes	47.62	48.68		
			T-test	p-value
Is this person paid a wage (cash/kind)? If yes, how much on average per month?	14148.49 (13163.74)	5713.49 (6693.14)	-6.0374	0.0000
Were there any other payments last season (daily expenses, bonus or incentive)? If yes, how much?	5925.00 (7499.44)	4363.64 (6986.08)		
How do you control the operator? (Repeat for all options)	n=42	n=187		
i.Call customers	7.14	9.09		
ii.Control by assistant operator/ aid	19.05	4.81		
iii. Engine hours	1.6 (3.88)	1.1 (2.89)		
iv.Field checks	33.33	30.48		
v.GPS tracking	21.43	16.58		
vi.Mileage recording	21.43	16.58		
vii.Monitor fuel level	0.00	3.74		
viii.No control	0.00	11.23		
ix.Other / manager	23.81	23.53		
x.Owner/relative follows tractors	2.38	3.74		
xi.Timed fieldwork	11.91	23.00		

Results on the relationship between machine operators and owners revealed that both STOs and PTOs used hired labour, with 79.1% and 67.3% respectively. It was also revealed that PTOs used more family relations (12.3%) to operate their machines than STOs. Moreover, most of the respondents had driving experience in relation to tractor or car. STOs had 64.3% experience and certificate, compared to 63.0% for PTOs. Trainings were also received by these operators.

Most of the trainings received were formal, with STOs receiving 33.3% formal training and PTOs receiving 52.4% informal trainings. About 44% to 48% of both groups were satisfied with the trainings acquired. The effective tools for monitoring machine operators were field checks, GPS tracking devices, mileage recording and timed field work. STOs were more efficient in monitoring than PTOs.

The data also show that STOs engaged hired labours, trained operators formally, and ensured they had certificates. This finding implies a significant difference in the wages paid to operators in cash and kind, and the fact that machine operators were hired within short notices.

Tractor Owners

a) Training on Mechanization and operation of state-imported and privately-purchased machinery

	State-imported	**Privately-purchased**	**Statistical difference**
Have you or any household member (machine operators for state-owned) received any training on mechanization?			
	n=19	**n=41**	
	Proportion (%) of respondents		**Chi square= 4.0667 p=0.044**
No	57.78	80.84	
Yes	42.22	19.16	
How many days did you take for training?	125.63 (265.27), n=19	105.15 (232.00), n=41	p=0.0082
What training have you received on mechanization?			
	n=19	n=41	
	Proportion (%) of respondents		**Chi square= 27.0777 p=0.352**
Machinery driving	52.63	75.61	
Machinery maintenance	68.42	80.49	
Machinery repairs	57.89	24.39	
Machinery economics	15.79	12.20	
Machinery safety	47.37	24.39	
What is the main machine operator/assistant works with?			
	n=77	**n=309**	**Chi square= 19.4131 p=0.559**
	Proportion (%) of respondents		
Combine-harvester	1.30	0.65	
Power tiller	1.30	0.32	
Sheller (stand-alone)	0.00	0.00	
Thresher (stand-alone)	0.00	0.32	
Tractor	94.81	98.38	

Water pump	2.60	0.32	
What is the relationship of the operator with owner?			
	n=66	**n=305**	**Chi square= 60.6522 p=0.000**
	Proportion (%) of respondents		
Hired labour	77.27	67.21	
Owner	1.52	7.21	
Owner's son/daughter	16.67	7.87	
Relatives	4.55	17.70	
What kind of prior driving experience/certificate does he/she have?			
	n=76	**n=290**	**Chi square= 4.2771 p= 0.233**
	Proportion (%) of respondents		
Car driving experience/certificate	10.53	4.83	
None	21.05	37.24	
Other (Trade Test Certificate)	1.32	0.34	
Tractor driving experience/certificate	67.11	57.59	

Both the state-imported machine operators (SMOs) and private machinery operators (PMOs) received some levels of trainings for different durations; while 80.9% of the private operators received trainings, 57.8% state-imported machine operators received training. The duration of the training was longer for SMOs than for PMOs. The training durations were found to be significant at 5%, indicating that the numbers of days used for training were adequate for treating the training contents.

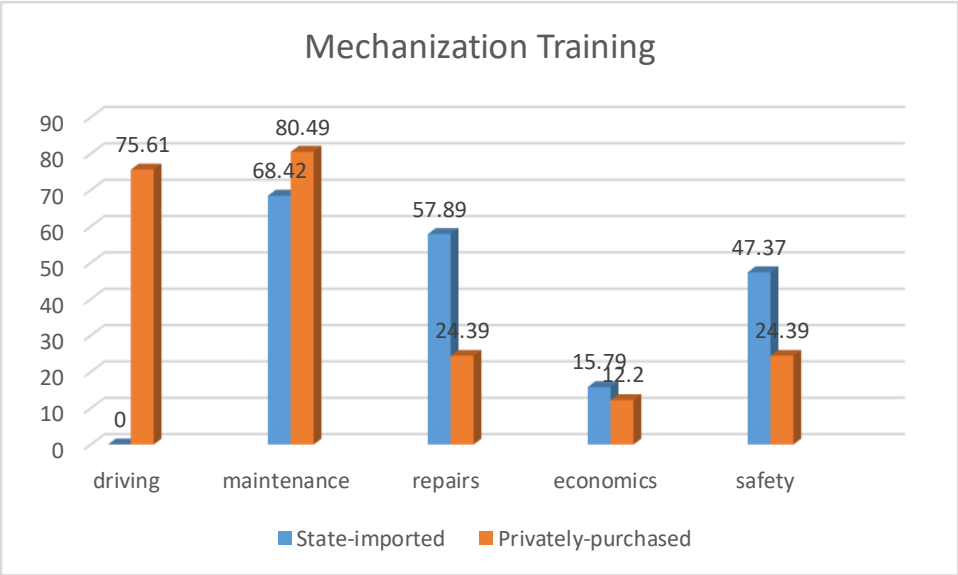

Figure 4.12: Training on Mechanization

The categories of training received by the respondents are presented in Figure 4.12. The data show that PMOs received 57.9%, 15.8% and 47.4% of training in machinery repairs, machinery economics and machinery safety, respectively. The major areas of training received by PMOs were machinery driving and maintenance.

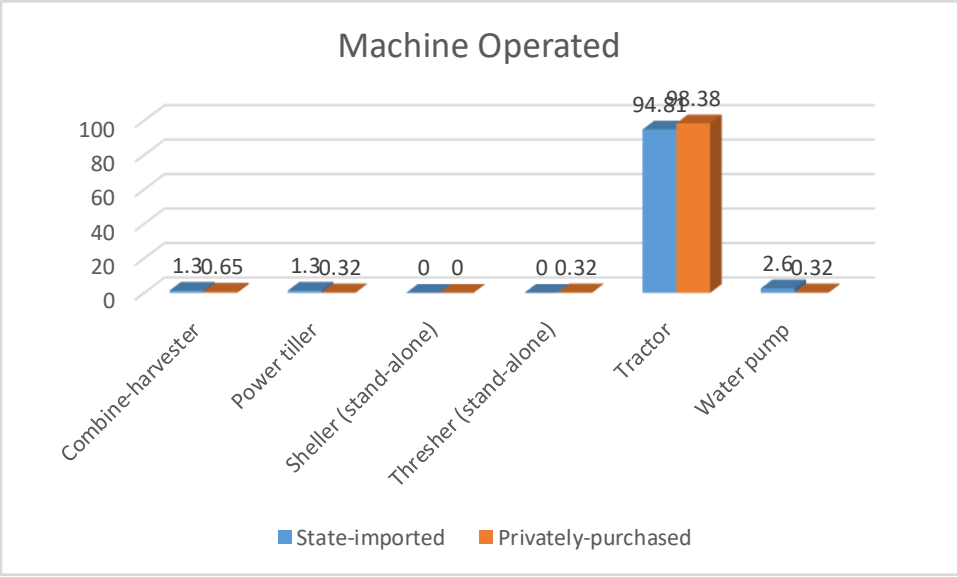

Figure 4.13: Operating Machine

Most of the machines operated were combine harvesters, power tillers, stand-alone shellers and threshers, water pumps and tractors. Tractor was the most prominent of these (Figure 4.13), which was 98.3% for PMOs and 94.8% for SMOs.
Data on the relationship between machinery owners and operators are presented in Figure 4.15.

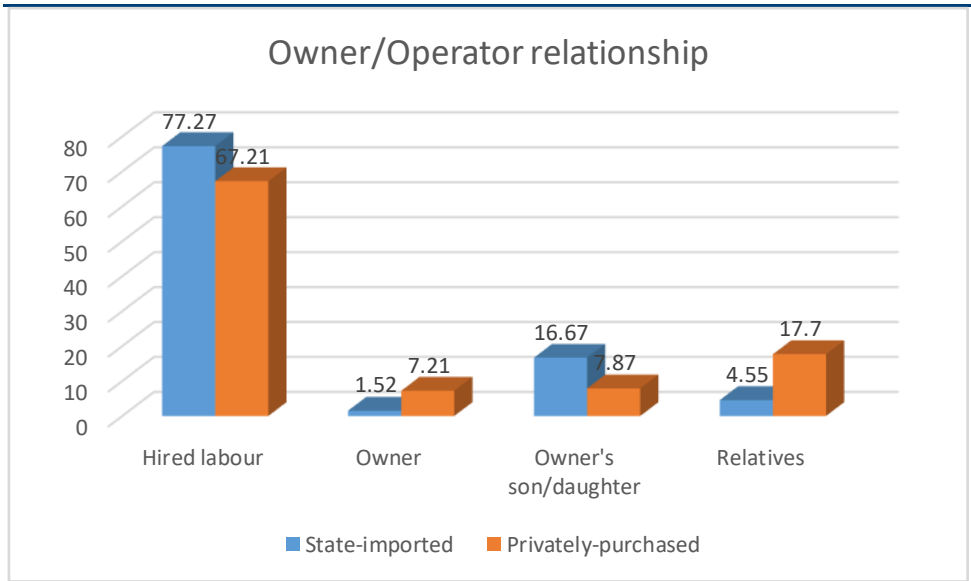

Figure 4.15: Relationship between Operator and Owner

Figure 4.15 shows that both SMOs and PMOs engaged hired labour, relatives and owner's children in their operations. The two groups involved 77.3% and 67.2% hired labour, respectively. PMOs engaged more relatives, and children of machine owners than SMOs. The low involvements of relatives by SMOs could be attributed to the stringent rules binding civil servants, while the profit-oriented nature of operations of PMOs encouraged them to involve relatives as cost-saving measures.

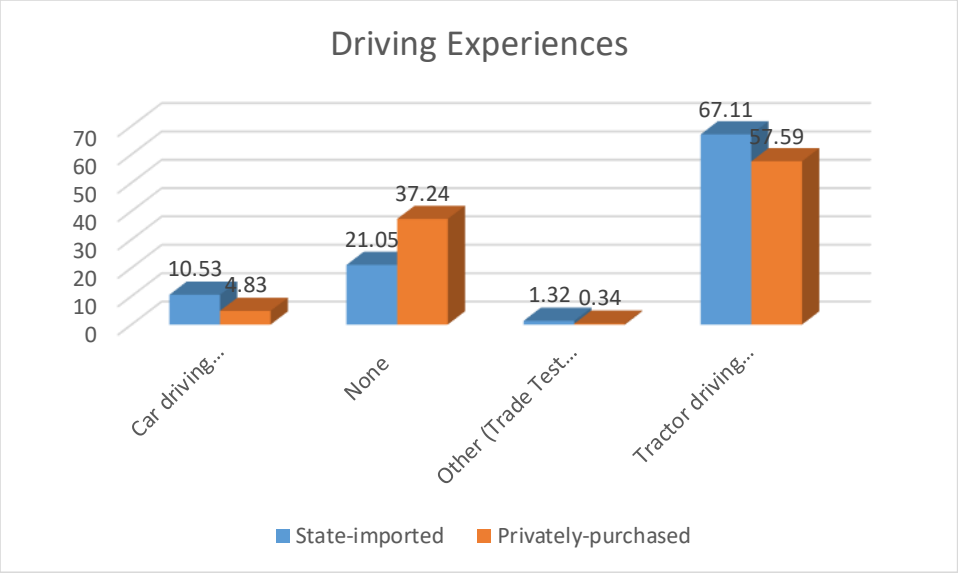

Figure 4.16: Driving Experiences

The results on machinery driving experience are presented in Figure 4.16. The results revealed that 67.1% and 57.6% of SMOs and PMOs respectively had tractor driving experience and certificates. Several PMOs had no driving experience. It can be deduced from this results that SMOs placed more emphasis on safety of their operators than PMOs.
The degree of maintenance carried out on the machineries of both the state-imported and privately purchased machineries were studied.

b) Maintenance of state-imported and privately purchased machinery

	State-imported	**Privately purchased**	**Statistical difference**
What kind of training has he/she received training on machine use/maintenance?			
	n=45	n=214	**Chi square=**
	Proportion (%) of respondents		
Formal	27.63	19	
Informal	32.89	135	
No training	7.89	33	
Trained by owners/ existing operators	31.58	103	
	State-imported	**Privately purchased**	**Statistical difference**
How many days was the training for machine use/maintenance?	95.14 (173.17) SE=26.72 n=42	160.67 (234.20) SE=17.03 n=189	p=
How long did you need to find a	25.31	16.24	p=

suitable operator (days)?	(84.70) SE=13.23 n=41	(35.24) SE=5.44 n=42	
How much is the operator paid (KES) on average per month?	54263.16 (44052) SE=10103.67 n=19	46333.75 (55880.63) SE=6250.63 n=80	p=
If an operator is paid per acre, how much (KES) was the payment?	51250 (50071.44) SE=17693.09 n=8	36758.63 (63565.9) SE=6171.45 n=106	p=
How satisfied are you with the knowledge and skills?			
	Proportion(%) of respondents		**Chi square=**
	n=45	**n=214**	**p=**
Not really	3.95	1.03	
Somehow	7.89	7.93	
Very much	40.79	44.14	
Yes	47.37	46.90	

*Significant at 10%; **Significant at 5%; ***Significant at 1%;

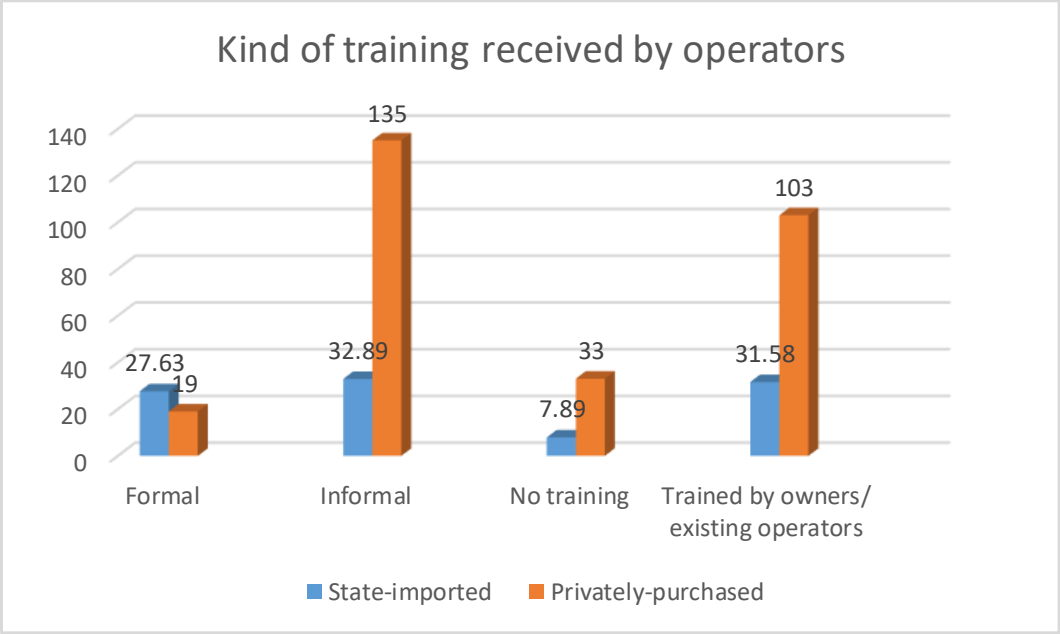

Figure 4.17: Training of machineries maintenance received by operators

The data on machineries maintenance (Figure 4.17) reveal that the respondents received mainly informal training, given by owners or other operators. PMOs had the greater number of informal trainings, while SMOs engaged more other operators to train them. The low number

of trainings generally, especially among SMOs, is an indication that little significance is given on machinery maintenance.

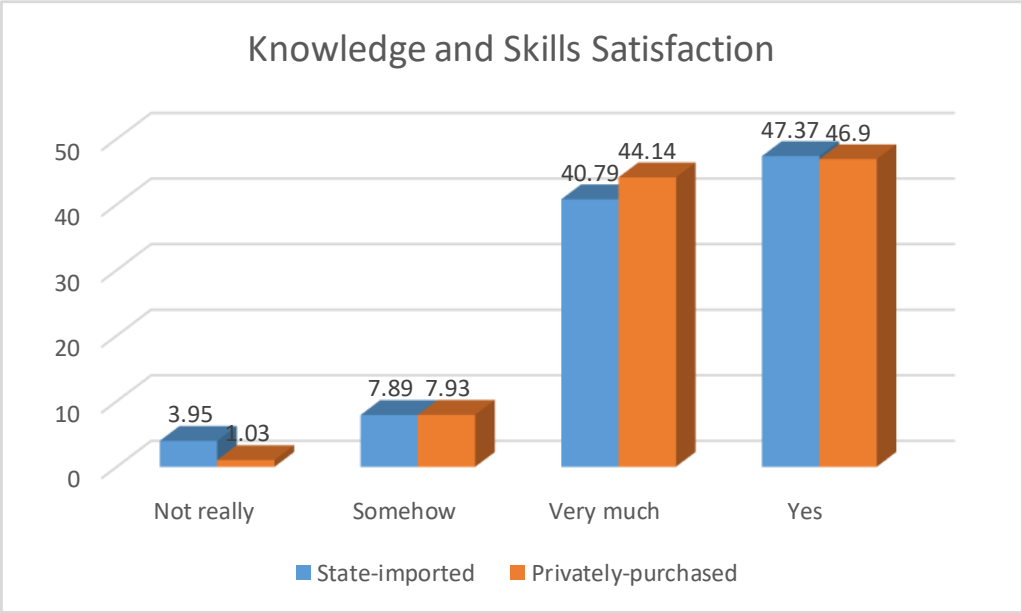

Figure 4.18: Knowledge and Skills Satisfaction

The data on knowledge of skills satisfaction (Figure 4.18) show that both groups of operators were satisfied with the level of knowledge and skills they acquired through training, with SMOs and PMOs having 40.8% and 47.7% respectively.

Training on maintenance was mainly formal in both categories of machinery ownership. The wage paid per month for hired machinery operators was much higher for state-imported machinery than for those operating the privately purchased ones. A possible explanation for state-owned operators was that they were government employees on a regular salary. In most cases, the operators of privately owned tractors were employed on a part-time basis. On the other hand, the monthly wage was higher for privately purchased than for state-imported machinery operator, although this was not significant. The level of satisfaction with the knowledge and skills received was high among over 90% of the respondents in both categories of machinery ownership.
The owners of privately purchased machinery used various methods for monitoring their operators, but owners of state-imported machinery used mileage recording, fuel level and field checks for monitoring.

4.5 Machinery Knowledge

The variables for knowledge of machineries were knowledge of hydraulic system, fuel system, cooling system, steering, lubrication, electrical, engine, PTO and general machine maintenance. The data on these are presented in Table 10.

Table 10: Knowledge of Machinery

How would you assess your knowledge on:			
	State-imported	**Privately purchased**	**Statistical difference**
	Proportion (%) of respondents		**Chi Square= p=**
Hydraulic system?	**n=45**	**n=214**	
Average	24.44	32.71	
Good	33.33	25.70	
Limited	20.00	21.03	
very good	11.11	6.08	
Very limited	11.11	7.48	
Cooling system?	**n=45**	**n=214**	**Chi Square= p=**
Average	17.78	35.05	
Good	40.00	35.98	
Limited	20.00	14.02	
very good	11.11	6.54	
Very limited	11.11	8.41	
Lubrication system?	**n=45**	**n=214**	**Chi Square= p=**
Average	24.44	29.91	
Good	40.00	35.05	
Limited	11.11	15.42	
very good	15.56	7.48	
Very limited	8.89	12.15	
Fuel system?	**n=45**	**n=214**	**Chi Square= p=**
Average	28.89	29.91	
Good	40.00	35.05	
Limited	11.11	15.42	
very good	15.56	7.48	
Very limited	4.44	12.15	
Electricity system?	**n=45**	**n=214**	**Chi Square= p=**
Average	26.67	29.44	
Good	20.00	24.30	
Limited	28.89	25.23	
very good	13.33	3.74	
Very limited	11.11	17.30	
PTO?	**n=45**	**n=214**	**Chi Square=**

Average	20.00	32.71	**p=**
Good	22.22	25.23	
Limited	33.33	24.77	
very good	15.56	5.14	
Very limited	8.89	12.15	
Engine?	**n=45**	**n=214**	**Chi Square=**
Average	24.44	30.84	**p=**
Good	35.56	24.30	
Limited	17.78	24.77	
very good	15.56	11.22	
Very limited	6.67	8.88	
Steering mechanism and tires?	**n=45**	**n=214**	**Chi Square=** **p=**
Average	31.11	35.51	
Good	22.22	31.78	
Limited	13.33	17.29	
very good	26.67	7.01	
Very limited	6.67	8.41	
Maintenance?	**n=45**	**n=214**	**Chi Square=**
Average	28.89	31.78	**p=**
Good	26.67	38.32	
Limited	6.67	12.15	
very good	31.11	13.55	
Very limited	6.67	4.21	
Driving?	**n=45**	**n=214**	**Chi Square=**
Average	24.44	25.23	**p=**
Good	24.44	28.04	
Limited	8.89	5.14	
very good	33.33	33.18	
Very limited	8.89	8.41	
Machinery economics?	**n=45**	**n=214**	**Chi Square=**
Average	46.67	41.12	**p=**
Good	28.89	28.97	
Limited	8.89	14.49	
very good	11.11	9.35	
Very limited	4.44	6.07	

The results in Table 10 reveal that both SMOs and PMOs were proficient in knowledge of hydraulics, cooling system, lubrication, fuel system, engine, maintenance, driving and machinery economics. The proficiency levels of both groups were between good and average, ranging from 30.3% to 40.0%. It was also observed that both groups had little knowledge of machine electrical systems and PTO, which could be attributed to the fact that the machines seldom had faults with electrical systems and PTO.

Generally, however, SMOs had more knowledge of machineries than their private counterparts.

Table 11: Constraints mentioned by state-imported and privately purchased machinery owners

Constraint	Level of the problem	State-imported	Privately purchased	Statistical difference
High prices/unavailability of operators		**n=45**	**n=214**	**p=**
	Big Problem	0.47	6.54	
	Medium Problem	7.48	29.91	
	No Problem	8.41	39.72	
	Small problem	4.21	22.90	
	Very big problem	0.47	0.94	
High prices/unavailability of technicians		**n=45**	**n=214**	**p=**
	Big Problem	20.00	14.49	
	Medium Problem	28.89	30.37	
	No Problem	26.67	24.30	
	Small problem	20.00	27.10	
	Very big problem	4.44	3.74	
Lack of genuine spare parts		**n=45**	**n=214**	**p=**
	Big Problem	20.00	31.31	
	Medium Problem	24.44	27.10	
	No Problem	11.11	14.49	
	Small problem	15.55	15.42	
	Very big problem	28.89	11.68	
Low demand		**n=45**	**n=214**	**p=**
	Big Problem	2.22	10.28	
	Medium Problem	31.11	35.98	
	No Problem	48.89	34.58	
	Small problem	13.33	18.69	
	Very big problem	4.44	0.47	
Lack of access to fuel		**n=45**	**n=214**	**p=**
	Big Problem	8.89	4.21	
	Medium Problem	26.67	28.97	
	No Problem	44.44	43.93	
	Small problem	20.00	21.03	
	Very big problem	0.00	1.89	
Low quality of operators		**n=45**	**n=214**	**p=**
	Big Problem	17.78	7.01	
	Medium Problem	24.44	29.91	
	No Problem	33.33	39.25	
	Small problem	24.44	23.36	
	Very big problem	0.00	0.47	

Low quality of technicians		**n=45**	**n=214**	**p=**
	Big Problem	11.11	14.95	
	Medium Problem	40.00	25.70	
	No Problem	28.89	28.51	
	Small problem	15.56	28.97	
	Very big problem	4.44	1.87	
High prices/unavailability of spare parts		**n=45**	**n=214**	**p=**
	Big Problem	31.11	21.03	
	Medium Problem	26.67	29.44	
	No Problem	15.56	16.36	
	Small problem	6.67	17.29	
	Very big problem	20.00	15.89	
Machine/attachment too expensive		**n=45**	**n=214**	**P=**
	Big Problem	31.11	25.70	
	Medium Problem	26.67	33.65	
	No Problem	17.78	11.21	
	Small problem	15.56	10.75	
	Very big problem	8.89	18.69	
Lack of knowledge on mechanized operations		**n=45**	**n=214**	**p=**
	Big Problem	17.78	9.81	
	Medium Problem	42.22	39.72	
	No Problem	24.44	26.64	
	Small problem	15.56	22.43	
	Very big problem	0.00	1.40	

Legend: *= 10% significant level; ** = 5% significant level; *** = 1% significant level

The data in Table 11 show that there was significant difference only for the constraints on low-quality technicians and that machine//attachment were very expensive. The proportion of state-imported machinery owners (STOs) who mentioned that low-quality technicians were not a problem was significantly high (about 58%), compared to that of privately purchased machinery owners (STOs) (about 30%). In addition, 28% of the owners of the state-imported machinery said that high prices of the machine/attachment were not a problem, compared to 12% of the privately purchased machine owners on same issue. The results show that owners of privately purchased machinery had more constraints than state-imported owners. These constraints observed by the privately purchased machinery operators could be attributed to the management style, i.e. lack of training (on driving and maintenance) for operators, use of relatives as operators, attitude to customer services, and others.

Table 12: Aspirations (on Likert Scale of 1 -10 where 1 is lowest)

What is the level of income that you have?	*mean=5.33* *n= 45* *SE=0.23*	*mean=4.96* *n=214* *SE=0.12*	
What is the level of income that you would like to achieve?	*mean=9.44* *n= 45* *SE=0.38*	*mean=10.66* *n=214* *SE=0.96*	Chi-square= p=
What is the level of income that you think you will reach within ten years?	*mean=10.04* *n=45* *SE=0.49*	*mean=11.24* *n= 214* *SE=0.96*	Chi-square p=
What is the level of social status you have at present?	*mean=5.40* *n= 45* *SE=0.22*	*Mean=5.19* *n= 214* *SE=0.14*	(p=
What is the level of social status that you would like to achieve?	*mean=8.80* *n=45* *SE=0.37*	*Mean=8.90* *n=214* *SE=0.46*	(p=
What is the level of social status that you think you will reach within ten years?	*mean=9.42* *n=45* *SE=0.44*	*Mean=9.46* *n=214* *SE=0.47*	p=

The data in Table 13 reveal that:

- There is a significant difference between state-imported and privately imported tractor owners on the level of income reached within ten years.
- There is a significant difference between the two categories of tractor owners on their social status level.
- All other parameters considered were not significantly different for the two tractor owner categories.
- This result should, however, be interpreted cautiously because, while privately purchased tractor owners may have expressed their opinion directly related to ownership of the tractor, state-operated tractor owners may have expressed their opinion based on rank or other considerations and not necessarily on the ownership of the tractors.

Table 14: Tractor Assessment

	State-imported	Privately-purchased	Statistical difference
How is the coolant level? (Repeat for all options)	Does not apply/not visible - 30.56 Ok (between B and C) – 47.22 Too high (above B) – 0.00 Too low (below C) – 22.22	Does not apply/not visible - 22 Ok (between B and C) - 56 Too high (above B) – 3.33 Too low (below C) – 18.67	P=- X^2 =
Does the engine start? (Repeat for all options)	No – 23.68 Yes, with help – 15.79 Yes, without help – 60.53	No – 14.94 Yes, with help – 13.64 Yes, without help – 71.43	P= X^2 =
Does the hydraulic system work?	No –15.79 Yes -84.21	No – 8.55 Yes – 91.45	P= X^2 =
Is PTO functioning?	Does not apply/not visible – 7.90 No - 15.79 Yes - 76.32	Does not apply/not visible – 13.91 No - 5.96 Yes - 80.13	P= X^2 =
What is the level of hydraulic oil? (Repeat for all options)			
What was the colour of hydraulic oil when last changed? (Repeat for all options)	Black - 42.11 Cannot assess – 21.05 Does not apply/not visible – 13.16 Yellow/brown - 23.68	Black - 30.05 Cannot assess - 8.97 Does not apply/not visible - 15.39 Yellow/brown - 45.59	P= **X^2** =
Do you use draft control for ploughing?	No - 44.74 Yes - 55.26	No - 35.26 Yes - 64.74	P= X^2 =
How is the oil level? (Repeat for all options)	Does not apply/not visible - 15.39 Normal - 61.54 Too high - 0.00 Too low - 15.39	Does not apply/not visible - 16.33 Normal - 71.43 Too high - 4.08 Too low - 8.16	P= X^2=
Which date does the oil cartridge indicate? (Repeat for all options)	Data not available		
Are there sediments in the	Does not apply/not visible – 19.44	Does not apply/not visible – 22.30	P= X^2 =

bowl?	No - 41.67 Yes - - 38.89	No - 52.03 Yes - 25.68	
How are the greasing points? (Repeat for all options)	Does not apply/not visible - 17.14 Mostly dry/hard - 22.86 Mostly wet -31.43 Some wet but some dry/hard-28.57	Does not apply/not visible - 15.54 Mostly dry/hard - 11.49 Mostly wet -32.43 Some wet but some dry/hard-40.54	P= X^2 =
Can the respondent show his/her greasing gun?	Does not apply/not visible – 0.00 No - 36.11 Yes - 63.89	Does not apply/not visible – 0.00 No - 40.82 Yes - 59.18	P= X^2=
Does it work?	No – 4.35 Yes – 95.65	No - 4.60 Yes - 95.40	P= X2 =
Is grease in it?	No - 13.64 Yes - 86.36	No - 17.44 Yes - 82.56	P= X^2 =
How is the radiator?	0-25% clean - 2.86 25-50% clean - 17.14 50-75% clean - 22.86 75-100% clean - 37.14 Does not apply/not visible – 20.00	0-25% clean - 0.67 25-50% clean - 16.11 50-75% clean - 51.68 75-100% clean - 17.45 Does not apply/not visible – 14.09	P= X^2 =
How is the fan belt?	Does not apply/not visible – 22.86 Ok - 65.71 Too loose - 5.71 Too tight - 5.71	Does not apply/not visible – 14.09 Ok - 70.47 Too loose - 8.72 Too tight - 6.71	P= X^2 =
How is the air filter?	Dirty - 20.00 Does not apply/not visible - 7.14 Somehow clean - 45.71 Very clean - 14.29 Very dirty - 2.86	Dirty - 11.41 Does not apply/not visible - 15.44 Somehow clean - 57.05 Very clean - 14.77 Very dirty - 1.34	P= X^2 =
Does tractor have a roll bar or cabin?	Does not apply/not visible – 16.67 No - 63.89 Yes - 19.44	Does not apply/not visible – 17.45 No - 65.77 Yes - 16.78	P= X^2 =
Please write down engine hours	142.30 (n=45) SE , 36.00	14101.90 (n=214) SE, 6730.84	X^2= P=

Are any warning lights on when the engine turns? (Repeat for all options)	Air cleaner indicator - 3.13 Alternator indicator - 28.13 Engine oil pressure - 15.63 No warning lights - 0.00 Not visible - 0.0 Others - 40.63 The tractor away for work – 0.00 Transmission oil filter - 0.00 Transmission/hydraulic oil pressure too low - 12.50	Air cleaner indicator – 6.73 Alternator indicator – 22.12 Engine oil pressure – 25.00 No warning lights - 0.00 Not visible -0.00 Others -32.69 The tractor is away for work –0.00 Transmission oil filter - 4.81 Transmission/hydraulic oil pressure too low –8.65	P= X^2 =

The data in Table 14 show that:

- There is significant difference between the two tractor owner categories on whether the engine started (88.5%, X^2 0.244); although, the tractors started over 90% of the time for both categories.
- There is significant difference for the condition of the radiators (51.6%, X^2 = 3.253), with the state procured tractors having 37.5% with radiators that were 75-100% clean, compared to 29.1% for the privately-owned tractors.
- There is significant difference between the categories on the state of warning lights, with state tractors having 25% of their tractors showing engine oil pressure indicator, as compared to 44.5% of privately owned tractors. There were 41.7% state-purchased tractors showing no lights, as compared to 25.5% private tractors.
- All other parameters considered showed not significant difference.

Conclusions

The survey was conducted in 3 states across 3 geopolitical zones of Nigeria during the major farming season. The performance of state-imported and privately purchased tractor operators were specifically surveyed. The study found that both state-imported and privately purchased tractor owners were educated, but with state-imported operators having more tertiary education. Tractor owners were commoners in their communities, belonged to a cooperative group, sourced their income to purchase tractors from farming operations and tractor hiring services, motivated to buy tractors because of the strength/horse power, and preferred Merssey Fergusson brand of tractor with capacity greater than 70hp for both state-imported and privately purchased tractor operators.

Major operational problems encountered by state-imported tractor operators were fuel supply and ignition and transmission systems, while those of privately purchased tractor operators was tyre problem. Major repairs on tractors were done in mechanic workshops for both state-imported and privately purchased tractor operators. Preferred machineries were tractor, ploughs and harrows, with the data for privately purchased operators higher than those of state-imported operators.

Farm operations carried out with these tractors were majorly ploughing, harrowing, ridging and transport, with the use of hired labour by both groups. Moreover, state-imported tractor operators outperformed their private counterparts, in terms of trainings received, duration of

training, and satisfaction with knowledge received. Most of the constraints encountered with tractor operation were surmounted by state-imported tractor operators. The income and social status aspirations of the operators were found to be significant for both groups.

Finally, state-imported tractor operators were generally better managed than their private counterparts, especially with regard to the provisions of enabling working environments, resources, motivation and level of freedom (as often provided in civil service work environments).

Study 3: An Assessment of Opinions and Policy Beliefs with Regard to Policy Instruments and Effects Related to Mechanization, Youth and Digitalization

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A Quote

"No realistic change can be expected from the present nature of Nigerian Agriculture, due to the drudgery attached to it, until the farmer finds an alternative to the hoe and cutlass technique of production. The clearing of bush, preparation of land, the sowing of seeds, the various post-planting operations are all processes in which the farmer's present tools can do little for high productivity per man day or per acre".

----- The Second National Development Plan (1970 – 74)

Introduction

Agricultural mechanization is considered one of the essential factors for growing agriculture and reducing poverty among farming households. Identifying appropriate support for mechanization is crucial in Nigeria, a country with potentially heterogeneous demand for mechanization. Nevertheless, information has been lacking regarding the institutional options for mechanization, public opinion on policy instruments related to mechanization, youth and digitalization in the wake of mechanization; the state of skills development for mechanization; and the effects of agricultural mechanization on rural communities. It is against this background that this research seeks to provide useful evidence with important implications for policy in Nigeria.

Tractorization, a key component of mechanized agriculture, has great potential for improving the livelihood of farming households in Nigeria, not only through the expansion of cultivated land and increase in output sales, but also by reducing the cost of land preparations. At the same time, the lack of supply of mechanization is a high constraining factor for many smallholder farmers in Nigeria, which grow traditional staple crops in a semi-subsistence manner. Identifying the institutional support for increased supply of mechanization services is, therefore, critical while also creating demand for mechanized farming practices. In addition to the government's goal to develop large-scale commercial farming practices through mechanization, a significant share of the benefits from mechanization may potentially arise from increased productivity of smallholder farmers in Nigeria. Mechanization policy for Nigeria must therefore consider these roles for institutional development.

In Nigeria, the demand for mechanization is determined by various factors, including farming systems, population density or labour wages (Pingali, 2007). Due to the heterogeneity in the agro-ecological environments and socioeconomic characteristics of farm households in SSA (sub-Saharan Africa), farm mechanization plays diverse roles. For instance, farm mechanization may be more effective in reducing labour costs than expanding area cultivated. In such a case, the goal for effective mechanization policies may be to raise the income of smallholder farm households through reduced production costs, rather than growing large-scale farms.

The market for mechanization services is underdeveloped in Nigeria, with uneven supply across locations (Takeshima *et al.,* 2013). Majority of the tractor services in Nigeria are provided by government through either subsidized direct sales or public tractor hiring services (Propcom, 2011), though private owner operators are emerging. While commercial markets exist in Nigeria, where imported tractors are sold, demand may be small and limited to private owner operators who have managed to accumulate adequate capital through business expansion after first acquiring subsidized tractors. Due to the low operational capacity and poor maintenance of equipment among public service providers, sub-optimal distribution of subsidized tractors, and high fixed costs, adoption of mechanization may be highly constrained by the lack of supply, leaving potential demand unmet for the majority of smallholder farmers.

Use of mechanization is associated with distinctive production characteristics (Takeshima *et al.,* 2013 and FAO, 2016). The level of agricultural mechanization in the country has remained low, with the non-mechanized practices, such as hand-hoe, dominating the farming system. The situation is increasingly compounded by a declining agricultural labour force caused by rural to urban migration, ageing farmer/producer population, as well as the HIV/AIDS and malaria pandemics (Propcom, 2009). There is no doubt that agricultural mechanization for the multitude of smallholder farmers in sub-Saharan Africa (SSA) has been a neglected issue for too long. The application of farm power to appropriate tools, implements and machines – "farm mechanization" – is an essential agricultural input with the potential to transform rural families' livelihoods by facilitating increased output of higher value products while eliminating the drudgery associated with human muscle-powered agricultural production. Such improved situation for smallholder farmers can enhance the supply chains in modern food systems.

The main objective of mechanization policy is to reduce drudgery in agriculture by providing mechanical power to replace some of the labour required in agricultural business. It is also the objective of the policy to reduce the high cost of agricultural production which arises largely from high labour wage rates and the high share of labour cost in the total cost of agricultural production (FMARD, 2001).

Strategies adopted to actualize the objectives include

i) Land clearing for agricultural purposes and the regulation of activities of all land clearing and development agencies.
ii) Provision of subsidy for agricultural land clearing.
iii) Support and assistance for entrepreneurs to receive bank loans to set up private agricultural mechanization enterprises and/or Tractor Hiring Units (THUs) and repair workshops
iv) Provision of training to tractor operators on the proper use of equipment to prevent soil loss and reduce soil erosion.
v) Intensified use of small motorized farm machines, ox-drawn equipment (animal traction), and promotion of the local manufacture of medium and large size farm machinery for land preparation, crop cultivation, harvesting, processing and storage on large scale farms.

vi) Acceleration of the development of the National Centre for Agricultural Mechanization; aimed at performing the function of standardization of farm machinery and equipment, alongside the promotion and production of locally designed prototypes;
vii) Partnerships with Universities, Polytechnics and Research Institutes in accelerating the development and local fabrication of suitable equipment for use by intermediate and small-scale farmers.
viii) Promotion of private sector participation in the commercialization of prototypes.

Policy belief systems can be understood to ‘‘include value priorities, perceptions of important relationships, perceptions of world states (including the magnitude of the problem), perceptions of the efficacy of policy instruments, etc.’’ (Sabatier, 1988). In the political science literature, the role of ideas and policy beliefs in explaining policy choices and facilitating political action has long been acknowledged and widely documented (Böcher, 2012; Grindle and Thomas, 1989; Goldstein and Keohane, 1993; Orren, 1988; Sabatier and Jenkins-Smith, 1993). Policy belief systems are critical vehicles for understanding the role of policy analysis in policy-oriented learning and how such learning impacts on government programmes. Sabatier (1988) considers that policy change is best seen as fluctuations in the dominant belief system (i.e. those incorporated into public policy) within a given policy subsystem over time. The research was therefore formulated to enhance understanding effect on the differences of opinions and beliefs regarding the best policy choices for Nigerian agriculture by highlighting the role that policy beliefs play.

Objective of the Research

The major objective of this research was to assess opinions and policy beliefs regarding policy instruments and effects related to mechanization, youth and digitalization.

Methodology

Sampling, Data Collection and Study Sites

Questionnaire interviews were held with different stakeholder groups as listed in Table 1. A total of 50 stakeholders were purposively selected for interview. The questionnaire was developed by an international group of experts and administered through e-mail, physical interviews through visitation, and/or a combination of both. The exercise was conducted between April and June 2019. Data collected were analysed using descriptive statistics. A multistage sampling procedure was used in selecting respondents from Local Government Areas (LGAs) initially selected from states based on the 6 geopolitical zones in Nigeria.

Table 1: Sample Distribution of Organization

Organization	Frequency	Percentage (%)
Farmer's Organization	1	2
Youth Association	4	8
Women's Association	1	2
National Governmental Body	6	12
Local Governmental Body	16	32
Non-Governmental Organization	2	4
Inter-Governmental Organization	0	0
Donor Organization	0	0
Research	5	10
Private Company	10	20
Development Organization	5	10
Total	**50**	**100**

Results and Discussion

General Information of Respondents

The mean age of the respondents was 48 years. This implies that respondents were in their active and productive years, hence, in a very good position to give the best responses and share good opinions on policies that can impact positively on Nigerian agriculture. Only about 4% were female, more than half (52%) were from rural areas, majority (69.2%) of whom grew up on the farm, and 74% own personal farms. Furthermore, 82% had first degrees and above, while 74% had background in either agriculture or engineering. The respondents had read an average of 10 scientific papers or policy briefs. The organizational characteristics of the respondents are shown in Table 2.

Agricultural Mechanization

Figure 1 shows respondents' mean preference for distribution of agricultural expenditures among specific programmes. In sharing government expenditure for the agricultural sector in Nigeria, respondents would influence the distribution of agricultural expenditures towards provision of input subsidies (mean = 26.09), extension services (21.47) and agricultural mechanization (21.24) (Figure 1). This implies that input, extension and mechanization were critical to agricultural growth in Nigeria. Respondents' attitude towards mechanization is depicted in Figure 2, which indicates that the majority (80%) of the respondents had positive and supportive attitude towards agricultural mechanization in Nigeria.

Preference for animal-draught and mechanical traction is shown in Figure 3. Generally, the mean preferred allocation of the agricultural mechanization was about 80% in favour of mechanical traction. This implies that respondents will rather give priority to mechanical traction than animal draught. This could be due to the practical advantages of mechanical traction over animal traction, which include efficiency, time and labour saving, reduced drudgery and wider hectarage coverage.

Table 3 reveals that 68% of the respondents believed agricultural mechanization to be the best way to make farming attractive for the youth, while 44% suggested overcoming hoe and cutlass types of farming should be a top priority. About half (48%) of the respondents totally disagreed that " knowledge and skill development programmes for tractor operators and technicians are needed", implying that tractor operators require some level of knowledge and skill development to improve in the quality of services they deliver to their clients.
Strategies for promoting smallholder mechanization are shown in Figure 4. Cooperative is believed by 58% of the respondents to have the highest potentials to promote smallholder mechanization in Nigeria, while ICT-based solution recorded the lowest rating.

Rural Youth

The attitude of rural youths towards agriculture is shown in Table 3. As indicated in Table 4, 60% of the respondents agreed with the fact that farming can become more attractive to the youth if the right policies and strategies are designed and put in place. The right strategy, as mentioned earlier, should include making agriculture attractive and less drudgery through mechanization. That 'the youth find farming unattractive under the current conditions of Nigeria agriculture' recorded the highest mean of 5.9. This result implies that there is absence of right policies to make farming attractive to the youths in Nigeria.
The potential of policies to make agriculture attractive to the youth is depicted in Figure 5. The majority (70%) of the respondents believed that agricultural mechanization has the highest potentials; improved rural infrastructure also had high potential, as indicated by 58% of the respondents, to make agriculture attractive to the youth.

ICT in Agriculture

The majority (62%) of the stakeholders were of the belief that ICT applications would help increase good governance by improving the management of agricultural agencies and by empowering farmers to demand better services (Table 5). This implies that the rate at which ICT applications and mobile services were assisting farmers in Nigeria was considered low by the respondents. In other words, ICTs in farming are grossly underutilized, especially through Android-based mobile applications that will guide and inform the farmers on best production practices.
The majority (58%, 58% and 54%) of the stakeholders believed that ICT has high potential in marketing, mobile payments/saving, and provision of agricultural extension service, respectively. Conversely, 28% of the respondents were of the belief that ICT has low potential in insurance provision (Figure 7).

Discussion

Policy Priorities

Based on the results presented above, the following policy priorities can be deduced from the sampled opinions and beliefs.

a) Agricultural mechanization should be a key thrust of the Nigerian agricultural policy. This is fully supported by the preference of 80% of the respondents for mechanical traction over animal draught. Furthermore, the respondents believed government expenditure on agriculture should emphasise the provision of input subsidies, extension service delivery and agricultural mechanization; this suggests that input, extension and mechanization are critical to agricultural growth in Nigeria.
b) Agricultural mechanization should be a key strategy to attract youth to agriculture. Nigerian youth, according to the respondents, found farming unattractive due to its drudgery condition in the country. Therefore, when drudgery is reduced through agricultural mechanization, farming would become attractive to the youth, in addition to generally advancing the frontiers of Nigerian agriculture.
c) There should be emphasis on ICT application in agriculture; this would also help increase good governance through improving the management of agricultural agencies, and empowering farmers to demand better services. ICT has high potential in both input and output marketing, mobile payments/saving, as well as the provision of agricultural extension services. The potentials of android phone-based applications in extension services delivery have been demonstrated by XYZ of Kenya.
d) Cooperative societies could serve as a vehicle for the promotion of smallholder mechanization in Nigeria.

Opinions and beliefs

The results indicated that major stakeholders believed that the use of hand-hoe technology should be played down by improving agricultural mechanization, using the private sector in the purchase, distribution and machinery services. This was the view of national and research organizations, youth associations and farmer organizations. Furthermore, the results also revealed that development of business models that can promote the activities of small-scale farmers is guaranteed when mechanization is improved. Cooperative group development was rated by all the organizations as a means of promoting smallholder mechanization in Nigeria.

Table 2. organizational characteristics of the respondents

	Farmer org.	Youth Ass.	Women Ass.	Nat. gov.	Local gov.	NGO	Inter-govt. org.	Donor	Research	Private c	Devpt. org.
Input subsidies	35.0	6.0	15	20.0	10.0	14.5	10.5	15.0	10.0	15.0	15.0
Extension services	11.0	45.0	25	30.1	23.0	29.0	15.0	30.0	31.0	25.0	30.0
Agricultural mechanization	13.0	15.0	25	15.6	20.5	12.0	35.0	8.0	10.0	35.0	7.0
Youth	4.0	13.0	15	5.7	15.5	11.0	8.0	15.0	15.0	5.5	12.0
ICTs in Agriculture	13.0	15.0	15	6.6	11.5	12.0	7.2	12.0	11.0	5.5	11.0
Environmental Sustainability	10.0	8.0	5	14.1	10.0	13.5	5.0	15.0	6.0	5.0	25.0
Others		6.0	-	10.3	13.0	5.0	4.5	5.0	17.0	4.5	4.0

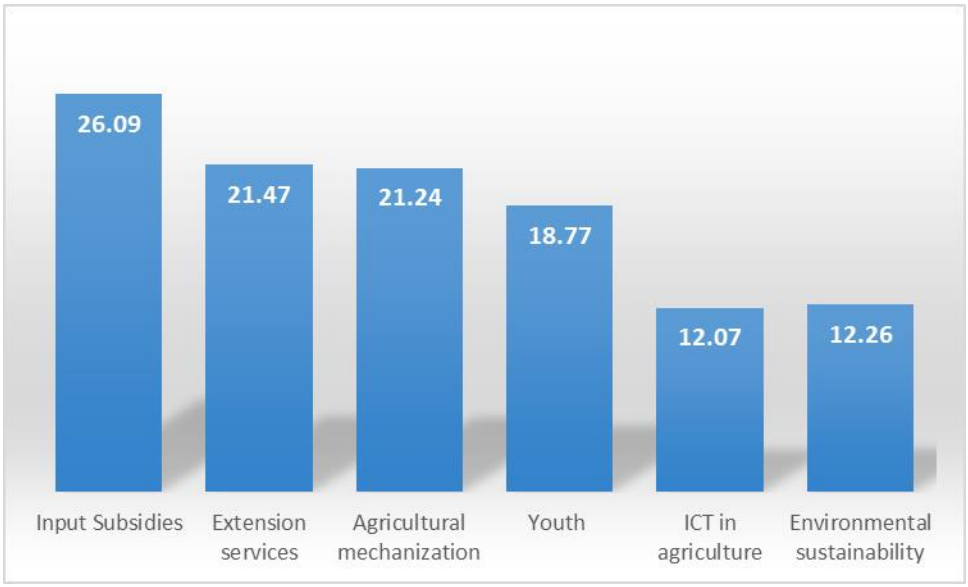


Figure 1: Mean preference distribution of agricultural expenditures among specific programmes

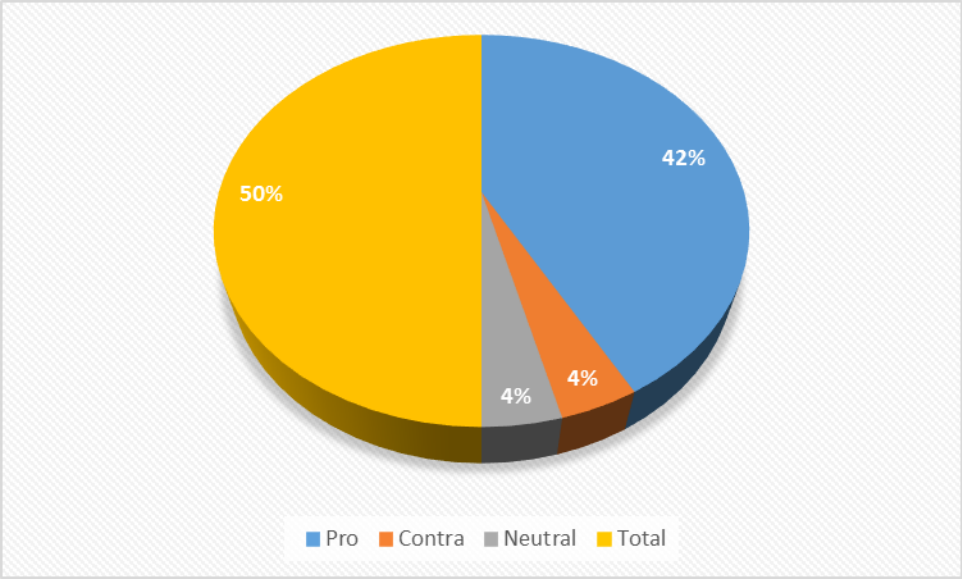


Figure 2: Respondents' attitude towards mechanization

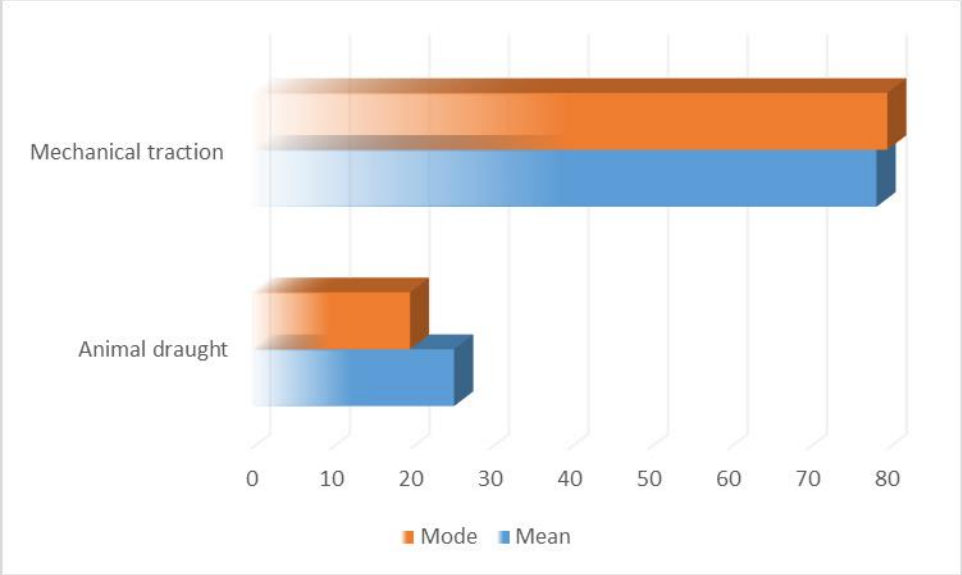


Figure 3: Respondents' prioritization of animal draught and mechanical traction

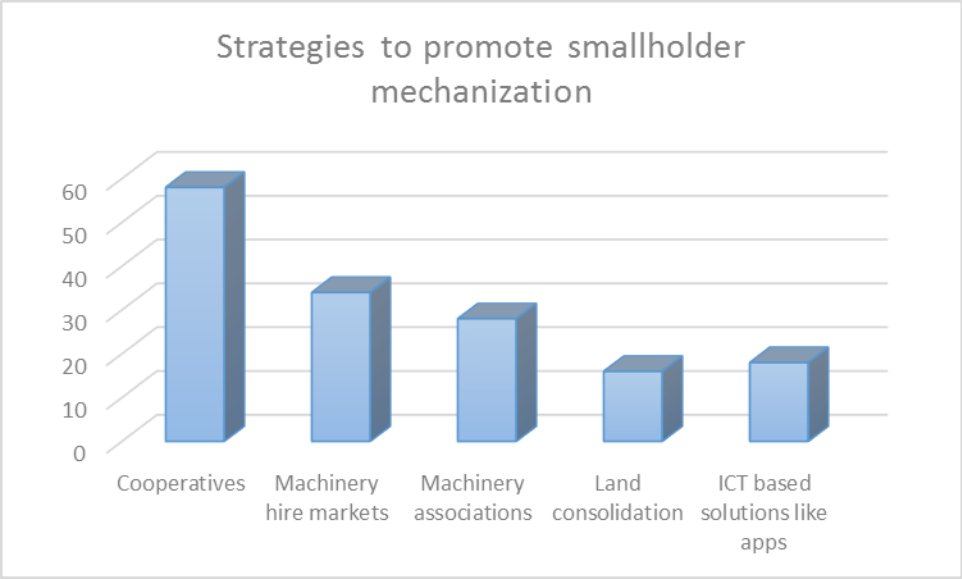


Figure 4: Rating of the potentials of different strategies to promote smallholder mechanization

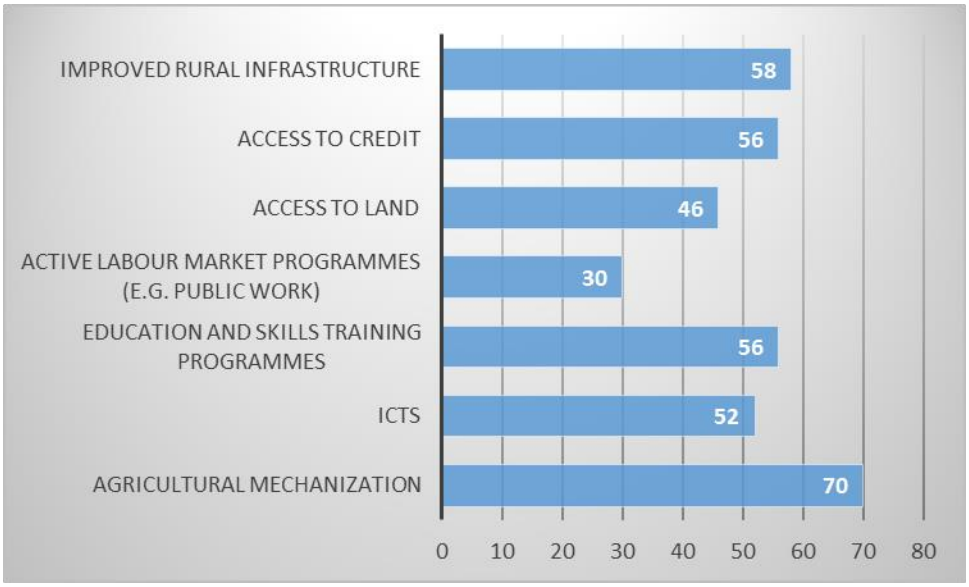


Figure 5: Rating of policies' potentials to make agriculture attractive for the youth

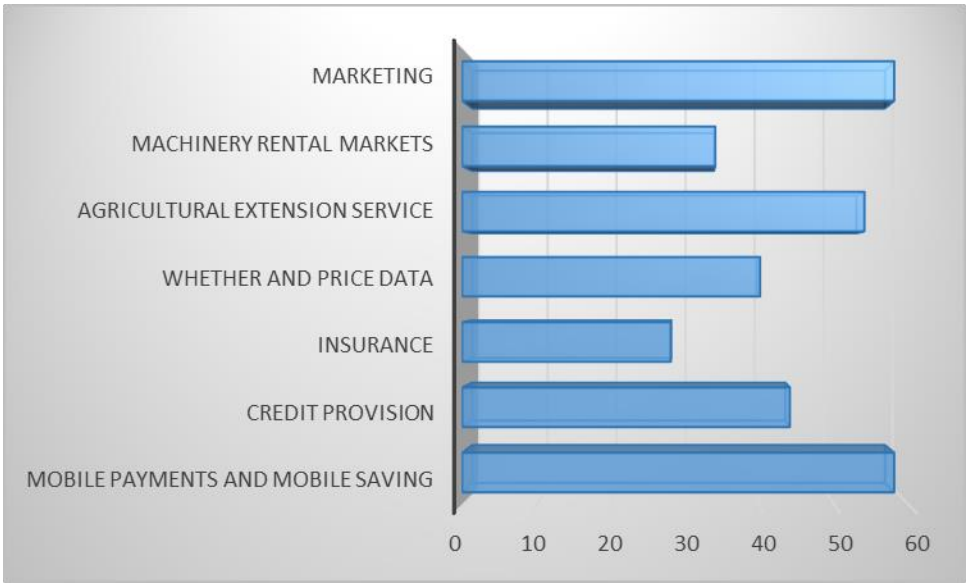


Figure 6: Rating of the potentials of ICT

Youth and digitalization

The results indicated a consensus that the current state of agriculture is not attractive to youths, as farmers represent poverty. This has implications for the need to make agriculture attractive to the youth by reforming the sector. Respondents would want dedicated policies that address inadequate access to credit and provision of mechanization equipment to encourage youth participation in agriculture, leveraging on ICT. Government and research organizations believed that mechanization, good policies and adequate training of personnel would encourage youth involvement in agribusiness activities.

Furthermore, the result showed that the use of ICT and mobile applications would provide adequate opportunities for agricultural development, especially with improved connectivity and provision of basic infrastructure. Also, improved machinery hiring services and provision of adequate market information were highly rated.

Table 1: Distribution of respondents by socio-demographic characteristics

Characteristics	Frequency	%	Mean
Age			48
Gender			
Male	47	94	
Female	3	6	
Origin			
Rural	26	52	
Urban	24	48	
Where grown up			
On the farm	18	69.2	
Not on the farm	8	30.8	
Farm ownership			
Own farm	37	74	
Do not own farm	13	26	
Educational Qualification			
College	1	2.0	
Undergraduate	2	4.0	
Diploma	6	10.0	
Bachelor	16	32.0	
Master	15	30.0	
PhD	10	20.0	
Educational Background			
Economic/Social Sciences	4	8.0	
Agriculture	22	46.0	
Engineering	13	28.0	
Business Administration	4	8.0	
Public Administration	3	6.0	
Others	2	4.0	
Where degree was obtained			
Own country (Africa)	44	88.0	
Own country (outside Africa)	0	0	
Foreign Country	0	0	
Both own and foreign	6	12	
Number of Scientific papers or policy briefs read			10

Table 2: Organisational characteristics

Organisation	Frequency	Percentage (%)
Farmer's Organisation	1	2
Youth Association	4	8
Women's Association	1	2
National Governmental Body	6	12
Local Governmental Body	16	32
Non-Governmental Organisation	2	4
Intergovernmental Organisation	0	0
Donor Organisation	0	0
Research	5	10
Private Company	10	20
Development Organisation	5	10

Table 3: Percentage distribution of the attitudinal statements ranking

Attitudinal statements	Preference according to scale (%)								
	1	2	3	4	5	6	7	Weighted score	Weighted mean
Agric mechanization is the best way to make farming attractive for the youth		4		6	12	8	68	616	6.23
Overcoming hoe and cutlass types of farming should be a top priority	12	14	8	2	6	12	44	482	4.92
As modern tractors are robust, easy to handle and require little maintenance, no knowledge and skill development programmes for tractor operators and technicians are needed	48	12	8	4	4	14	8	272	2.78
The private sector has failed to promote mechanization. Therefore, the state needed to import/distribute machinery	10	14	6	10	14	6	38	468	4.78
The lifetime of machinery imported during past government programmes were typically short	20	10	10	20	2	6	30	406	4.14
Given the challenges of government efforts to import/distribute machinery, the private sector should lead mechanization	4	10	8	2	14	18	42	528	5.39

"The lifetime of machinery imported during past government programmes was typically short."	10	10	10	24	10	12	20	418	4.27
"Providing knowledge and skills for tractor operators and technicians should be done by the private sector because they make profit selling machines and equipment"	42	14	6	6	4	10	16	304	3.10
"The private sector has no incentive to provide knowledge and skills development for mechanization, therefore the government should do these activities"	22	8	20	24	6	12	6	338	3.45
"Current government efforts to provide knowledge and skills development for mechanization are sufficient"	8	2	2	6	20	28	30	520	5.31
"Pushing agricultural mechanization too much will cause rural unemployment"	20	6	6	20	6	14	26	426	4.35
"Using tractors and ploughs has led to big problems with regard to soil erosion."	12	8	4	6	4	24	40	508	5.18

Youth and Digitization

Table 4: Measure of rural youth's attitude to agriculture

Rural youth's attitude to agriculture	Scale (%)							Weighted score	Weighted mean
	1	2	3	4	5	6	7		
"The youth finds farming unattractive under current conditions."	16	8	14		2	14	44	476	4.86
"Designing the right policies farming can become attractive for the youth."	2			6	6	24	60	620	6.33
"We should not be concerned if the youth leaves farming to find work in urban areas"	48	10	6	2	8	10	14	292	2.98
"Youth are not involved enough in agriculture policy processes."	6	2	14	6	10	24	36	522	5.33
"Youth lack role models in agriculture."	10	4	12	8	24	18	22	468	4.78

"Providing too much education unnecessarily raises the aspirations of the youth, which can become dangerous when not enough jobs are created for them."	26		10	12	12	16	22	414	4.22
"Today's education system prepares the youth well for the job market."	20	10	16	10	2	14	26	404	4.12

Table 5: Rating the attitudinal statements about ICT in agriculture

Attitudinal statements about ICT in agriculture	Scale (%)								
	1	2	3	4	5	6	7	Weighted score	Weighted mean
"ICT applications and mobile services provide tremendous opportunities for agricultural development."		2	4	4	12	18	58	606	6.18
"Low connectivity still limits the possibilities of many households to use ICT applications and mobile services"	8			6	10	26	48	574	5.86
"We need more quality control of ICT applications and mobile services."	2	4		8	10	28	46	582	5.94
"ICT applications and mobile services are already helping farmers."	4	8	8	14	14	16	34	504	5.14
"Wealthy and educated households benefit more from ICT applications and mobile services."	4		6	8	16	14	50	568	5.80
"ICT applications use personal and sensitive data and we should care more about data privacy and sovereignty."	4	6	6	16	12	8	46	528	5.39
"ICT applications may help to increase good governance by improving the management of agricultural agencies and by empowering farmers to demand better services."			2	10	16	8	62	608	6.20

The result in Table 5 indicated that majority of the stakeholders were convinced that ICT applications would help increase good governance by improving the management of agricultural agencies and empowering farmers to demand better services (weighted mean of 6.2), and that ICT applications and mobile services provide tremendous opportunities for agricultural development (6.18).

Conclusion

The study identified the provision of physical access to tractorization, complimented by the use of ICT, as a necessity for moving smallholders out of their present ‘‘hoe and cutlass’’ nature of farming. Agricultural mechanization is critical to making farming attractive to the youth. Past initiatives of government in promoting mechanization have not been generally successful. This study contributed in some measures to providing a base for constructive policy discussions on mechanization.

Study 4: State of Skills Development for Mechanization

Daudu, C. K., F. O. Issa, A. A. Wahab, Y. Ndirpaya, and AO. Fatunbi

Abstract

The research assessed the condition of skills development for mechanization in public and private institutions in Nigeria. Random sampling was used to select 3 states from three out six geographical zones. The selected states were Kaduna, Niger and Oyo. Structured questionnaire was designed to elicit information from 17 selected institutions. Purposive sampling technique was used to choose institutions with agricultural engineering programme/training in the universities, mid-level college, polytechnics and other mechanization training schools. The data were analysed using descriptive statistics. The result of the analysis indicated that 53.8%, 38.5% and 7.7% of public universities, mid-level colleges and polytechnics were captured respectively. The average age of private institutions was 34 years, while that of the public institutions was 37 years. Also, teaching staff constituted majority (69.2%) in the public institutions, while management staff were the majority (66.7%) in private institutions. Across the institutions, male students outnumbered their female counterparts, except in polytechnics. The preferred courses of studies for male were mechanical, civil and agricultural engineering (in that order), whereas female students preferred chemical and petroleum engineering. COREN and NUC were the accredited bodies for the universities' engineering programmes, while NABTEB did for mid-level colleges and polytechnics. The percentage of regular staff members was 47%, while temporary staff was 53% in the universities, with an average of 23 years teaching experience. Most teaching staff were undergoing PhD and master's programmes in all the institutions and preferred to have more training in the areas of curriculum development and information technology. Part-time staff were more than permanent staff in the universities. The difference between public and private budgets for 2018 in mid-level college was above 7 million naira, with private institutions having a higher budget. With regard to suggestions in mid-level college,, 50% was on curriculum contents development, while 50% was on course delivery. Some students dropped some courses, and this was attributed to lack of fees, lack of interest and the irrelevance of some courses. It was suggested that there should be increase in financial allocations to the various institutions for the purpose of training facilities and infrastructural development.

Introduction

The Importance of Skills Development for Agricultural Mechanization

Using farm machinery is not very profitable without the appropriate knowledge and skills required to operate them. Successful mechanization requires the provision of both theoretical knowledge (e.g. significance of maintenance) and practical skills (e.g. how to do maintenance well). Untrained operators are neither aware of the need for regular services nor possess the skills to do this properly. This causes harm to engines, leads to costly repairs, and slows down the agricultural mechanization process. The scenario underscores the need for well-planned skill development and training for agricultural mechanization practitioners. In Nigeria, basic

knowledge about agricultural mechanization is undertaken by universities, polytechnics and specialized colleges and institutions.

Ochi (2004) described agricultural education as a course or training provided by various colleges of agriculture, trade centres, faculties of agriculture of the universities/ polytechnics and training provided by the universities of agriculture. Similarly, Osinem (2008) described agricultural education as education and training given in agriculture from primary school through secondary and special schools to the university. Additionally, Agbulu (2010) defined agricultural education as the provision of systematic learning which are designed to train students with skills, competences, abilities, techniques, attitudes, knowledge and meaningful practical training required for use in vocational agriculture. Agricultural education provides a learner with sound academic knowledge and skills as well as opportunity to apply this knowledge through classroom activities, laboratory experiments, project participation and supervised agricultural experiences. Agricultural engineering education is a course of study which integrates knowledge and skills in farm programmes and activities aimed at exposing students to the occupation and vocational opportunities in agriculture. It assists in developing skills which individuals need in order to be established and successful in agricultural activities (Orohu, 2011).

Agricultural engineering as a course, belongs to agricultural education and engineering. This is because it has to do with using engineering principles to solve problems in agriculture. So, it involves having knowledge and skills in both agriculture and engineering.

Overview of Agricultural Engineering around the World and Nigeria

The first use of crude tools to till the earth may be taken as the beginning of agricultural engineering principle. The activities of a prehistoric farmer that man was and his entire livelihoods, that includes food, clothing and shelter centre around fundamental engineering disciplines. With man's relentless search for ways of improving various processes associated with tillage and food production (Makanjuola, 1977), agricultural engineering may arguably be said to have been in existence since prehistoric times. It was first listed, according to Stewart (1979), as a profession in University of Nebraska, USA, in 1896 with mechanical, electrical, civil or chemical engineers as the earliest group of engineers in agriculture and foundation staff. These Engineers-in-agriculture came together to form the American Society of Agricultural Engineers (Odigboh, 1985), which later became American Society of Agricultural and Biological Engineers (ASABE) in 2010 (Adekoya, 2013). In 1905, Professor J. B. Davidson of Iowa State University developed a curriculum which focused on farm mechanization to evolve a global system for managing the production, processing, storage and handling of food and fibre (Stewart, 1979; Adekoya, 2013). The professionalism of agricultural engineering may be interpreted as a response to the industrial revolution, knowledge explosion and rapid growth of the American agriculture in the early part of the 20th century. Early responsibilities of agricultural engineers were undertaken by agronomists, civil, electrical or mechanical engineers (Mijinyawa, 2005) until 1959 when some of these engineers were recruited for training in Britain to become the first set of agricultural engineers in Nigeria (Odigboh, 1985; Igbeka, 2002). In 1967, University of Nigeria, Nsukka awarded the first bachelor's degree in agricultural engineering to Messrs U.P.C. Akudo and E. Nwalo. The number of universities with programmes in agricultural engineering, according to Ogunsina and Taiwo (2018), has grown from one in

1962 to 27 in 2017. This was in line with Wahab (2019) who found that a number of universities, both public and private, with agricultural engineering department in Nigeria as at 2019 was 29 and polytechnics/ mid-level colleges with agricultural engineering programme was 42. However, this research is not only interested in finding out the institutions, but also to assess the state of skills development for mechanization and as well suggest means of improving the qualities of training by various institutions.

Objectives of the research are to:

1. assess the state of skills development for mechanization, and
2. suggest ways of improving knowledge and skills required for mechanization development.

Study Sites, Sampling and Data Collection

Sampling and study sites were taken to reflect sites for the study on tractor survey, described ealier. Structured questionnaire was designed to elicit information from 17 selected institutions on tractor driving, maintenance and/or repair. Purposive sampling technique was used to select institutions with agricultural engineering programme/training in the universities, mid-level colleges, polytechnics and other mechanization training schools. The collected data were analysed using descriptive statistics.

List of the selected institutions within the study area were:

1. TOHFAN (Ambel Tractor driving school), Kaduna Road, Zaria, Kaduna State
2. Ahmadu Bello University (A.B.U), Samaru, Zaria, Kaduna State
3. Kaduna State University, Kaduna, Kaduna State
4. Kaduna State Polytechnic, Kaduna, Kaduna State
5. Mahindra Training School, Kaduna, Kaduna State
6. Federal Forestry of Mechanization, Kaduna State
7. Division of Colleges of Agriculture (DAC), Samaru, Zaria, Kaduna State
8. Niger State Agricultural Mechanization Development Authority (NAMDA)
9. Tractor Owners and Operators Association of Nigeria (TOOAN), Niger State
10. Machine and Equipment Corporation Africa (MECA), Niger State
11. Federal University of Technology, Minna, Niger State
12. Ibrahim Badamosi Babangida University, Lapai, Niger State
13. College of Education, Minna, Niger State
14. The Federal Polytechnic, Bida, Niger State
15. Technical University, Ibadan
16. Federal College of Agriculture, Ibadan
17. Federal College of Forestry, Ibadan
18. National Centre for Agricultural Mechanization (NCAM)

Results and Discussion

The types of institutions considered for the research included universities, mid-level colleges and polytechnics, of both private and public nature. There were limited institutions providing capacity building skills to support tractor operation and maintenance; these were public universities (53.8%), mid-level colleges (38.5%) and polytechnics (7.7%) (Table 1). The results

were in contrary to that of Wahab (2020) who discovered that polytechnics and mid-level colleges with agricultural engineering department were more than universities in Nigeria. The average age of private institutions was 34 years, while this was 37 years for public institutions. This was in line with the findings of Ogunsina and Taiwo (2018) that observed most of the public institutions running agricultural engineering programme were established about 35 years ago. This indicated that public institutions were older than private ones in Nigeria. Also, teaching staff constituted majority (69.2%) of workers in public institutions, while management staff were the majority (66.7%) in private institutions.

Table 1. Types of Institution

Type of institution	Public (n=14)	Private (n=3)
a. University	53.8	0
b. Mid-level college	38.5	33.3
c. TVET	0	0
d. Local/village polytechnic	7.7	0
e. Other (short term)	0	66.7
Average age of institution (years)	37	7
Number of branches (including head branch)	4	1
Years worked in the institution (n=17)	17.7 (SD=12.56)	6.33 (SD=9.3)
Respondent's post/role in this institution:		
a. Management	30.8	66.7
b. Administrative	0	0
c. Teaching	69.2	0
d. Support staff	0	33.3
e. Other		

a. Historical Information of the Sampled Institutions

The ability of institutions to impart knowledge depend on the number and quality of staff employed. The total number of people working in the universities increased from 18 in 2017 to 1035 in 2018. In the same vein, the number of teachers/lecturers in the institutions increased from 4 in 2017 to 259 in 2018. The number of male students who enrolled at the institutions decreased (though with a very small margin) from 118 in 2017 to 117 in 2018, while that of female enrolment decreased very sharply from 118 (in 2017) to 64 (in 2018). Eighty-three percent (83%) of the institutions had mission statements and strategic plans.

In the Mid-level Colleges between 2014 and 2015, the number of both teaching and non-teaching staff increased by 63%, but then continually decreased from 2015 to 2018.

In the Polytechnics, the number of people working in the institutions between 2017 and 2018 remained the same (3,380) (Table 2). There was a slight decrease in the number of teachers/lecturers working in the institutions between 2017 and 2018, from 814 to 809 respectively. The number of male students at the institutions decreased very sharply from 9,920 in 2017 to 1,682 in 2018, while that of female students increased from 13,208 in 2017 to 15,211 in 2018. All the institutions had mission statements and strategic plans.

Table 2: Historical Information of the Institutions

Table 2a: The Universities

Category 1: Universities	**2018**	**2017**	**2016**	**2015**	**2014**	**Year of establishment**
Number of people (irrespective of designation) work /worked in this institution in:	1035	18	-	-	-	-
Number of teachers/lecturers' work/worked in institution in:	259	4	-	-	-	-
Number of male students are/were enrolled in institution in:	117	118	-	-	-	-
Number of female students are/were enrolled in institution in:	64	118	-	-	-	-
Have a vision and/or mission statement (n=5)	83%					
When was vision and/mission statement updated?	2017					
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done	3					
Have a strategic plan (n=5)	83%					
Number of years before current strategic plan run out	93					

Table 2b: Colleges

Category 2: Mid-College Level	**2018**	**2017**	**2016**	**2015**	**2014**	**Year of establishment**
Number of people (irrespective of designation) work /worked in this institution in:	952	1170	1331	1433	882	
Number of teachers/lecturers work/worked in institution in:	421	397	458	376	292	
Number of male students are/were enrolled in institution in:	1047	1193	942	1372	739	
Number of female students are/were enrolled in institution in:	574	535	424	712	492	
Have a vision and/or mission statement (n=6)	100%					
Number of years since the vision and/mission statement was updated	4068					
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done	2024					

Have a strategic plan (n=4)	60%	
Number of years before current strategic plan run out?	30	

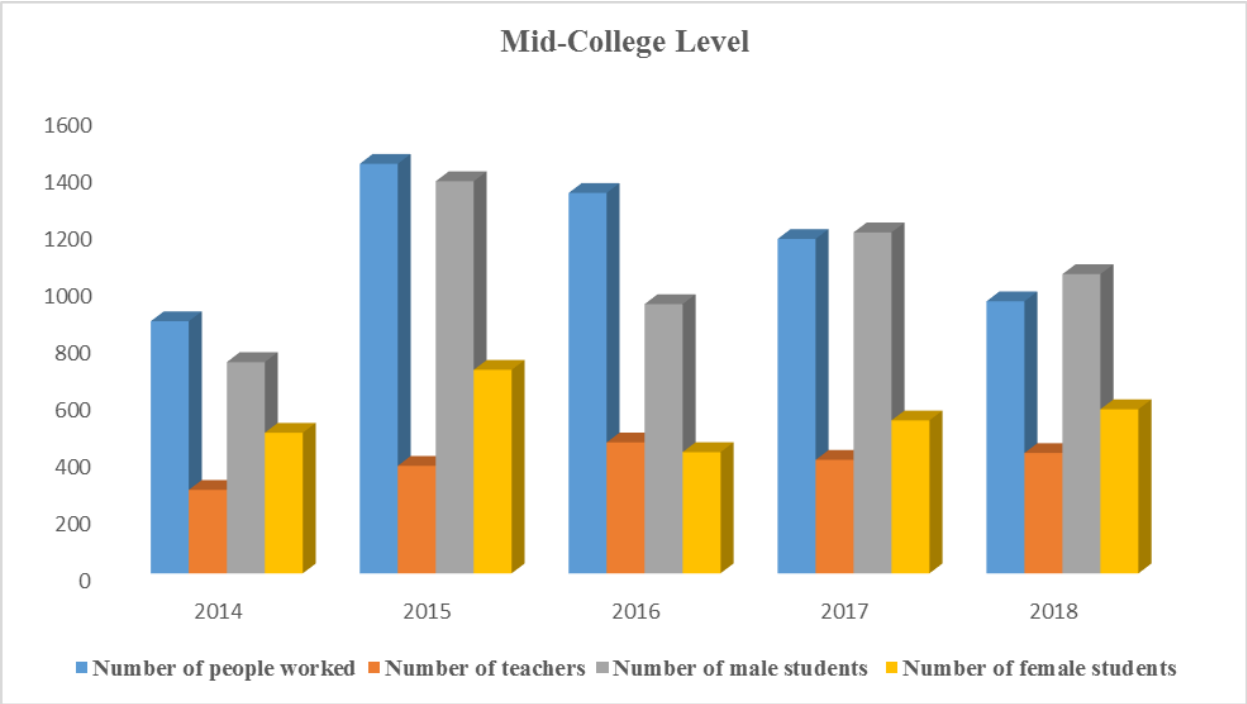


Figure 1: Mid-College Information

Table 2c: TVET

Category 3: TVET	2018	2017	2016	2015	2014	Year of establishment
Number of people (irrespective of designation) work /worked in this institution in:	-	-	-	-	-	-
Number of teachers/lecturers' work/worked in institution in:	-	-	-	-	-	-
Number of male students are/were enrolled in institution in:	-	-	-	-	-	-
Number of female students are/were enrolled in institution in:	-	-	-	-	-	-
Have a vision and/or mission statement (n=6)	-					
Number of years since the vision and/mission statement was updated	-					
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done	-					
Have a strategic plan (n=4)	-					
Number of years before current strategic plan run	-					

out?		

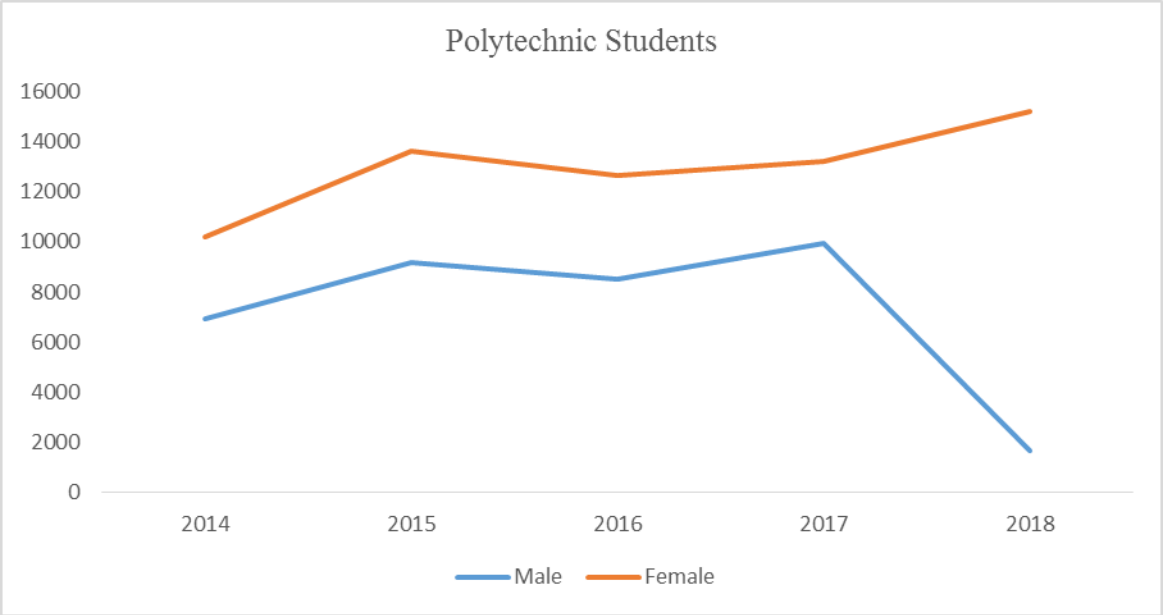


Figure 2: Polytechnic Information

Table 2d: Polytechnic

Category 4: Local/Village Polytechnic	**2018**	**2017**	**2016**	**2015**	**2014**	**Year of establishment**
Number of people (irrespective of designation) work /worked in this institution in:	3380	3380	3389	3389	3392	2014
Number of teachers/lecturers work/worked in institution in:	809	814	814	817	817	1957
Number of male students are/were enrolled in institution in:	1682	9920	8509	9200	6923	-
Number of female students are/were enrolled in institution in:	15211	13208	12633	13621	10211	-
Have a vision and/or mission statement (n=1)	100%					
Number of years since the vision and/mission statement was updated	3					
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done	2					
Have a strategic plan (n=1)	100%					
Number of years before current strategic plan run out?	-					

Table 2e: Others

Category 5: Others	**2018**	**2017**	**2016**	**2015**	**2014**	**Year of establishment**
Number of people (irrespective of designation) work /worked in this institution in:	180	25	10	-	-	
Number of teachers/lecturers work/worked in institution in:	10	5	3	-	-	-
Number of male students are/were enrolled in institution in:	57	15	10	-	-	-
Number of female students are/were enrolled in institution in:	2	-	-	-	-	2018
Have a vision and/or mission statement (n=2)	10%					
Number of years since the vision and/mission statement was updated	2016					
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done	2017					
Have a strategic plan (n=1)	50%					
Number of years before current strategic plan run out?	1					

Table 3: Historical Information of the Institution (Public vs Private) in 2018

Category 1: Universities	**Public**	**Private**	**Statistical difference**	
Number of people (irrespective of designation) working in 2018	1038	-		
Ave. number of people (irrespective of designation) working in 2014-2017:	18	-		
Number of teachers/lecturers working in 2018	259	-		
Ave. number of teachers/lecturers working in 2014-2017:	4	-		
Number of male students are enrolled in 2018	117	-		
Ave. number of male students are enrolled in 2014-2017:	118	-		
Number of female students enrolled in 2018	64	-		
Ave. number of female students	118	-		

enrolled in 2014-2017:				
Have a vision and/or mission statement (n=1)	83%	-		
Number of years since the vision and/mission statement was updated	2017	-		
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done	2017	-		
Have a strategic plan (n=1)	83%	-		
Number of years before current strategic plan run out?	93	-		

Category 2: Mid-College Level	**Public**	**Private**
Number of people (irrespective of designation) working in 2018	952	-
Ave. number of people (irrespective of designation) working in 2014-2017:	908	-
Number of teachers/lecturers working in 2018	421	-
Ave. number of teachers/lecturers working in 2014-2017:	381	-
Number of male students are enrolled in 2018	1047	-
Ave. number of male students are enrolled in 2014-2017:	1062	-
Number of female students enrolled in 2018	574	-
Ave. number of female students enrolled in 2014-2017:	541	-
Have a vision and/or mission statement (Public n=2, Private n=1)	100%	100%
Number of years since the vision and/mission statement was updated		29
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done	-	5
Have a strategic plan (n=1)	60%	100%
Number of years before current strategic plan run out?	30	1

Category 3: TVET	**Public**	**Private**
Number of people (irrespective of designation) working in 2018	-	-
Ave. number of people (irrespective of designation) working in 2014-2017:	-	-
Number of teachers/lecturers working in 2018	-	-

Ave. number of teachers/lecturers working in 2014-2017:	-	-
Number of male students are enrolled in 2018	-	-
Ave. number of male students are enrolled in 2014-2017:	-	-
Number of female students enrolled in 2018	-	-
Ave. number of female students enrolled in 2014-2017:	-	-
Have a vision and/or mission statement (n=2)	-	-
Number of years since the vision and/mission statement was updated	-	-
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done	-	-
Have a strategic plan (n=1)	-	-
Number of years before current strategic plan run out?	-	-

Category 4: Local/Village Polytechnic	**Public**	**Private**
Number of people (irrespective of designation) working in 2018	3380	-
Ave. number of people (irrespective of designation) working in 2014-2017:	3388	-
Number of teachers/lecturers working in 2018	809	-
Ave. number of teachers/lecturers working in 2014-2017:	816	-
Number of male students are enrolled in 2018	1682	-
Ave. number of male students are enrolled in 2014-2017:	8638	-
Number of female students enrolled in 2018	15211	-
Ave. number of female students enrolled in 2014-2017:	12419	-
Have a vision and/or mission statement (n=1)	100	-
Number of years since the vision and/mission statement was updated	3	-
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done	2	-
Have a strategic plan (n=1)	100	-
Number of years before current strategic plan run out?	-	

Category 5: Others	Public	Private
Number of people (irrespective of designation) working in 2018	-	180
Ave. number of people (irrespective of designation) working in 2014-2017:	-	17.5
Number of teachers/lecturers working in 2018	-	10
Ave. number of teachers/lecturers working in 2014-2017:	-	4
Number of male students are enrolled in 2018	-	57
Ave. number of male students are enrolled in 2014-2017:	-	12.5
Number of female students enrolled in 2018	-	2
Ave. number of female students enrolled in 2014-2017:	-	-
Have a vision and/or mission statement (n=2)	-	10%
Number of years since the vision and/mission statement was updated	-	5
Number of years since the last needs (knowledge, skills, & attitudes) assessment was done	-	-
Have a strategic plan (n=1)	-	50%
Number of years before current strategic plan run out?	-	1

Programme Description (all programmes)

This section discusses the various programmes undertaken by the sampled institutions. The discussion includes the number of applicants, student enrolled, and students who completed the courses, as well as number of drop-outs. Furthermore, the accreditation body, as well as year of accreditation were discussed. About 40 programmes (including engineering, agriculture, environmental studies, and business management courses at PhD, MSc, BSc, HND and ND levels) were identified.

Mechanical, civil and agricultural engineering were the most sought courses (by male) in the engineering field. Female applicants preferred chemical, petroleum and agricultural bio-environmental engineering. This buttressed the findings of Ogunsina and Taiwo (2018) who stated that more male applied for agricultural and mechanical engineering courses than female. Software engineering was the least course applied for in the engineering field. More than 74% of male students who enrolled for mechanical engineering completed the course, while less than 2% dropped out. Also, 87.5% of female students that enrolled for chemical engineering completed the course. Over 98% of male students who enrolled for electrical engineering completed the course. The number of male dropouts was highest in electrical electronics engineering, while female drop-out was highest in civil engineering.

a. Universities

For agricultural engineering programme in the universities, average number of applicants was 19 male and 3 female, which was ratio 6:1. This shows that female students applying for agricultural engineering programme were far below their male counterparts. The result was in line with that of Aderemi et al. (2009), who found that female enrolment in engineering/ technology was below 30% in most Nigerian institutions. Also, Mohammed and Abdulquadri (2012) reported a ratio of 40/60 for women/men involvement in agricultural production and advocated equitable participation for women and men for increased productivity, especially in reducing postharvest losses. Additionally, Ogunsina and Taiwo (2018) illustrated a typical scenario in their study on Obafemi Awolowo University, Nigeria, where an average of 5 female students enrolled for agricultural engineering per session in 10 years, constituting about 16% of the class. Although the number rose to 12 in a particular year, the percentage (15%) was still in the same range. Mohammed and Abdulquadri (2012) concluded that low enrolment of female students has limitations in the presence of female in agricultural engineering.

A. University

List of programs offered in this institution	Total number of applicants		Total number enrolled		Number of those that completed the program (last graduation)		Number of those that dropped out of the program in the last graduating group		Is this program accredited?	body Accredited to	Year accredited
	Male	Female	Male	Female	Male	Female	Male	Female			
Agric Engineering	19	3	10	1	-	-	-	-	-	NUC	-
Biomedical Engineering	26	20	16	7	-	-	-	-	-	-	-
Cyber Security	24	3	7	2	-	-	-	-	-	-	-
Food Science and Technology	21	4	4	4	-	-	-	-	-	-	-
Industrial Chemistry	13	21	9	3	-	-	-	-	-	-	-
Mechanical Engineering	12	23	9	7	-	-	-	-	-	-	-
Mechatronic Engineering	28	0	4	9	-	-	-	-	-	-	-
Microbiology	24	14	14	0	-	-	-	-	-	-	-
Petroleum Engineering	21	33	15	3	-	-	-	-	-	-	-
Physics With Elect	18	4	9	17	-	-	-	-	-	-	-
Software Engineering	4	9	6	3	-	-	-	-	-	-	-
Statistics	16	5	4	8	-	-	-	-	-	-	-
computer science	0	0	6	3	-	-	-	-	-	-	-
BSc Agric Eng	0	0	0	0			-	-	Yes	COREN and NUC	2018

MSc Agric Eng	-	-	-	-	-	-	-	-	Yes	COREN and NUC	2018
Power and Mech	-	-	-	-	-	-	-	-	Yes	COREN and NUC	2018
Soil and Water	-	-	-	-	-	-	-	-	Yes	COREN and NUC	2018
Processing	-	-	-	-	-	-	-	-	Yes	COREN and NUC	2018
Plug Agric Eng	-	-	-	-	-	-	-	-	Yes	COREN and NUC	2018
Power and Mech	-	-	-	-	-	-	-	-	Yes	COREN and NUC	2018
Soil and Water	-	-	-	-	-	-	-	-	Yes	COREN and NUC	2018
Processing	-	-	-	-	-	-	-	-	Yes	COREN and NUC	2018
B.Agric Engr	-	-	-	-	-	-	-	-	Yes	NUC	2016
Msc Agric Engrg	-	-	-	-	-	-	-	-	Yes	NUC	2017
Farm Power and Mech	-	-	-	-	-	-	-	-	Yes	NUC	2017
Soil and Water	-	-	-	-	-	-	-	-	Yes	NUC	2017
Crop Process and Storage	-	-	-	-	-	-	-	-	Yes	NUC	2017
PhD Agric Engrg	-	-	-	-	-	-	-	-	Yes	NUC	2017
Farm Power and Mech	-	-	-	-	-	-	-	-	Yes	NUC	2018
Soil and Water Conserv.	-	-	-	-	-	-	-	-	Yes	NUC	2018
farm power and mech	-	-	-	-	-	-	-	-	Yes	NUC	2010
soil and water	-	-	-	-	-	-	-	-	Yes	NUC	2005
crop processing and storage	-	-	-	-	-	-	-	-	Yes	NUC	2015
water and aquaculture	-	-	-	-	-	-	-	-	Yes	NUC	2016
agric economics and ext	-	-	-	-	-	-	-	-	Yes	NUC	2016
crop production	-	-	-	-	-	-	-	-	Yes	NUC	2017
Mean (S.D.) for the 2 universities for all programs											

B. Mid-Level College

List of programs offered in this institution	Total number of applicants		Total number enrolled		Number of those that completed the program (last graduation)		Number of those that dropped – out of the program in the last graduating group		Is this program accredited ?	body Accredited to	Year accredited
	Male	Female	Male	Female	Male	Female	Male	Female			
ND Forestry Tech	-	-	-	-	-	-	-	-	1	NBTE	-
ND Horticulture	-	-	-	-	-	-	-	-	1	NBTE	-
ND Wood and Paper	-	-	-	-	-	-	-	-	1	NBTE	-
ND Forestry Tech	-	-	-	-	-	-	-	-	1	NBTE	-
HND Agric Extention	-	-	-	-	-	-	-	-	1	NBTE	-
HND Crop production	-	-	-	-	-	-	-	-	1	NBTE	-
HND Wood Tech	-	-	-	-	-	-	-	-	1	NBTE	-
ND Agric Tech	140	60	86	75	100	31	0	2	1	NBTE	2011
ND Agric Engineering	64	6	64	6	50	10	-	-	1	NBTE	2011
ND Home and rurals	5	13	5	13	20	12	-	-	1	NBTE	2012
HND farm power	36	13	36	13	30	9	-	-	1	NBTE	2011
HND crop production	15	6	15	6	25	10	-	-	1	NBTE	2011
HND Pest Control	5	4	5	4	45	10	-	-	1	NBTE	2013
HND Animal Production	21	15	21	15	14	10	-	-	1	NBTE	2012
HND Agric. Extension	19	16	19	16	3	1	-	-	1	NBTE	2011
HND Post Harvest	35	7	35	7	0	0	-	-	1	NBTE	2012
HND Horticulture	1	0	1	0	0	0	-	-	1	NBTE	2012
ND Agric. Eng	-	-	17	7	17	5	0	2	1	NBTE	-
HND Agric. Eng	-	-	12	0	5	0	7	0	1	NBTE	-
HND AEM	-	-	11	17	11	9	0	2	1	NBTE	-

HND CPT	-	-	9	2	5	2	4	0	1	NBTE	-
ND AGT	-	-	23	6	19	6	4	0	1	NBTE	-
ND FOT	-	-	9	2	4	2	5	0	1	NBTE	-
HND FOT	-	-	11	1	7	1	4	0	1	NBTE	-
ND FOT	-	-	4	1	4	1	0	0	1	NBTE	-
HND HLT	-	-	15	7	11	5	4	2	1	NBTE	-
ND	-	-	14	10	13	5	1	5	1	NBTE	-
National Diploma in Agricultural Technology	150	13	80	11	53	10	-	-	1	NBTE	2,013
National Diploma in Horticultural Technology	16	0	11	0	23	3	-	-	1	NBTE	2,013
National Diploma in Science Laboratory Technology	83	117	62	70	37	41	-	-	1	NBTE	2,010
National Diploma in Food Technology	10	27	5	21	3	21	-	-	1	NBTE	2,010
National Diploma in Computer Science	70	65	64	43	57	33	-	-	1	NBTE	2,016
Higher National Diploma in Agricultural Extension Management	59	28	46	19	18	3	-	-	1	NBTE	2,016
Higher National Diploma in Pest Management Technology	11	8	9	6	7	1	-	-	1	NBTE	2,016
National Diploma in Statistics	46	27	41	13	30	11	-	-	2	NBTE	2,015
National Diploma in Animal Health and Production Technology	78	31	45	24	30	6	-	-	2	NBTE	2,017
ND Agric Tech	-	-	-	-	-	-	-	-	1	NBTE	-
ND animal health & prod	-	-	-	-	-	-	-	-	1	NBTE	-
ND Home and rurals	-	-	-	-	-	-	-	-	1	NBTE	-
HND agric ext & mgmt.	-	-	-	-	-	-	-	-	1	NBTE	-
HND crop production	-	-	-	-	-	-	-	-	1	NBTE	-
HND pest mgmt.	-	-	-	-	-	-	-	-	1	NBTE	-
HND Home & Rural Econs	-	-	-	-	-	-	-	-	1	NBTE	-
Mean (S.D.) for the 5 college for all programs											

C. Village Level polytechnic

List of programs offered in this institution	Total number of applicants		Total number enrolled		Number of those that completed the program (last graduation)		Number of those that dropped – out of the program in the last graduating group		Is this program accredited d?	body Accredited to	Year accredited
	Male	Female	Male	Female	Male	Female	Male	Female			
Agric and Bio-environment engineering	162	84	153	77	146	73	7	4	1	NBTE	-
Civil Engineering	210	96	205	89	192	79	13	10	1	NBTE	-
Chemical Engineering	171	88	168	86	165	82	3	4	1	NBTE	-
Mechanical Engineering	316	53	301	48	293	43	8	5	1	NBTE	-
Electrical Engineering	382	103	378	93	371	86	7	7	1	NBTE	-
URP	166	110	161	103	158	101	3	2	1	NBTE	-
estate management	141	109	139	108	137	105	2	3	1	NBTE	-
building technology	152	132	148	129	144	126	4	3	1	NBTE	-
quantity survey	171	167	166	163	162	158	4	5	1	NBTE	-
survey and general information	181	159	179	156	171	153	8	3	1	NBTE	-
architectural tech	189	71	186	68	181	62	5	6	1	NBTE	-
computer science	601	3066	579	3059	567	3041	12	18	1	NBTE	-
nutrition and dietics	510	812	506	808	501	792	5	16	1	NBTE	-
hospitality management	102	203	99	198	96	194	3	4	1	NBTE	-
mass communication	101	219	94	216	91	209	3	7	1	NBTE	-
Accounting	503	2698	501	2691	482	2683	19	8	1	NBTE	-
business management	213	432	211	426	202	417	9	9	1	NBTE	-
public administration	609	2523	603	2511	571	2491	32	20	1	NBTE	-
banking and finance	710	3011	698	3002	691	2989	7	13	1	NBTE	-

	121	423	118	419	115	413	3	5	1	NBTE	-
Mean (S.D.) for the 1 polytechnic for all programs											

D. Others

List of programs offered in this institution	Total number of applicants		Total number enrolled		Number of those that completed the program (last graduation)		Number of those that dropped – out of the program in the last graduating group		Is this program accredited?	body Accredited to	Year accredited	
	Male	Female	Male	Female	Male	Female	Male	Female				
farm machinery repair/maintenance	25	0	20	0	10	0	3	1	1	1	FMARD	2018
farm machinery and maintenance	70	0	65	0	45	0	0	1	2	0	FRSC	2019
Training of agric contractors	10	0	10	0	5	0	3	2	0	0	-	2019
capacity building, ICL	180	0	180	0	0	0	0	0	0	0	-	-

a) Universities

Agricultural mechanization program	Expected types of jobs/ occupations for graduates		
	Government employment	Private-sector employment	Self-employment
1. Youth Empowerment	16.67% (n=6)	16.67% (n=6)	33%% (n=6)
2. BSC	50% (n=6)	33%% (n=6)	33%% (n=6)
3. B.Tech	50% (n=6)	33%% (n=6)	33%% (n=6)
4.			

b) Colleges for Short-term Training

Agricultural mechanization program	Expected types of jobs/ occupations for graduates			
	Government employment	Private-sector employment	Self-employment	Others
farm power and machinery	66%(N=6)	50% (n=6)	33.33% (n=6)	25% (n=6)
HND Crop Production	33.33% (n=6)	50% (n=6)	33.33% (n = 6)	25% (n=6)
ND Agric Eng	-	-	25% (n=6)	-
ND Agric. Tech				

a) Universities

Agricultural mechanization program	If you had the opportunity to restructure program, would you recommend change to content of courses of training within the program?		
	YES, highly recommend	YES, recommend	NO; not recommend
1. Agriculture	100% (n=1)	-	-

Information on the Teaching/Instruction Staff

a. University Level

Part-time staff were more than permanent staff in the universities. The result shows regular staff constituting 47%, while temporary staff were 53%. The average years of teaching experience was 23. For staff in training, 43.8% were undergoing PhD, whereas 36.6% were undergoing master's programme. Seventy-two percent (72%) indicated that they highly recommended further training for the staff, the areas of training mostly desired being technical competencies (20.5%), hands-on skills equipment (26.4%), curriculum development (21.8%), IT, communication & interpersonal skills (31.38%).

Type of staff	Characteristics of the Teaching/Instructing staff			
	Ave. age	Gender (%female)	Years of teaching / instructing in current institute	Total years of teaching / instructing
Regular (long-term contracted / permanent)	47.53	7.32	23	24.73
Temporary (short-term contract) / part-time	53	92.68 (n=82)	-	-

Type of staff	Highest level of education				
	University postgraduate (PhD)	University postgraduate (Master or equiv.)	University graduate (bachelors or equiv.)	Technical training (higher diploma or equiv.)	Other
Regular (long-term contracted / permanent)	43.82%	36.62	12.5%	13.64	-
Temporary (short-term contract) / part-time	100 (n,1)	-	-	-	

Type of staff:	Would you recommend further training for the staff?			
	Highly recommend	Recommend	Indifferent	Not recommend
Regular (long-term contracted / permanent)	72.22% (n=72)	27.78%(n=72)	-	-
Temporary (short-term contract) / part-time	100 (n=1)	-	-	-

Type of staff:	Type of further training recommend for the staff				
	core / course technical competencies	Hands-on skills equipment / machine	Curriculum development	IT, communication & interpersonal skills	Other
Regular (long-term contracted / permanent)	20.50% (n=239)	26.35% (n=239)	21.76%(n=239)	31.38% (n=239)	0.42% (239)

b. Mid-level college

Similarly, part-time staff were more than permanent staff in mid-level colleges, as it was in the universities. The results show that regular staff were 48%, while the average years of teaching experience was 18. For staff in training, 67% were undergoing PhD, whereas 33% were undergoing master's programme. Seventy-two percent (72%) recommended further training for staff in such areas as technical competencies (42.9%), hands-on skills equipment (28.6%) and curriculum development (28.6%).

Type of staff	Characteristics of the teaching/instructing staff			
	Ave. age	Gender (%female)	Years of teaching / instructing in current institute	Total years of teaching / instructing
Regular (long-term contracted / permanent)	48	100 (n=3)	17.67	17.67

Type of staff	Highest level of education				
	University postgraduate (PhD)	University postgraduate (Master or equiv.)	University graduate (bachelors or equiv.)	Technical training (higher diploma or equiv.)	Other
Regular (long-term contracted / permanent)	66.67(n=3)	33.33% (n=3)	-	-	

Type of staff:	Would you recommend further training for the staff?			
	Highly recommend	Recommend	Indifferent	Not recommend
Regular (long-term contracted / permanent)	66.67(n=3)	33.33% (n=3)	-	-

Type of staff:	Type of further training recommend for the staff

	core / course technical competencies	Hands-on skills equipment / machine	Curriculum development	IT, communication & interpersonal skills	Other
Regular (long-term contracted / permanent)	42.86% (n=7)	28.57%(n=7)	28.57%(n=7)	-	

c. Local/Village polytechnic

Part-time staff were more than permanent staff of local polytechnics. The result shows that regular staff were 47%, with an average of 18 years teaching experience. For staff in training, 42% were undergoing PhD while 58% were undergoing master's programme. All the respondents recommended further training for staff, in the area of technical competencies (100%).

Type of staff	Characteristics of the teaching/instructing staff			
	Ave. age	Gender (% female)	Years of teaching / instructing in current institute	Total years of teaching / instructing
Regular (long-term contracted / permanent)	47	0%(n=12)	15.08	-

Type of staff	Highest level of education				
	University postgraduate (PhD)	University postgraduate (Master or equiv.)	University graduate (bachelors or equiv.)	Technical training (higher diploma or equiv.)	Other
Regular (long-term contracted / permanent)	41.67	58.33	-	-	

Type of staff:	Would you recommend further training for the staff?			
	Highly recommend	Recommend	Indifferent	Not recommend
Regular (long-term contracted / permanent)	100 (n=1)	-	-	-

Type of staff:	Type of further training recommend for the staff				
	core / course technical competencies	Hands-on skills equipment / machine	Curriculum development	IT, communication & interpersonal skills	Other
Regular (long-term contracted / permanent)	100 (n=1)	-	-	100 (n=1)	

Temporary (short-term contract) / part-time	-	-	-	-	

Program Content, Admission and Delivery (Regular Courses)

a. Universities

There were 40 core and 4 optional courses that students in the university offered. The number of students who signed for the courses were 2,062, while the lecturers were 253. Some students dropped some courses due to lack of fees, lack of interest and irrelevance of the courses.

Program content, admission and delivery (Universities)

	Short	Regular	Difference
Nature of the course			
Compulsory (core)	40	37	3
Optional (selective)	4	7	3
Total number of students signed for the course	2062	1595	467
Total number of lecturers who can teach this course	253	173	80
Number of students that completed (last academic year)	2062	1280	782
Number of those that dropped–out of the course in the last graduating group	82	39	43
Reasons for dropping out:			
Lack of fees	13	11	2
Lack of interest	21	11	10
Program difficult	0	0	
Program irrelevant	1	0	1
Other	0	0	
Proportion of the course that is hands-on (%)	37	46	9
Time it takes to complete (months)			
Months	100%(n=45)	100%(n=24)	
Weeks			
Days			
Adequacy of this course in terms of its ability to produce graduates with the required knowledge and skills			
Excessive		-	
Adequate	100% (n=45)	100% (n =29)	
Inadequate			

a. Mid-level colleges

There were 15 short core courses (optional courses were not reported) that students in mid-level colleges studied. The number of students who signed for the courses were 2,062, while the

lecturers were 253. Also, some students dropped some courses because of lack of fees, lack of interest and irrelevance of the courses.

College	Short	Regular	Difference
Nature of the course			
Compulsory (core)	15	1	14
Optional (selective)			
Total number of students signed for the course	282	0	282
Total number of lecturers who can teach this course	63	10	53
Number of students that completed (last academic year)	294	0	294
Number of those that dropped–out of the course in the last graduating group	0	0	
Reasons for dropping out:	-	-	
Lack of fees	-	-	
Lack of interest	-	-	
Program difficult	-	-	
Program irrelevant	-	-	
Proportion of the course that is hands-on (%)	90		
Time it takes to complete (months)			
Months	100%(n=15)		
Excessive			
Adequacy of this course in terms of its ability to produce graduates with the required knowledge and skills?			
Adequate	100%(n=15)		

C. Local/village polytechnic

There were 15 short core courses that students in local polytechnics studied; no optional course was reported. The number of students who signed for the courses were 2,062, with 253 lecturers teaching the courses. Some students also dropped some courses due to lack of fees, lack of interest and irrelevance of the course.

Polytechnic	Short	Regular	Difference
Nature of the course		-	
Compulsory (core)	8	-	
Optional (selective)	2	-	
Total number of students signed for the course	205	-	
Total number of lecturers who can teach this course	-	-	
Number of students that completed (last academic year)	-	-	
Number of those that dropped out of the course in the last graduating group	58	-	
Reasons for dropping out:	-	-	

Lack of fees		-	
Lack of interest		-	
Program difficult		-	
Program irrelevant		-	
Other		-	
Proportion of the course that is hands-on (%)	80	-	
time it takes to complete (months)		-	
Months	60%(n=10)	-	
Weeks		-	
Days		-	
Adequacy of this course in terms of its ability to produce graduates with the required knowledge and skills?	-	-	
Excessive		-	
Adequate		-	
Inadequate		-	

D. Others

	Short	**Regular**	**Difference**
Nature of the course		-	
Compulsory (core)	4	3	
Optional (selective)		-	
Total number of students signed for the course	80	195	
Total number of lecturers who can teach this course	12	9	
Number of students that completed (last academic year)	40	135	
Number of those that dropped–out of the course in the last graduating group	12	-	
Reasons for dropping out:	-	-	
Lack of fees		-	
Lack of interest		-	
Program difficult		-	
Program irrelevant		-	
Other		-	
Proportion of the course that is hands-on (%)	85	87	
time it takes to complete (months)		-	
Months	75%(n=4)	-	
Weeks		75% (n=4)	
Days		-	
Adequacy of this course in terms of its ability to produce graduates with the required knowledge and skills?	-	-	
Excessive		-	
Adequate	100%(n=4)	75% (n=4)	

Inadequate		-	

i. Resources and finances

Category 1: Universities	Public	Private	Statistical difference
Total budget in 2018	1,016,722,312	-	1,016,722,312
Ave. Annual average total budget in 2014-2017:	58,923,756	-	58,923,756
Annual total budget for agricultural mechanization department/program in 2018	-	-	-
Annual average total budget for agricultural mechanization department/program in 2014-2017:	-	-	-
Sources of institute's finances (%)			
Government grants	90	-	
Student fees/levies	5	-	
Bank loans	-	-	
Third-party funds (e.g. donors)	-	-	
Own sources (e.g. business)	5	-	
Other	-	-	
Agricultural mechanization program only			
Proportion of students (%) financing (paying fees) their studies by:			
Government grants	-	-	
Own sources (e.g. family savings)	-	-	
Other scholarships	-	-	
Other	-	-	

University	Ranking of current status of the resources (No.)			
Type of Resource:	Excessive	Adequate	Inadequate	Very inadequate
Physical infrastructure (e.g. classes, workshops)	-	1	1	1
Tools, equipment, machinery	-	1	2	1
Textbooks, print media	-	1	2	1
Audio-visual	-	2	1	-
Other	-	-	-	-

Category 2: Mid-level college	Public	Private	Statistical difference
Total budget in 2018	150,000,000	866,415,540	716,415,540
Ave. Annual average total budget in 2014-2017:	151,000,000	619,588,261	468,588,261
Annual total budget for agricultural mechanization department/program in 2018	-	-	
Annual average total budget for agricultural mechanization department/program in 2014-2017:	-	-	
Sources of institute's finances (%)			

Government grants	-	-	
Student fees/levies	-	-	
Bank loans	-	-	
Third-party funds (e.g. donors)	-	-	
Own-sources (e.g. business)	-	-	
Other	-	-	
Agricultural mechanization program only			
Proportion of students (%) financing (paying fees) their studies by:			
Government grants	-	-	
Own sources (e.g. family savings)	-	-	
Other scholarships	-	-	
Other	-	-	

Mid-level college	**Ranking of current status of the resources (No.)**			
Type of resource:	Excessive	Adequate	Inadequate	Very inadequate
Physical infrastructure (e.g. classes, workshops)	-	-	-	-
Tools, equipment, machinery	-	-	-	-
Textbooks, print media	-	-	-	-
Audio-visual	-	-	-	-
Other	-	-	-	-

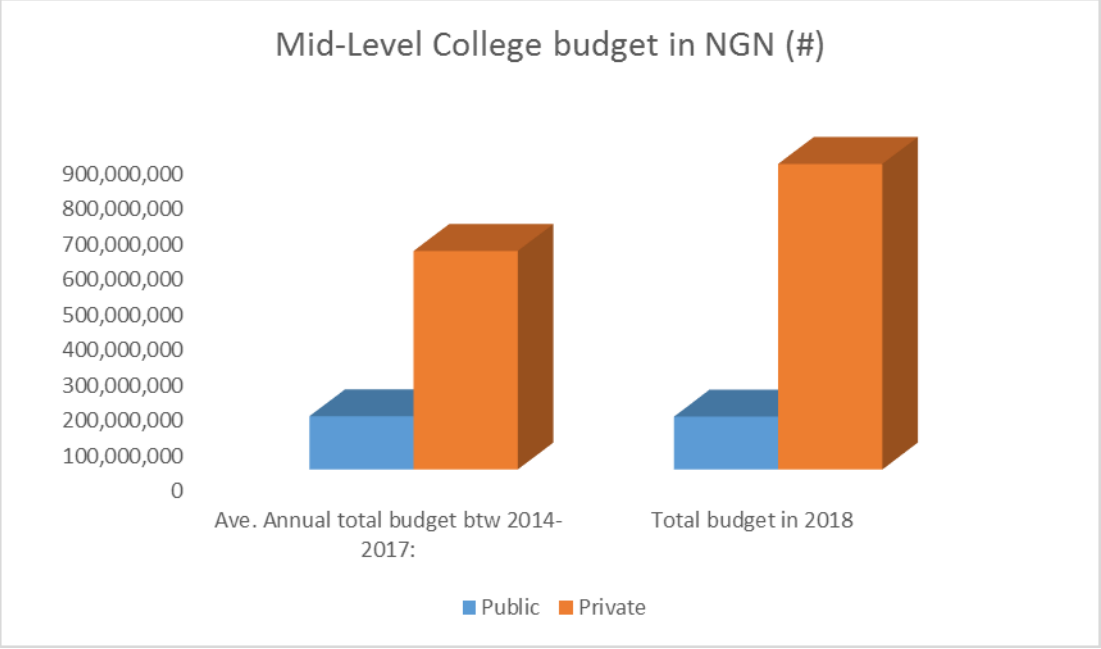


Figure: Difference between Public and Private Budget

Category 3: Others	**Public**	**Private**	**Statistical difference**

Total budget in 2018	-	4,000,000	4,000,000
Ave. Annual average total budget in 2014-2017:	-	30,125,000	30,125,000
Annual total budget for agricultural mechanization department/program in 2018	-	1,500,000	1,500,000
Annual average total budget for agricultural mechanization department/program in 2014-2017:	-	1,175,000	1,175,000
Sources of institute's finances (%)	-	-	
Government grants	-	-	
Student fees/levies	-	50	
Bank loans	-	-	
Third-party funds (e.g. donors)	-	-	
Own-sources (e.g. business)	-	50	
Other	-	-	
Agricultural mechanization program only			
Proportion of students (%) financing (paying fees) their studies by:			
Government grants	-	-	
Own sources (e.g. family savings)	-	-	
Other scholarships	-	-	
Other	-	-	

Others	**Ranking of current status of the resources (No.)**			
Type of resource:	**Excessive**	**Adequate**	**Inadequate**	**Very inadequate**
Physical infrastructure (e.g. classes, workshops)	-	-	1	-
Tools, equipment, machinery	-	1	-	-
Textbooks, print media	-	-	1	-
Audio-visual	-	1	-	-
Other	-	-	-	-

Linkages with other stakeholders (private sector, companies / organizations, NGOs)

a. Universities

Category of stakeholders	**Ave. number of years of collaboration**	**Type of linkages with this stakeholder (No.)**				
		Financial assistance	**Providing students for training**	**Providing attachment / internships**	**Employment of students**	**Other**
Private sector	-	-	-	-	-	-
Public	14	2	1	2	-	2
NGOs	-	-	-	-	-	-
Other	-	-	-	-	-	-

Category of	**Ever made**	**Nature of Suggestion made (%)**	**Considered**

stakeholders	suggestions concerning study curriculum, delivery methods etc. (%)	Curriculum contents	Course delivery	Other	their suggestions (%)
Private sector	-	-	-	-	-
Public	64.29	64.29	7.14	28.57	64.29
NGOs	-	-	-	-	-
Other	-	-	-	-	-

b. Mid-level college

The result of the analysis indicated that mid-level colleges used to have an average of 5 collaborators in a year, where students go for internships. Also, in order to improve the quality of training received by students, the institutes provided opportunities for the stakeholders to give suggestions from time to time concerning study curriculum, delivery methods and others. All the suggestions (100%) received were from public institutions; while 50% was on curriculum contents development, 50% was on course delivery.

Some of the training schools on agricultural mechanization claimed that most of the suggestions they received were from public institutions; although, they occasionally received from private ones too. All the suggestions received through public institutions were considered, while only 50% of the suggestions received from private organisations was put into use. This could be attributed to the accreditation processes being done from time to time by public organisations; failure to implement the suggestions could lead to the forfeiture of the school training licence.

Category of stakeholders	Ave. number of years of collaboration	Type of linkages with this stakeholder (No.)				
		Financial assistance	Providing students for training	Providing attachment / internships	Employment of students	Other
Private sector	-	-	-	-	-	-
Public (ITF & NBTE)	5	0	0	50	-	50 (Regulate programme)
NGOs	-	-	-	-	-	-

Category of stakeholders	Ever made suggestions concerning study curriculum, delivery methods etc. (%)	Nature of Suggestion made (%)			Considered their suggestions (%)
		Curriculum contents	Course delivery	Other	
Private sector	-	-	-	-	-
Public	100	50	50	0	100
NGOs	-	-	-	-	-

c. OTHERS

Category of stakeholders	Ave. number of years of collaboration	Type of linkages with this stakeholder (No.)				
		Financial assistance	Providing students for	providing attachment	Employment of students	Other (No.)

		(No.)	training (No.)	/ internships (No.)		
Private sector	6	-	-	-	-	-
Public	3	-	-	-	-	-
NGOs	-	-	-	-	-	-

Category of stakeholders	Ever made suggestions on concerning study curriculum, delivery methods etc. (%)	Nature of Suggestion made			Considered their suggestions (%)
		Curriculum contents (%)	Course delivery (%)	Other (%)	
Private sector	66.67	40	60	-	50
Public	100	100	-	-	100
NGOs	-	-	-	-	-

Inventory and Inspection of Physical Resources, Equipment and Tools

Physical inspection of machinery and equipment in the university

Physical inspection of machinery and equipment – University				
Name of machinery/equipment	Working condition (%)		Site where they are used	
	Average	Good	Present (seen)	Absent
Mower	-	-	-	-
Brush Cutter	-	-	-	-

d. Physical inspection of machinery and equipment – Mid-level college						
Name of machinery/equipment	Working condition (%)				Site where they are used (%)	
	Poor/very poor	Average	Good	Excellent	Present (seen)	Absent
Tractors	0	0	0	100	-	-
Plough	0	0	100	0	-	-
Harrows	0	0	0	100	-	-
Ridgers	0	100	0	0	-	-
Trailer	0	0	100	0	-	-
Lincoln Arc welding Machine	0	0	0	100	-	-
Fimer welding machine	0	100	0	0	-	-

Lathe machine	0	0	0	100	-	-
Maize sheller	0	0	0	100	-	-
Milling Machine	0	0	0	100	-	-
Bulldozer						
Mower						
UTM						
Boom Sprayer						
Knapsack sprayer						
Shear force Apparatus						
Trailer						

General Suggestion for Further Development of the Sampled Institutions

The suggested areas required for agricultural knowledge and skills development in the institutions were:

1. Construction of standard workshops in the institutions
2. Agricultural engineering units should be created
3. There should be increase in financial allocation to the institutions for the purpose of training facilities and infrastructural development.
4. More tools and equipment like tractors, planters, harrow, plough, etc should be provided for practicals.
5. Employ more qualified teachers in various institutions
6. There should be frequent training for the staff.

Conclusion and Recommendations

Education in engineering is particularly important to the development of agricultural knowledge and skills in Nigerian institutions. This study has shown that there is poor staff strength in the area of agricultural engineering and finance, and this has implications for the acquisition of agricultural knowledge and skills in various institutions. Teaching staff constituted majority (69.2%) in the public institutions, while management staff were the majority (66.7%) in private institutions. Curriculum and course contents were not attractive to the students, to the extents that some courses were dropped.

Considering the vast agricultural resources that Nigeria has and the strategic position it occupies as Africa's most populous nation, harnessing the education of agricultural engineers towards total agro-industrial development deserves critical attention.

The following recommendations are made:

1. There is an urgent need to develop low level skill support institutions for tractor operation and maintenance.
2. There should be increase in financial allocations to the institutions for the purpose of training facilities and infrastructural development.
3. More tools and equipment like tractors, planters, harrow, plough, etc should be provided to allow for practical experiences in various institutions in order to improve knowledge and training.

4. More young teaching staff should be mentored by old staff in various institutions for the purpose of training in agricultural engineering.
5. Curriculum and course contents need to be redeveloped to make the courses more interesting and attractive.

Study 5: Effects of Agricultural Mechanization on Rural Communities

Daudu, C. K., A. A. Wahab., N. Yarama, AO. Fatunbi, E. O. Adejoh, U. A. Angara and E. T. Omisope

Abstract

The study was conducted to identify the effects of agricultural mechanization on rural communities. Three states (Oyo, Niger and Kaduna) were purposively selected based on farm mechanization (predominantly) practised in the areas. Participatory Impact Diagram (PID) was used in locations where a sub-sample of the interviewed beneficiaries of a machinery programme was located. Different groups (men, women and youths) were chosen from selected communities across the study states. Each group consisted of an average of 12 participants and a total 35 PID were conducted. The data were analysed using descriptive statistical tools of frequency and percentage. The findings revealed that mechanization brought both positive and negative impacts on the study area. Among the positive impacts identified were reduction in drudgery, increase in farm productivity, improved socioeconomic status (some farmers married more wives), access to education for children, increased purchasing power of the household, increase in number of travelling, etc. The negative impacts of mechanization on the rural communities were increase in the rate of unemployment, reduction in soil fertility, increase in soil erosion, increase in conflicts among farmers, and increase in crime rates. The rural communities believed that mechanization has drastically reduced drudgery, saved their time and allowed them to cultivate more lands. It was recommended that the extra income generated through mechanization should be used to expand farmlands and increase farm productivity through procurement of more productive resources.

Introduction

Farm mechanization is a crucial input for agricultural production. Without a review of patterns and progress from around farm power and the appropriate complementary tools, implements and machines, farmers would struggle to emerge from subsistence production. With demands being exerted on the planet's natural capital by the ever-intensifying population pressure, the need for sustainable mechanization becomes increasingly urgent. Over 60% of farm power in sub-Saharan Africa is still provided by people's muscles (mostly from women, the elderly and children); only 25% of farm power is provided by drudge animals and less than 20% of mechanization services are provided by engine power (Kienzle *et al.*, 2013). Tractor use intensity is defined as the number of tractors in use per 1000ha of agricultural land (arable and permanent crops).

When agricultural mechanization/ tractorization replaces traditional labour sources, there is implications for rural employment levels, changes in the urban-rural dual structure and population growth, etc. Tractorization interacts with the rural populace to induce or alleviate poverty (Binswanger and Von Braun, 1991). Tractorization in some instances have been reported to lead to agricultural growth, improve employment opportunities, as well as expansion in food supply. In some other instances, it induced institutional and market failure, with adverse consequences for the poor.

Traditional method of land clearing for food and agricultural production is tedious and involved manual labour with the use of cutlass, axe, hoe and other hand tools. This has reduced youth involvement in agriculture and is the major cause of recurrent movement of the young ones from rural to urban areas. Tractor use in Africa are concentrated in a small number of countries, with 70% in South Africa and Nigeria. If South Africa is excluded, primary land preparation in Africa is estimated to rely entirely on human muscle power of about 80% of cultivated land, with draught

animals used on 15% and tractors on the remaining 5%. In contrast, in Asia, land preparation is performed by tractors on over 60% the cultivated land (FAO, 2008, 2013)
However, inappropriate use of agricultural machinery may also cause some damage to agricultural environment. Therefore, the techniques of environment-friendly agricultural mechanization should be adopted, to bring agricultural mechanization in harmony with the natural environment, maintain the ecological stability and achieve sustainable development. This requires specific mechanization measures to allow crops to be established with minimum soil disturbance, so that the soil can be protected under organic cover for as long as possible.

Sampling, Data Collection and Study Sites

Focus group discussions were held in locations where a sub-sample of the interviewed beneficiaries of a machinery programme or buyers of machinery were located. Different groups were chosen from selected villages across the study states. These groups included women, men and youths separately. Each group consisted of about 12 persons. The interview groups were heterogeneous in terms of the participants' backgrounds.
Three researchers oversaw guiding the discussion process, while two assistants facilitated the discussion process (for example, in taking notes or drawing the impact tree on paper (cf. Figure 1). The results of the discussion were presented on a cardboard paper, placed either at the centre of the group or on a flip chart. Neutral places, such as schools, town halls, or village head residence were used for the conduct of the interview. Tractor owners (or their close family members) were not included in the interview.
In total, 35 focus group discussions were held across the 3 sampled states. Participatory Impact Diagram was used to facilitate the discussions. Participatory Impact Diagrams are tools used to assess the positive and negative impact of development interventions. The protocol used for the research was agreed upon at the training workshops held at the National Agricultural Extension and Research Liaison Services (NAERLS), Ahmadu Bello University, Zaria and Federal Ministry of Agricultural and Rural Development (FMARD), Abuja. The tool was applied separately for men and women to capture gender effects. As part of the discussion, the sub-project aims to investigate who had access to mechanization and how people accessed tractor services.
Information gathered from the groups were digitized and compiled by states and later pooled to obtain a national perspective.

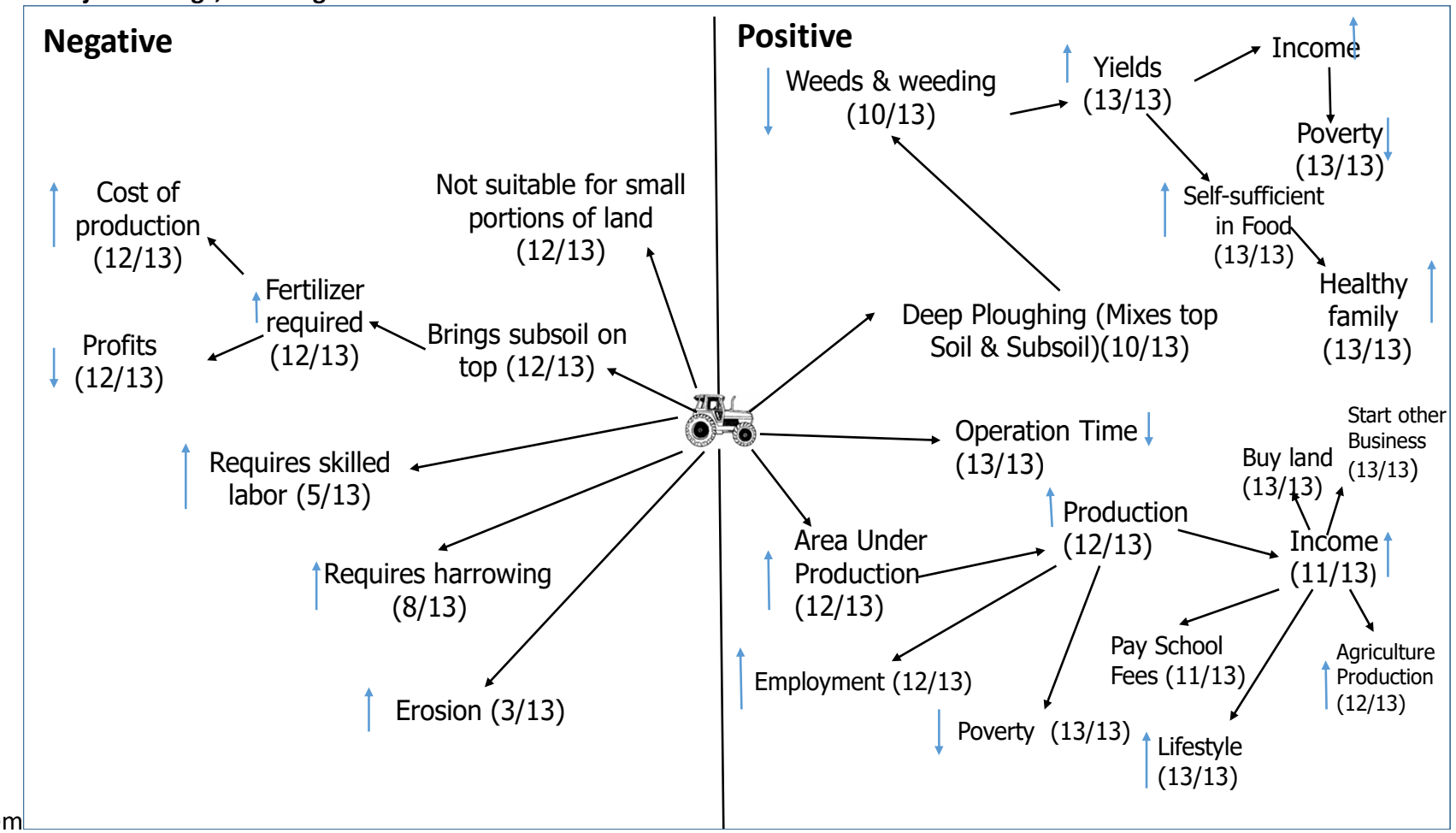
Number of participants in each PID by state/location and gender on the impacts of tractor use in Nigeria for 2019

Table 1: Distribution of Participants for each PID

State	Community	LGA	№ of Participant
Kaduna	Shika Gari	Giwa	12
	Gungurfa I	Giwa	12
	Maraban Guga	Giwa	10
	Nasarawan Buhari	Giwa	13
	Biye	Giwa	14
	Gwanki	Makarfi	11
	Kaura	Zaria	12
	Saminaka	Lere	15
	Kauru	Kauru	10

	Lazuru	Lere	18
Oyo	Iya Ibeji	Oyo west	17
	Ojongbodo	Atiba	30
	Onigaari	Afijio	10
	Iya Ibeji Men group	Oyo West	9
Niger	Agaie	Agaie	15
	Ndache Kolo II	Agaie II	10
	Egunkpa	Agaie	15
	Gidan Kwano Women wing I	Agaie	12
	Gidan Kwano women wing II	Agaie	13
	Ndache Kolo	Tagagi	10
	Ndache Kolo women wing	Tagagi	10
	Sabongari	Agaie	8
	Ndache Kolo II New settlement (Group 1)	Agaie	8
	Ndache Kolo II New settlement	Agaie	8
	Umas cooperative	Bosso	12
	Ekpagi Men wing	Agaie	10
	Shetta community women wing	Bosso	20
	Ekpagi community women wing	Agaei	8
	Shatta community men wing	Bosso	13

1.1. Major Findings, Challenges and Limitations



them

Legend: Black arrows show direction of influence, while blue arrows show increase or decrease

Effect of Tractor across Gender

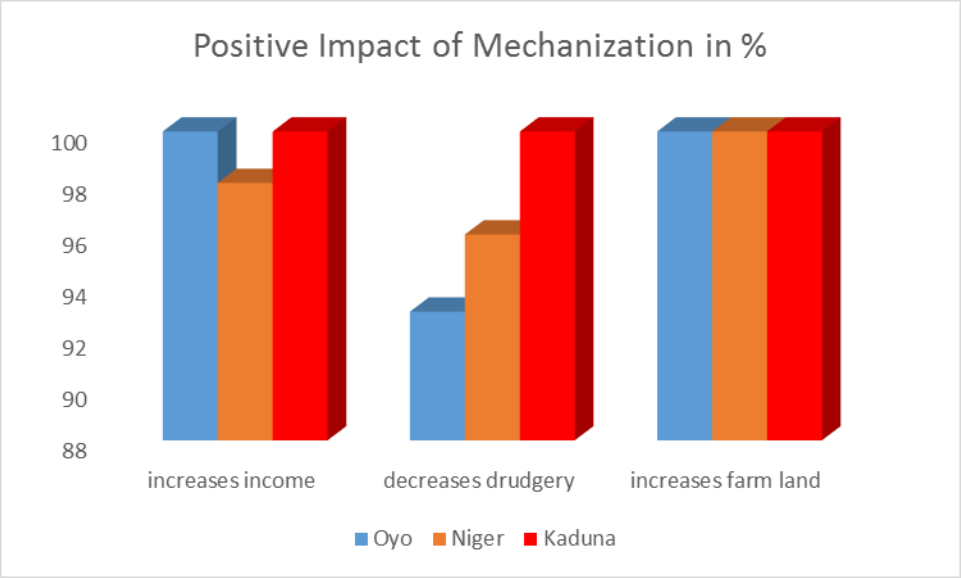
The female respondents in Oyo associated tractor use in farm operations to increase in leisure and sustainability, both at 67%, indicating that an increase in income calls for leisure and ensures sustainability (Table 2). Increase in income due to tractor use by female farmers in Niger State brought about change in both social and financial status and led to pilgrimage and luxury. This hinges on increase in number of hajj performed/travelled (100%), luxury (100%) and increase in clothing (77%). Kaduna women farmers associated tractor use to increase in comfort (at 100% respondent level).

Table 2: Effects of tractor across Gender

Effect Peculiar to Oyo women on Tractor Use			
S/N	**Effect**	**Frequency**	**%**
1	Increase leisure time	30	67
2	Increase sustainability	30	67
Effect Peculiar to Niger women on Tractor Use			
S/N	**Effect**	**Frequency**	**%**
1	Increase in Hajj attendance	13	100
2	Increase luxury	15	100
3	Increase clothing	13	77
4	Increase travel	15	100
Effect Peculiar to Kaduna women on Tractor Use			
S/N	**Effect**	**Frequency**	%
1	Increase comfort	10	100

Positive Impacts of Tractor use on the Community

Respondents across Oyo, Niger and Kaduna states believed that tractor use in farming led to an increase in productivity at 100%, 100% and 98% respectively. The respondents in Oyo, Niger and Kaduna agreed that mechanization led to increases in income at 100%, 98% and 100% respectively; that tractor utilization brought about reduction in drudgery at 98%, 96% and 100%; and that tractor use in farming led to reduction of man-hour requirements for various farming operations by 100%, 95% and 92% respectively. This last finding is contrary to what Monayem et al (2005) had found, that farm mechanization is an opportunity to create more employment opportunities for both male and female rural labourers.



Dissimilar positive effects across the states were seen in value addition: reduced labour requirements and time-saving at 100% respondent level in Oyo state. Increased food availability to farmers, increased number of wives, increased travel and hajj attendance were reported in Niger State at 97%, 93%, 100% and 90% respectively. Kaduna State farmers reported increased soil pulverization, comfort and soil fertility at 62%, 100% and 87% respectively.

Table 3: Positive Effects of Tractor Use

	Oyo			Niger			Kaduna		
S/N	**Effect**	**Freq.**	**%**	**Effect**	**Freq.**	**%**	**Effect**	**Freq.**	**%**
1.	Increase productivity	25	100	Increases food	30	97	Increase production	51	98
2.	Increase income	45	100	Increases output	154	99	Reduces drudgery	12	100
3.	Increase cultivated area	15	100	Increases number of wives	15	93	Increase ease of operation	22	100
4.	Reduce drudgery	15	93	Reduces man hour	42	95	Increase comfort	10	100
5.	Increase yield	15	100	Increases school attendance	33	97	Increase transportation	23	100
6.	Saves time	10	100	Reduces drudgery	65	96	Increase income	10	100
7.	Value addition to farming	10	100	Increases number of cattle	15	100	Reduce time of operation	24	92
8.	Reduce labour	45	100	Increases income	56	98	Increase pulverization of soil 8	13	62
9.				Increases land	23	100	Improve soil	14	71

							moisture		
10				Increases luxury	23	96	Increase soil fertility	13	87
11				Increases building	43	93	Increases land	19	100
12				Increases clothing	38	87			
13				Increases business	13	100			
14				Increases good health	36	89			
15				Increases consumption	13	100			
16				Increases travel	31	100			
17				Increases farm size	20	100			
18				Increases productivity	8	100			
19				Increases education	10	100			
20				Increases purchasing power	8	100			
21				Increases number of bicycles	8	100			
22				Increases germination	10	8			
23				Increases ease of transport	35	97			
24				Increases farming	23	100			
25				Increases women in farming	20	90			
26				Increases economic activities	43	100			
27				Increases employment	20	65			
28				Reduces dependency	8	100			
29				Increases diversification	13	100			
30				Increases hajj attendance	21	90			

Negative Impacts of Tractor Use

The research also found the negative impacts of tractor use. Respondents at 100%, 93% and 89% across Oyo, Niger and Kaduna states respectively (Table 3) believed that using tractor for farming reduces soil fertility. The also opined that tractor use brought about increased soil erosion, (100%, 96% and 84% in Oyo, Niger and Kaduna states respectively). Farmers in Oyo, Niger and Kaduna at 100%, 100% and 73% respectively believed that tractor use increased unemployment. The research also found that mechanization has led to poor quality of farm produce (100%), increased conflicts among farmers (78%) and increased crime rate (100%) in Oyo, Kaduna and Niger respectively. Similarly, 100% of the respondents in Niger listed increase in immorality as an effect of tractor use. It was also believed by 63% of farmers in Niger that tractor use has reduced firewood availability for domestic use; 100% of farmers Niger also attributed tractor use to increases in bad roads across the state. Farmers in Kaduna attributed tractor use to the development of strange weeds, unhealthy competition, and increased pollution at 62%, 67% and 86% respondent level, respectively.

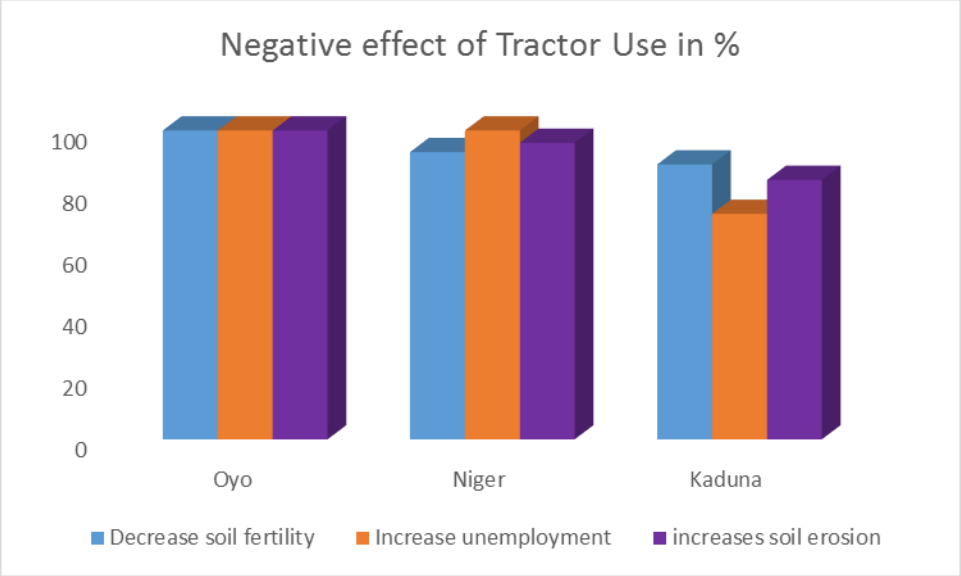


Table 4: Negative Effects of Tractor Use

S/N	Oyo State			Niger State			Kaduna State		
	Effect	**Freq.**	**%**	**Negative effect**	**Freq.**	**%**	**Negative effect**	**Freq.**	**%**
1.	Decrease soil fertility	30	100	Reduces Fertility	92	93	Increase soil degradation	12	67
2.	Increase erosion	40	100	Shortens useful life of land	15	67	Increase pollution	22	86
3.	Increase loss due to perishability of crops	15	100	Increases herbicide use	15	100	Increase unemployment	37	73
4.	Increase cost of production	15	100	Increases erosion	144	96	Decrease soil nutrient	27	89

5.	Increase unemployment	25	100	Reduces cattle route	15	100	Increase conflict	36	78
6.	Increase deforestation	15	100	Reduces grazing area	50	100	Unavailability	14	100
7.	Not readily available for timely operation	10	100	Increases criminality	25	100	Higher cost of operation	14	100
8.	Increase market surplus	10	100	Reduces yield	10	100	Increase expenses	10	100
9.	Encourages inorganic farming	15	100	Increases deforestation	87	91	Increase weed	13	62
10.	Increase environmental pollution	15	100	Increases fertilizer	28	96	Increase erosion	37	84
11.	Poor quality of produce	15	100	Increases encroachment	26	88			
12.				Increases conflict	56	75	Increase competition	12	67
13.				Increases cost of production	46	85			
14.				Increases soil degeneration	13	77			
15.				Increases unemployment	32	100			
16.				Reduces soil structure	10	50			
17.				Reduces firewood for food	8	63			
18.				Increases bad road	10	100			
19.				Reduces security	12	100			
20.				Increases destruction of crops	10	100			
21.				Increases immorality	12	100			
22.				Reduces income	12	100			
23.				Destroys houses	8	100			
24.				Poor maintenance	13	46			

Conclusions

The PID results indicated the positive effects of mechanization in rural communities. These included significant reduction in drudgery and increase in production capability and yield. Increased yield means more sales, income, and assets, such as houses more wives, and pilgrimages with families, and overall increase in socioeconomic status.

Some mechanization challenges iterated by the respondents were increased soil degradation. Due to the continuous use of tractor on the fields, topsoil was gradually washed off, resulting in erosion. Soil erosion reduces soil fertility and hence, increases in fertilizer, insecticide and herbicide applications. More so, due to the reduction of youths engaged in manual farm work, communal unemployment was on the increase, resulting in clashes and disputes within the community.

The major limiting factor to mechanization in the study states was the inability of farmers to hire tractors to work on their farms. It took weeks, especially during peak mechanization season, before a tractor was engaged to work. This loss of time affected planting schedules, and sometimes influenced the choice of crop to be planted. Another limitation mentioned was inaccessibility to diesel fuel due to the far distance to fuel stations.

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