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Research Report

Opportunities and Challenges for Local Agricultural Machinery Manufacturers

Insights from Nigeria

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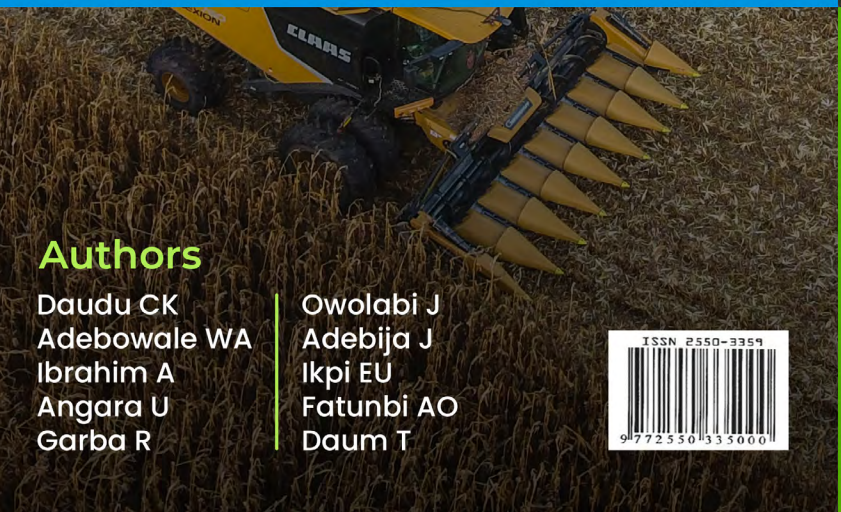

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About FARA

The Forum for Agricultural Research in Africa (FARA) is the apex continental organisation responsible for coordinating and advocating for agricultural research-for-development. (AR4D). It serves as the entry point for agricultural research initiatives designed to have a continental reach or a sub-continental reach spanning more than one sub-region.
FARA serves as the technical arm of the African Union Commission (AUC) on matters concerning agricultural science, technology and innovation. FARA has provided a continental forum for stakeholders in AR4D to shape the vision and agenda for the sub-sector and to mobilise themselves to respond to key continent-wide development frameworks, notably the Comprehensive Africa Agriculture Development Programme (CAADP).
FARA's vision is to "Reduced poverty in Africa as a result of sustainable broad-based agricultural growth and improved livelihoods, particularly of smallholder and pastoral enterprises" its mission is the "Creation of broad-based improvements in agricultural productivity, competitiveness and markets by strengthening the capacity for agricultural innovation at the continental-level"; its Value Proposition is the "Strengthening Africa's capacity for innovation and transformation by visioning its strategic direction, integrating its capacities for change and creating an enabling policy environment for implementation". FARA's strategic direction is derived from and aligned to the Science Agenda for Agriculture in Africa (S3A), which is in turn designed to support the realization of the CAADP vision.

Disclaimer

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Executive Summary

The survey on local agricultural machinery manufacturers was carried out in Nigeria between 2nd and 9th June 2021. The objective of the survey was to identify opportunities and challenges related to local manufacturing and to develop policy recommendations on how to make such manufacturers thrive. Multistage sampling technique was used to select the respondents. Three states were purposively selected for the research. The basis for purposive selection was the high concentration of local manufacturers in those States. Kaduna (core North), Niger (North Central), and Oyo (South) states were selected. List of local manufacturers was obtained from Agricultural Machineries and Equipment Fabricators Association of Nigeria (AMEFAN) and Federal Institute of Industrial Research (FIIRO), Oshodi, Lagos State. Snowball technique was used to select additional local manufacturers to make up 30 respondents per state, making a total of 90 local manufacturers for the study. Additionally, thirty (30) key informant interviews and 10 net map discussion sessions were held that cut across the selected states. Structured questionnaire was used to elicit information from the local manufacturers, while checklist was used to get the required information from the identified key stakeholders. The findings identified raw material providers, financial institutions, training institutions, farmer's association, gasoline and gas suppliers and electricity suppliers as the major actors in the local agricultural manufacturing industry. The study further revealed that most of the stakeholders were familiar with agricultural manufacturing operations and challenges confronting the sector. It was also deduced generally that the local agricultural manufacturing sector in Nigeria performed below average. This was as a result of numerous factors, such as inadequate capital, high cost of raw materials, epileptic power supply, inadequate training, insecurity, bad roads and insufficient commitment on the part of policymakers. However, majority of the respondents were optimistic that local agricultural machinery has the potential to meet the yearning of smallholder farmers in Nigeria once the identified challenges are addressed. The study, therefore, recommended regular and intensive consultation among the identified key stakeholders, and making policies or work on the implementation of existing ones towards resolving issues on factors impeding progress of manufacturing agricultural machineries in Nigeria.

Introduction

Agricultural mechanization around the World

Agricultural mechanization is the art of using machines on the farm in order to remove drudgery and thereby increase agricultural production. Agricultural mechanization, according to Oni (2011), is the application of mechanical technology and increased power to agriculture, largely as a means to enhance the productivity of human labour and often to achieve results well beyond the capacity of human labour. This includes the use of tractors of various types, as well as animal-powered implements and tools, and internal combustion engines.

Agricultural mechanization is basically dealing with the replacement of human and animal labour by mechanical devices in farming activities (Akinbamowo, 2013). According to Simalenga (2000), agricultural mechanization embraces the manufacture, distribution and operation of all types of tools, implements, machines and equipment for agricultural land development, farm production, crop harvesting and primary processing.

Since the Industrial Revolution, replacement of human labour and draught animals in agriculture with machinery has occurred worldwide, but there is a big gap between industrialized and developing countries in this respect. The first application of power to agricultural production in the industrialized countries took place at the beginning of the nineteenth century. At first this had little impact on the overall agricultural production, because the machinery was cumbersome and costly. In North America and Australia, tractors became a significant factor after World War I, but in Europe, this was not the case until after the World War II. Mechanization in the rest of the world stayed far behind (UNDP, 1995). Table 1 show the world state of mechanization.

Table 1: The World state of mechanization

Area	Population Economically Active in Agriculture in 1992 (×1000)	Tractors			Harvester/Threshers		
		Number of Tractors in 1992	Change Since 1979–1981 (%)	Persons per Tractor	No. of Harvesters/ Threshers in 1992	Change Since 1979–1981 (%)	Persons per Harvester
World	1,116,057	26,137,136	16.4	43	3,861,239	8.8	289
Africa	158,025	554,349	20.4	285	71,797	33.6	2,201
North and Central America	19,878	5,843,151	3.2	34	849,812	−1.3	23
South America	24,080	11,52,142	23.0	21	121,655	18.2	198
Asia	874,897	5,670,108	40.1	154	1,316,934	30.2	664
Europe	20,055	9,864,083	14.4	2	781,663	−4.2	26
Oceania	2,003	401,399	−5.8	5	60,088	−3.7	33
USSR (former)	17,933[a]	2,580,000[a]	−0.6	7	675,300[a]	−10.9	27

Source: Alexandratos, 1995.

Agricultural mechanization covers all levels of farming and processing technologies, from simple and basic hand tools to more sophisticated and motorized equipment. It eases and reduces hard labour, relieves labour shortages, improves productivity and timeliness of agricultural operations, improves the efficient use of resources, enhances market access and contributes to mitigating climate related hazards (Akinbamowo, 2013; Haruna & Junior, 2013; Mrema et al., 2014 and Simalenga, 2000). Today, the debate on development of agricultural mechanization turns into the debate on integrated on-farm and off-farm applications, to achieve sustainable mechanization along the entire agri-food chain, including resource conservation, waste avoidance, and creation and maintenance of rural infrastructure (Mrema et al., 2014).

The United Nations Food and Agriculture Organization (FAO) and the United Nations Industrial Development Organization (UNIDO) concluded that the goal of agricultural mechanization is to end hunger, achieve food security and improved nutrition and promote sustainable agriculture. Thus, sustainable mechanization considers technological, economic, social, environmental and cultural aspects when contributing to the sustainable development of the food and agriculture sector (FAO and UNIDO, 2008; Fonteh, 2010 and Haruna et al., 2013).

In the pre-industrial stage in Western countries, one of the strategies for increasing agricultural production was mechanization. At this stage, the agricultural sector used high-capacity machinery for crop operations that were suitable for large lands and replacement of labour. History shows that agricultural mechanization led to rapid industrialization in the Western Hemisphere. More recently in the twenty-first century, many Asian countries have embraced this Western thinking and implemented mechanization policies in accordance with their own particular circumstances (Amongo and Larona, 2015). Mechanization technology changes with industrial growth in the country and economic and social progress of the farmers. While the loss of interest in agriculture by land-owners and the lack of access to agricultural labour force for farm operations are among the most important social and economic issues in highly industrialized countries, increasing the area of cultivation and labour productivity are the requirements of mechanization in developing countries. Therefore, mechanization technology requires dynamic and regional conditions (Singh, 2006).

For example, mechanization in the USA and Canada has dramatically changed from the perspective of cultivation based on the time of initial deployment; in many developing countries, however, agriculture still strongly depends on labour (Schmitz and Moss, 2015). To this end, developing countries, on their path to achieving food security, need to design their own strategies for agriculture.

Agricultural mechanization in Africa

The revolutionary of agricultural mechanization in Africa started with the discovery of iron metallurgy in parts of Nigeria, Cameroon and Central Africa as early as the 2,000 BCE (Starkey, 2000). The smelting of iron ore became a major economic activity that guided the production of knives (machete, cutlass), axes and hand hoes.

This in turn piloted settled farmlands, animal husbandry and creation of canals (Karim et al.,2013). These ancient tools continue to exist till today. Before these tools, animal traction was introduced for tillage and wheeled transport, especially during the colonial period. However, their adoption was limited by the fact that many crop-growing farmers did not own work animals, there were poorly developed veterinary services, inappropriate import of equipment and the low understanding by local farmers on profitability of recommended operations (Karim et al., 2013).

Although Africa missed out on the Green Revolution that changed drastically agriculture in Asia, African farmers began using tractors where tractor imports were financed by the government. Through the Marshall Plan, governments became involved in the direct import of tractors and machinery, activities against which private sector importers could not compete (Mrema et al., 2007, Pingali et al., 1987). Between 1945 and 1981, there were three distinct waves in the introduction of tractors and quiet periods in between. However, studies conducted in the 1960s concluded that tractors caused unemployment in Africa, hence government policy to slow down mechanization and consequently the drastic decrease in the number of tractors in the region (Mrema et al., 2007). Accordingly, FAO and AUC (2018) reported that, at the time of independence in the 1960s, Africa was at the same level of mechanization – if not higher – than most Asian countries. Nevertheless, these tractors increased very slowly thereafter, peaking at just 275,000 in 1990 before declining to 221,000 units in 2000.

Furthermore, the FAO and African Union Commission (AUC) found that in 1961, Africa had 2.4, 3.3 and 5.6 times more tractors in use

than Brazil, India and the People's Republic of China respectively, but by 2000 the reverse was the case: at the turn of the century, there were 6.9, 4.4 and 3.7 more tractors in use in India, China and Brazil respectively, than in the entire Africa region (including South Africa). Similarly, in 1961, there were approximately 3.4 times more tractors in use in Africa than in Thailand; by 2000, however, Thailand had the same number as Africa.

In 2000, the tractors in use in Africa were concentrated in a small number of countries, with 70 percent in South Africa and Nigeria. If South Africa is excluded, primary land preparation in Africa was estimated to rely entirely on human muscle power on about 80 percent of the cultivated land, with draught animals used on 15 percent and tractors on the remaining 5 percent. In contrast, in Asia, land preparation was performed by tractors on over 60 percent of the cultivated land (FAO, 2013; FAO and AUC, 2018).

Nigeria History of Mechanization

At the time of Nigeria's independence, most farm operations were performed with hand tools; farm productivity then was very low, but the population was few and the basic food need of the country was met through import. Increasing population, decreasing agricultural land, increasing demand for food, extensive land degradation and inadequate infrastructure have been the major factors affecting the agriculture sector in Nigeria (Ladeinde et al., 2009). This situation has forced all stakeholders in the private and government sectors to pay attention to agricultural mechanization. Mechanization systems are often categorized into man, animal and engine-powered technology. Takeshima et al. (2013) reported that 85% of human power, 11% of animal power and 4% of engine power accounts for the overall sources of power for agricultural production in Nigeria.

In Nigeria, the estimated number of tractors available in the country is 45,000, with implements (World Bank, 2014), including government-facilitated and privately owned ones. This means 5.70 per 100 sq.km, that is, tractor density of 0.2hp/ha, far below the FAO recommendation of 1.5 hp/hectare (1.1kw/hectare). Mechanization, like other inputs, has a cost implication, requiring an initial capital investment apart from the operational costs, such as fuel, servicing, and maintenance. All these services are provided by different tractor agencies, whose participation is critical for mechanization to effectively take place (Karim et al., 2013). Thus, achieving food security in an environmentally sustainable way is one of Nigeria's greatest challenges (Alemu et al., 2017). Despite the various efforts by successive administrations to adopt mechanization into farming activities in Nigeria, farm mechanization is still facing tough challenges.

Agricultural mechanization in Nigeria, as reported by Asoegwu and Asoegwu (2007), involves the harnessing, controlling and organizing of all inputs of production, such as land, capital, labour, research, education, communication/information, and engineering/technology in agricultural practices. It embraces the use of tools, implements and machines or agricultural

land development, crop production, harvesting, preparation for storage, storage, and on-farm processing. Mechanization involves three main power sources: human, animal, and mechanical.

General Status of Local Manufacturing

Development of Local Agricultural Manufacturing Industry in Nigeria

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

The establishment of Nigeria machine Tools Limited (NMTL) in 1980 and National Agency for Science and Engineering Infrastructure (NASENI) in 1992 triggered the expansion of rural non-farm activities, especially manufacturing of farm machinery and equipment spare parts, machinery installation, repair and maintenance services. NMTL and NASENI are the public establishments, while the Allamit Nigeria Limited and Hanigha Nigeria Limited are the private enterprises that are leading in spare parts manufacturing in Nigeria. Spare parts of tractors, diesel engines, threshers and power tillers are both imported and locally produced. This saves a huge amount of foreign currency and decreases dependency on import. The spare parts subsector is employing a significant number of skilled and semi-skilled labour forces.

Ozumba et al. (2019) discovered that a large percentage of machines are imported into the country with no export of locally manufactured agricultural machinery, as indicated in Table 2.

Table 2: Number of imported agricultural machineries

Items	2013	2014	2015	2016
Total Market Size	63,000	68,000	72,000	104,500
Total Local Production	3,000	3,000	5,000	7,500
Total Exports	0	0	0	0
Total Imports	60,000	65,000	67,000	97,000
Imports from the US	15,000	18,000	10,000	20,000

Source: www.export.gov

More so, Omofunmi and Olaniyan (2018) revealed that Nigeria depends on import of agricultural machinery, which could be in full or in parts. Imported agricultural machinery include tractor, power tiller, diesel engine, plough, harrow, ridger, combine harvester, self-propeller transplanter, rice transplanter, and thresher. The main importers of these machines are Niji-Lukas Nigeria Limited, Famousil Rich Enterprises, Base Bond International Limited, Bertola Machine Tool Limited, Dizengoff West Africa Nigeria Limited, El-Hanan-Ventures Limited, Mantric Nigeria Limited, Jopfack International Limited, Centro Machinery Nigeria Limited, TaboV Nigeria Limited and ATC Nigeria Limited. Among these importers, the two leading ones are Dizengoff West Africa Limited and Bertola Machine Tool Limited. Currently, Nigeria does not have agricultural machinery manufacturers, as obtained in other developing or developed countries like India, Pakistan, Europe, etc., but only fabricators. This has limited the capacity of the agricultural machinery production and technical know-how; thus, making the country to rely mainly on import of agricultural machineries.

Policy on Ease of Doing Business

The World Bank (WB) Ease of Doing Business 2020 Report that compares business regulation for local firms in 190 economies showed that Nigeria's ranking jumped from 146 to 131 (Figure 1), representing the second-highest annual progress of 11.45% in a decade. The highest annual growth remains at 14.2%. Dealing with construction permits (14.6%) and trading across borders (6.1%) had the best growth. The country improved its rank in 5 parameters while moving closer to global best practices in 2 parameters. WB also recognized Nigeria as the tenth most improved economies. It should, however, be noted that Nigeria only restored to its earlier position (of 131st) of 2013.

The Nigerian government had in 2016 set up the Presidential Enabling Business Environment Council (PEBEC) to improve its EDB ratings under the office of the vice president. The goal of the Council was to make Nigeria a progressively and sustainably easier place for doing business. PEBEC's mandate was to make recommendations on institutional reforms to promote Nigeria's investment attractiveness. In February 2017, PEBEC approved a 60-day National Action Plan 'with clear deliverables and timelines for MDAs responsible for implementing each line item in the Plan.' By 18th May 2017, the office of the president issued three executive orders (EOs), effective immediately and targeting public service improvements to touch every sphere of the economy.

The country's rank was far lower than its fellow MINT countries (Mexico, Indonesia, Nigeria, and Turkey). MINTs are classified using the population size, favourable demographics, and emerging economies. Turkey (33) topped the MINT, followed by Mexico (60) and Indonesia (73). Meanwhile, eight (8) sub-Saharan Africa countries rank in the top 100 positions. For instance, Mauritius (13), Rwanda (38), Kenya (56), South Africa (82) created friendlier regulations than Nigeria. Lower middle-income economies like Malawi (109), Uganda (116), Ghana (118), and Lesotho (122) also offer a more attractive environment.

According to the report on Ease of Doing Business (2019) that covered 12 areas of business regulation, ten of which were: starting a business, dealing with construction permits,

getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts, and resolving insolvency. These were included in the ease of doing business score and ease of doing business ranking. Doing business also measured regulation on employing workers and contracting with the government. Economies were ranked on their ease of doing business from 1 to 190. A high ease of doing business ranking means the regulatory environment is more conducive to the starting and operation of a local firm. The rankings were determined by sorting the aggregate scores on 10 topics, each consisting of several indicators, giving equal weight to each topic. The rankings for all economies were benchmarked to May 2019. The result indicated that New Zealand was first, while Nigeria was 131st. Somalia was ranked last (190th position).

In Nigeria, ease of doing business for 2019 considered four indicators: starting a business, dealing with construction permits, registering property and enforcing contracts. Four major sources of information used were: the relevant laws and regulations, expert respondents, the governments of the economies covered and the World Bank Group regional staff. Among States in Nigeria, starting a business took an average of 26 days for 10 procedures and cost 29% of income per capita. This was similar to the average time for sub-Saharan Africa, though 42% less costly. There was significant variation in the ease of starting a business across states. Table 3 shows that the Federal Capital Territory (FCT) Abuja remained the easiest place to start a business. It took 7 procedures and 10 days, at a cost of 25.4% of income per capita. In contrast, in Ondo State, the same process required 12 procedures over 37 days at a cost of 28.9% of income per capita. The difference in time was largely driven by variations in the uptake of new electronic services for business registration. In states where the adoption of an online platform for business registration was widespread, the time to start a business was less than half that of states where the use of electronic services was low. On the average, stamp duty and CAC registration fee together accounted for more than half of the total cost of starting a business. These fees were determined by federal statutory requirements and did not vary across the country. There were differences in the business premises registration fee charged by state authorities. This fee ranged from NGN2,000 ($9) in Kebbi and Zamfara to NGN100,200 ($455) in Gombe. This made Gombe not only the most expensive state to start a business in Nigeria but one of the most expensive locations globally.

Table 3: States in Nigeria Status in term of Starting business, dealing with construction permits, registering property and enforcing contracts

State	Average DTF score, 2018 (4 Indicators)	Average DTF score, 2014 (4 Indicators)	Starting a business		Dealing with construction permits		Registering property		Enforcing contracts	
			Rank	DTF score	Rank	DTF score	Rank	DTF score	Rank	DTF score
Abia	53.90 ↑	48.24	16	77.10	13	72.72	34	17.67	32	48.11
Adamawa	54.34 ↑	52.83	36	71.96	9	73.63	23	23.93	33	47.84
Akwa Ibom	55.66 ↑	53.41	21	76.17	18	71.31	26	21.46	24	53.70
Anambra	53.50 ↑	48.60	19	76.69	21	70.18	32	19.33	34	47.80
Bauchi	60.60 ↑	56.85	22	76.06	5	74.10	15	28.26	2	63.99
Bayelsa	57.76 ↑	54.55	27	75.35	12	72.93	21	24.31	12	58.46
Benue	58.21 ↑	55.78	23	75.91	19	71.03	12	30.62	21	55.26
Borno	60.55 ↑	56.96	13	77.66	16	71.81	13	29.73	4	62.97
Cross River	49.02 ↓	52.67	31	74.45	6	73.96	37	0.00	35	47.69
Delta	54.97 ↑	51.73	14	77.46	32	63.14	20	25.09	23	54.18
Ebonyi	51.16 ↑	50.19	32	74.36	31	63.44	24	22.56	36	44.28
Edo	55.19 ↑	52.91	30	74.69	29	64.07	29	21.15	8	60.83
Ekiti	56.81 ↑	53.89	24	75.58	4	74.76	19	25.62	28	51.29
Enugu	56.82 ↑	48.79	3	81.70	28	65.32	9	31.63	31	48.62
FCT Abuja	59.85 ↑	56.57	1	85.61	27	65.83	4	36.45	27	51.49
Gombe	59.58 ↓	59.87	26	75.37	15	72.27	6	33.86	17	56.82
Imo	51.21 ↑	48.84	34	73.16	23	69.12	33	19.32	37	43.25
Jigawa	64.36 ↑	62.20	9	78.43	3	79.06	3	36.79	3	63.14
Kaduna	65.97 ↑	54.76	5	81.43	17	71.63	1	45.72	1	65.10
Kano	63.01 ↑	58.78	7	79.73	2	79.38	7	32.73	10	60.20
Katsina	62.68 ↑	59.31	6	80.14	10	73.52	5	34.10	5	62.94
Kebbi	57.06 ↑	55.50	20	76.38	14	72.37	35	17.09	6	62.40
Kogi	57.72 ↑	55.07	28	75.21	22	69.84	14	29.27	18	56.56
Kwara	54.68 ↑	52.73	29	74.84	26	67.60	18	25.73	30	50.54
Lagos	54.90 ↑	49.52	2	83.67	37	51.37	16	27.73	16	56.84
Nasarawa	55.40 ↓	55.58	10	78.35	34	61.12	22	24.04	14	58.09
Niger	60.87 ↑	58.65	17	76.94	1	79.71	11	30.65	19	56.16
Ogun	57.97 ↑	55.01	4	81.69	11	73.11	28	21.21	20	55.89
Ondo	56.74 ↑	54.59	37	71.04	8	73.89	27	21.28	9	60.74
Osun	55.07 ↑	54.50	35	72.48	24	68.56	31	19.77	11	59.46
Oyo	53.41 ↑	52.64	18	76.76	33	61.35	25	22.11	25	53.41
Plateau	55.07 ↑	54.29	25	75.48	30	63.71	17	26.57	22	54.51
Rivers	50.58 ↑	48.14	8	79.47	36	53.21	36	16.31	26	53.34
Sokoto	56.35 ↑	54.66	33	73.80	7	73.95	30	20.37	15	57.27
Taraba	57.70 ↑	55.14	12	77.91	20	70.55	10	31.23	29	51.10
Yobe	60.02 ↑	58.26	11	78.05	25	68.34	8	32.42	7	61.27
Zamfara	57.78 ↓	59.12	15	77.11	35	58.26	2	37.39	13	58.37

Source: Ease of Doing Business (2019)

Suggested way forward to improve the doing of business in Nigeria is as shown in Table 4.

In terms of registering property, on the average, an entrepreneur had to go through 12 procedures over 73 days and pay 15.3% of the value of the property to transfer land, making Nigeria one of the most difficult and expensive places to register property in the world. Registering property was easiest in Kaduna, where it took 8 procedures and 44 days at a cost of 9.5% of the property value. By contrast, in Rivers State, the same process took 12 procedures in 112 days and cost 25.1% of the property value. The time to register property was largely dependent on a single requirement: the state governor's consent, which on the average accounted for almost two-thirds of the total time— ranging from four days in Gombe to six months in Kebbi. The following fees were typically incurred in all states, but their amount differed significantly: search fee, inspection fee, consent fee, registration fee, stamp duty and legal fees.

Table 4: Summary of reform recommendations to improve the ease of doing business in Nigeria

What can be improved?	Relevant institutions and stakeholders
Starting a business	
Increase awareness of the availability of electronic services and the option of self-registration Adopt e-signature for business registration Assess the possibility of introducing a flat fee for CAC incorporation and stamp duty Adopt risk-based approaches to business premises inspection or eliminate the inspection altogether Move state tax registration online and in the long term, integrate the incorporation process with state and federal tax registration	Federal level: - Corporate Affairs Commission (CAC) - Federal Inland Revenue Service (FIRS) State level: - Ministries of commerce - State tax offices - State high courts - Company seal providers
Dealing with construction permits	
Update and implement the legislative framework Make the permitting process more transparent Simplify the structure of the building permit fees Introduce a risk classification to preconstruction requirements and inspections Introduce mandatory liability on structural defects Introduce automation for reviewing the building permit application Implement robust GIS technology to eliminate the need for a site analysis report and site inspections	State level: - Private town planners and other private specialists - Permit-issuing agency (i.e. urban planning board, town planning department, physical planning department, etc.) - Fire service departments - Water and sewerage providers
Registering property	
Consider delegating the governor's consent and reducing the number of reviews Increase transparency by making public all requirements and fees to complete a property transaction Assess the feasibility of reducing costs and simplifying the cost structure for property transfers Introduce service delivery standards for the land registry and create specific and separate mechanisms to file complaints Continue the digitization process of titles and cadastre maps and create electronic services Reduce time to obtain decisions on land disputes from the courts	Federal level: - Federal Inland Revenue Service (FIRS) State level: - Governors - Ministries of lands - Land registries/deed registries/bureaus of lands - Surveyor general's offices - State geographic information services - State boards of internal revenue - State high courts
Enforcing contracts	
Limit adjournments and introduce effective time limits Consider the introduction of specialized commercial courts or divisions and fast-track procedures in small claims courts Perform a resource review to evaluate the need to hire more judges and staff Further promote alternative dispute resolution	Federal level: - National Judicial Council State level: - State high courts - Magistrates' courts - District courts

Source: Ease of Doing Business (2019)

The Doing Business 2020 study shows that developing economies are catching up with developed economies in ease of doing business. The economies with the most notable improvement in Saudi Arabia, Jordan, Togo, Bahrain, Tajikistan, Pakistan, Kuwait, China, India, and Nigeria. There is therefore the need for legislative support towards government intervention to improve EBD through such instrument as executive order. To rank as the top 100 economies in 2023, the government needs to give urgent intervention to the above four (4) parameters. PEBEC also needs to introduce massive reforms to property law, international trade, electricity, and tax laws.

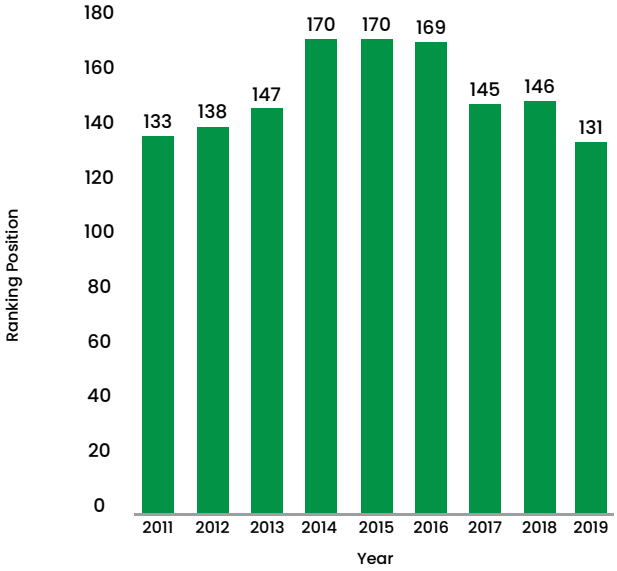


Figure 1: Nigeria in ease of doing business (2011-2019)
Source: Word Bank 2020 Ease of Doing Business

Policies for Promoting Agricultural Mechanization in Nigeria

The main objective of the policy on agricultural mechanization is to reduce drudgery in agriculture by providing mechanical power to replace some of the labour required in agricultural business. The policy objective is also 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. After the discovery of oil at Oloibiri in today's Bayelsa State in 1959, Nigeria's agricultural productivity

continued to lag behind as a source of foreign exchange earnings.

Since agriculture is generally seen to propel economic growth and facilitate the achievement of structural transformation and diversification of economies globally, successive administrations from 1960 to date have put in place several food policies aimed at making the sector take its rightful place.

According to Nehemiah (2015), the period 1960-1972 was characterized by very limited policies in favour of agricultural development; but Nigeria began to witness agricultural development policies from 1973 that supported mechanization of the sector, as highlighted below:

1. Nigerian Agricultural and Cooperative Bank (NACB), 1973: It was mandated to provide loans to farmers to encourage commercial/mechanized farming. The target was achieved through loan grants to farmers at a single digit interest rate.

2. Agricultural Development Projects (ADPs), 1975: Their establishment promoted the introduction of modern technology through agricultural research and extension services.

3. National Grains Reserve Programme (NGRP), 1975: It promoted modern infrastructural facilities development in the nation for storage of grains. This programme established modern grain silos in all state capitals of grain-producing states.

4. Operation Feed the Nation (OFN), 1976: It was introduced to mobilize people to take active part in agricultural production. Under the programme, agricultural inputs, such as improved seeds, fertilizers, credit, and mechanization activities were highly subsidized in the nation.

5. The River Basin Development Authorities, 1977: The mandate of the authorities was to boost the economic potentials of the existing water bodies, particularly irrigation and fishery with hydroelectric power generation and domestic water supply as secondary objectives (Ayoola, 2001). Eleven River Basin Development Authorities Centres were built across the nation and equipped with farm machineries.

6. The Green Revolution, 1980: The programme was mandated to provide improved seeds, fertilizers, pesticides, herbicides, irrigation water, credit, appropriate mechanization, agro-service centres, improved marketing system, and pricing policy as well as other incentives necessary for agricultural development. The target was to make the country self-sufficient in basic food production within five years and to rehabilitate and restore export of agro-products in seven years.

7. National Agricultural Land Development Authority (NALDA), 1992: The mandate of NALDA was to develop lands for massive mechanized farms. The authority was heavily equipped with modern land-clearing equipment, such as bulldozers. The opening of virgin lands for agricultural production was achieved.

8. Establishment of Agricultural Institutions: Institutions for supporting agricultural mechanization were established across the nation; these included the National Centre for Agricultural Mechanization (NCAM) Ilorin, established in 1990; Agricultural Extension and Research Liaison Services (AERLS), Ahmadu Bello University Zaria, established in 1963; International Institute of Tropical Agriculture (IITA) established in 1967; International Livestock Centre for Africa (ILCA), etc.

9. National Fadama Development Project (NFDP), 1993: It was designed to empower communities and strengthen agricultural development in irrigable lands in all states of the country through agro-financing support (World Bank, 2015). Production of food products during dry season boosted farmers' economy and food supply.

10. National Special Programme on Food Security (NSPFS), 2002: Its objectives were to assist farmers in achieving their potential for increasing output and incomes on a sustainable basis; strengthen the effectiveness of research and extension services in bringing technology and new farming practices developed by research institutes to farmers and ensuring greater relevance of research to the farmers; concentrate initial efforts in pilot areas for maximum effect and ease of replication by non-project farmers; train and educate farmers in the effective utilization of available land, water and other resources and facilities to produce food and create employment on a sustainable basis; and utilize international experience for integrated farming practices in Nigeria to maximize use of existing facilities and knowledge to spread benefits to wider areas.

11. The Seven-Point Agenda: Agricultural Policy Thrust, 2007: The policy centred on increasing agricultural production through increased budgetary allocation and promotion of the necessary developmental, supportive and service-oriented activities to enhance production and productivity and marketing opportunities, increasing fiscal incentives to agriculture, and reviewing import waiver anomalies with appropriate fiscal policies on agricultural imports; promotion of agricultural machinery and inputs through favourable tariff policy (FMARD, 2007).

12. Agricultural Transformation Agenda (ATA), 2012: Its target was to:

i. Eliminate corruption in the seed and fertilizer sector.
ii. Improve the functioning of market institutions.
iii. Establish staple crop processing zones to attract private sector and reduce post-harvest losses, add value to locally produced agricultural products, and foster rural economic growth.
iv. Assure food security.

13. Agricultural Equipment Hiring Enterprises (AEHE), 2014: AEHE Targets to achieve the following in collaboration with public-private partnership (PPP):

i. Make available a minimum of 6000 units of tractors;
ii. Make available a minimum of 6000 power tiller;
iii. Make available 13000 units of harvest and post-harvest machines to mechanize

agriculture.

iv. To lease/ hire out various kinds of agricultural equipment for land preparation;
v. Harvest and postharvest activities;
vi. Establish 1200 AEHE centres across the nation.

14. The Agricultural Promotion Policy (APP), 2016: It built on the successes of ATA and closed the key gaps noticed in it. The policy was founded on several guiding principles, a number of which were carryovers from ATA, reflecting the strong desire for policy stability. New elements added to reflect the lessons from ATA, as well as priorities emerging from the aspirations of the Buhari administration, were:

i. **Agriculture as a business –** focusing the policy instruments on a government-enabled, private sector-led engagement as the main growth driver of the sector.
ii. **Agriculture as key to long-term economic growth and security—**focusing policy instruments on ensuring that the commercialization of agriculture includes technologies, financial services, inputs supply chains, and market linkages that directly engage poor rural farmers because rural economic growth will play a critical role in the country's successful job creation, economic diversity, improved security, and sustainable economic growth.
iii. **Food as a human right –** focusing the policy instruments for agricultural development on the social responsibility of government with respect to food security, social security and equity in the Nigerian society; and compelling the government to recognize, protect and fulfil the irreducible minimum degree of freedom of the people from hunger and malnutrition.
iv. **Value chain approach –** focusing the policy instruments for enterprise development across successive stages of the community value chains on the development of crop, livestock and fisheries subsectors, namely, input supply, production, storage, processing/ utilization, marketing, and consumption.
v. **Prioritizing crops –** focusing policy on achieving improved domestic food security and boosting export earnings requires a measure of prioritization. Therefore, for domestic crops, the initial focus for 2016 – 2018 was to expand the production of rice, wheat, maize, soybean and tomato. For export crops, the initial focus was cocoa, cassava, oil palm, sesame, and gum Arabic. From 2018 onwards, the export focus added bananas, avocado, mango, fish and cashew nuts.
vi. **Market orientation –** focusing policy instruments on stimulating agricultural production on a sustainable basis, and stimulating supply and demand for agricultural produce by facilitating linkages between producers and off-takers while stabilizing prices or reducing price volatility for agricultural produce through market-led price stabilization mechanisms (commodity exchanges, negotiated off-take agreements, extended farm-gate price under value chain coordination mechanisms, agricultural insurance, etc).
vii. **Factoring climate change and environmental sustainability –** focusing policy instruments on the sustainability of the use of natural resources (land and soil, water and ecosystems) with the future generation in mind while increasing agricultural production,

marketing, and other human activities in the agricultural sector.

viii. **Participation and inclusiveness –** focusing instruments on measures to maximize the full participation of stakeholders, including farmer's associations, cooperatives, and other groups, as well as NGOs, CBOs, CSOs, development partners and the private sector.

ix. **Policy integrity–** focusing policy instruments on measures for sanitizing the business environment for agriculture, in terms of accountability, transparency and due process of law, ensuring efficient allocation and use of public funding and fighting corruption on all programmes involving public resources.

x. **Nutrition sensitive agriculture –** focusing policy instruments on addressing the issues of stunting, wasting, underweight and other manifestations of hunger and malnutrition with particular reference to the vulnerable groups, which include children under 5, nursing mothers and persons with chronic illnesses and disabilities.

xi. **Agriculture's linkages with other sectors –** focusing policy instruments on the relationship between agriculture and other sectors at federal and state levels, particularly industry, environment, power, energy, works and water sectors (FMARD, 2016).

Organizations for Promoting Agricultural Mechanization

To boost and encourage agricultural mechanization, the government over the years established various organizations to promote better ways of doing agriculture through research and development (R&D). Research institutes have different agricultural mandates. One of them is the National Centre for Agricultural Mechanization (NCAM), Idofian, Ilorin, Kwara State. NCAM has the mandate to research into agricultural mechanization through the development of sustainable indigenous mechanization technologies. As part of its mandate to develop low cost machines, the Centre has developed several machines for the various types of crops grown in Nigeria. However, NCAM pays more attention to root and tuber crops, especially cassava, than other crops. According to Ozumba et al. (2019), this is as a result of government's efforts in promoting the export of cassava chips to China and for the incorporation of 10% cassava flour in the bread industry (in addition to 90% wheat flour).

The Standards Organization of Nigeria (SON) is committed to providing standards and quality assurance services for all products, services and processes in Nigeria in line with international best practices and to ensure continual improvement. NCAM, in collaboration with SON, has developed seven standards and test codes for agricultural equipment, namely:

1. Nigerian Standard Test Code for Grain and Seed Cleaners.
2. Nigerian Standard Test Code for Maize Sheller.
3. Nigerian Standard Test Code for Agricultural Tillage Discs.
4. Nigerian Standard Specification for Agricultural Tillage Disc: Part I –Concave Discs.
5. Nigerian Standard Specification for Agricultural Tillage Disc: Part II –Flat Discs.
6. Nigerian Standard Terminology for Tillage and Tillage Equipment.
7. Nigerian Standard Test Code for Groundnut Sheller.

Also in collaboration with SON, NCAM has prepared four standards and test codes awaiting approval of the Nigerian Standards Council. The drafts are:

1. Draft Nigerian Standards Test Code for Grain planters.
2. Draft Nigerian Standards Test Code for Grain harvesters.
3. Draft Nigerian Standards Test Code for Weights and Measures.
4. Draft Nigerian Standards Test Codes for Grain Threshers.

Current Policy on Agricultural Mechanization in Nigeria

Presently, in an attempt to enhance local trade and exports, the government has introduced some policies and programmes (AfCFTA, 2020), such as:

1. Policy aimed at improving access to international markets by:
    a. Enhancing access to market information through a national agricultural information system.
    b. Creating specialized export market support teams to enhance export capacity.
2. The Nigeria – Africa Trade and Investment Promotion Programme (NATIPP) is a programme jointly launched by the African Export-Import Bank, Nigerian Export-Import Bank and the Nigerian Export Promotion Council. The aim of NATIPP is to facilitate the expansion of Nigeria's trade and investment in Africa.
3. The Presidential Economic Diversification Initiative (PEDI) is aimed to enhance trade capacity in agriculture by facilitating new investments in the agricultural and agro-allied industries, reducing regulatory bottlenecks and enabling access to credit.
4. The Zero Reject Initiative was launched to enhance the acceptability of Nigerian products internationally. It is aimed at improving agricultural exports through the institution of global quality standards and product standardization.
5. The government has placed trade barriers on select agricultural goods to protect local producers and stimulate growth of the industry. In addition, several economic incentives are offered to agriculture investors in Nigeria, including income tax relief, zero import duty on equipment, and VAT exemptions.

Government Initiatives in Agricultural Infrastructure

1. The federal government is establishing Special Agro-Industrial Processing Zones (SAPZs) to concentrate agro-processing activities. SAPZs are aimed at boosting productivity, integrating production and enhancing the processing and exporting of select commodities.
2. As part of its plans to aid the free flow of goods, the government is constructing rail lines across the country. Once completed, these would serve as alternatives to road transport and enhance the distribution of goods and commodities within the country.
3. In addition to its development of railway infrastructure, the federal government is investing in the rehabilitation and construction of roads linking numerous parts of the country. A

key example is the ongoing rehabilitation of the Lagos-Badagry expressway which serves as a key component of the West African trade route.

4. Also, in addition to the six existing seaports, the government has commenced the development of ports in Akwa Ibom and Lagos to enhance Nigeria's maritime capabilities. The Nigerian Ports Authority has also signed an MOU with the Royal Port of Antwerp.

Challenges of Agricultural Mechanization in Nigeria

Sahel (2017), Kasali (2018), Omofunmi and Olaniyan (2018) and Ozumba et al. (2019) observed some of the challenges of agricultural mechanization in Nigerian sector as:

1. **Funding of research and development activities:** Research activities, which are major contributors to increased productivity in the agricultural sector have not been adequately funded by the government. Most research findings originating from government universities and research institutions have not been properly coordinated and disseminated to farmers who are meant to be the ultimate beneficiaries of these findings.

2. **Poor extension agent—farmer ratio:** There is inadequate attention paid to extension services by both federal and state governments despite the critical nature of these services. Retired extension personnel are not replaced, and the few available ones are poorly motivated. This has led to a wide gap between the available extension agents and the number of farmers they are to serve. This therefore hinders many research successes getting to the end users who really need them.

3. **Low private investment:** Moreover, agricultural research activities have received low patronage from private investors. This has tactically left these research activities in the hand of government, unlike in the developed world where they are driven by the private sector. This is due to the neglect of agriculture by the government and its ability to see agriculture as business. The role of government should be policy formulation and creation of a conducive environment for private sector participation.

4. **Lack of synergy among stakeholders:** This also has greatly slowed down the development of agricultural machinery research in Nigeria. Academic and research institutions, financial institutions, farmers, investors and other stakeholders in the sector have weak linkages and working relationship. This has resulted in the poor dissemination of breakthroughs in research to farmers, inadequate information to access loan facilities, etc. This should be tackled through various appraisal seminars and conferences for relevant stakeholders and exhibitions/farmers field days in the sector. More importantly, in the developed countries, there exists strong synergy between financial and research institutions. The situation in Nigeria is different because most financial institutions believe more in businesses that can bring quick financial returns on investment than in research, which may take years to achieve its goal. Most times, financial institutions do not welcome

innovative research with huge social benefits to farmers and the society.

5. **Fragmented farming systems:** Most farmers in Nigeria are small-holders, managing a few hectares for their farming operations. The average farm size of a smallholder in Nigeria is between 0.7 and 2.2 hectares. Fragmented landholdings often make it difficult to use mechanization and cause inefficiencies in agricultural production. Farm output is low as a result of low returns on investment. Most of these farmers are used to the traditional way of farming which involves the use of hoes and cutlasses. This has made it somewhat difficult for farmers in the country to adopt the use of agricultural machinery in boosting their farm productivity.

6. **Local knowledge:** There is very low level of access to information on mechanization, which limits stakeholders in the agricultural sector, especially farmers, in adopting mechanization. Moreover, inefficient extension delivery system has led to a situation in which extension agents with information on mechanization opportunities are unable to transfer such requisite information.

7. **High cost of machines:** The cost of mechanization input for crop production and processing is very high due to the surge in foreign exchange. Moreover, it is difficult for farmers and processors to sustain the recurring costs of operating equipment. Poor access to finance is a major constraint to the adoption of mechanization as it makes it difficult for scaling service providers and new entries to access the capital required to procure equipment.

8. **Poor access to maintenance services and spare parts:** Poor access to local expertise for the repair and maintenance of machineries is a major constraint to sustainable mechanization in Nigeria. Currently, there are not enough technicians trained to deal with the types and brands of machines available. The poor quality of maintenance services for agricultural machinery is fuelled by a lack of awareness of the benefits of maintaining machines, lack of commitment to maintenance plans, high cost of maintenance and poor user habits. Moreover, the market for machine spare parts is flooded with low quality parts which result in the repeated breakdown of machines. It is important to create a culture of maintenance of agricultural machinery, because it is indispensable to obtain the benefits that come with the use of agricultural machinery.

9. **Poor status of the local agricultural equipment fabrication industry:** Majority of agricultural technologies fabricated in the country cannot compete with their foreign counterparts. Hence, it deprives fabricators the opportunity for export, to earn foreign exchange and increase the nation's GDP.

10. **Land tenure system:** The law that all lands belong to the government has greatly hindered agricultural mechanization. Also, many agricultural lands have been converted by government to residential estates.

Conclusively, it is deduced from the review of literature that the status of agricultural machinery manufacturing industry in Nigeria is not encouraging, as manufacturers are faced with a lot of challenges that need addressing as soon as possible. However, certain efforts have been made by the government through various policies to improve the situation.

Methods

Study Area

This survey was carried out in Nigeria between 2nd and 9th June 2021. Nigeria is located in West Africa, between latitude 4° and 14° north of the equator and longitudes 3° and 14° east of the Greenwich meridian within the tropical zone. The average temperature in Nigeria is 27.5°C in the south and 36.9°C in the north. The country is divided into 36 states and a Federal Capital Territory, which is the administrative seat of the government. These states are further sub-divided into six geo-political zones, namely, Northeast (NE), Northwest (NW), Middle belt/ North central (NC), South-south (SS), Southeast (SE) and Southwest (SW).

It has an estimated population of 200 million (World Bank, 2017) and land area is 923,768 km2 (92.4 million hectares), out of which about 84 million hectares are arable; about 40% of this arable part is being cultivated.

Three states were purposively selected: Oyo, Kaduna and Niger. Oyo State covers a land area of 27,000 square kilometres and is made up of 33 local government areas and divided into four agricultural zones: Ibadan/Ibarapa, Oyo, Ogbomoso and Saki. Oyo State is located on latitude 07° 23'17.9"N and longitude 03° 53'30.9"E (Map of the World, 2015).

Kaduna State is located in the northwest zone of Nigeria (KDSG, 2008), occupying an area of 48,473.2 sq. kilometres and lying between latitude 9° 10' and 11o 30N and longitude 6° 20' and 9° E. It is located at an elevation of 704m above sea level and is a trade centre and major transport hub for the surrounding agricultural areas, with its rail and road junctions. The state has 23 LGAs. Furthermore, Niger State is in the north-central zone, occupying 1,270,000 km2 (490,000 sq. mi), which makes it the largest state in West Africa. Over 80% of its land area lies in the Sahara. The state has 25 LGAs.

Multistage sampling procedure was used to select local manufacturers. In the first stage and in order to ensure regional representation, Nigeria was divided into core north, north-central and south. In the second stage, one state was purposively selected from each division. The basis for purposive selection was high concentration of local manufacturers. Hence, Kaduna (core north), Niger (north-central), and Oyo (south) states were selected. Third, a list of local manufacturers was obtained from Agricultural Machineries and Equipment Fabricators Association of Nigeria (AMEFAN) and Federal Institute of Industrial Research (FIIRO), Oshodi, Lagos State. Additionally, snowball technique was used to select more local manufacturers to make up the proposed 30

respondents per state. This gave a total of 90 local manufacturers selected for the study. Individual local manufacturers were interfaced through an interview scheduled, administered using Computer Assisted Personalized Interview (CAPI) by well-trained researchers. The data collected were analysed using simple descriptive statistics, such as frequency, mean and percentages. The results were also presented graphically using pie chart, bar chat, line graph and histogram.

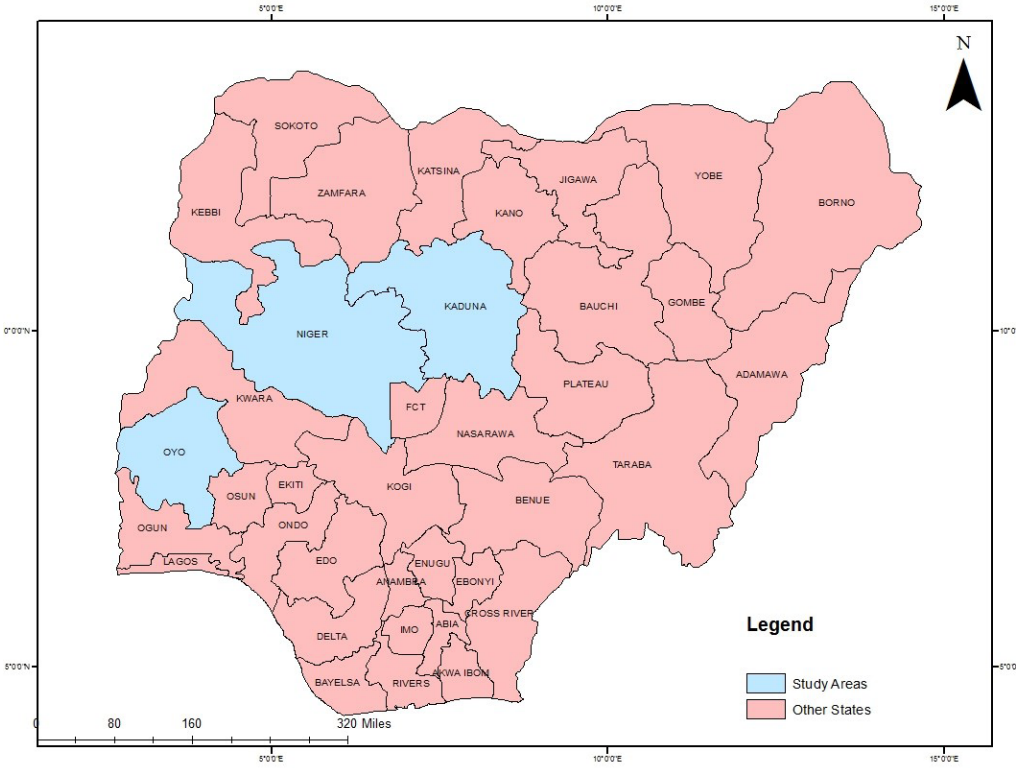


Figure 1: Map of Nigeria showing the research States

Net-mapping session

Stakeholders in the local manufacturing business were identified with the help of AMEFAN, FIIRO, ADP, farmers' association and local manufacturers in the research states. Three (3) locations were conveniently selected in three different LGAs (Table 5) in Niger and Oyo states, while four (4) locations were conveniently selected in Kaduna State, totalling ten (10) net-maps. Between 7 and 13 representatives of various actors in the local manufacturing sector participated in each of the net-map session conducted for this study. The three LGAs (for Niger and Oyo) and four LGAs (for Kaduna) were purposively selected from each zone based on concentration of local

manufacturers. In Oyo State, the selected LGAs were Ibadan Southwest, Akinyele and Ibadan Northeast (from Ibadan/Ibarapa Zone). In Kaduna State, Lere, Ikara, Zaria and Giwa LGAs were selected, while Bosso, Bida and Changa LGAs were selected in Niger State.

Participatory approach was used to identify actors and factors, links among stakeholders, as well as determine the influence that each actor had on local manufacturing. Information collected was based on the perception of participants on identified actors. Data were also collected on the constraints associated with local manufacturers of farm machineries in the study area.

Materials used for the exercise were: cardboard, marker of different colour, actor cards of different colour, bottle caps that served as influence tower, nails which stacked towers, improvised actor figurine, notepads and pens, and table or flat floor to place the cardboard. Information collected was based on the perspectives of specific actors (farmer-based organizations, processors, marketers, raw material suppliers, finance institutions, knowledge and skill building institutions, policymakers and regulatory bodies). Data were also collected on the constraints associated with local manufacturer of farm machineries in the study area. A checklist was used to guide the discussion of the interview.

Table 5: Distribution of participants and communities where net maps were conducted

State	LGAs	Community	№ of Participants
Kaduna	Lere	Saminaka	11
	Ikara	Ikara	14
	Giwa	Giwa	16
	Zaria	Galma	8
Niger	Bosso	Maikunkele	9
	Bida	Bida	16
	Chanchaga	Gida Dutse	11
Oyo	Akinyele	Moniya	7
	Ibadan South West	Apata	9
	Ibadan North East	Idi Ape	8
Total			**10**

Key Informants

Purposive sampling method was used to select 10 key informants (institutions) per state, totalling 30 key informants for the study. The relevance of mandate to agricultural machineries manufacturing was the basis for purposive selection. Checklist was administered on the key informants. A list of the key informants interviewed is in

Table 6: Sample distribution of respondents and location

Items	State	Local manufacturer	Key Informants	Net-Maps	LGAs
Core North	Kaduna	30	10	4	Lere Ikara Zaria Giwa
North Central	Niger	30	10	3	Bosso Bida Chanchaga
Total		**90**	**30**	**10**	

Results

Business background of local manufacturers

i. **Year of business establishment**

Twenty-four percent of the local manufacturers indicated that they established their businesses between 1996 and 2000 (Figure 2), while 12% established theirs between 2016 and 2020.

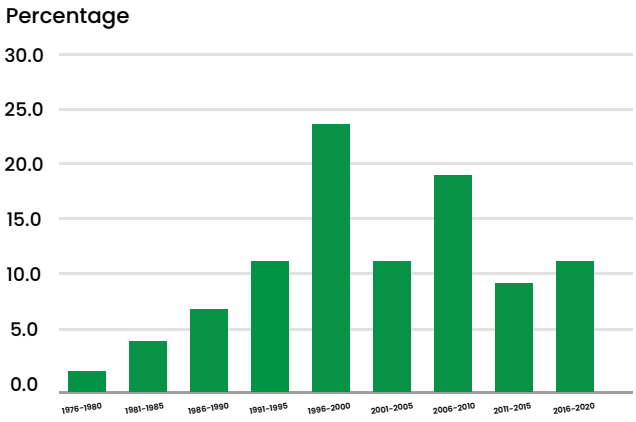


Figure 2: Year of business establishment

ii. Business ownership type

The business ownership type indicated by the majority (96%) was private sector (domestically-owned) (Figure 3).

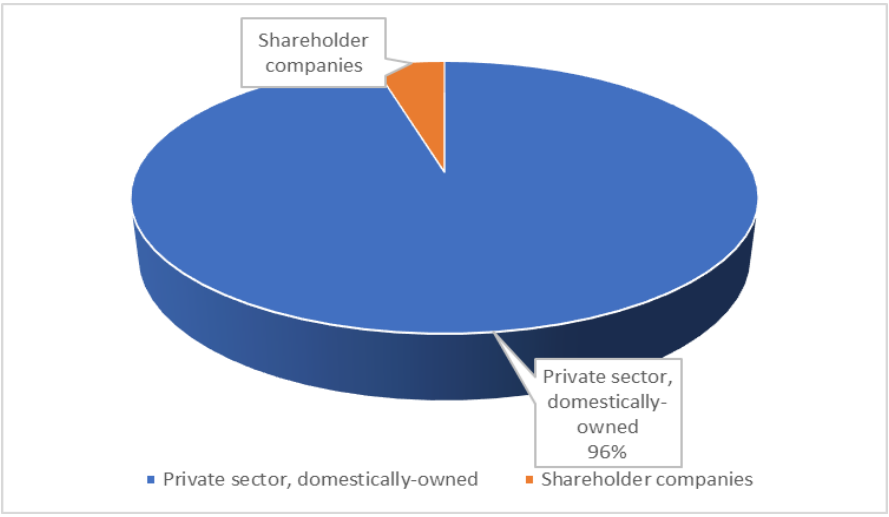


Figure 3: Business ownership types of manufacturers

iii. Founder/ownership of the business

The majority (90%) of local manufacturers interviewed were founder/owner of the business (Figure 4).

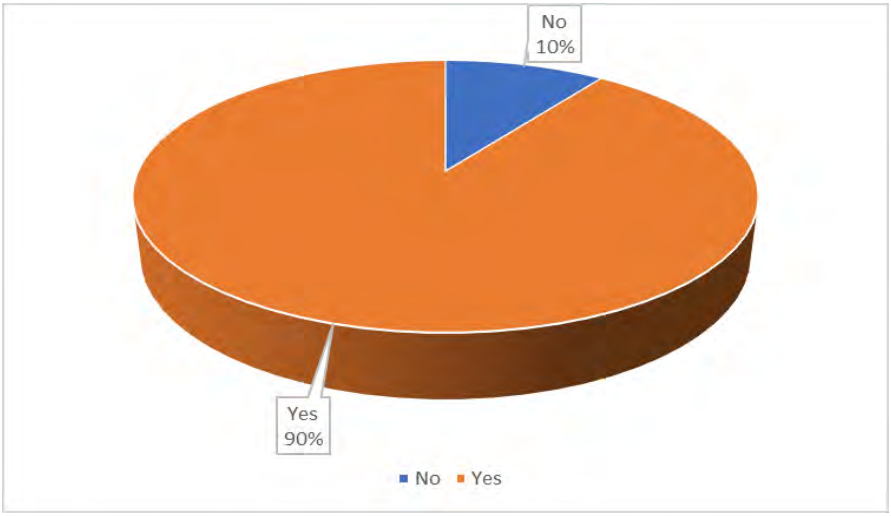


Figure 4: Founder/ownership of manufacturing business

iv. Age of local manufacturer

The result shown in Figure 4 shows that majority (59%) of the ages of local manufacturers were between 41 and 60 years. Age denotes maturity, capacity and responsibility. This implies that the manufacturers had the required age to handle serious business lines of manufacturing machines.

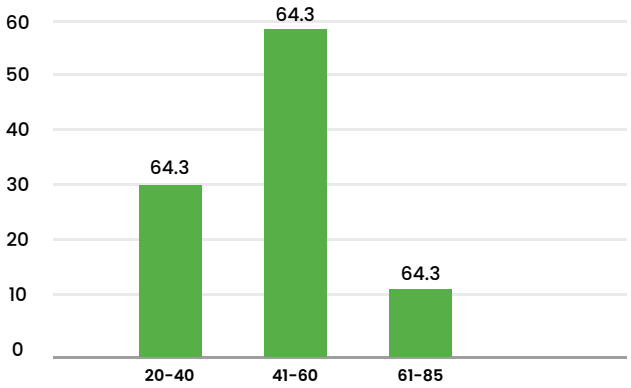


Figure 5: Age distribution of local manufacturers

v. Gender of local manufacturer

Almost all (99%) of the local manufacturers were male. This may be due to the fact that the nature of job demands a lots of strength, such as possessed by men.

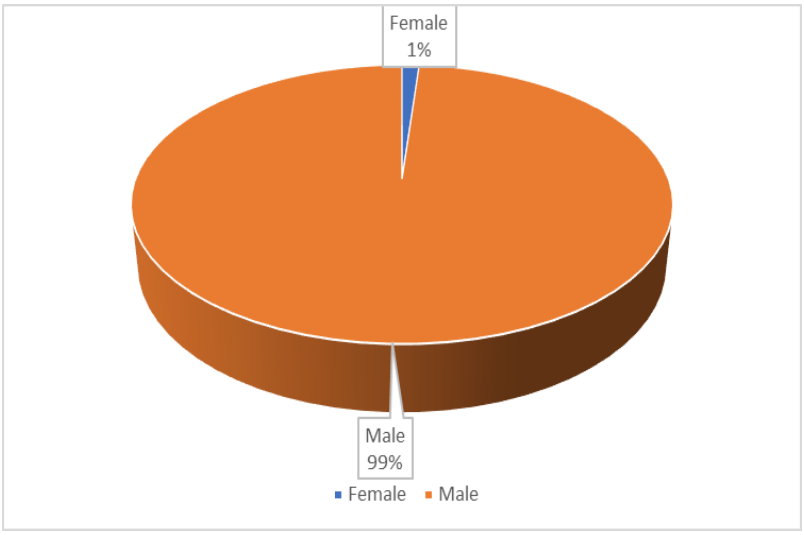


Figure 6: Gender distribution of local manufacturers

vi. Educational background of local manufacturer

As shown in Figure 6, about 45% of the manufacturers had engineering background, while 40% had background in agriculture. This result agrees with a priori expectation, as the activities of these local machine manufacturing stemmed from the agricultural engineering field/discipline.

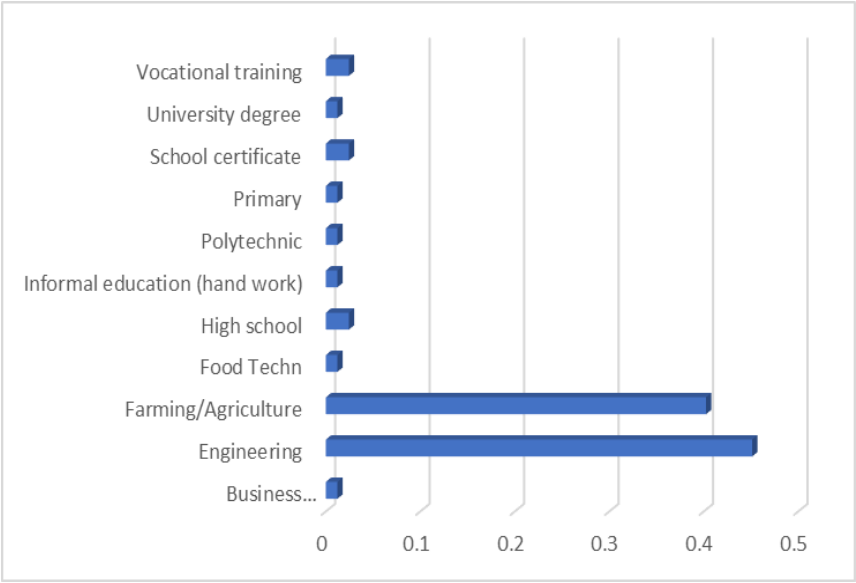


Figure 7: Distribution of local manufacturers according to educational background

vii. Educational level of local manufacturer

The educational level of 30% of the manufacturers was secondary school, while that of 18% was Bachelor's degree.

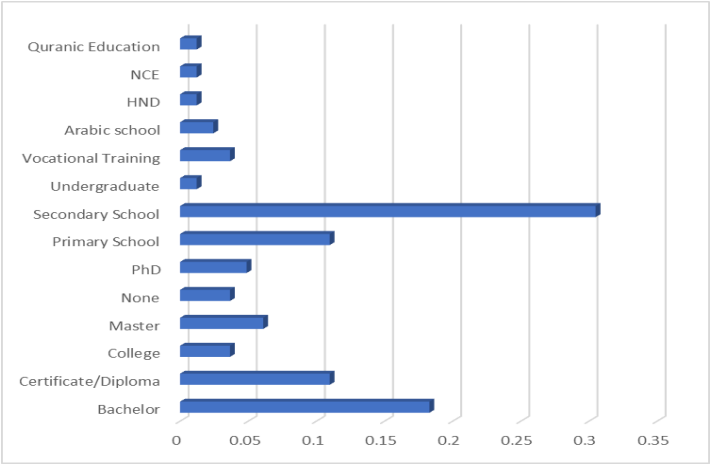


Figure 8: Distribution of local manufacturers according to educational level

viii. Local manufacturer's reception of training on business administration, management and accounting

Majority (56%) of the respondents never received training on business administration, management and accounting. This result portends possible low business performance (inefficiency) among the manufacturers. The prosperity of any business (manufacturing of agricultural machines inclusive) highly depends on the administrative, management and accounting capabilities of the owner.

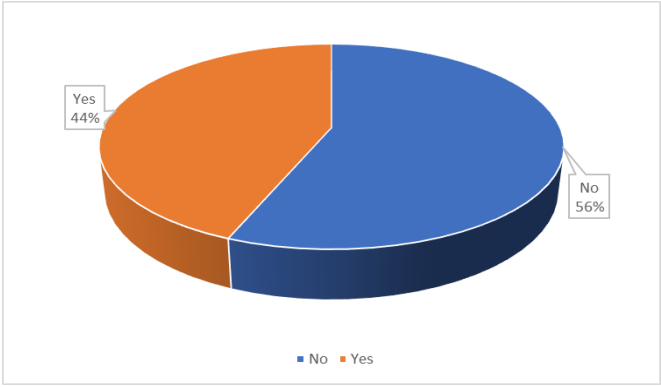


Figure 9: Distribution of Local manufacturer's according to training on business administration, management and accounting

ix. Ownership of cultivation of farmland

The majority (65%) of the local manufacturers cultivated farmland. It is a common situation in Nigeria for people to operate farms as secondary occupation. Also, some sort of business integration was indicated in the result obtained, as machines produced were also used on their personal farms.

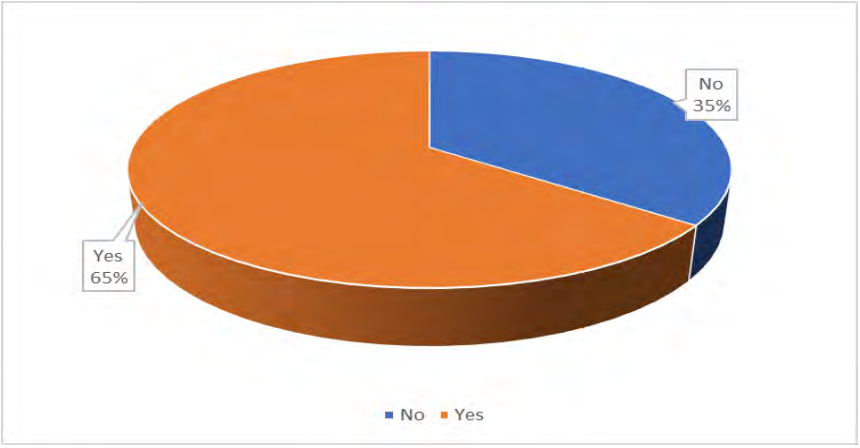


Figure 10: Ownership of farmland

x. Becoming a local manufacturer

Several reasons were adduced by the majority (>90%) for becoming local manufacturers. These include natural talent, encouragement by parents, interest in metal work, inspiration by course of study and attendance of technical school.

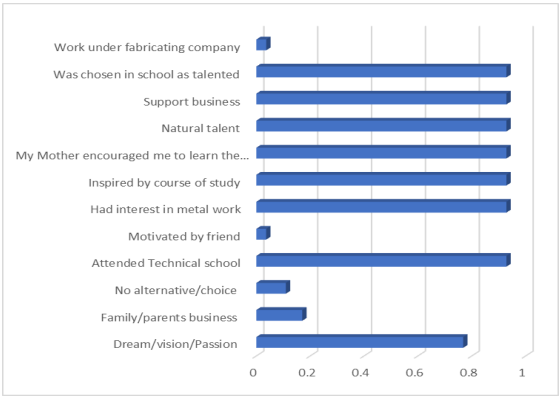


Figure 11: Distribution of local manufacturer according to business inspiration

xi. Entry barriers faced by local manufacturers

Lack of capital (80%), lack of market access (30%), and poor enabling environment (20%) were the most rated barriers faced by the local manufacturers. Huge initial capital is required to start the manufacturing of agricultural machines. This problem is further compounded by inefficient loan administration, characterized by high interest rate in commercial banks. The result is in line with the research of Omofunmi and Olaniyan (2018).

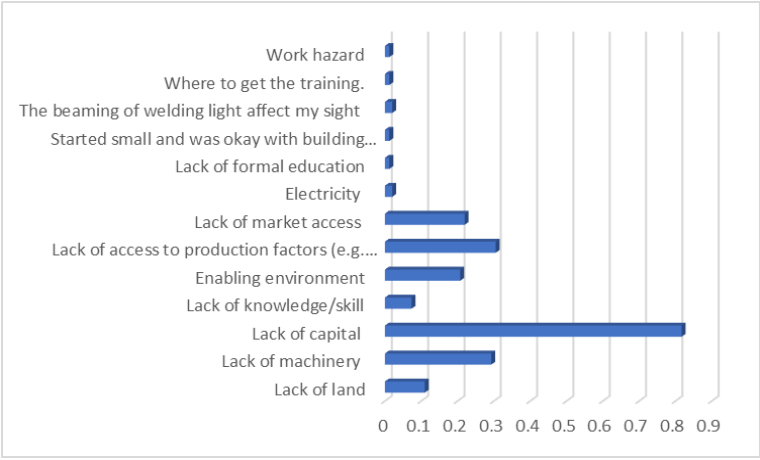


Figure 12: Distribution of local manufacturer according to entry barriers faced

xii. Formal business registration

Majority (55%) of the local manufacturers had formal registration of their businesses. This could have enhanced the growth of their businesses through formal engagement with relevant stakeholders and government patronage.

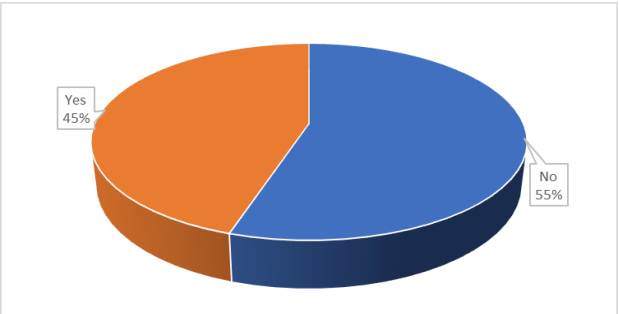


Figure 13: Distribution of local manufacturer according to business registration

xiii. Membership of association/organization

Result in Figure 14 indicates that the majority (57%) of the local manufacturer belong to association. This could have enhanced their ability to push for better policy environment that is capable of increasing their efficiency.

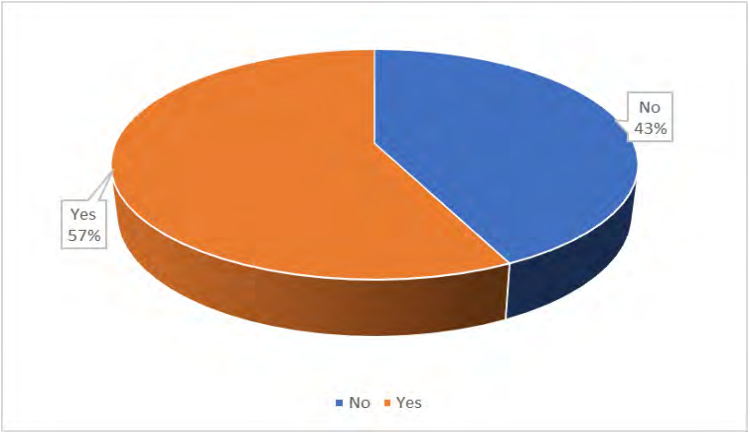


Figure 14: Distribution of local manufacturer according to membership of association

xiv. Location of business

Most (44%) of the local manufacturers operated in cities. This could be due to their quest to be close to sources of raw materials.

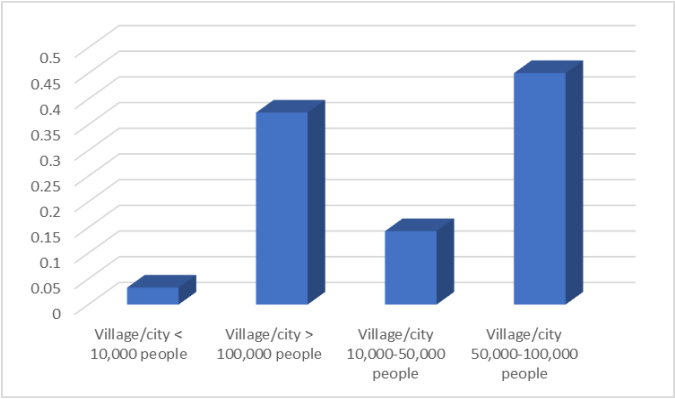


Figure 14: Distribution of local manufacturer according to membership of association

Design and Production

i. Source of product design

The result in Table 5 indicates that majority (80%) of the local manufacturers developed the design on their own, while 67% copied their design from other manufacturers. All the respondents interviewed in Kaduna and Niger states indicated that they did not get the design from government agency. This is an indication that the impact of government agencies with the mandate on farm equipment and machinery designs was not felt. Figures 16, 17 and 18 show some of the locally produced machines in Niger, Oyo and Kaduna states respectively.

Table 7: Source of product design (percentage)

*Source of Product Design	Kaduna	Niger	Oyo	Average
Own development	70	90	80	80
Copy from other manufacturers	70	50	80	67
Government bodies	0	0	10	3
Ideas/requests of customers	50	90	50	63
Ideas/requests of employees	0	20	10	10
Internet	0	0	10	3

*Multiple choice allowed

Figure 16: Locally produced maize sheller at ADP office, Niger State

Figure 17: Local manufacturer in Akinyele LGA, Oyo State

Figure 18: Maize Sheller produced by 85 years old fabricator in Saminaka, Kaduna State

ii. Research and development (R & D)

Generally, 54% of the local manufacturers (Figure 19) interviewed conducted their own research and development activities. At the state level (Figure 19), 80% of the respondents conducted their own R&D in Oyo State, whereas 37% and 47% did theirs in Kaduna and Niger states, respectively.

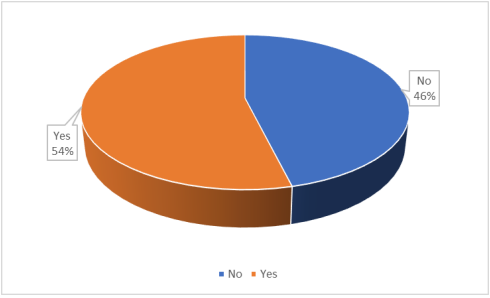


Figure 19: Local manufacturers conducted own research and development

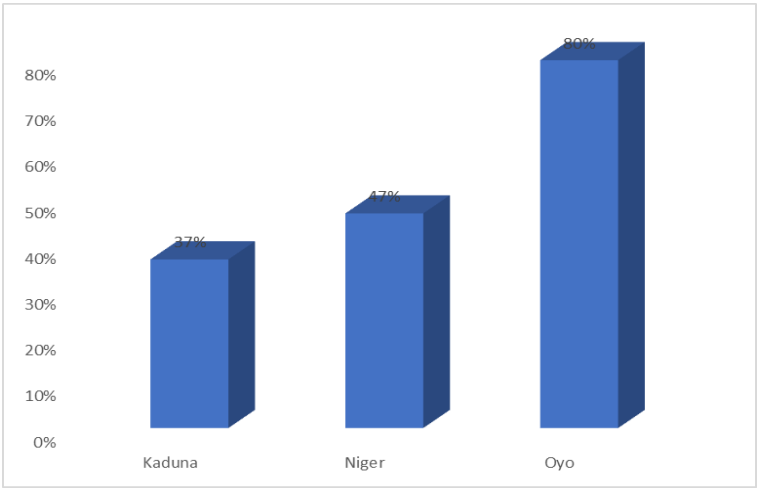


Figure 20: Own research and development (R&D) at state level

iii. Yearly revenue spent on research and development

Among the local manufacturers that conducted their own research and development activities, 31% spent 10-30% of their revenue on R&D yearly (Figure 21).

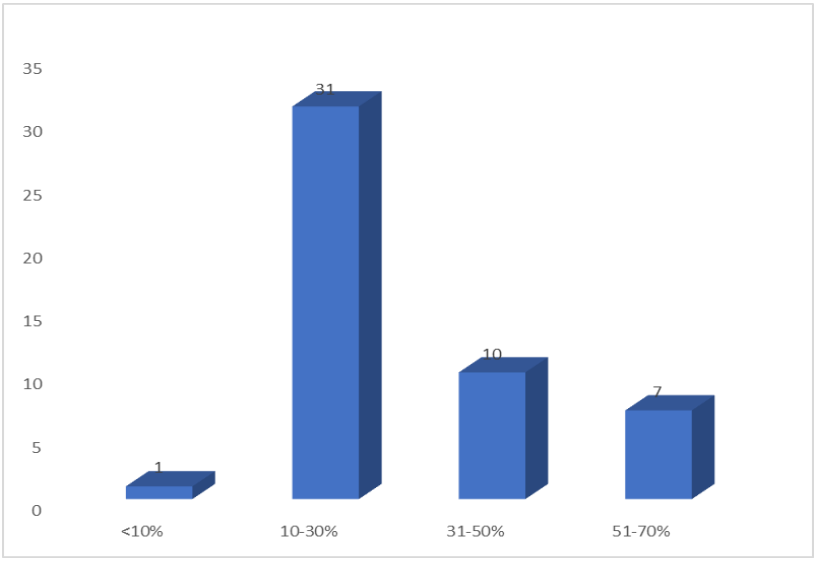


Figure 21: Yearly revenue spent on research and development

iv. Customer needs identification

Figure 22 shows that 35% of the local manufacturers identified their customers' need through field experiment, followed by specifications given by customers (24%).

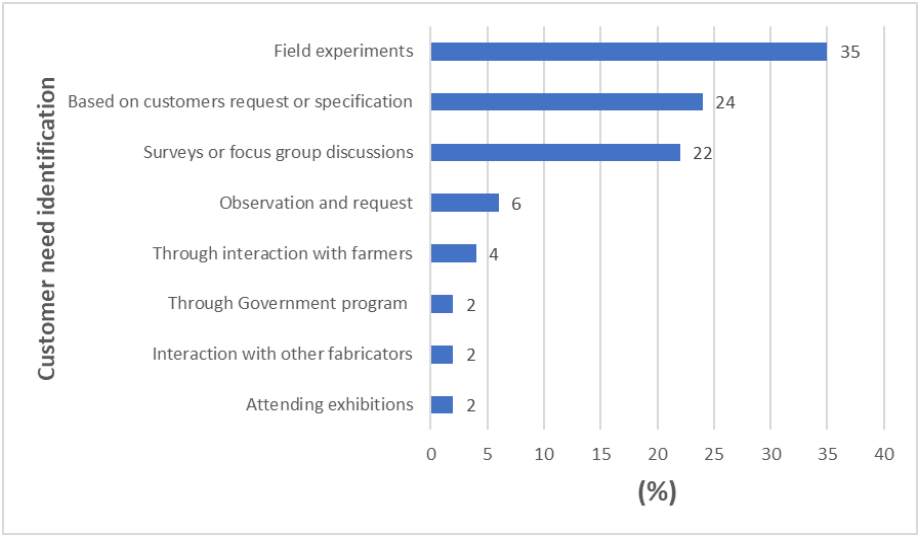


Figure 22: Customer's need identification

v. Invention of new type of machine

Sixty percent (60%) of the respondents invented new types of machines and designs (Figure 23). This shows the level of commitment that some of them had, despite the challenges facing them.

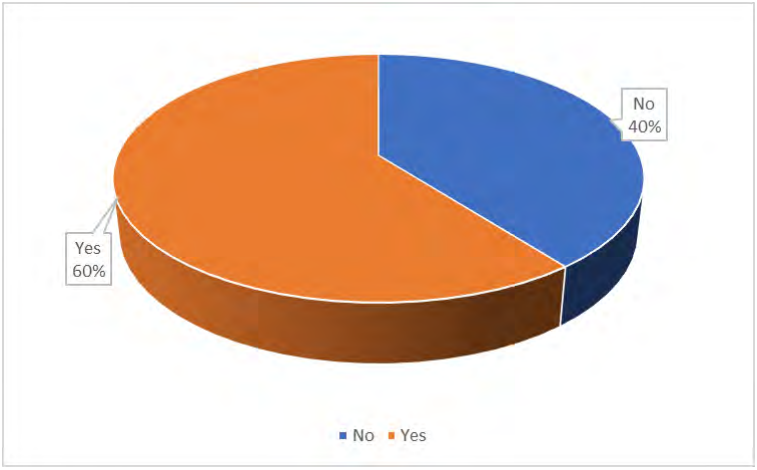


Figure 23: Invention of new type of machinery or design

vi. Sectors buying the products

Almost 80% of the respondents produced the machines for crop production and postharvest handling. Food processing and value chain addition had 67%, while forestry had (1%) (Figure 24).

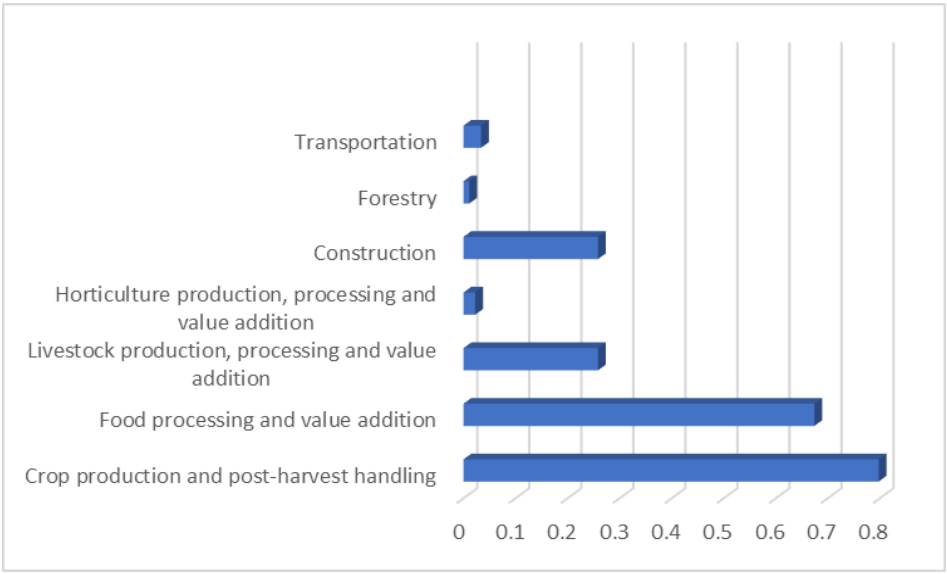


Figure 24: Sectors buying the products

vii. Number of machine type produced

Figure 25 shows that threshing (62%), shelling (58%) and milling (53%) machines were the most types produced by the local manufacturers. Boom sprayer production was just 1%. This buttresses the claim above by these local manufacturers that almost 80% of their production was for crop production and postharvest handling.

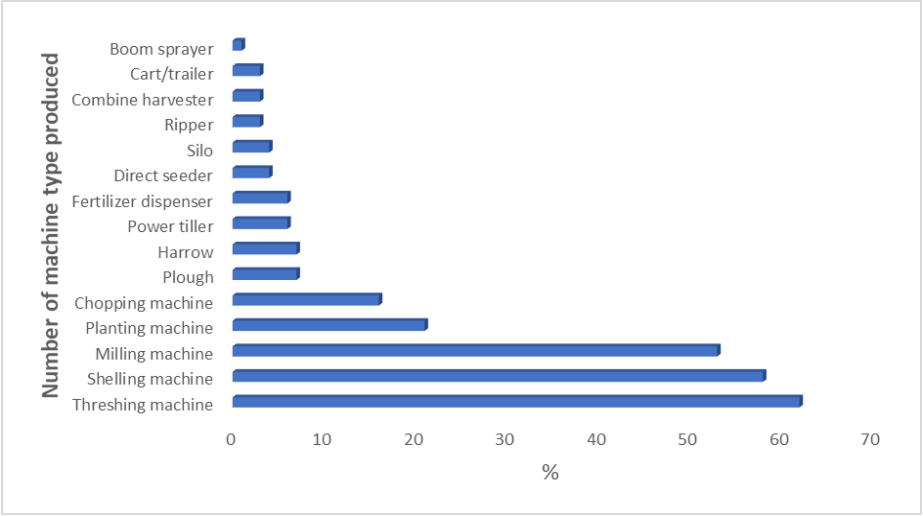


Figure 25: Number of machine type produced

viii. Use of renewable energy to run the machine

Most of the respondents (79%) claimed that they did not use renewable energy to run machines (Figure 26).

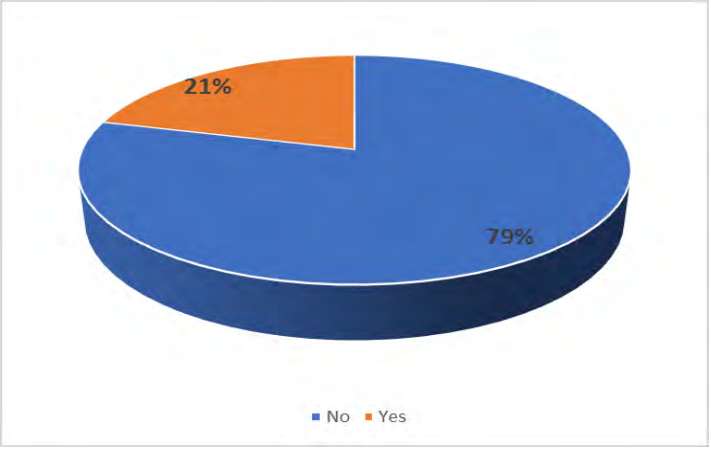


Figure 26: Use of renewable energy to run the machine

ix. Machineries run by renewable energy

The machines run with renewable energy (Figure 27) were shelling (42%), threshing (47%) and milling (26%) machines.

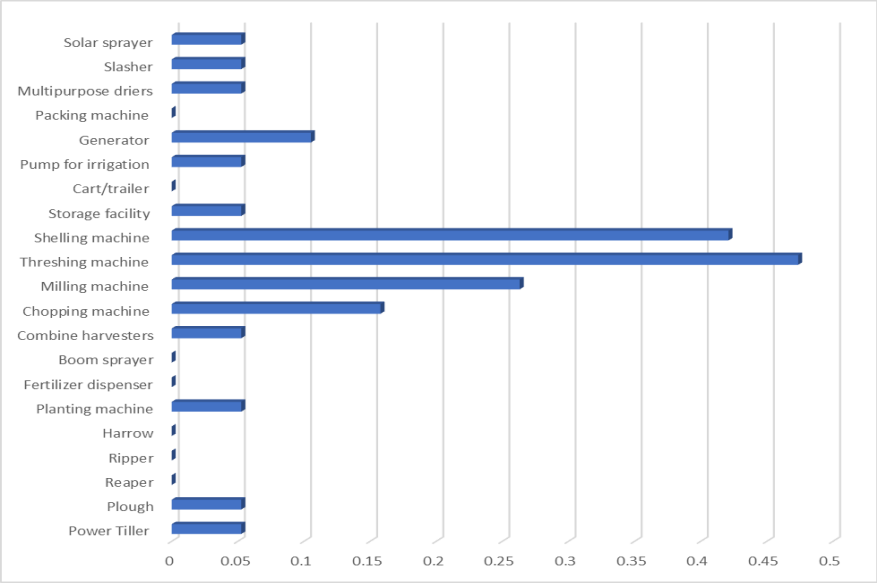


Figure 27: Distribution of Machineries run by renewable energy

x. Reasons for not using renewable energy

About 26% of the respondents attributed the reason for not using renewable energy to 'no demand for it' (Figure 28), while 25% others said 'it was not feasible'. Also, while 1.3% perceived that running renewable energy was costly, 19% claimed there was no knowledge for it. With the epileptic supply of electricity in the country and huge amount of expenditure by local manufacturers on power generating sets and other machines, there is an urgent need to train fabricators on how to generate electricity through renewable energy system.

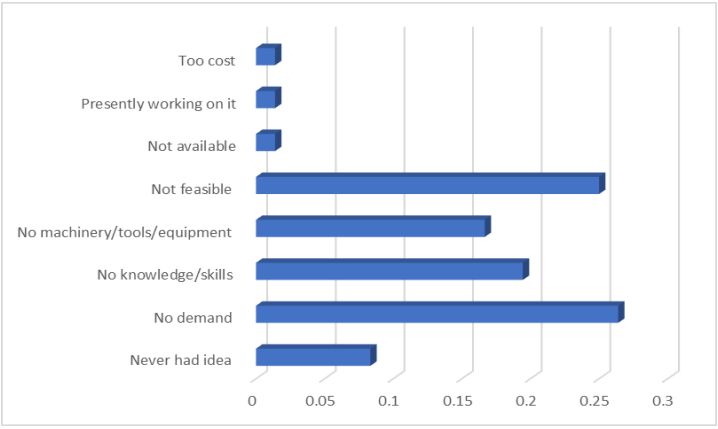


Figure 28: Reason for not using renewable energy

xi. Basis for machine production

Figure 29 shows that majority (54%) of the respondents produced machines on demand. Only 10% produced on regular basis. The major reason given for producing on demand was lack of capital (67%) (Figure 30).

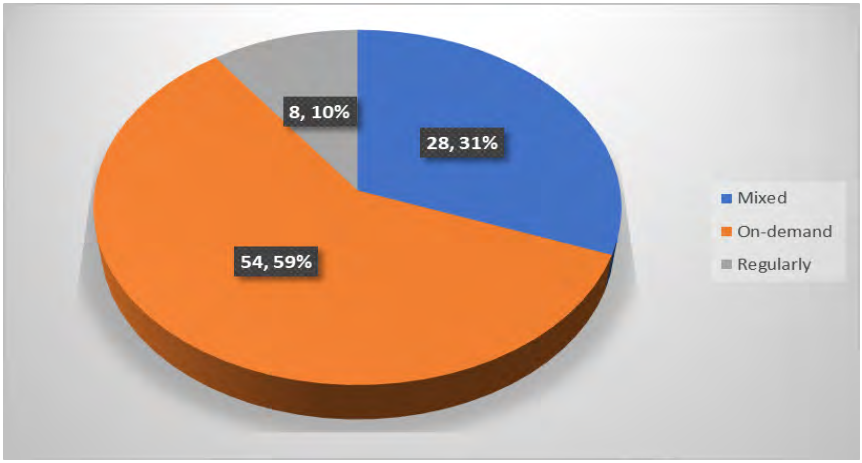


Figure 29: Basis of machine production

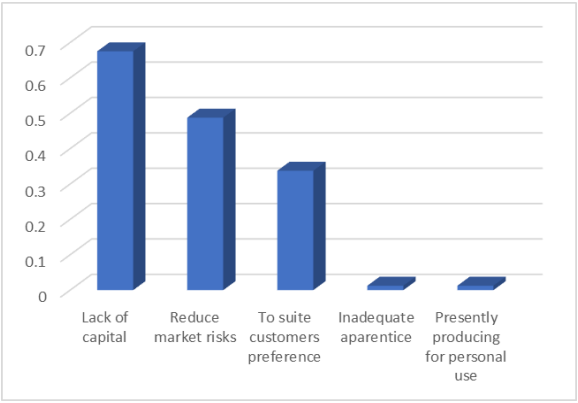


Figure 30: Reason for producing machine on-demand

xii. Adherence to machine standard

Most of the respondents (65.5%) claimed that they adhered to the machine standards during the process of production.

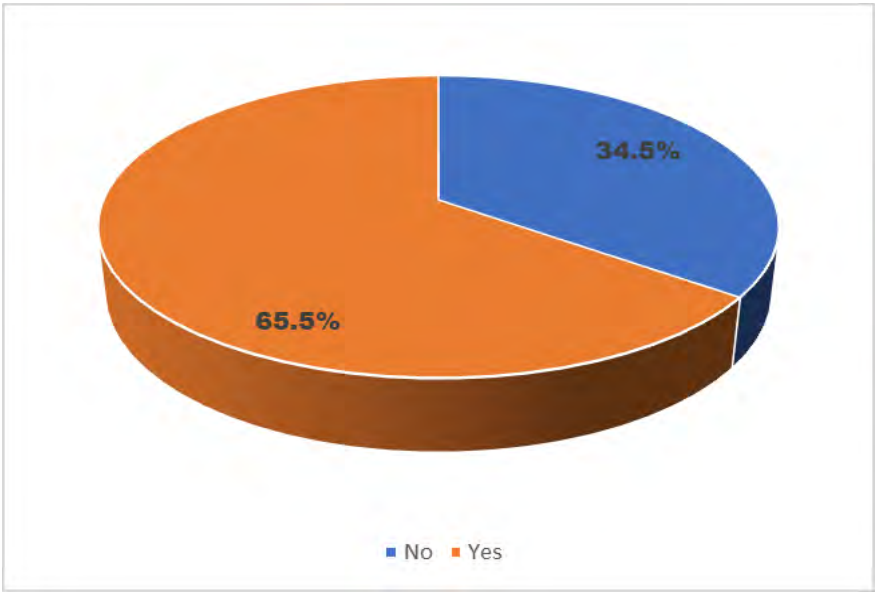


Figure 31: Adherence to machine standards

xiii. Certification of machineries produced

The machines produced by local manufacturers were not certified in most cases. Only 15.9% of the respondents certified their machines (Figure 32). This is because most of the local manufacturers were not aware of the government agencies in charge of the certification process.

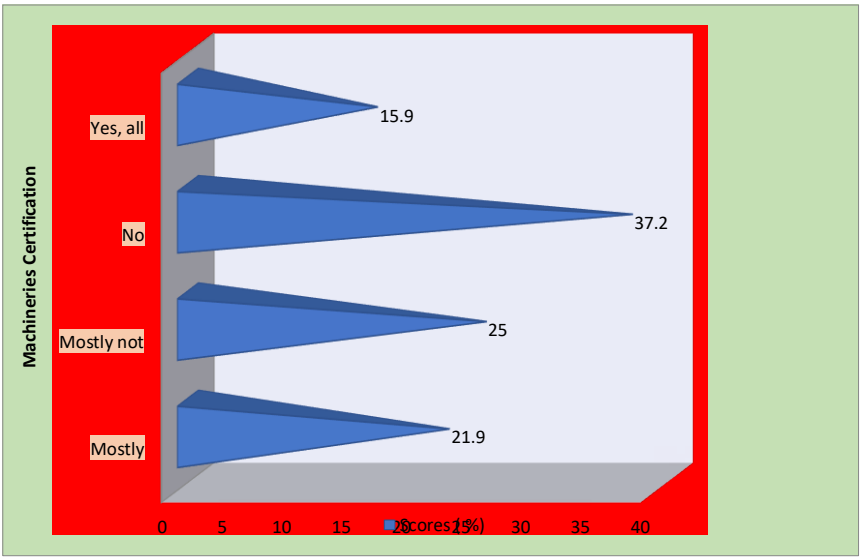


Figure 32: Certification of machines produced

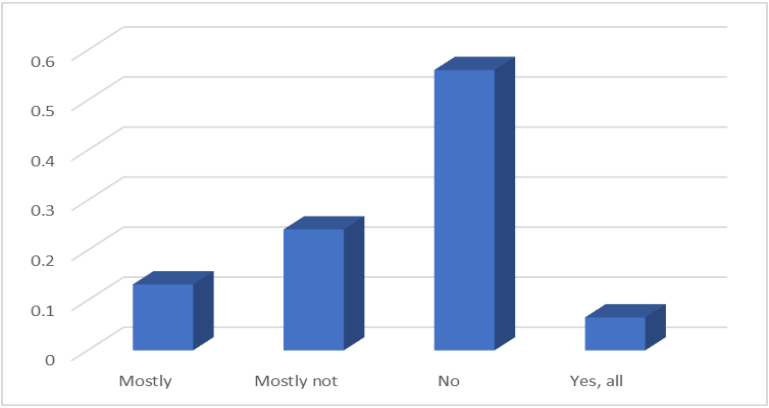


Figure 33: Machinery tested officially

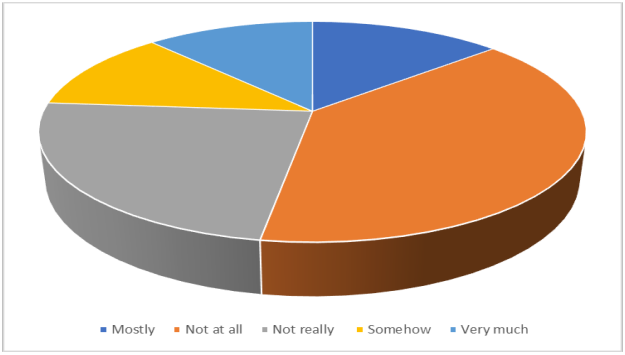


Figure 34: Satisfaction with the finished product

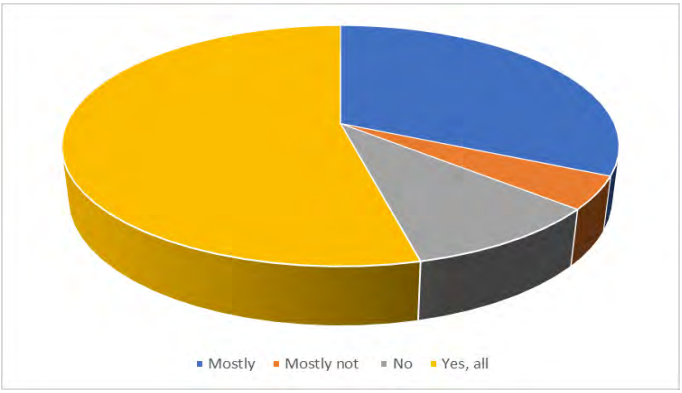


Figure 35: Giving warranty on the products sold

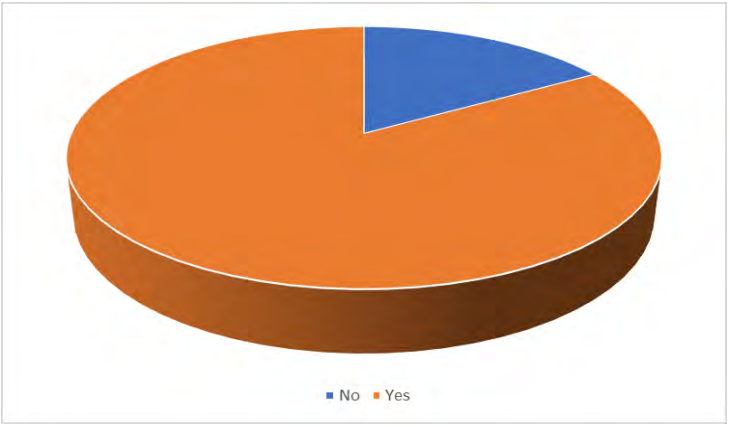


Figure 36: Provision of after-sale services

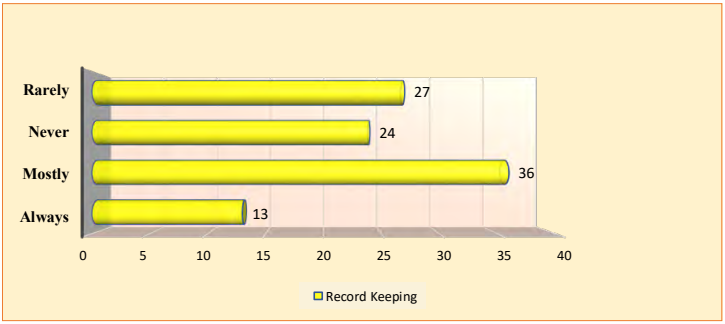


Figure 37: Distribution of local manufacturers for record keeping

Cost and Price of Machines

Table 8 shows the costs of machine production for the last 12 months and 3 years ago. The costs of production and selling prices in 3 years ago were half of those of the last 12 months. This is attributed to sudden increases in the prices of raw materials; this was also a reason the local manufacturers ranked raw material suppliers (net map result) as the most influence among stakeholders in the sector. At the receiving end, farmers and processors (as end users) complained seriously about the high increases in prices of these machines.

Table 8: Cost and price of machine

Machine	Average production costs (Last 12 months)	Average price (Last 12 months)	Average production costs (3 years ago)	Average price (3 years ago)
Cart/trailer	700000	850000	350000	425000
Storage facility	45000	60000	35000	50000
Shelling machine	162500	206250	129400	158369
Threshing machine	146200	190600	107600	150417
Milling machine	148700	183200	116130	154087
Chopping machine	217500	272500	170000	217500
Combine harvesters	605000	825000	450000	675000
Boom sprayer	130000	150000	115000	128000
Fertilizer dispenser	110500	130000	75000	105000
Planting machine	84360	102900	65000	78800
Direct seeder	90000	110000	68000	80000
Harrow	280650	318300	220600	250000
Ripper	105000	126600	83000	105000
Plough	145000	236600	195000	236000
Power tiller	215000	265000	205500	240250

Figure 38 compares the quantity of machineries sold in the last 12 months and 3 years ago. The quantity sold in the last 3 years was more than that for the last 12 months. Shelling, threshing and milling machines were the only 3 that the quantities sold 12 months ago tripled those of 3 years ago. This might be attributed to the interest that was developed in the 3 machines by processors and farmers. Despite doubling of prices in the last 12 months, the manufacturers sold more quantities of these machines.

Figure 38: Comparison of average quantity sold

Marketing and Customers

Method of advertisement

Advertisement can help generate interest to customers about a brand. Figure 39 shows the method of advertisement by tractor owners. The data show that about 71% of the respondents used word of mouth as the most common method of advertisement. The least method was the use of flyers and posters. This implies that the respondents used mainly traditional/ crude methods of advertisement. Although the use of social media (28%) was gaining interest, its potential was yet to be reached, compared to the use of other methods, such as machinery exhibition (30%).

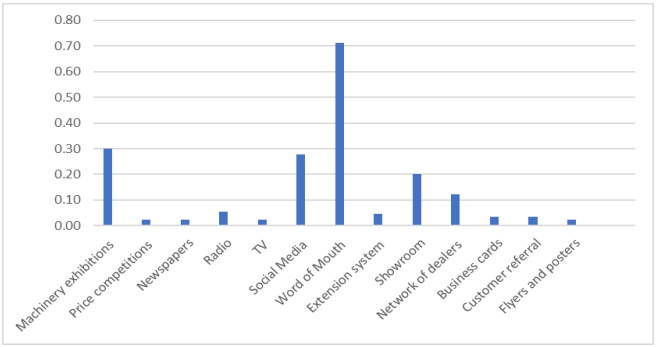


Figure 39: Method of advertisement

Main customers

Customers are important in any business, because they drive revenue. Figure 40 shows that the most important customers for the agricultural machinery business were medium-scale farmers, who owned about 2-15 hectares. There was, however, a significant use of machineries by smallholder farmers (58%), while they were least used by farmer cooperatives (60%). This might be because cooperatives in Nigeria are still underdeveloped and are yet to reach their full potential.

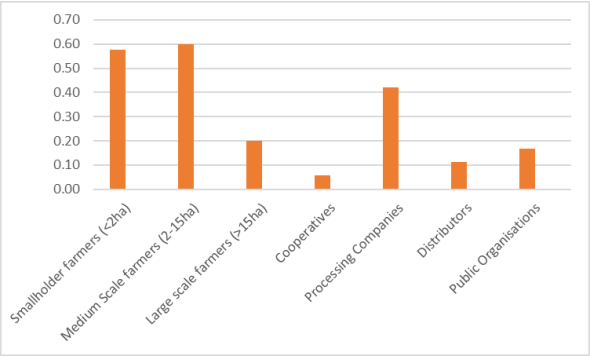


Figure 40: Manufacturer main customers

Location of customers

Customer location should inform a business owner about the marketing strategy to use for the business to succeed. Figure 41 shows that majority of the customers of agricultural machinery owners were outside the villages but within the LGA (67%), followed closely by customers within the village (60%). This indicates that the machinery owners operated mainly within their immediate environment. Notably, export from the country was significantly low or not well exploited. This might be because local demand of machineries was on the increase.

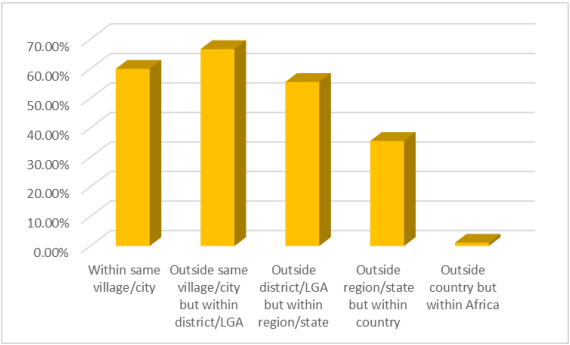


Figure 41: Manufacturer customer location

Method of Payment

In Figure 42, about 92% of the customers paid for their machineries mostly with cash. There shows that electronic or bank transfer was not the most preferred method of transaction in the study area. The result corroborates earlier finding that majority of the customers resided in villages where many banks were not available or favoured. In Nigeria, 41.6% of the population in the rural areas are financially excluded, according to a 2016 survey (EFInA, 2016).

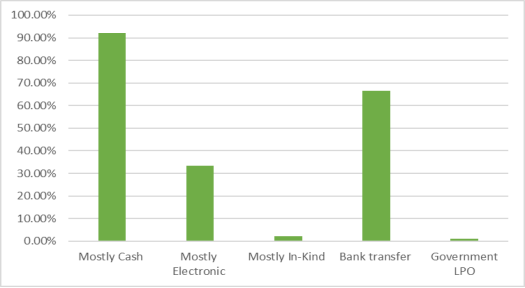


Figure 42: Preferred method of payment

Need for a down payment before production

The result in Figure 43 indicates that machineries were produced on a need basis (84%), an indication of the low capital base of producers. Moreover, this could be because they produced and sold within their location, or that knowledge of demand for machinery in other areas was primitive.

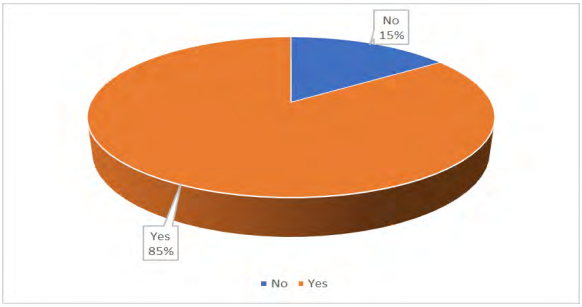


Figure 43: Down payment before production

Credit service to customer

The ability to access goods and/or services with the understanding of paying is an option considered by the manufacturers. About 76% of the farmers (Figure 44) reported that they advanced machineries to customers on credit basis. This indicated an established relationship between the manufactures and their customers. Mani et al. (2017) found that inheritance, experience, kinship and honesty influence the conduct of rural marketing system, where most transactions are on credit.

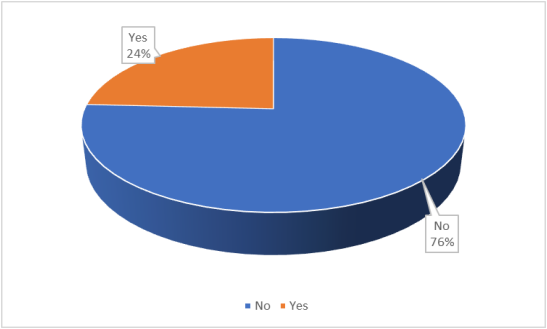


Figure 44: Credit advancement to customers

Production Efficiency

Majority of the producers (73%) were able to meet all machinery request made by customers (Figure 45). This implies a near level of efficiency among the machinery producers in the study area.

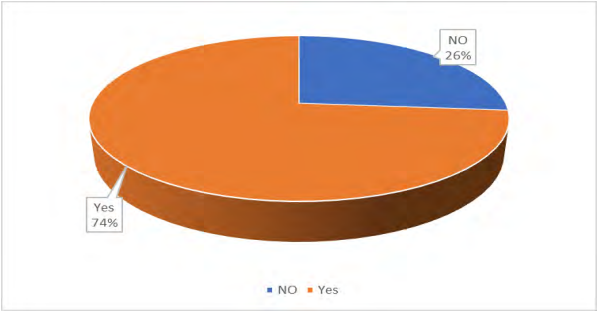


Figure 45: Meeting customer request for machinery

Main competitors

Table 9 reveals that the main competitors of the producers are from within themselves (67%). Manufacturers within the country and importers of machineries were 28% and 29% respectively, are close competitors, but by their margin are not considered as threats or strong competitors.

Table 9: Main competitors in the business

*Competitors	Frequency	Percentage
Manufacturers from area (Village/city/district/LGA)	60	66.67
Manufacturers outside area but within country	25	27.78
Manufacturers outside the country but with Africa	4	4.44

Importers of machinery	26	28.89
Government programs	1	1.11

*Multiple response allowed

Competitive advantage compared to importers of machinery

Figure 46 reveals that the manufacturers felt their machineries were of high quality. About 67% of the respondents believed that the quality of their work set them apart from competitors, especially importers. Others opined that prices (44%), availability (38%) and local adaptability (32%) gave them the competitive advantage.

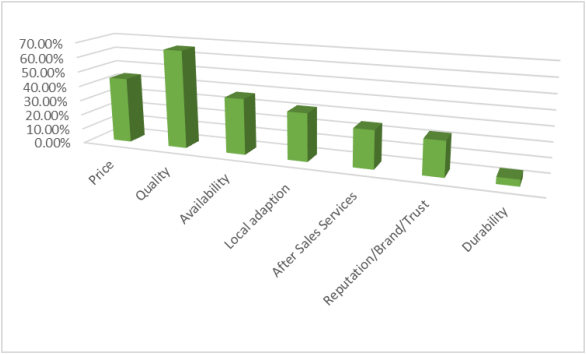


Figure 46: Perceived advantage over importers

Number of competing local manufacturers in an area

Oyo State had the highest number of agricultural machinery manufactures (18), as indicated in Figure 47. This is followed closely by Kaduna State (15). On the average, the country had about 14 local competitors that in study areas. The implication is that the manufacturers had knowledge of their competitors. Knowledge and understanding of competitors is critical in a marketing strategy.

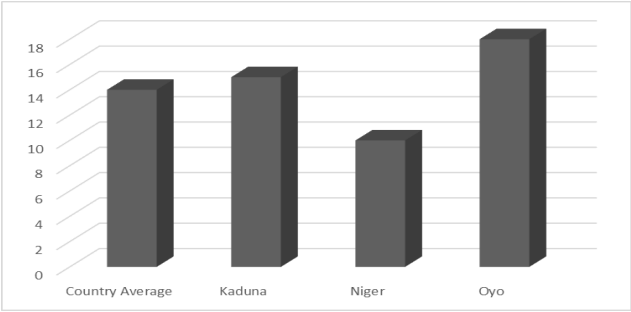


Figure 47: Number of competing local manufacturers

Point of sale of product

Figure 48 presents data on the point of sale of manufactured machineries. The data show that 81% of the manufacturers sold their products in their workshops. Agricultural machineries are heavy duty equipment; hence, transporting them requires special means. Moreover, as indicated earlier, majority of the customers of these manufacturers were located within the same villages, hence the use of the workshop as the sales outlet.

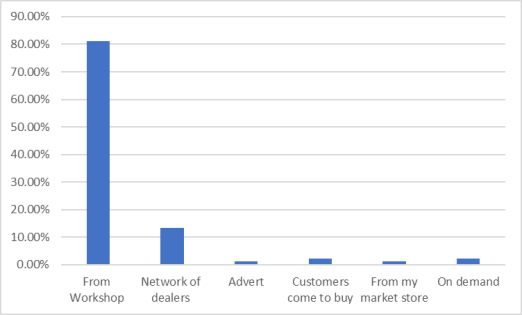


Figure 48: Place of sale of manufactured products

Profit utilization

Figure in 49 shows that a little over half (51%) of the respondents invested their profits back into their businesses, while 49% used them for other investments. This implies growing and expanding businesses in agricultural machinery manufacturers.

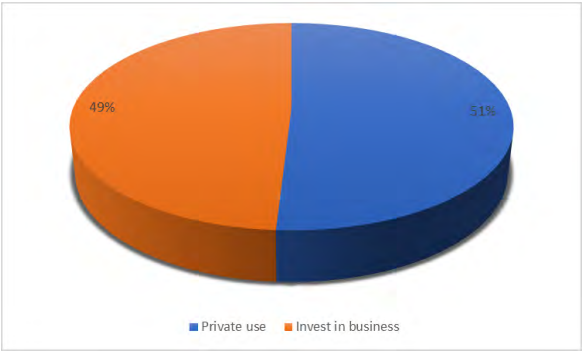


Figure 49: Potential use of profit from sales

Employees, Knowledge and Skills

Current staff strength

Majority of the manufacturers (66%) had an average of 6 employees under them; moreover, about 11% of them did not have any staff at all (11%) (Table 10).

Table 10: Number of Employed staff

Group	Frequency	Percentage	Average
0	10	11	
1-10	59	66	6
11-20	17	19	15
21-30	3	3	28
>30	1	1	45

Staff strength in three years ago

In the last three years, the average number of staff of the respondents is presented in Table 11.

Table 11: Number of staffs employed in the last three years

Group	Frequency	Percentage	Average
0	5	6	
1-10	66	73	6
11-20	18	20	14
21-30	0	0	
>30	1	1	

Educational background of employees

Figure 50, shows that 51% of the employees in the manufacturing industry had agricultural background or qualification, while about 43% had engineering background or certificate. Although there were other qualifications (such as artisans, primary and secondary school certificates, technical and vocational certificates), the number of employees with university degrees was very low (1%). The implication of this is that the study manufacturers were not exactly orthodox. Okoye (2016) opined that technical and vocational education is the engine of economic growth in Nigeria.

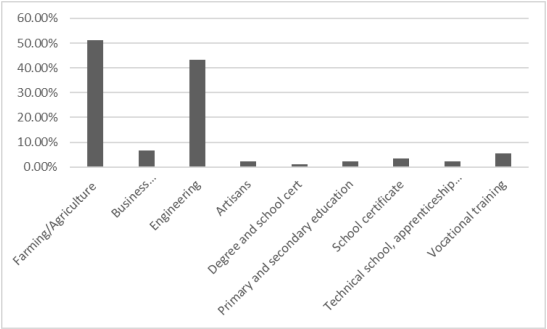


Figure 50: Educational background of employees

Educational level of employees

The data in Figure 51 show that the highest qualification of employees in agricultural machinery industry was secondary school certificate (about 58%), closely followed by primary school (30%) and vocational training (28%). The result is in tandem with earlier finding that the industry is not completely conventional. Furthermore, the data show that there was no PhD holder in the industry.

Thus, Ojimba (2012) stated that much emphasis on university education in Nigeria has always reduced the economic opportunities of those who are more work-oriented than academics, where skills can be acquired in technical training centres.

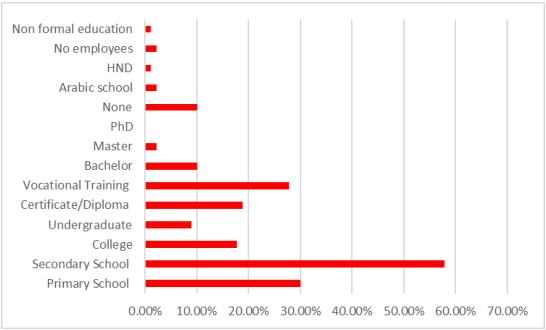


Figure 51: Educational qualification of employees

Satisfactory level with knowledge/skills hired staff after they completed their education

About 44% of the employers were mostly satisfied with the knowledge and skills of their staff (Figure 52), 20% were very much satisfied, while only 5% were not satisfied with their staff. This shows that on the average, the satisfaction level of the employers about their employees was commendable.

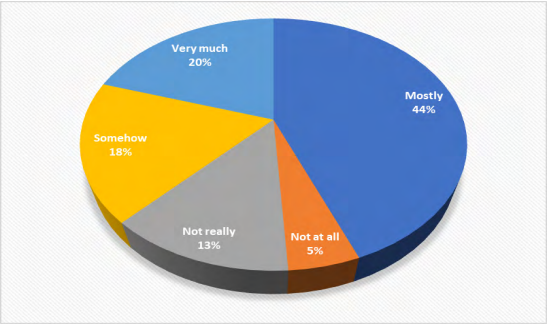


Figure 52: Satisfaction level of knowledge of employees

On-the-job training

Majority of the employers (74%) attested to the fact that they provided on-the-job training for their employees (Figure 53). This means that skills are acquired more on the job than at formal training in school. This was affirmed by earlier findings that majority of the employees were secondary school certificate holders.

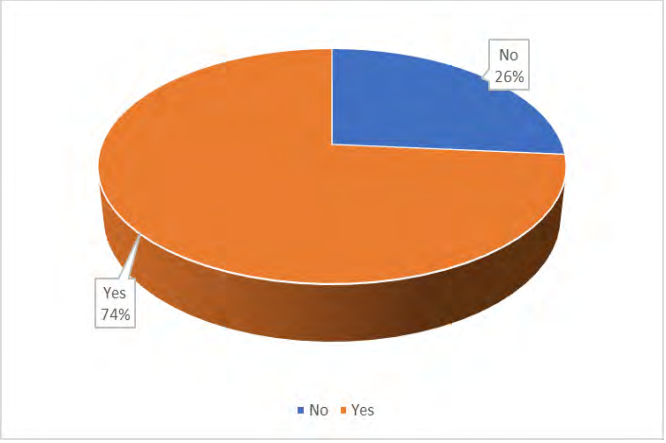


Figure 53: On the job training of employees

Trainee identification

Earlier results have indicated that the agricultural machinery production industry is an informal sector. This is corroborated by the data in Figure 54, in which majority of the trainees identified by employers were through informal requests from parents or guardians (about 52%). There were also informal requests from prospective trainees themselves. Formal applications (34%) and collaboration with training institutions (36%) for some skills acquisition were used by employers to identify trainees.

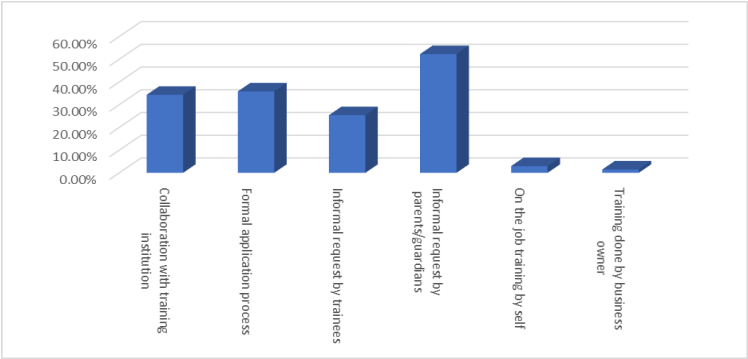


Figure 54: Identification of trainees by the manufacturers

Duration of training

On the average, the trainees attended training for 5 months in a year (Table 12). Those that attended the training between 2 and 5 years, completed the years. This suggests that training of trainers could take from 5 months to 5 years.

Table 12: Duration of training

Months Class	Frequency	Months Average
1-12	46	5
13-24	6	24
25-36	5	36
36-48	5	48
49-60	5	60

Salary scale

Table 13 shows that there were some trainees who did not receive any salary from their trainers. The reason given by the trainers was that inflation made it difficult to pay the trainees. On the other hand, some trainees earned between ₦7,417 and ₦55,000 in a month.

Table 12: Duration of training

Salary Class	Frequency	Salary Average
0	37	0
1000-20000	24	7417
20001-40000	3	25000
40001-60000	3	55000

Number trained in the last three years

The data in Figure 55 show that an agricultural machine manufacturer could train up to 25 trainees in about three years.

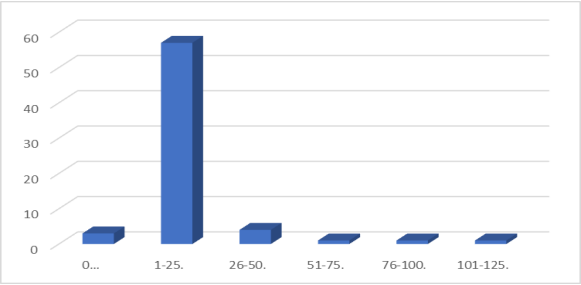


Figure 55: Number of staff trained in the last three years

Collaboration with vocational schools

About 64% of the respondents indicated that they did not collaborate with other vocational schools when training their trainees (Figure 56), as against the 36% that collaborated with vocational schools. This finding affirms earlier finding that trainees were mostly identified through informal requests from parents. The Federal Ministry of Budget and National Planning (2018) suggested that there is a need to address the supply and demand sides of the integrated employment approach by focusing on improving the quality of technical and vocational education and training in the labour-intensive construction and agriculture sectors and the occupational field of industrial mechanics.

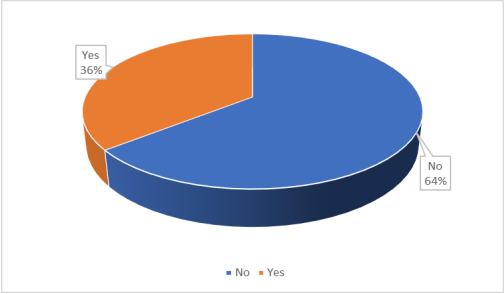


Figure 56: Collaboration with vocational schools

Trainees' situation at the end of the on-the-job training

Figure 57 provides the situation of the trainees at the end of the training. About 78% of the trainees were set free by their trainers to establish their own businesses. On the other hand, 40% of the trainees were hired by the trainers and put on a salary. This particular category of trainees were paid higher than newly recruited trainees.

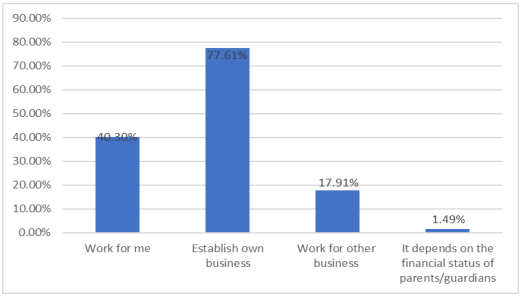


Figure 57: Position of the trainees after on-the-job training

Enabling Business Environment

Access to loan/credit to support the business in the last 3 years

Credit is an important resource in nearly all commercial agricultural businesses. It provides the opportunity to pay the cost of additional resources now from future earnings. However, 80% of agricultural machinery manufacturers (Figure 58) did not apply for or access credit facilities in the past three years. This implies underutilization of agricultural finances, as offered by the Federal Government. Nigeria's Agricultural Credit Guarantee Scheme Fund (ACGSF) is known to enhance agro-allied entrepreneurs' capacity to procure inputs needed for production.

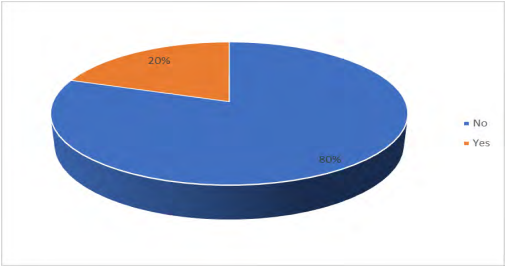


Figure 58: Access to loan in the last three years

Purpose of the loan

Among the respondent that accessed credit (in Figure 58), 65% used the loan to buy raw materials (Figure 59), while 35% used it to purchase equipment and other machineries.

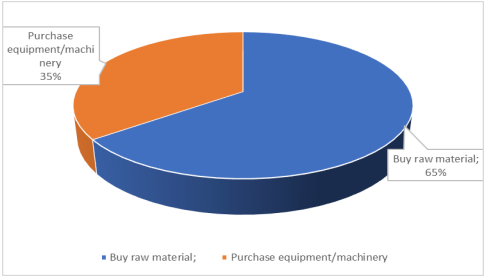


Figure 59: Access to credit

Reasons for not accessing loan

In Table 14, 30% of the respondents indicated that they did not access credit because they did not believe they could get. They attributed this to lack of knowledge on how to apply for the credit. Conversely, 27% of the respondents reported that they were discouraged by the bleak process of obtaining loan from banks. This gives an indication of low or poor capital-intensive expansion by the manufacturers.

Table 14: Reasons for not accessing credit

Reason	Frequency	Percent
Didn't believe I could get it	22	30
Prefer other sources	12	16
Strict repayment schedules	5	7
Tedious application process	20	27
Building business gradually	1	1
Didn't believe in borrowing	1	1
Each time I try I always get frustrated	1	1
High interest rate	5	7
Lack of knowledge on how to apply	1	1
No body to guide me	2	3
Not accessible	2	3
Not know how to go about it	1	1
Grand Total	**73**	**100**

Received loan

The data in Figure 58 show that only 20% of the manufacturers applied for loan, out of which 89% received the loan (Figure 60). This means that, although access to loan was low among the manufacturers, those that painstakingly applied for the loan received it.

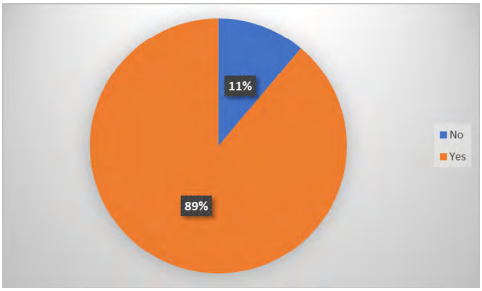


Figure 60: Manufacturers that received loan/credit

Reason for non-disbursement of loan

Further from Figure 60, about 11% of the respondents did not receive the loan they applied for. In Figure 61, 31% of the respondents indicated that there was no apparent reason given for declining their requests. However, 21% indicated that it was due to lack of collateral. The lack of collateral is a typical challenge when it comes to access and receipt of loan in Nigeria.

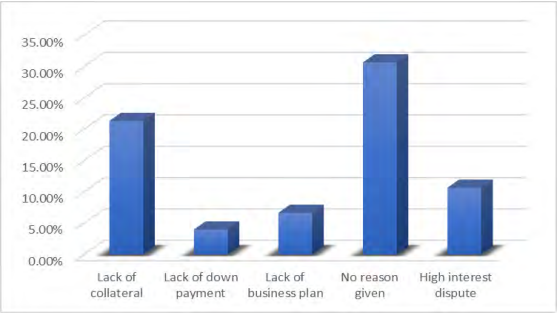


Figure 61: Reasons for not receiving the loan

Sources of loan/credit

The result in Figure 62 showed that the bulk of the manufacturers who obtained loan did so from microfinance bank (43%). While others obtained their loan from family and friends. There was no credit from government or any non-government organization. Family and friends and commercial banks lend out credit, as indicated by 33% and 24% of the respondents respectively.

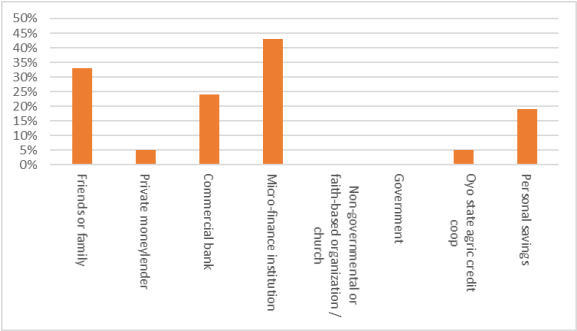


Figure 62: Source of credit

Interest rate

The data in Table 15 show that the most dominant (43%) interest rate was between 10-15%. The rate was also as high as 21-26%, as indicated by 36% of the respondents. This further confirms earlier findings on the fact that high interest rate poses a challenge to farmers' access to loan.

Table 15: Rate of interest

Interest rate (%)	Frequency	Percentage
<10	2	14
10-15	6	43
16-20	1	7
21-26	5	36

Type of support received from the government in the last 3 years

Only about 16% of the manufacturers affirmed that they received support on knowledge and skills (Figure 63), but Figure 64 reveals that the support came from donors only.

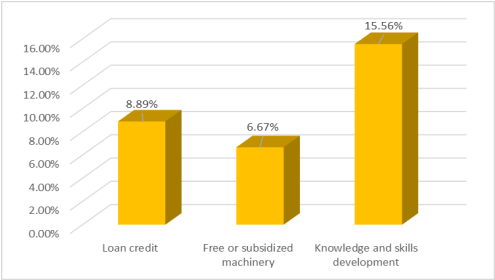


Figure 63: Type of support received

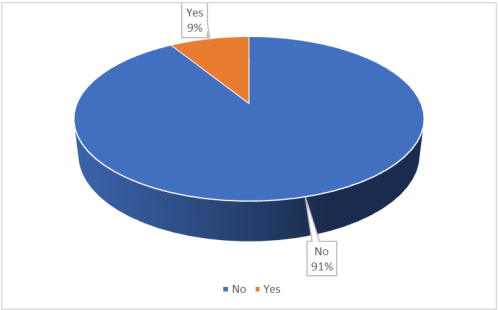


Figure 64: Support from donors

Access to the electricity grid

The data in Figure 65 show that 81% of the manufacturers had direct access to electric supply. The presence of power supply significantly influences industrial production and is directly related to the amount of work or revenue that can be achieved in a given period of time.

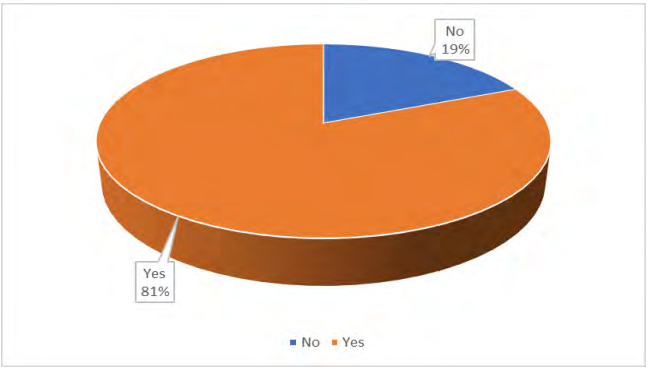


Figure 65: Access to electricity grid

Taxes

Figure 66 shows that 96% of the respondents were required pay taxes to the government. The amount of tax paid by any business can determine and affect its profit.

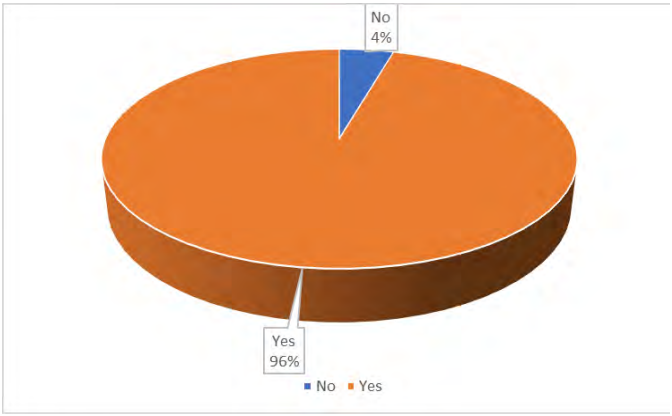


Figure 66: Paid taxes

Effect of government policies and regulations

In every business, there are government policies that affect a business positively or negatively. About 55% reported that there were negative policies affecting their business (Figure 67). Further, local and national taxes ranked as the most critical policy that negatively affected the agricultural machinery production industry (Table 16). Environmental regulations ranked second among the negative effects of policies, closely followed by import regulations. The reason for this might be because of the need to import some industrial machineries that were used during the manufacturing process.

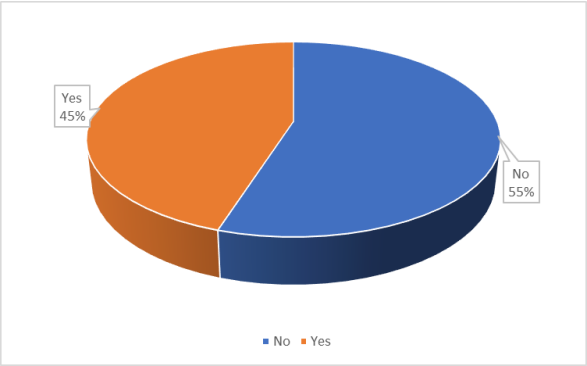


Figure 67: Policies and regulations affecting manufacturers business

Table 16: Negative policies affecting the business

Negative Policies	Percentage	Rank
High Local or national taxes	78.05%	1st
Poor Environmental regulations	39.02%	2nd
Bad Import regulations	21.95%	3rd
Government competition (e.g. government machinery imports)	9.76%	4th
Insecurity	4.88%	5th
Poor Government subsidy	2.44%	6th
Inflation	2.44%	6th

Factors affecting the business

The major constraint to the success of agricultural machinery manufacturers was the unreliability of electricity; this ranked first among the constraints (Table 17). Energy supply crisis is an ongoing failure of the Nigerian power sector with regard to adequate electricity supply to industrial producers despite a rapid growing economy. The results also revealed a lack of access to finance (70%) as a critical constraint to the machinery business. Although credit has always been an integral component of the overall government policy to accelerate agricultural and industrial development in Nigeria, majority of small, medium and large-scale agricultural industries were constrained due several policy issues (Table 16).

Other limiting factors were cost of electricity (39%), finance (36%), poor access to production factors (28%) and machinery or equipment. These were factors related to production and ranked 3rd, 4th, 5th and 6th respectively. This is because modern equipment are costly; hence, the manufacturers lacked the necessary finance to purchase them. With regard to the study area, improvised materials were mostly used during production. In addition, there was lack of

modern and sophisticated equipment in the study area which invariably limited the capacity of production.

Table 17: Limiting the success of manufacturing business

Factors	Percentage	Rank
Access/reliability to electricity	76.67	1st
Access to finance	70.00	2nd
Costs of electricity	38.89	3rd
Costs of finance	35.56	4th
Access to production factors	27.78	5th
Access to machinery/equipment	27.78	6th
Market access	18.89	7th
Lack of standards and certification	14.44	8th
Peace and stability	13.33	9th
Access to skilled staff	10.00	10th
Import regulations	10.00	11th
Access to land	7.78	12th
Costs of land	5.56	13th
High cost of materials	2.22	14th
High taxation	2.22	15th
Exchange rate	1.11	16th
Lack of raw materials	1.11	17th

Overall Business Climate

In Figure 68, a combined total of 53% of the respondents believed that the business environment was fairly good. This implied that there is significant room for improvement if the identified constrains in Tables 16 and 17 are reduced to the barest minimum. Although there were those that believed the business was excellent (7%), they were countered by 23% others that it was somewhat bad (23%) and in dire need of support.

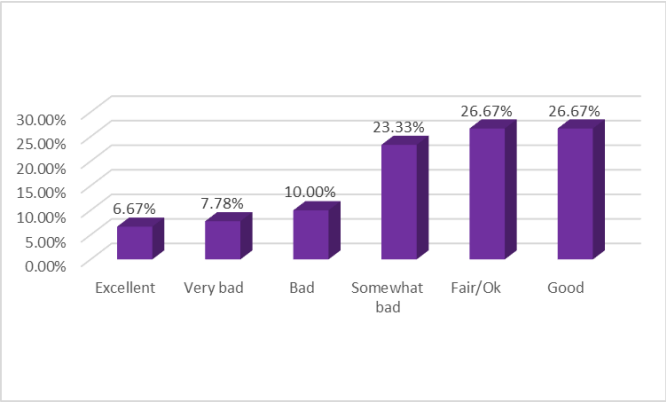


Figure 68: Overall business climate

Changes in business environment in the last three years

The respondents were divided over changes that occurred during the last three years in the business environment. In Figure 70, about 27% of them opined that the business environment had improved marginally, while 28% stated that it became marginally worse in the last three years. They attributed this to the insecurity situation and high inflation rates in the last 3-5 years. On the other hand, 14% believed the environment had drastically improved, while 13% said it stagnated. They reported that the situation was stagnant especially because of the challenges outlined in Table 17. The 14% which reported it had improved said it was because of the new enabling environment for businesses in the country.

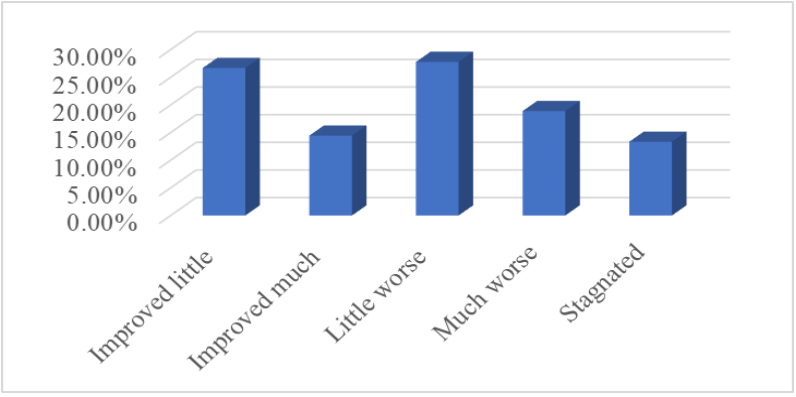


Figure 69: Changes in business environment

Addition Challenges and Opportunities

Challenges of local manufacturing

A myriads of challenges confront local manufacturing of agricultural machineries in Nigeria. Results in Table 18 indicate that the major challenges of local manufacturing were high cost of raw materials (82%), poor funding or inadequate capital (80%), insecurity (78%) and poor infrastructure (76%). The high cost of raw materials could be as a result of the high inflation rates. According to a study published by the International Conference of the West African Society of Agricultural Engineering, 90% of farmers in Nigeria use hand tool technologies. Many farmers lack the resources to acquire agricultural machinery like tractors and ploughs due to their high costs. Also, the steel industry, which provides the needed raw materials for machine manufacturing and fabrication outfits in Nigeria has not been fully developed; most steels are imported from China. In most hardware stores in the country, the chances are that a majority of the tools on display came from China, India or South Korea (Asoegwu and Asoegwu, 2007). This is a great challenge to the local manufacturing industries.

The efforts of NASENI's 6 development centres on agricultural machines and tools have not been felt because the agency is interested in process lines and pilot plants manufacture rather than individual unit operations machines. The centres are: (i) Scientific Equipment Development Institute, Enugu (SEDI-E), (ii) Scientific Equipment Development Institute, Minna (SEDIM), (iii) Centre for Adaptation of Technology (CAT) Awka, (iv) Engineering Materials Development Institute (EMDI), Akure, (v) Hydraulic Equipment Development Institute (HEDI), Kano, and (vi) National Engineering Design Development Centre (NEDDEC), Nnewi and their machine building workshops. So NASENI partnered other groups to develop agricultural machines as laboratory prototypes (Onwualu and Pawa, 2004). Therefore, it is expected that NASENI would expand and direct its efforts to agricultural machines, using prototypes that are sourced from higher institutions.

Table 18: Distribution of challenges confront local manufacturing of agricultural machineries in Nigeria

S/№	Challenges	%
1.	High cost of raw materials	82
2.	Poor funding (inadequate capital)	80
3.	Insecurity	78
4.	Poor infrastructure	76
5.	Bad policies	69

6.	Unintended beneficiaries of government support	65
7.	Non-involvement of stakeholders in policy implementation	65
8.	High cost of electricity	65
9.	Lack of equipment and raw materials	61
10.	High tax	57
11.	Poor access to loan	57
12.	High exchange rate	55
13.	Scarcity of production inputs (raw materials)	53
14.	Competition from Import	50
15.	High interest on loan	48
16.	Poor materials	43
17.	Poor publicity of local manufacturing activities	30

Opportunities of Local Manufacturing

Despite the challenges highlighted above, the local manufacturing of agricultural machineries in Nigeria has a lot of opportunities waiting to be harnessed/exploited. Table 19 presents the major opportunities, including availability of large/huge markets for finished products (85%), availability of cheap raw materials (75%) and availability of skilled personnel (70%). No doubt, with a population of over 200 million, Nigeria presents a large market for finished products, going by the number of mouths to feed.

Table 19: Opportunities available for the local manufacturing of agricultural machineries in Nigeria

S/№	Challenges	%
1.	Availability of large/huge market for sales of finished products	85
2.	Availability of cheap raw materials (if properly harnessed through committed investment)	75
3.	Availability of skilled personnel (work force)	70
4.	Quality research findings	62

5.	Development of home-grown technologies and innovations	54
6.	Availability of extension services	45

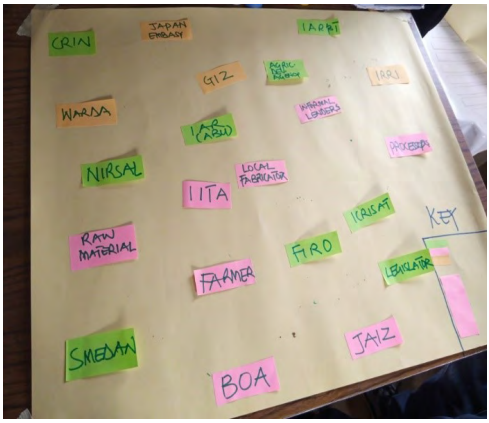
Results from Net Map Sessions

From the ten (10) net-map sessions conducted, various actors were identified to influence the study outcome. The locations and the participants at the various net map sessions are presented in

Some of the Identified actors as presented during the session

Players and actors as identified were:

i. Fabricators
ii. Raw materials suppliers
iii. Legislators
iv. Financial institutions.
v. Training and research institutes
vi. Service providers
vii. Politicians
viii. Farmers
ix. Security institutions
x. Marketers
xi. The traditional leaders in various communities
xii. Processors



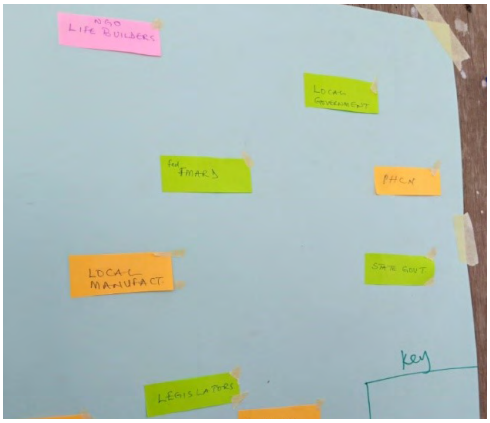


Figure 70: Some of the identified actors during net map session

Linkage & Connection Among the Actors

The actors identified and their connection/relationship were outlined. Local manufacturers, being the centre of the activity, being the product manufacturers and related with each other, were:

i. Legislators put laws/policies in place to enhance machine fabricators' activities
ii. Financial houses to earmark funds in the form of loans and aids for local manufacturing; although most of the actors complained that they needed money but could not access any.
iii. Research institutes to provide modern innovations to make enhance manufacturing activities and output; to also provide training for fabricators and others in the value chain.
iv. Service providers should be experts in some specialized operations; these services should be available and accessible to fabricators.
v. Farmers and processors are the end users, so they are critical to the manufacturing activities.
vi. Security institutions are from both government and private security outfits; they play a major role to make life and property safe.
vii. The place of local chiefs and community leaders cannot be over-emphasized. They are the fathers of the land.

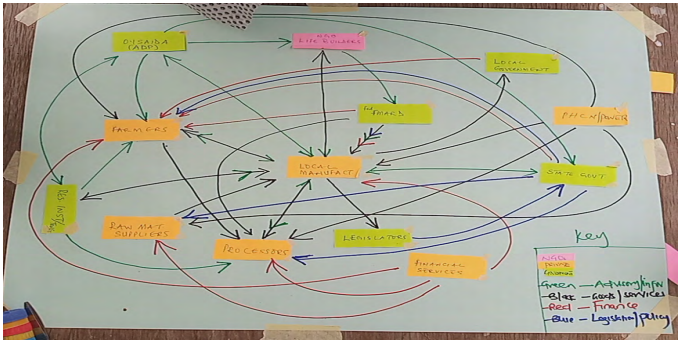


Figure 71: Linked actor during one of the net map sessions

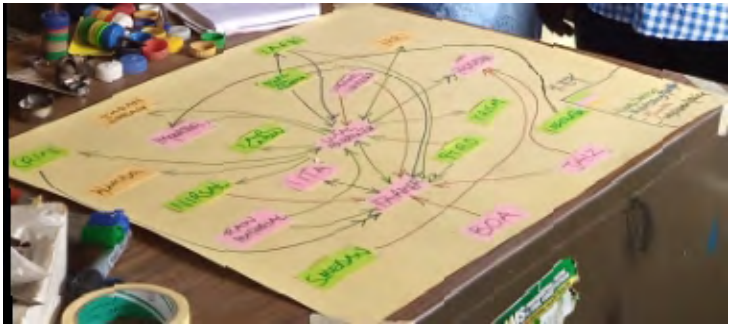
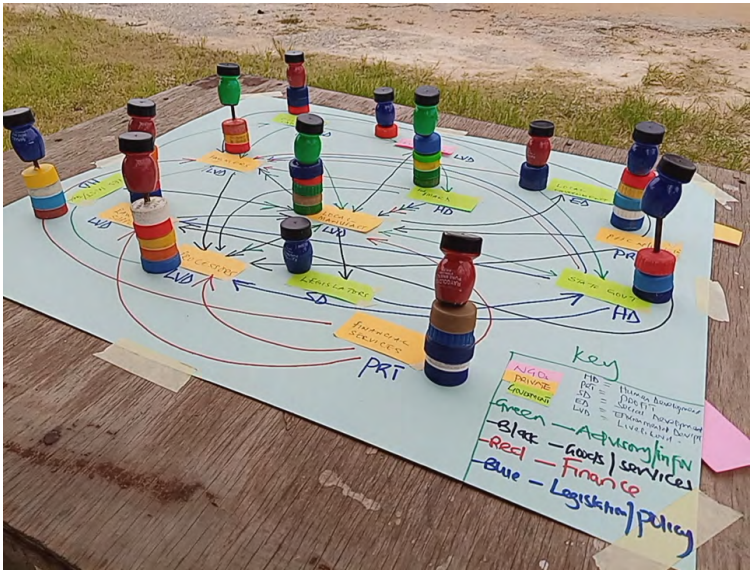
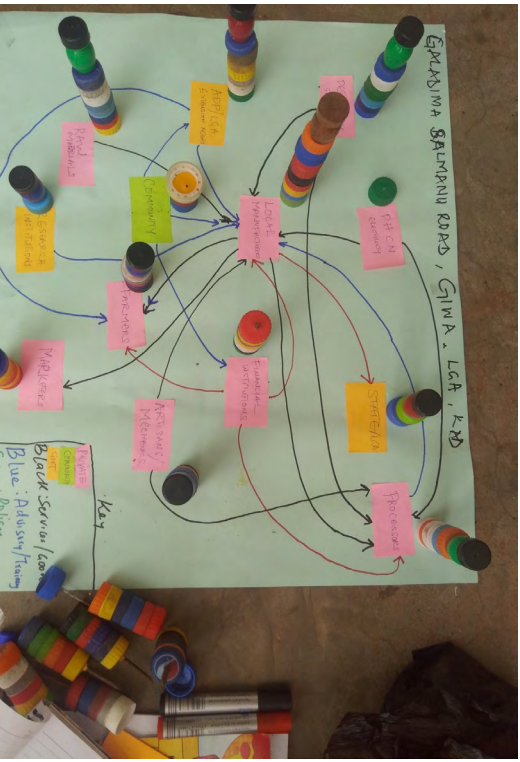


Figure 72: Another linked actor during one of the net map sessions

Influence level

It was found that raw material suppliers, processors and smallholder farmers had the same level of influence (90%). The actors claimed that financial institutions should have been at the same level as raw material suppliers, but did not feel their impact, having provided no loan. Financial institutions had 60% level of influence. In addition, training institutions, ADPs, LGAs and state authorities had about 40% level of influence. Finally, legislators and donor agencies (such as DFID, GIZ and USAID) had no influence whatsoever on the study outcome.




EMLADIMA SALIMANU ROAD, GIWA. LGA, KD
Key


DAMS
BOA
JAIZ
PRO
PPI


NIRSAN
DFID

Some of the bottlenecks identified by stakeholders

1. Poor patronage and support from government
2. Poor electricity supply
3. High cost of raw materials
4. Poor economic status of the country
5. Political instability
6. Absence of import regulations and certifications
7. Inadequate skilled labour
8. Security challenge
9. Decrease in quality, durability and quantity of raw materials.
10. Lack of capital and bureaucracy in access to capital
11. Lack of sophisticated equipment and machine need for the job
12. Increase in transportation cost

Causes of the bottlenecks and how they can be addressed

According to the stakeholders interacted with, bottlenecks persisted because of corruption and the lack of political by government. The following suggestions for overcoming the bottlenecks were made:

1. There should be grants and support for SMEs of local fabricators in order to boost their production.
2. Government should be determined in addressing the gross shortage of power supply. This way, locally produced machines can compete favourably and advantageously with imported products.
3. There should be easy access to cost-effective and affordable loans to boost production of equipment and machineries required by smallholder farmers.
4. Agencies responsible for machinery design should step up efforts to provide modern and state of the art designs for adoption by local fabricators.
5. Regular trainings and special skills set workshops should be provided to young fabricators to advance their knowledge of fabrication.
6. Establishment of high-tech industry for the manufacture of sophisticated equipment like prime mover and others.
7. Government agencies should contract and patronize made in Nigeria products to motivate local fabricators to produce more.
8. There is the need to regulate and checkmate substandard products made in the country or imported into it.
9. Provide adequate security across the country so that fabricators can be patronized from anywhere in the country without fear.

Results from Key Informant Interviews

The outcomes of the key informant interviews indicated that the condition of local agricultural manufacturing was not impressive, as it performed below average. More so, almost 70% of agricultural machineries were imported, while 30% were locally produced. However, the imported machines were often modified by local manufacturers before they could be used in the country. The few machineries produced evolved through identification of farmers' needs, requests by farmers and processors, fear of food insecurity and, to a large extent, favourable policies.

Opportunities for local agricultural manufacturing sector included:

i. Availability of cheap raw materials (harnessed through committed investment).
ii. Availability of a large market for finished products.
iii. Development of home-grown technologies and innovations.
iv. Potential of the local manufacturing sector to dominate machine import, due to reduced production cost.
v. High demand in local agricultural machineries due to the fact that more people (especially youth) would become involved in farming.

To harness these opportunities, the following were suggested by the key informants:

i. By allowing the local sector to be well-equipped and make optimum use of human resources for self-sustenance.
ii. Government should provide huge investment especially in improving infrastructure.
iii. Establishment and enforcement of law to strictly regulate import of agricultural machineries.
iv. The private sector and people in diaspora should be encouraged to increase investment in local machineries production.
v. There should be government policy favourable to local contents.
vi. Creation of an enabling environment for investors in equipment development and manufacturing.
vii. Engineering raw materials and/or components should be made available and accessible. For example, IAR&T has stated that: "There is no single manufacturer of conveyor belts in Nigeria, same with bearings; how can mechanization be developed without these components?"

Some of the key constraints to the development of local agricultural manufacturing sector are:

i. Lack of sophisticated machines for production; some individuals are reluctant to fund it. According to Saminaka Local Manufacturers Association: "There are aging machineries and technologies, resulting in poor quality products; hence, we need sophisticated equipment and machineries for our work.... Also, most local agricultural manufacturers do not have access to machines, equipment and spare parts at affordable rates. The government should help focus in this area....

ii. Inadequate finance (lack of initial fund by interested manufacturers).
iii. Poor infrastructure (particularly electricity and road).
iv. Inadequate market information to enhance the utilization of market opportunities and coordination of market actors.
v. High patronage of imported machines, due to unwholesome preference for foreign than locally manufactured materials. The Nigerian Fish Farmers Association, however, noted that "most of these imported machines are often locally modified to suit our purpose".
vi. Lack of technical know-how due to inadequate training.
vii. Inadequate information on modern techniques.
viii. High cost of improved technologies
ix. Poor interest due to poor policy environment
x. Environmental factors and problem of inadequate raw materials and policy inconsistencies
xi. Lack of local equipment manufacturers
xii. Inadequate research
xiii. Lack of political, will as well as corruption by government officials

Conclusion and Policy Recommendations

Conclusively, the research was able to establish that the status of local agricultural manufacturing industry in Nigeria was not good enough, as the manufacturers were battling with a lot of challenges. Among the challenges facing the sector were poor power supply, lack of capital, low skills capacity, insecurity, and multiple taxation. Most of these constraints can be directly addressed through government policies—such as reducing multiple taxation by state and local governments, regulating electricity supply and tariff for manufacturers of agricultural machineries, increasing patronage of local manufacturing, training and re-training of local manufacturers, and collaboration with NGOs and multinationals to invest in the local agricultural manufacturing sector. Consequently, the following recommendations are made:

1. **Development partners**
   - i. The latest Word Bank (2018) policy report on ease of doing business in Nigeria should be well studied, to help identify areas and states of interest and focus.
   - ii. The current Nigerian policy on agriculture and mechanization, as indicated in this report, should be understood and followed in investing in the agricultural manufacturing industry.
   - iii. The various opportunities in the local agricultural manufacturing sector, as identified in this report, should be maximized in order to support a profitable work environment.
2. **Government**
   - i. Local manufacturers should be encouraged and supported to manufacture farm equipment, such as tractors, harrows, ploughs, sprayers, planters and so on. This will increase the availability of such machines in Nigeria.
   - ii. Provision of regular electricity, reduction of duties on raw materials, government patronage of locally produced machines, and provision of subsidies to encourage local fabrication are some measures that can be taken by government.
3. Private sector/donor
   - i. There should be increased involvement and investments in the agribusiness value chain. State and federal governments remain the biggest buyers of farm equipment, the entrance of well-capitalized private sector investors in the agricultural space is expected to further boost market demand for inputs.
   - ii. The private sector should partner the public sector to provide the basic infrastructures required for rapid and sustainable business development. This will strengthen Public Private Partnership (PPP) arrangement in agricultural mechanization.
4. **NGOs/donors**

i. It is glaring from the study outcomes that inadequate credit seriously constrained local machine manufacturing. Therefore, there is need to facilitate access to loan for small and medium enterprises in the sector.

ii. In the area of capacity building, a lot can be achieved by the local manufacturers through regular well-packaged trainings along the manufacturing value chain—that is, from production to marketing and post-sale services.

5. Third Sectors (e.g. farmer-based organizations, manufacturing association, etc.)

i. Agricultural manufacturers should revive their cooperative societies and associations to enable them access government incentives and new innovations/inputs necessary to increase outputs and profits.

ii. There should be a strong collaboration between the manufacturers and vocational training centres. Trainings should be formalized and integrated into the Technical and Vocational Education and Training (TVET) such that certificates are obtained at the end of any training. This way, more youths would become involved in the local agricultural manufacturing industry.

iii. Farmer-based organizations should encourage the use of locally made agricultural equipment and machineries. This will boost the morale of the local manufacturers.

iv. Farmer-based organizations should strengthen their cooperatives so that any equipment or machinery that cannot be afforded by an individual is acquired through group efforts (cooperative).

References

AFCFTA (2020). Current State of Nigeria Agriculture and Agribusiness Sector. Paper presented by Taiwo Oyaniran, Associate Director, PwC Nigeria at AFCFTA 2020 workshop.

Akinbamowo, R.O. (2013). A review of government policy on agricultural mechanization in Nigeria. Journal of Agricultural Extension Rural Development, 5(8): 146–53.

Alemu, M. H., Olsen, S.B., Vedel, S. E., Kinyuru, J. N. & Pambo, K.O. (2017). Can insects increase food security in developing countries? An analysis of Kenyan consumer preferences and demand for cricket flour buns. Food Security, 9(3), 471–84.

Amongo, R.C., Larona, M.L. (2015). Agricultural mechanization policies in the Philippines. Beijing: United Nations Centre for Sustainable Agricultural Mechanization.

Asoegwu, S. and Asoegwu, A. (2007). An Overview of Agricultural Mechanization and Its

Environmental Management in Nigeria. Agricultural Engineering International: the CIGR Ejournal. Invited Overview 6 (IX). May.

Enhancing Financial Innovation and Access (EFInA) (2016) Survey report of enhancing financial innovation & access (EFInA). Available on http://www.efina.org.ng/assets/A2F/2016/Key-Findings-A2F-2016.pdf

FAO (2013). Mechanization for rural development: A review of patterns and progress from around the world. ICM Vol. 20. AGP Division. Rome, FAO. 336 pp.

FAO (2016). Agricultural mechanization, a key for sub-Saharan African smallholder. Integrated Crop Management (ICM 23). Rome. (available at http://www.fao.org/3/a-i6044e.pdf).

FAO and AUC (2018). Sustainable Agricultural Mechanization: A Framework for Africa. Addis Ababa. 127pp. Licence: CC BY-NC-SA 3.0 IGO.

FAO and UNIDO (2008). Agricultural mechanization in Africa, Asia and Latin America. Time for action: planning investment for enhanced agricultural productivity. Rome: FAO.

Federal Ministry of Agriculture and Rural Development (FMARD) (2016). The Agriculture Promotion Policy (2016–2020). Available online on www.fmard.gov.ng. Accessed 16thMarch, 2021.

Federal Ministry of Budget and National Planning (FMBNP) (2018). Skills Development for Youth Employment – SKYE in Nigeria.

Fonteh, M.F. (2010). Agricultural mechanization in Mali and Ghana: strategies, experiences and lessons for sustained impacts. Rome: FAO.

Haruna, I.M. & Junior, J.A. (2013). Mechanization practice: a tool for agricultural development in Nigeria: a case study of Ifelodun local government area of Kwara State. International Journal of Basic and Applied Science, 2(3), 98–106.

Iheanacho, A. C., Olukosi, J. O. and A. O. Ogungbile (2003). Economic efficiency of resource use in millet based cropping systems in BornoState of Nigeria, Nigerian Journal of Tropical Agriculture. 2: 33 -42.

Kaduna State Government (KDSG) (2008): Kaduna State Achievements, Data on Estimated Annual Animal Population and Fish Production Investment Opportunities

16-18 (3) (PDF) Seroprevalence of Brucellosis in sheep in Maigana and Birnin Gwari agro-ecological zones of Kaduna State, Nigeria. Available from: [accessed Jun 27 2021].

Karim H, Lawrence J. C., John. E. A. and Josef K. (2013). Sub-Saharan Africa: Guidelines for preparing a strategy. Plant production and protection division, Food and Agriculture Organization of the United Nations, Integrated

Crop Management Vol. 22-2013, Rome, 2013.

Kasali, M.Y. (2018). Present Status and Future Prospects of Agricultural Machinery Research Activities in Nigeria. Agricultural Mechanization in Asia, Africa and Latin America (AMA). Special Issue: Agricultural Mechanization and Industry in Africa. Vol.49, No.2, spring 2018.pp.135-149.

Ndubuisi, C. O. (2019). The Role of Mechanized Agriculture in a Developing Economy. A Paper Presented to School of Engineering Technology, Federal Polytechnic Nekede Owerri, Imo State, On her 1st National Conference,12th -15th November @ 1000 Capacity Auditorium

Mani, J. R., Z. Abdussalam & M. A. Damisa (2017): Analysis of the Structure and Conduct of Date-Palm Marketing in Katsina State, Nigeria. Samaru Journal of Agricultural Education (SJAE), 7(1), 1-8.

Mrema, G, Baker, D. and Kahan, D. 2007 Agricultural Mechanisation in sub-Saharan Africa. Time for a New Look.

Mrema, G., Soni, P. & Rolle, R.S. (2014). A regional strategy for sustainable agricultural mechanization: sustainable mechanization across agri-food chains in Asia and the Pacific region. Bangkok: FAO.

Ojimba, D. P. (2012). Vocational and technical education in Nigeria: issues, problems and prospects' dimensions (IPP). Journal of Educational and Social Research, 2(9), 23-23.

Okoye, R., & Arimonu, M. O. (2016). Technical and Vocational Education in Nigeria: Issues, Challenges and a Way Forward. Journal of Education and Practice, 7(3), 113-118.

Onwualu, A. P. and N. P. Pawa. (2004). Engineering infrastructure for the manufacture of agricultural engineering machines in Nigeria: The role of NASENI. Proc. 2nd International Conference of the West African Society of Agricultural Engineering, Kumasi, Ghana. 20-24 Sept. 2004.

Osabohien, R. Mordi, A. & Ogundipe, A (2020). Access to credit and agricultural sector performance in Nigeria. African Journal of Science Technology Innovation and Development, 1-9.

Ozumba, I. C., O. A Ogunjirin, O. O. Opadotun, T. Iorpev, S. Kang (2019). A Review of Current Status of Agricultural Mechanization in Nigeria International Journal of Agriculture and Biological Sciences –ISSN (2522-6584) Jan & Feb 2019.

Pingali, P., Bingot, Y., and Binswinger, H.P. 1987. Agricultural Mechanisation and the Evolution of Farming Systems in sub-Saharan Africa. John Hopkins University Press.

Sahel, (2017). Nigeria's Mechanisation Landscape. Vol. 17. Pp 1-9.

Schmitz, A. & Moss, C. B. (2015). Mechanized agriculture: machine adoption, farm size, and labor displacement. AgBioForum, 18(3), 278–96.

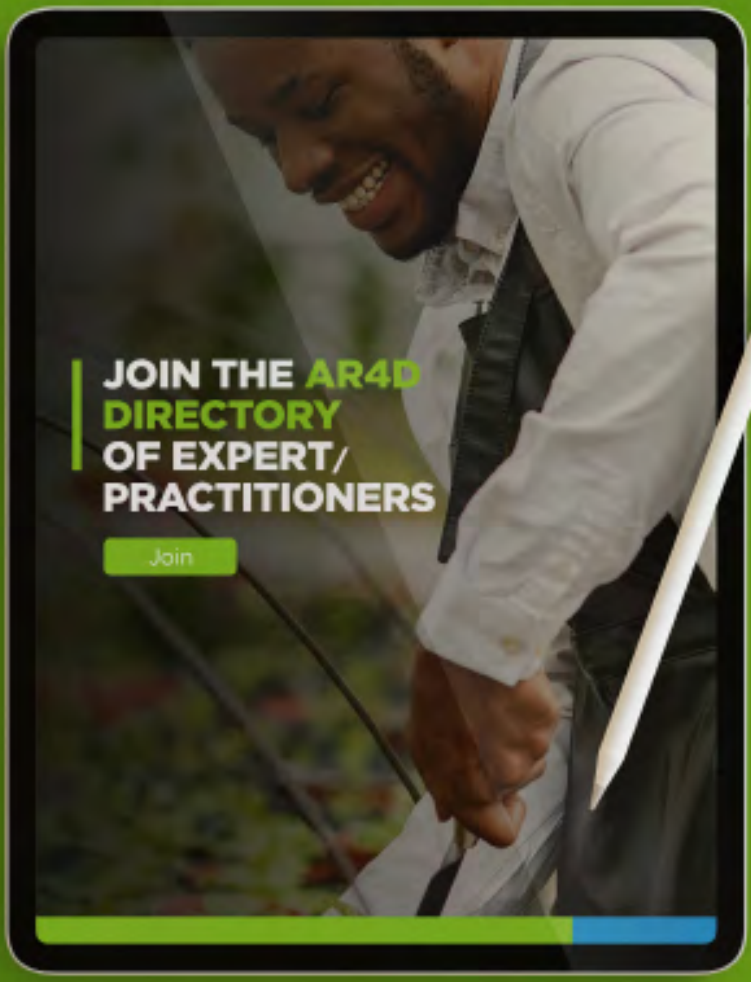
Simalenga, T. E. (2000). Entrepreneurship in mechanized agriculture technology-oriented operations. Journal of Agricultural Mechanization in Asia, Africa and Latin America (AMA), 31(3):61–88.

Singh, G. (2006). Estimation of a mechanization index and its impact on production and economic factors a case study in India. Biosystems Engineering, 93 (1),99–106.

Starkey, P. (2000). The history of working animals in Africa. The origins and development of African livestock: Archaeology, genetics, linguistics and ethnography, 478-502

Word Bank (2014). Agribusiness Indicators: Nigeria. The International Bank for Reconstruction and Development/ The World Bank 1818 H Street, Washington DC.

Takeshima, H, A.N. Pratt, and X. Diao (2013). Agricultural Mechanization patterns in Nigeria, Insights from House Farm Household Typology and Agricultural Household Model Simulation, International Food Policy Research Institute (IFPRI), Washington, DC. pp3-6.



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