

# Transforming Nigerian Agriculture through Mechanisation:

A market study on trends and  
opportunities

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**agramondis**

Propcom



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## Executive summary

Compared to other parts of the world, agricultural mechanisation in Sub-Saharan Africa is low. Nigeria's tractor density is 1% of the global average and will need to increase by the 14-fold to around 100,000 tractors to provide for 80% tractorisation. As for now, human labour remains the main source of power, cultivating over 70% of the arable land. Animal traction is used on one-quarter of land.

The low rate of mechanisation is in part explained by the small average farm size in Nigeria. The majority of farms are under 3 ha. Farms of 3 ha and more are using animal traction more often than smaller ones. From 5 or 6 ha, tractors hire becomes attractive. Another factor is the low number of working tractors in the country, which is further compounded by poor utilisation of the existing tractor fleet, which has the technical potential to cultivate at least four times as much land as is currently cultivated by tractor.

Nigeria does not currently have a domestic tractor manufacturing industry and spent close to USD 1bn on tractor imports between 2015 and 2019. To cover its demand for an additional 100,000 tractors over the next ten years, Nigeria will need to import c. 15,000 tractor per year, which it achieved in 2018 and 2019.

The majority of tractors in Nigeria today are being hired out, informally or via formal hire platforms. Current demand for tractor services outstrips supply by at least a factor five, creating market opportunities for new tractor hire businesses. Such businesses offer attractive returns to equity investors.

Key pointers for shaping investment incentives are

1. Better understand farmers' needs: Farmers are the ultimate customers of mechanisation, yet their needs, aspirations and drivers are largely missing from the discourse on mechanisation.
2. Focus on 2-wheel tractors: 2-wheel tractors have not featured highly in past mechanisation efforts yet seem the most appropriate technology for a large segment of Nigeria's farmers (those with less than 3 to 5 ha). They offer practical advantages and an attractive business case for investors in mechanisation services.
3. Redefining the role of booking agents: Booking agents are likely to become obsolete as technology advances, increasingly allowing farmers to connect with each other and with tractor service providers directly. However, there can be a role for booking agents in providing technical expertise as well as aggregation services.
4. Technology integration: With an atomised demand side in the tractor hire market, digital technology will be a critical enabler for maximising tractor capacity utilisation and reducing downtime, travel and idle time.
5. Supporting new entrants in the market with technical advice: The tractor hire market offers opportunities for start-ups and other new entrants. Helping these businesses navigate the

technical challenge and avoid known mistakes will increase their chances of success in the market and thereby speed up mechanisation.

6. Facilitating credit finance: Credits for movable assets like tractors and mechanization equipment are difficult to get in Nigeria. We recommend that Propcom Mai-karfi convenes a coalition of banks and government guarantors that creates a standardised path to credit provision for tractor buyers.
7. An inclusive mechanisation strategy: Mechanisation has the potential to include or leave behind currently disadvantaged groups, such as women and youths. To maximise the positive impact of mechanisation, we recommend designing interventions with disadvantaged groups in mind and how they may be integrated in a mechanization strategy, benefitting themselves and the wider economy.
8. Advocating effective policies for mechanisation: Federal and State governments have a historically intervened in the tractor market, with negative effects on its development. Instead, governments should focus on creating conducive boundary conditions for private sector, especially building and coordinating institutional capacities for testing, research and development of agricultural equipment and training agricultural engineers.
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## Abbreviations and units

bn	Billion
FAO	Food and Agricultural Organization of the United Nations
g	Gram
ha	Hectare
hp	Horsepower
km <sup>2</sup>	Square kilometre
m	Million
NAERLS	National Agricultural Extension and Research Liaison Services
NEDP	National Economic Development Plan
NGN	Nigerian Naira
NIPC	Nigeria Investment Promotion Commission
t	Metric tonne
SDGs	Sustainable development goals
UN	United Nations
USD	US dollar

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# 1 Introduction

## 1.1 Background and purpose and of this study

A key constraint impeding the potential of Nigeria's agricultural sector is the low and insufficient number of tractors available to mechanised service providers to serve a growing demand of smallholder farmers who predominantly use crude implements (hoes, cutlasses and machetes) and draught animals. Resultantly, the smallholder farmers' productivity and income remain low. Therefore, the need to accelerate the availability and supply of agricultural mechanisation cannot be overemphasized.

IFPRI ((2019) estimates that In Nigeria, there are approximately 7 tractors per 100 km<sup>2</sup> of arable land, compared to other African countries such as South Africa, Kenya, Zambia, Ghana and Burkina Faso with 43, 27, 21, 11 and 9 tractors per 100 km<sup>2</sup> of arable land, respectively (World Bank, 2014). Nigeria's tractor density (0.2hp/ha) is below the FAO's recommended 1.5 hp/ha (World Bank, 2014a). The low level of mechanisation limits the amount of land that can be cultivated as well as the productivity of smallholder farmers. It also means that many smallholder farmers do not have access to tractor services and continue to rely on manual labour. This limits the amount of land they can farm (and thereby inhibits their development into more professional farmers) while maintaining the need for often hard and monotonous labour, supplied by an informal and often vulnerable labour force. One of the reasons for the low number of tractors is the absence of financing options for buying tractors and other equipment, which in turn goes together with a low overall investment into agriculture.

It is against this backdrop that Propcom Mai-karfi and the Nigerian Investment Promotion Commission (NIPC) agreed to commission a study that captures Nigeria's agricultural mechanisation sector and maps out the investment opportunities and private for-hire enterprises operating in the industry. The outcome of the study will be used by the NIPC to attract domestic and foreign investors to the agricultural mechanisation space.

Agramondis Ltd is the consultancy firm engaged by PM to undertake the study.

## 1.2 Objectives

Specific objectives of this study are to:

1. Understand the dynamics and gain in-depth insights into the position of the Nigerian mechanisation landscape
2. Identify viable business opportunities that can attract both domestic and foreign investment into the industry.
3. To increase smallholder farmers' access to mechanisation services to improve their productivity, incomes and livelihoods, particularly in North-Eastern Nigeria.

## 1.3 Approach

The market study draws largely on a thorough desk review, quantitative market data and key informant interviews. Where detailed reliable data was less available, the analysis also draws on qualitative information, expert estimates and anecdotal information, which has been triangulated to understand robustness and uncertainties. 57 reports have been evaluated and 16 Key Informant Interviews were conducted which included critical stakeholders and industry experts, see Section 6.1.

## 2 The role of mechanisation in Africa's agricultural sector

### 2.1 Putting agricultural mechanisation in context

For Africa to achieve food security and zero hunger as defined in the sustainable development goals (SDGs) laid out by the United Nations (UN), the continent has to develop sustainable ways to produce and distribute food in large quantities. Agricultural mechanisation plays an important role in the path towards achieving that objective.

According to FAO's definition, *Agricultural Mechanisation* refers to the application of tools, implements, and powered machinery as inputs to achieve agricultural production. There are three principal sources of power that are applied in agriculture:

1. **Human muscle power** using manually operated tools and equipment, such as hoes, cutlasses or treadle pumps.
2. **Animal muscle power** using draught animals such as horses, oxen, mules, donkeys and bulls to drive tillage implements, mills or to transport farm produce.
3. **Engine power**, obtaining energy from sources such as fossil fuels, wind or solar resources.

In this study, we use the term 'agricultural mechanisation' primarily to describe the shift from human and animal muscle power to engine power; and to describe the agricultural mechanisation *sector*, including manufacturing, distribution, financing, maintenance and repair of agricultural tools, implements and machines.

### 2.2 Benefits of agricultural mechanisation

Mechanisation has been one of the cornerstones of agricultural development in the US, Europe, Brazil and other high output producers, contributing to the global transformation of the farming landscape and increasing the volume of agricultural production. Agricultural mechanisation enables management of larger farms and the introduction of heavy tasks that are difficult to achieve with human or animal muscle power (Kirui, 2019).

Benefits of agricultural mechanisation include

1. *Increased land in production*, through an increase in the power inputs to farming activities
2. *Increased productivity*, through improvement in timeliness and efficiency of farm operations and the ability to perform tasks that are difficult to perform without mechanical aids reducing drudgery
3. *Improved quality*, by increased quality and value of work, produce and processed products

Mechanisation has also led to macro-economic changes such as

1. Shifts in the labour markets from large numbers of unskilled, often seasonal, workers in agriculture to more skilled jobs (upskilling) and opportunities in direct and supporting roles such as the operation of tractors, repair, tractor booking and demand aggregation etc.
2. Increased production of agricultural products per unit of labour and land (factor productivity)

3. 'Industrialisation' of agriculture, through streamlined processes and use of chemical inputs, e.g. fertilizers
4. Development of rural entrepreneurship and associated jobs.

## 2.3 Global agricultural mechanisation

Agriculture globally is becoming increasingly mechanised, with an average of 200 tractors per 100km<sup>2</sup>, see Figure 1. The global agricultural tractors market was valued at USD 55.37 billion in 2018 (Propcom Mai-karfi), 2020) and is expected to expand at a CAGR of 3.0% from 2020 to 2027 (Grand View Research, 2020). North America dominates the global agricultural tractors market at 15.2% of global market share in 2014 led by the United States and Canada. Globally, growth is being driven by increasing farm mechanisation rates and increasing costs of farm labour in developing countries. The growth of agricultural mechanisation is lowest in Sub-Saharan Africa (see Figure 2) and is estimated at 0.7% in Nigeria.

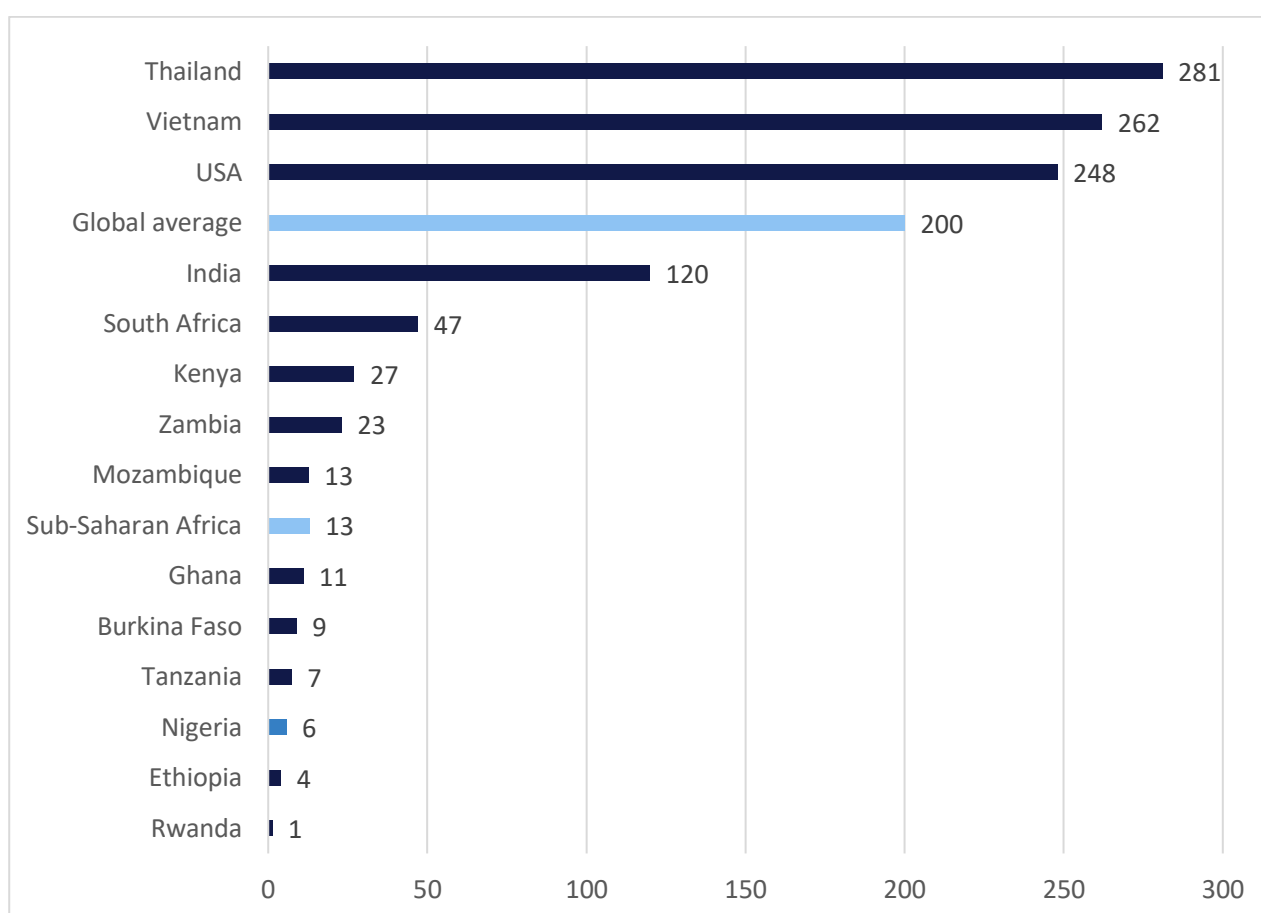


Figure 1: Number of tractors per 100 km<sup>2</sup> of arable land in 2012 in selected countries. Source: World Bank (2014); FAO (2012).





Figure 2: Expected growth of the global tractor market for 2020 to 2025. Source: Mordor Intelligence 2020.

## 2.4 Agricultural mechanisation in Africa

For decades, farm power in most African countries has relied to a large extent on human muscle, based on operations that depend on the hoe and other hand tools (Kirui & Braun, 2018). This heavy reliance on human power is a cause of low productivity and low rates of agricultural commercialization in Africa. Sub-Saharan farmers use nearly three times as much human power as farmers in North Africa, and tractor power in North America is six times higher. In Sub-Saharan Africa, the rate of capital depreciation exceeds the rate at which capital is invested in agriculture, and this applies directly to farm machinery (World Bank Group, 2014). As a result, annual capital stock per worker has been declining over the last 20 years (FAO 2012). This is emblematic of the very low rates of agricultural investment that are typical throughout much of the region (World Bank Group, 2014). Unless this investment can be significantly increased, smallholder farmers in Africa will continue to rely overwhelmingly on their power and that of their draft animals.

The use of tractors in Sub-Saharan Africa has shown little increase over the past 40 years, during which, for comparison, tractor use in Asia has increased tenfold. As a result, the average tractorisation rate in Sub-Saharan Africa in 2012 was 13 tractors per 100 km<sup>2</sup> of cultivated land, compared to a global average of 200 (see Figure 1) and 91 and 104 tractors in South Asia and Latin America, respectively (Kirui & Braun, 2018). Also note that there are marked differences between countries, with tractor use in Kenya being four times higher than in Nigeria and 20 times higher than in Rwanda.

## 2.5 Constraints to agricultural mechanisation in Africa

Several factors have been attributed to the low level of investment and uptake of mechanisation among smallholder farmers in Sub-Saharan Africa (FAO, 2016; Kirui & Braun, 2018), such as:

- 1. Affordability:** Smallholder farmers are, almost by definition, resource-poor and often have difficulty investing in physical assets in general and in agricultural machinery in particular. The high cost of agricultural machinery, due primarily to exchange rate shocks, presents a strong deterrent to mechanisation investments, with negative implications for affordability by private sector investors and long payback periods on loans intended to fund procurement. For example, the price of 4-wheel 75hp tractors currently favoured for mechanisation activity has risen to 120% from an average of NGN5 million in 2015 to NGN11 million in 2019 (Propcom Mai-karfi, 2019).
- 2. Availability:** Tractors and agricultural machinery can be either imported or locally made, with potential associated problems in both cases. Locally manufactured machinery is usually low in quality and high in price while the imported ones are of high quality and expensive.
- 3. Lack of farmer skills:** African farmers have relatively limited access to new knowledge. The level of farmer training is low and opportunities for further training are limited. This means that farmers rely on commercial mechanisation service providers to both provide the tractors and operate them. Given that the commercial mechanisation service providers themselves sometimes have more machines than people to operate them, the lack of technical skill from the farmers makes the mechanisation process much slower.
- 4. Constraints within the private sector:** Private sector agricultural machinery manufacturing is at an early stage in many countries in Sub-Saharan Africa; it is hampered by international competition and imports and held back by less developed distribution networks.
- 5. Gender issues in smallholder mechanisation:** In Sub-Saharan Africa, women usually contribute about 60–80% of the labour for food production. However, men often conduct commercial transactions at the farm level and consequently make decisions and control the resources required to invest in mechanisation (especially capital).
- 6. Lack of infrastructure:** Missing institutions, especially those that would be required to ensure adequate technicians and skilled personnel to operate and repair farm machinery.
- 7. Governance challenges:** Governance challenges here are found in three basic types of governance structures or institutional settings under which mechanisation services can be provided: the private sector (market governance), the government sector (state governance), and the third sector (community governance). All three types of governance structures face challenges. The private sector, for instance, faces market failures that stem from the underdevelopment of capital markets needed to fund the economies of scale that the operation of mechanisation tools such as tractors, based on their indivisible nature, requires. Another reason for market failure is transaction costs and risks, which can lead to failures in complementary supply chains (Kydd and Dorward 2004). For example, access to credit, a precondition to mechanisation, is often limited because of lack of collateral - in Ghana, for instance, 80% of the land is customary (USAID 2013) - and the riskiness of rain-fed farming (Binswanger and McIntire 1987; Sacerdoti 2005).

## 2.6 Success stories: Kenya, Zambia and Thailand

### **Kenya**

Kenya has the second-highest number of tractors in sub-Saharan Africa, at about 27 per 100 km<sup>2</sup> (as shown in Figure 1), which appears to reflect the country's movement towards larger-scale, commercialized farming. Small-scale farmers in Kenya, unlike their counterparts in most other African countries, have as a matter of necessity, embraced the use of tractors for land preparation. The present level of agricultural mechanisation in Kenya ranges from 95% on large farms to as little as about 4% on some smallholdings. Overall, it is estimated that about 30% of the operations on small farms are done with tractors and motorized equipment (FAO, 2009; World Bank Group, 2014; Nkanya, 2016; Wawire, et al, 2016).

### **Kenya's Advantage**

**Private sector dominance:** Agricultural mechanisation, in terms of companies in the country dealing in agricultural machinery and equipment, in Kenya is dominated by the private sector (Warwire et al., 2016) and it is servicing a developed and equally private sector-driven agriculture industry. There are well-established private companies in the country dealing in agricultural machinery and equipment including, Farm Engineering Industries Ltd, Massey Fergusson, Hughes Ltd (Ford), John Deere and Car&General. Some medium-scale firms like Ndume, Jalbert Engineering and KickStart also deal in farm machinery; these firms import and manufacture auxiliary equipment such as ploughs, harrows, planters, sprayers, mills and silage processors. Ndume is the largest local manufacturer while Jalbert and KickStart are more involved with simpler technology for smaller farmers.

**Supporting institutions** There are several institutions involved in testing, fabricating and evaluating of agricultural mechanisation technologies including private universities, non-governmental organizations (NGOs) and private companies. There are many agricultural machines that have been developed and modifications/improvements made. These technologies include tillage implements, irrigation equipment and agro-processing equipment.

**Government institutions:** The main government players in agricultural mechanisation services in Kenya include:

- a. *Agricultural Engineering Services:* This is a division within the Ministry of Agricultural, Livestock and Fisheries that provides mechanisation and land and environmental services
- b. *Research Institutions:* The establishment of Agricultural Mechanisation Research Institute (AMRI) by Kenya agricultural and livestock research organization (KALRO). The mandate is to generate and disseminate agricultural mechanisation technologies and innovations that are geared towards enhancing productivity and value addition in Kenya
- c. *Agricultural Mechanisation Services:* There are about 23 Agricultural Machinery Services (AMS) across the country, which have been devolved to the County governments to provide hire tractor machinery services for the farmers within the counties
- d. *Universities with Agricultural Engineering departments:* They are involved in research in agricultural machinery including testing and fabrication of agricultural machinery in the country.

## **Interventions**

The State Department of Agriculture (SDA) in Kenya invested in:

- Development of agricultural mechanisation policy to guide the subsector
- Strengthening of agricultural mechanisation stations and Agricultural Technology Development Centres (ATDCs)
- Community marketing infrastructures
- Establishment of Agricultural Mechanisation Research Institute (AMRI) under the Agricultural Mechanisation Research Institute (KARLO)
- Irrigation development
- Capacity building for county staff.

## **In summary**

Kenya's agricultural mechanisation dominance in Sub-Saharan Africa happened as a result of high private participation which is effectively supported by the government. For agricultural mechanisation to thrive and grow in Nigeria, private participants must be incentivized to start and sustain agricultural mechanisation initiatives that can be both affordable and available to small and medium-scale farmers across the country and these initiatives must enjoy government support to allow the businesses thrive and scale.

## **Zambia**

With dedicated Farm Power and Mechanisation Centres, as well as strong national research capacities and a recognition of the role of the private sector, Zambia has shown itself to be effective in advancing the uptake of mechanisation along the value chain (Malabo Montpellier Panel, 2018). Zambia posted an average annual agricultural machinery growth of about 3% within the last 10 years. Agricultural output grew on average by about 8.5% over the same period.

## **Zambia's Advantage:**

### **Institutional innovations**

- Creation of a liberalized system aimed at integrating the private sector in input supply and other value-chain segments through policies and agricultural reforms (since 1990)
- Provision of technical services on mechanisation by the Ministry of Agriculture (since 2015)
- Formulation of concrete targets for mechanisation within the National Agriculture Investment Plans (NAIP and the Second National Agricultural Policy (SNAP) in 2016.

### **Programmatic interventions**

- Creation of the Zambia Agriculture Research Institute (ZARI), to generate and adapt new agriculture technologies, situated within the Ministry of Agriculture
- Support of research and technology adaptation also through non-profit organizations, like the Indaba Agricultural Policy Research Institute (IAPRI)
- Supply of machines, offers of training and app-based hiring services by private companies such as Rent to Own (RTO).

In terms of impact, some of these organisations have recorded successes and others are yet to be fully assessed. For instance, with 42 working paper-type outputs and 19 policy briefs produced in 3 years, IAPRI is viewed as a productive, hard-working and professional organisation. As of the time of this study, the impact of ZARI and RTO are difficult to measure.

#### Implementation modalities

- Government key programmes led by the Ministry of Agriculture with a focus on different stages of the value chain, research and development, skill development
- Involvement of the private sector through public-private partnerships.

#### **Thailand**

Mechanisation plays a pivotal role in Thailand, where agriculture is rapidly transforming from subsistence farming to agribusiness model on the country's 46.6 % total land allocation to agricultural activities. With average farm size of 4.04 ha/ household, Thailand is a host of 5.9 million farms on 23.9 million ha agricultural land or 46.6 % of the total land area. Nearly 50 % of the total agricultural land is cultivated for rice, 21.5 % for field crops, and 21.2 % for fruit or horticultural crops (Soni, 2016). Agricultural mechanisation for rice production has been the most impressive when compared to other crops in Thailand. The number of agricultural tractors per 1,000 ha of arable land in Thailand has exponentially increased since the 1960s. While the FAO put Thailand's tractor density at 285 tractors per 100km<sup>2</sup> in 2012 (World Bank, 2014), Soni (2016) estimates 500 tractors per 100km<sup>2</sup> of arable land.

#### **Thailand's Advantage:**

##### Anchoring mechanization in National Economic Development Plans since 1978

Mechanisation has been included in every 4-year National Economic Development Plan (NEPP) since 1978, with targets and ambitions increasing as the industry developed.

##### Creating institutional capacities for testing, adapting and developing agricultural machinery

*Table 1: Local manufacturers of agricultural machinery in Thailand. Source: Thepent (2014)*

<b>Agricultural machinery</b>	<b>Local manufacturers (numbers)</b>
Power tiller (2-Wheel walking tractor)	275
Tillage implements (small and large)	329
Planter	16
Sprayer	447
Harvester	386
Other	164
Repair & maintenance workshops	1,192
<b>TOTAL</b>	<b>2,809</b>

Thailand complemented and integrated existing international research capacities, in particular the International Rice Research Institute (IRRI), with newly established national institutions: the Society of Agricultural Engineers (TSAE) in 1976, the National Agricultural Machinery Center (NAMC) to test agricultural machinery, in 1979, and the Thai Machinery Association (TMA) in 2001. In addition, the 7<sup>th</sup> NEDP (1992 to 1996) includes specific objectives on research and development of agricultural machines. Together, they created the necessary engineering capacities for testing, adapting and developing machinery specifically for Thai needs.

#### Production of Mechanisation tools and equipment

Currently, Thailand is capable of producing most of the machinery needed for its agricultural operations.

Most of the farmers use locally produced machinery, such as 4-wheeled tractors, power tillers, plough, harrow, pumps for irrigation, sprayers, threshers, reapers, combine harvesters, cleaning equipment, dryers, rice milling machines, processing equipment, etc. However, the machines locally produced by small or medium manufacturers lack standardization in quality, durability and performance. Some specific/sophisticated machines are imported by Thai companies from overseas. Table 1 shows the number of local Thai companies that manufacture mechanisation equipment.

#### Insights from the success stories

Common to the three case studies – Kenya, Zambia and Thailand – are the following approaches

1. **Anchoring agricultural mechanisation in national policy** via long-term plans and strategies; and **policy consistency** (at least in the cases of Kenya and Thailand), where national plans and mechanisation targets build on each other and successes already achieved (in the case of Zambia, it may be too early to make such a statement)
2. Policies focus on **creating institutional capacities** for research and development of agricultural equipment, testing and training of agricultural engineers
3. **Non-intervention** in the private sector: governments abstain from intervening in the market and limit themselves to **creating a conducive environment for the private sector** to develop the market.

In addition, Thailand has, over the past four decades, developed an automotive industry which includes domestic manufacturing of tractors, tractor parts and equipment.

These insights should be reflected in any Nigerian mechanisation strategy.

## 2.7 Role of governments in mechanisation

Governments across Sub-Saharan Africa increasingly recognise the low tractorisation rate as a barrier to agricultural development. As there is no significant domestic tractor production, African countries rely on imports. Traditionally, governments have played a significant role in importing tractors. However, when we compare the share of private sector imports and the tractorisation

rates of different countries, we notice that countries with high tractorisation also tend to have a low involvement of government in tractor imports, suggesting that the private sector may be a more effective driver of tractor importation than the public sector: In 2011/12 Kenya, Zambia and Ghana had 100% private sector imports. In Mozambique, Burkina Faso and Rwanda, 60%, 59% and 42% of imported tractors were imported by the private sector, respectively. In Nigeria and Tanzania, 90% of imported tractors were bought by the government (World Bank, 2014). In both countries, there is traditionally strong national and state government involvement in the direct importation of tractors, which are then distributed to cooperatives and group farms at subsidised cost (World Bank, 2014a).

While we do not have a rigorous analysis of the effect of government intervention on agricultural mechanisation, the cited information suggests a correlation between higher mechanisation and less government intervention among African countries. In a similar vein, Takeshima and Lawal (2018) find that in Nigeria, privately owned tractors are used more efficiently than state-owned ones, and that tractor service providers who sourced their tractors on the open market run twice as profitable as those who acquired their tractor via a state-subsidised scheme. Lastly, the above analysis of successful mechanisation policies in Kenya, Zambia and Thailand shows that, while policy seems a success factor in all three countries, it focuses on creating a stable and conducive policy environment for the private sector, but does not intervene in the market directly, e.g. by buying or selling tractors.

## 2.8 The future of agricultural mechanisation in Africa

Historic trends and future projection: Not only is current tractor use low in Sub-Saharan Africa, but IFPRI (2010) also estimates that by 2030, still only 25% of farmland in Africa will be cultivated by tractors, whereas in other parts of the developing world, this figure is 50% to 75%, see Figure 3. Sub-Saharan Africa is the only region with a projected increase in the use of draught animal use, which in other regions reduces in favour of tractors.

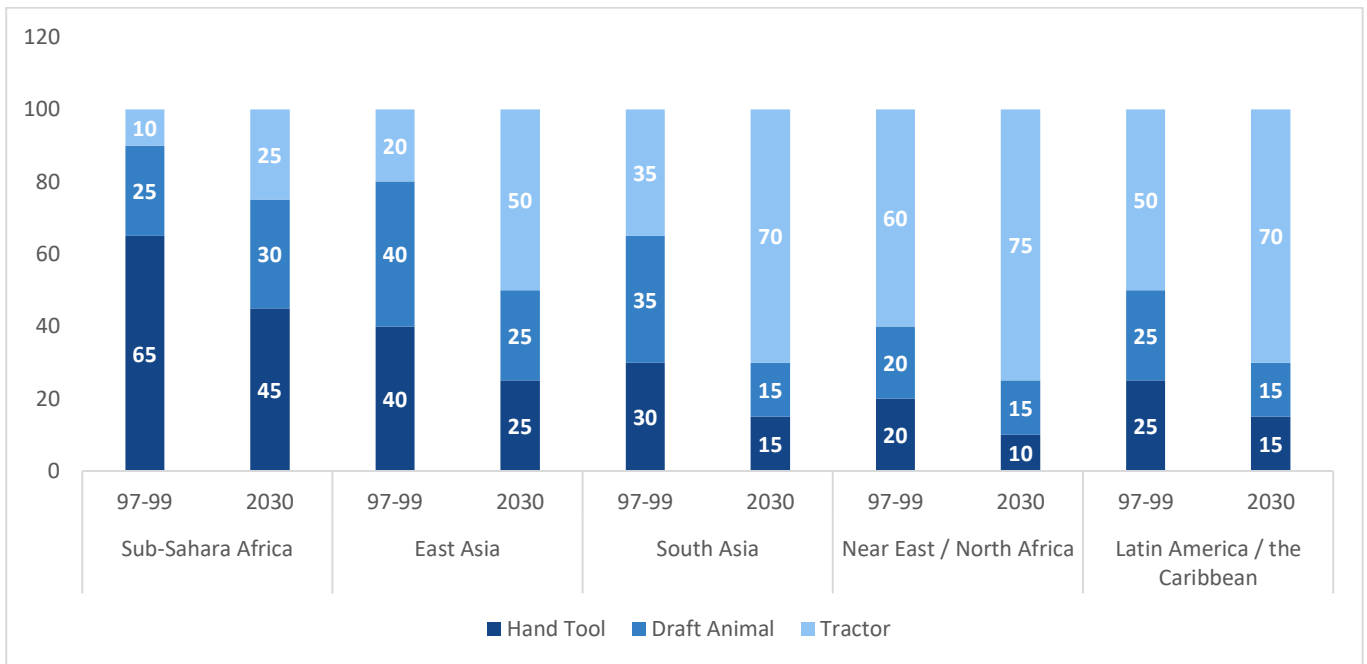


Figure 3: Percentage of area cultivated by different power sources in 1997-99 and 2030 (projected) across regions of the developing world. Source: IFPRI (2010).

**The role of ag-tech:** Agricultural mechanisation around the world and especially in developing economies face enormous challenges that pose threats to the development of that sector. Some of the challenges centre around the unavailability of mechanisation tools like tractors, cost of purchase, lack of operating capabilities, etc. These problems however can be combated if the sector also evolves to catch up with the tech revolution that has changed other sectors like transportation and real estate. Emerging technologies like Cloud-based technology, robotics and mobile devices will become the centre of this change. In Africa, some companies have begun to adopt these technologies to solve the problems of tractor availability. One of the companies doing this is Hello Tractor.

*Hello Tractor* was founded in 2014 in Nigeria by Jehiel Oliver, an entrepreneur with a finance background, to connect “tractor owners to farmers through a digital app” (Foote, 2018). The key components of the Hello Tractor business model are a monitoring device that allows for the remote monitoring of tractors, costing 80 to 200 \$US, and a digital booking platform that matches farmers with the nearest tractors. The monitoring device records, for example, GPS data, fuel efficiency and operator activity, depending on the version chosen. The recorded data can be accessed via smartphone or computer.

Having real-time data promises tractor owners easier management of tractors and operators, for example, by showing maintenance needs and controlling fraud. The digital booking platform, which shows customers’ requests and can be used for fleet management, promises to ensure high machinery utilization rates. For smallholder farmers, finding the nearest tractor via a digital booking platform promises to reduce the transaction costs of accessing tractor services. *Hello Tractor* uses IoT technology to connect tractor owners to smallholder farmers in need of tractor service, providing insights to de-risk and improve service delivery, ensuring tractor owner success while



delivering market-led, sustainable impact to smallholder farmers. Given the potential for both tractor owners and farmers, Jehiel Oliver argues that Hello Tractor is “a hybrid. An Uber-meets-Salesforce for tractors” that is “connecting farmers in need of service to tractor owners, while also enhancing a tractor owner’s existing business” (Foote, 2018).

The below-cited IFPRI projection is a decade old. The fact that most farms in Africa have yet to mechanise creates opportunities for businesses and solutions using new technologies like Hello Tractor that can make the workplace on and off the farm safer and more productive while creating employment for the next generation across the value chain. Agricultural mechanisation will be augmented by emerging technologies, such as drone technologies, robotics, artificial intelligence (AI), deep learning, machine learning, Internet of Things (IoT), embedded systems and software, intelligent sensors, Big Data, and autonomous agricultural and farming equipment.

Just as biological innovations and plant breeding are altering the map of production possibilities and profitability, digital technologies will have considerable implications for the future competitiveness of African farmers in global and regional markets (Malabo Montpellier Panel, 2018). The business success of tractor-focused tech companies like Hello Tractor and Traxi in Nigeria show that this is no longer only a future vision but becoming reality already.

Growth of medium size farmers: Although smallholder farmers continue to make up the largest share of farmers in Africa, there has been a rise in the number of medium-scale farms in recent years. This has been driving demand for increased mechanisation and contributed to a rise in the share of new tractor owners. Medium-scale farms, defined as having a farm size between 5 and 100 hectares, contribute disproportionately to the growth of agricultural production (Jayne, 2019). They account for a rising share of total farmland (20% in Kenya, 32% in Ghana, 39% in Tanzania, and more than 50% in Zambia; Malabo Montpellier Panel, 2018) as well as total agricultural production (47% in Zambia, 34% in Tanzania, 40% in Ghana and 20% in Nigeria; Jayne, 2019). Malabo Montpellier Panel (2018) find that in Tanzania, the likelihood of purchasing a tractor rises once the land size is greater than six hectares. In northern Ghana, half of all tractor owners cite land expansion as the primary motivation for investing in a tractor.

The increased number of medium-scale farmers who are also tractor owners creates new potential for hiring-out services to cater to the needs of smaller farmers, who are otherwise unable to afford to invest in larger-scale machinery or technologies (Malabo Montpellier Panel, 2018).

## 3 Agricultural mechanisation in Nigeria – a sector snapshot

### 3.1 The overall level of mechanisation

Nigeria is still at the early stage of agricultural mechanisation. In 2014, 4% and 24% of farm households in Nigeria use tractors and animal tractions, respectively, covering 7% and 25% of cultivated areas (Takeshima & Lawal, 2018).

### 3.2 Geographic patterns of mechanisation

Takeshima & Kennedy (2019) note different patterns of mechanisation between the different geopolitical zones based on agricultural households using (but not necessarily owning) different sources of traction power (Table 2). NAERLS & FMARD (2020) publish State-reported tractor and draught animal numbers (Figure 4). The authors caution that figures may be under-reported. Comparing the data in Table 2 and Figure 4 shows a loose correlation: Both sources find the greatest concentration of tractor use/tractors in the North Central zone, followed by the two Northern zones. Takeshima & Kennedy report similar tractor use numbers in the South West as in the North West, whereas NAERLS & FMARD finds no significant numbers of tractor in the Southern zones at all.

A similar comparison can be drawn for animal traction, though NAERLS & FMARD report the number of traction animals, and only for selected States, while Takeshima & Kennedy report household use of animal traction, so a slightly different measure.

Overall, reliable information about the geographic distribution of mechanisation assets is missing, though a higher concentration of mechanisation assets in the Northern zones is plausible, considering farm sizes and cropping patterns, as discussed below.

*Table 2: Percentage of agricultural households using tractors or animal traction. Source: Takeshima & Kennedy (2019), based on Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) 2010/11, 2012/13 and 2015/16. Note: Figures are simple averages from three rounds of LSMS-ISA, adjusted for sample-weights. Figures may not add up to 100% due to rounding errors.*

Region	Tractors	Animal traction			No tractor / animal traction
		total	owned	rented	
Nigeria	4	24	14	10	73
North West	2	53	28	25	47
North East, excl. Taraba	5	64	42	22	33
North Central + Taraba	11	5	3	2	85
South East	0	0	0	0	>99
South South	0	0	0	0	>99
South West	5	0	0	0	95

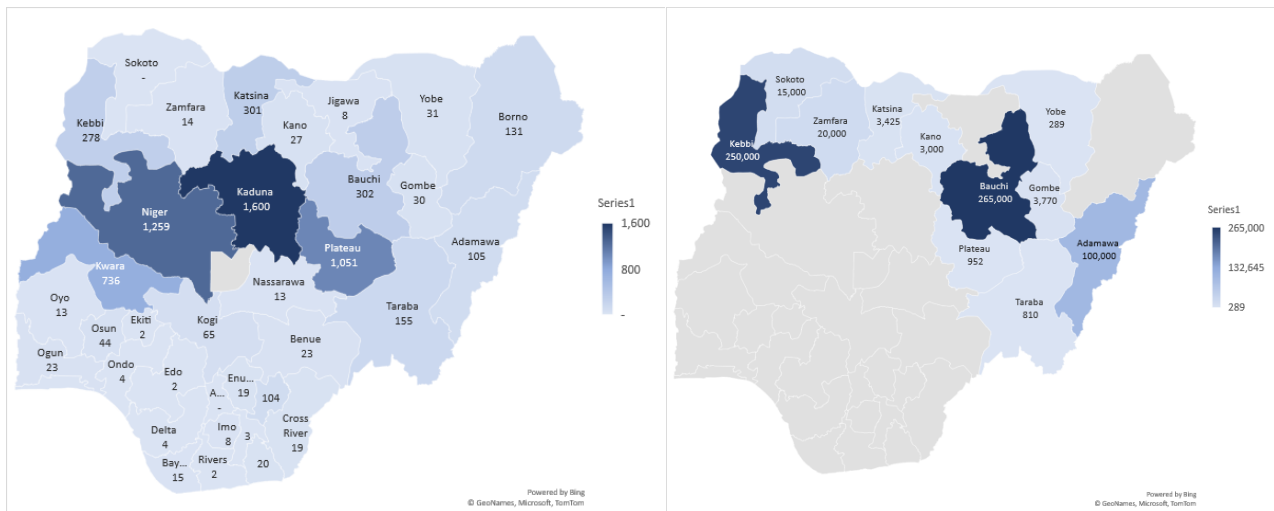


Figure 4: Number of functional tractors (left) and draught animals (right) across the States (average 2019 and 2020). Source: NAERLS & FMARD (2020).

### 3.3 Animal traction

Animal traction remains the most important source of non-human power, used by one quarter of Nigerian farming households.

**Animal traction in the South is limited by livestock diseases:** The geographic concentration of traction animals in the North (as shown above) is caused by the prevalence of the tsetse fly transmitted Trypanosomiasis disease, which prevents cattle keeping in the South. Other reasons favouring greater use of animal traction in the North are the types of crops grown there, especially rice, which tends to respond positively to plough use (see below); and the lighter soils and level land in the North which lends itself to using draught animals (Takeshima & Lawal, 2018).

**Use of animal traction increases with farm size:** Takeshima and Lawal (2018) show, that the use of animal traction increases with farm size (Figure 5): 47% of farms of 3 ha and above use animal traction. The data from Takeshima and Lawal (2018) do not differentiate farm sizes greater than 3 ha, but we may assume that from a certain farm size upward, tractors increasingly replace animal traction. For Tanzania, the Malabo Montpellier Panel (2018) find this to be true from 6 ha upward.

Also, Takeshima & Lawal (2018) find statistically significant evidence that the adoption of tractor services replaces animal traction in the North West and North East, where animal traction is used most widely.

**The use of animal traction varies across crops:** Figure 6 shows the use of animal traction in different crops. Small grains crop, especially sesame (Beniseeds) and millet, as well as legumes, benefit particularly from good tilth, making ploughing economically attractive. These crops are also mostly grown in the North: According to the National Bureau of Statistics (2019), millet is cultivated by 36% to 49% of farming households in the North and sesame by 14%. Cassava and Yam benefit from mechanisation but are grown in the wetter climates of the South where animal traction is not viable because of Trypanosomiasis.

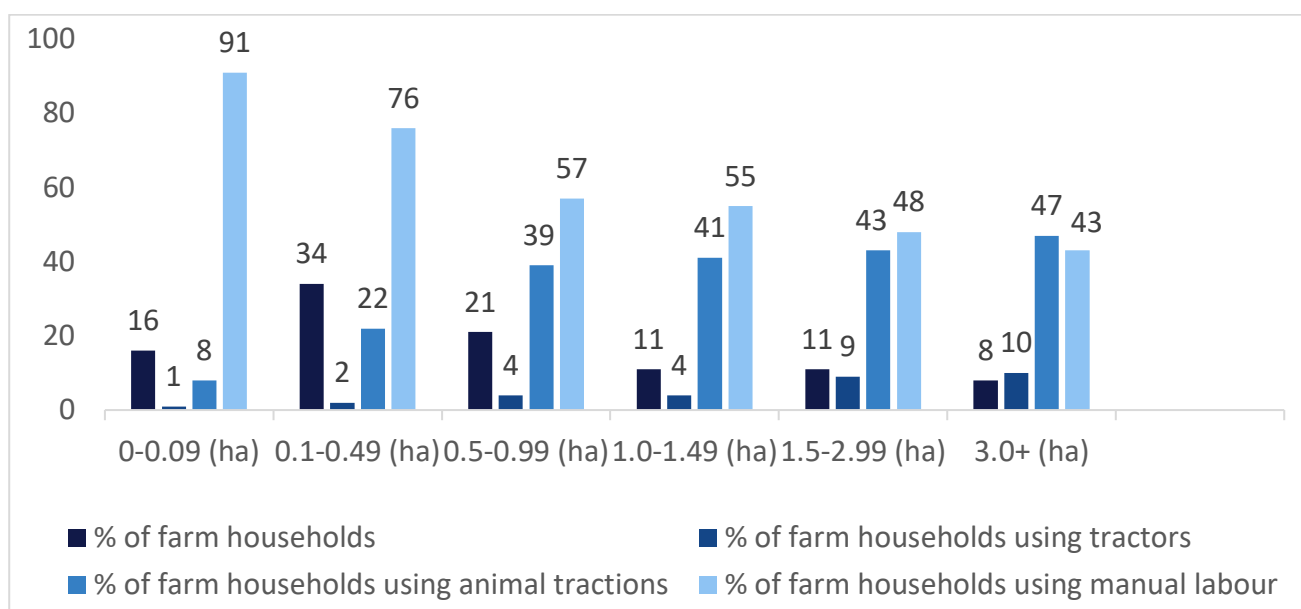


Figure 5: Farm size distributions and mechanisation level. Source: Takeshima & Lawal (2018).

### 3.4 Tractor use

**Tractor use is low in Nigeria, except in rice.** Table 3 shows the estimated area cultivated by tractor for different arable crops. Tractor use is in the single-digit percentages, except for rice, where 31% of the cropland are tractor cultivated. The relatively higher tractor use in rice may be explained by (a) the fact that rice is a ‘plough positive crop’ i.e. responds positively to ploughing, making ploughing economically attractive (Pryor, 1985; Alesina, Giuliano, and Nunn, 2011); and (b) rice farms tend to be larger than other farms, leading to different economies of scale.

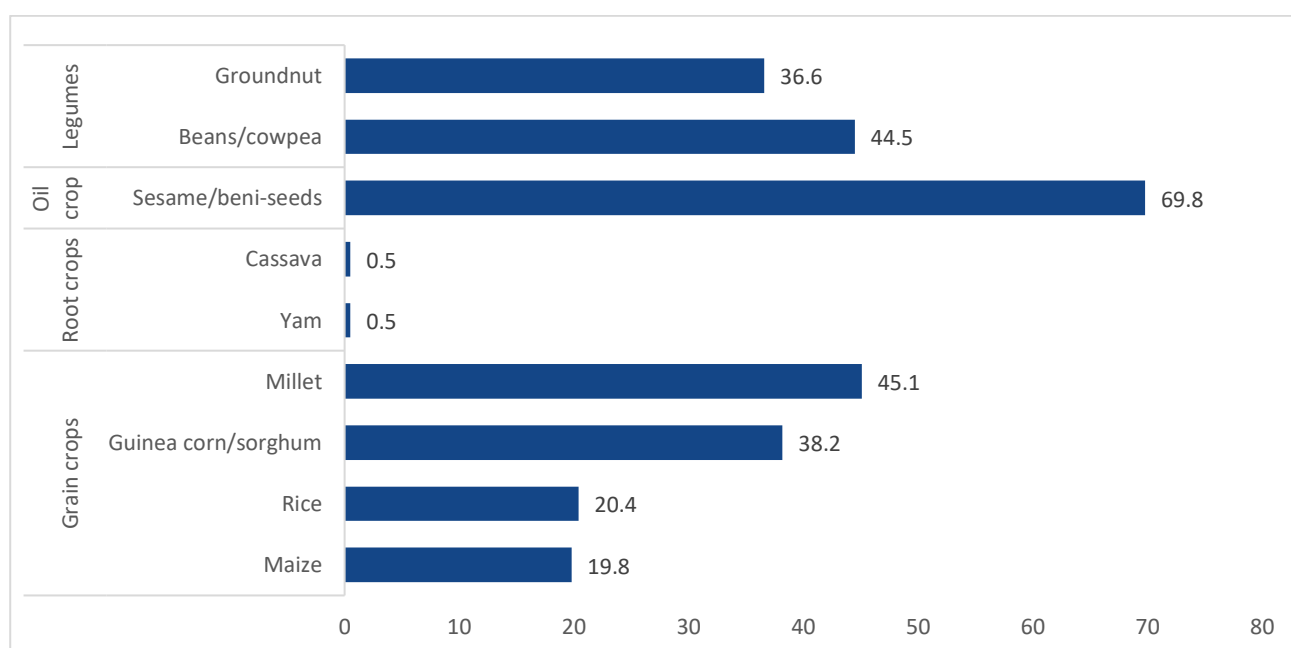


Figure 6: Use of animal traction by crop type (% of plots growing crop), Source: Own analysis, data source National Bureau of Statistics (2019).

Table 3: Estimated tractor usage in different crops in Nigeria. Source: Takeshima & Lawal (2018).

Crops	Tractor cultivated area (1,000 ha)	Share (%) of the cropped area with tractor use
Rice	410–790	31
Maize	140–240	6
Cowpea	50–90	4
Cassava	50–120	3
Groundnut	10–60	3
Yam	10–70	2
Millet	20–50	2

**Farm size and tractor use:** Nigeria is dominated by small-scale farming with about 80% of smallholder farmers having a median farm size of 0.5 ha, and less than 10% of farm households cultivate 3 hectares or more. Nationally, the average farm size 1.28 ha, see Table 4. However, the adoption rates of tractors and animal tractions are positively correlated with the farm size, see Figure 5, and in many cases become economic only as farm sizes increases from small-scale (below 5 ha) to medium and large-scale (Takeshima & Lawal, 2018). Farms of 5 ha and above mainly hire tractor services. Owning a small 65-hp tractor becomes economically attractive from 50 ha upward (Chijioke Okoli, Tata International, pers. comm, 2020).

Tractor-hire operators usually demand at least 3 ha of contingent land to plough (TOHFAN, 2020). Using the figures from Figure 5, this means that in the North two or three farmers need to pool their total cultivated land to achieve this land size, and in the South three to ten farmers. As the total cultivated land size is further broken down into plots, an individual farmer’s demand will usually be even lower, which means that a larger number of farmers need to pool demand for a commercial tractor hire service. Booking agents play an important role in aggregating and coordinating demand but they typically charge a 10% margin, which inflates the costs of tractor services.

Table 4: Average plot number, plot size, farmland holding and cultivated area across regions. Source: NBS LSMS-ISA (2019).

Region	# of Plots	# of Cultivated Plots	Average Plot Size (hectares)	Total Land Holdings (hectares)	Total Cultivated Area (hectares)
North Central	3.10	2.76	0.66	2.05	1.95
North East	2.81	2.08	0.83	2.31	2.03
North West	2.87	2.16	0.46	1.28	1.21
South East	3.04	2.08	0.17	0.52	0.30
South South	3.06	2.31	0.18	0.55	0.43
South West	1.96	1.41	0.63	1.24	0.99
NIGERIA	2.85	2.16	0.45	1.28	1.12

**Medium-scale farmers both critically rely on tractor services and drive their availability.** The segment of medium size farmers (5 to 100 ha) is rising in economies in Sub-Saharan Africa where farm expansion is not land-limited: E.g. in Nigeria, the share of national marketed crop output value produced by medium-scale farms rose from 7% to 18% between 2011 and 2016, report Jayne et al. (2019). The same authors identify access to tractor services as a major enabler for expanding farm size; as well as the presence of medium-scale farmers as the driver for the availability of tractor services to other, smaller farmers in the area.

**Tractor utilization rates:** Takeshima & Lawal (2018) report that tractors observed in 2014 cultivated on average between 103 ha and 160 ha (figures for owners of government-provided tractors and privately sources tractors, respectively), where 20% to 30% of that runtime was used on owners' farms and the remainder hired out. In a sample of 111 tractor owners in Nasarawa and Kaduna, they find that the monthly run-time of tractors varies between 24 and 147 hours (figures for owners of government-provided tractors and privately sources tractors, respectively).

Conversely, corporate tractor owners and hiring platforms we spoke to in our Key Informant interviews unanimously report that their tractors are fully utilised during the season and hardly idle even during the off-season. This suggests the utilisation of 1,200 hours<sup>1</sup> per year or more, so 10 to 50 times the rates reported by Takeshima & Lawal. The large difference may indicate a relative overrepresentation of commercial tractor owners on online hiring platforms, compared to individual farmers owning a tractor. By 'commercial owner' we mean those who do not use tractors on their farm but solely for hiring them out. Their tractors then travel across the country with the rains, to maximise their utilisation. By comparison, Takeshima & Lawal (2018) find that among the owners they surveyed, typically 75% of hiring services are provided within the owner's home Local Government Area and half of all hiring services are provided within the village.

By international comparison, the 1,200 operating hours assumed for commercial owners are still low. In Germany, farmer-owned tractors typically run between 500 and 1,000 hours per year, but tractor run by hire services clock 2,000 hours and more. If we hypothetically apply these utilization rates to the estimated 7,000 tractors in Nigeria, they could cultivate nearly 20% of Nigeria's arable land<sup>2</sup>. In other words, an increased utilisation rate could take Nigeria's mechanisation from 4% to 20% without increasing the tractor fleet. This is a hypothetical calculation. Under field conditions in Nigeria, such utilization rates may not attainable. However, the calculation highlights the potential of better utilization of existing assets.

**The useful life span of tractors in Nigeria:** The World Bank (2014a) reports an average tractor life span of 6 to 7 years in Nigeria, compared to 10 to 20 years in the US or Europe. Poor tractor management and a high proportion of tractor use for road transport contribute to increased wear,

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<sup>1</sup> Based on a conservative interpretation, assuming 100% utilisation during 1 month (30 days), plus 70% utilisation during 8 months (0.7 x 240 days = 168 day), with one day equalling 6 hours of field work: (30 days x 100% + 240 days x 70%) x 6 hours/day = 1,188 hours.

<sup>2</sup> 7,000 tractors times 2,000 hours equals 14m tractor hours. Assuming a ploughing speed of 0.5 ha per hour, this amount can cultivate 7m ha, out of 34m ha, which equals 19%.

while difficulties to get suitable spares or competent mechanics to service and repair tractors often leave tractors out of service well before the end of their useful life.

Nkakini & Etenero (2019) find that the median age of 60 government-owned tractors in Delta State was 4.4 years. However, a comparison group of 29 privately owned tractors were on average 8 years old. We may assume that most tractors run by commercial hiring services are still relatively new but that commercial owners may also have the means to look after their tractors better and that therefore, lifespan may increase as commercial tractor hiring becomes more common.

**Tractor sizes:** The most common size of tractor in Nigeria are 75 hp 4-wheel tractors (Takeshima & Lawal, 2018; Olufunke Adebola, Chief Data Scientist at Hello Tractor, pers. comm., 2020). As discussed above, this size becomes economic to hire from an area of 3**Tractor ownership by individual farming households has declined towards zero over the last decade.** The National Bureau of Statistics regularly surveys agricultural households for ownership of tractors and other farming assets. As can be seen in Figure 7, the share of households reporting to own a tractor has dropped from 1.6% in 2010/11 to 0.1% in 2018/19. This drop is consistent across regions, with exception of the South East where tractor ownership has increased over the period.

The main factor explaining the steady decline may be the weakening Naira: Until the end of 2014, the official exchange rate was stable at around 1USD = NGN155. Devaluations of the Naira happened in 2015, 2016, 2017 and 2020 and in 2020 the exchange rate is 1 USD = 385 NGN, inflating the price for imported good by a factor of 2.5. The 2015 price of 4-wheel 75 hp tractors was NGN 5m in 2015, rising to NGN 11m in 2019 (Propcom Mai-karfi, 2019).

We may assume that this has made tractors unaffordable for farming households and that no new tractors were bought to replace old ones that have gone out of service. Spare part prices are affected by the forex inflation, too, which will have shortened the lifespan of tractors because where have become unaffordable, hence speeding up the retirement of the existing fleet. During the same period, a value-added tax (VAT) rate of 5% has also been introduced on import of tractors, which was previously 0%.

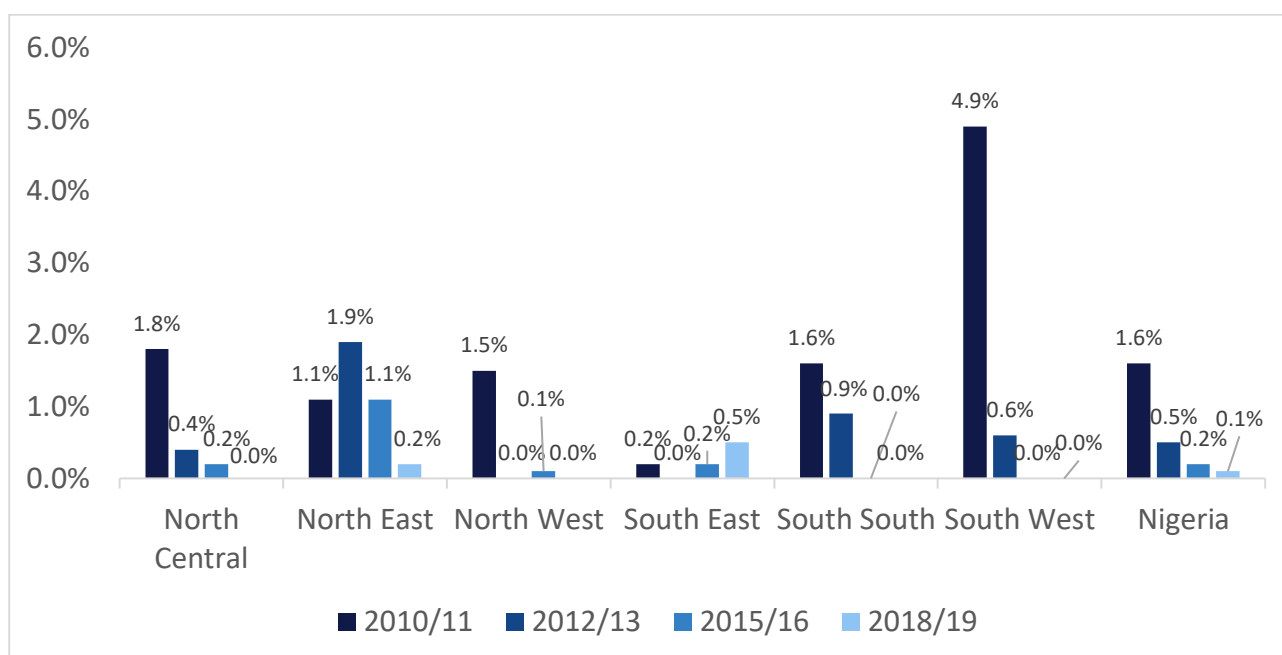


Figure 7: Percent of tractor owned by households across regions. Source: Own analysis, data source National Bureau of Statistics LSMS-ISA (2012, 2014, 2016 & 2019).

### 3.5 Formal and informal factors influencing the sector

Factors influencing the sector can be grouped into two broad categories: formal and informal. The formal factors comprise of all the regulations and policies such as agricultural-related policies like farmland tenure system, fuel price (for tractors), R&D in the sector, local manufacturing and economic-specific factors like ease of trade and interest rate subsidy. The informal factors on the other hand are generally sociocultural issues like traditions, culture, and other unwritten but accepted way of doing things.

Table 5 below summarizes some initiatives born out of formal agricultural mechanisation policies in Nigeria.

### 3.6 The role of government in Nigerian mechanisation

Nigerian governments have long intervened in the domestic tractor market. Until recently, both Federal and State governments procured tractors and distribute them to the private sector at a subsidized price or favourable loan conditions. Historically this practice crowded out the private sector from tractor import and thus prevented the development of a private tractor market (World Bank, 2014)

The Nigerian Federal government had discontinued the subsidized distribution of tractors in 2012 (World Bank Group, 2014; Takeshima & Lawal, 2018) and shifted its focus to the promotion of private-sector tractor-hiring services through its mechanisation implementation programme (MIP), which includes establishing private sector–managed Agricultural Equipment Hiring Enterprises (AEHE) across different locations in Nigeria (Takeshima et al. 2014).



Table 5: Schemes that support Agricultural Mechanisation in Nigeria. Source: Asoegwu et al. (2007).

S/N	Scheme	Services	Aim
1	Agricultural Equipment Hiring Enterprises (AEHE)	Land preparation Planting Weeding Harvest/threshing Farm transportation Irrigation activities	The short-term (5 years) goal of the establishment of the AEHEs is to help deploy over 40,000 other mechanised equipment for land preparation, planting, weeding, harvest/threshing, farm transportation and other simple irrigation activities across the country.  To ensure that smallholder farmers have access to available, accessible and affordable farm gate mechanisation services for optimum yield per hectare.
2	The Agricultural Machinery Mechanics and Operators Training Centre (AMMOTRAC)	Short and long-term training	To train operators and mechanics to drive and maintain farm machinery.
3	The African Regional Centre for Engineering Design and Manufacturing (ARCEDEM)	Development of capability for engineering design and manufacturing of industrial and agricultural machines and equipment	To develop and produce equipment prototypes in priority areas, including agriculture, for the creation of small and medium scale industries in Africa
4	National Centre for Agricultural Mechanisation (NCAM)	Land development Training Machinery hiring Certification Consultancy Fabrication	Developing simple need-based and low-cost technologies using locally sourced materials that reduces drudgery, increase farmers' efficiency, productivity, and income

However, in January 2020, the Minister of Agriculture and Rural Development announced the Green Imperative Programme, a USD 1.1 bn donor-funded agriculture mechanisation scheme and in May approved 95% of the funds for the acquisition of 10,000 tractors and 50,000 assorted implements, all to be assembled in Nigeria (Nairametrics, 2020 and NIPC, 2020). State governments also continue the import and subsidised distribution of tractors and other agricultural equipment: In 2020, 25 State governments procured 422 tractors and distributed 397 of them (NAERLS & FMARD, 2020).

The cited the World Bank (2014) report suggests that governments' direct intervention in the market (by buying and selling subsidised tractors and equipment) negatively impacts the development of the market. This is consistent with our findings from Section 2.7: There we found that the extent of agricultural mechanisation in African correlates negatively with the extent of market intervention by the government; that private-sector players are more efficient and profitable than state-run or state subsidised players; and that countries that have successfully mechanised their agricultural sectors set strong policies to create institutional capacity in agricultural engineering but abstain from intervening in the market directly.

It may be debated whether the historic and continued market interventions by Federal and State governments are causal Nigeria's low mechanisation. However, creating a coordinated, consistent and predictable policy setting for mechanisation is a common feature of successful examples of agricultural mechanisation elsewhere. These policies must (a) focuses on creating institutional capacity to support private-sector mechanisation, especially in testing, research and development and training of engineers; and (b) abstain from direct intervention or distortion of the market, e.g. by importing, buying, selling or subsidising tractors.

This is in line with what Nigerian agribusinesses ask form their governments, too: In the 2021 Nigerian Agribusiness Leaders Survey (Agramondis, 2021), 81% of respondents stated that the policy intervention that would help the Nigerian agribusiness sector most was "creat[ing] a predictable and coordinated policy environment", making it the highest ranking of six listed policy interventions. By contracts, market interventions (price setting) received support from 36% of respondents, making it the lowest ranking intervention<sup>3</sup>.

### 3.7 Main market players

Experience worldwide shows that success in agricultural mechanisation depends on the effective demand for the outputs of farming (including off-farm value addition) and the mechanisation system factors in the entire agri-food chain (FAO & AUC, 2018). This requires an understanding of the needs of each key stakeholder and a location-specific analysis that will consider the appropriate technological and institutional solutions depending on the context (Daum and Birner 2020).

**Primary stakeholders:** Primary stakeholders are farmers and those who directly interface with farmers:

1. *Farmer/Farmer groups:* Further categorized as:
  - a. Individuals
  - b. Agribusinesses. They are involved in farming activities and use tractors. E.g., Sam Adeyemi Group.
2. *Tractor Manufacturers:* E.g., John Deere, Tryctor
3. *Dealers/Suppliers:* They distribute tractors (both new and used) through their supply chains. E.g., Farm4me, Dizengoff Nigeria.

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<sup>3</sup> Preliminary unpublished results, as of 06 January 2021. Results will be published on <https://agramondis.com> in Q1 2021.

4. *Tractor Commercial Hire Services*: These businesses take advantage of technology to connect smallholders to tractors. E.g., Traxi, Agri Share, ACT-Agribusiness.
5. *Repairers/maintenance Services*: This subcategory repair faulty tractor parts and source for spare parts
6. Associations: E.g., TOHFAN, AFAN

**Secondary stakeholders:** Secondary stakeholders are at the second layer of connection with the farmers and play an assistive role, e.g., knowledge/capacity builders, and government, smart farming technology (trackers). The secondary stakeholders are enablers of the mechanisation sector. This category of stakeholder is subdivided into the following:

1. *Government/Public sector*
2. *Sector support organizations*. This is further divided into:
  - a. *Financial support*: E.g., Donors, development organizations, investors.
  - b. *Technical support*: Further divided into:
    - I. Capacity building organizations
    - II. Extension services
3. *Research and development*: Further divided into:
  - a. *Research institutions*. E.g., IITA; National Centre for Agricultural Mechanisation, NCAM; Institute of agricultural research and training (IART); National Root Crops Research Institute (NRCRI)
  - b. *Specialized University departments*. E.g., The Agric. & Bioresources Engineering department of the University of Nigeria, Nsukka; Department of Agricultural and Bio-Resources Engineering of Ahmadu Bello University, Zaria, Nigeria
4. *Banks, Insurance Companies etc.*

The technical support organizations cater to the following:

1. Fostering knowledge availability, linking opportunities amongst stakeholders. For example, NAMEL through a PPP arrangement with the Federal ministry of agriculture is implementing an agricultural equipment hiring enterprise (AEHE) model (NAMEL, 2019). AEHE is an enterprise model equipped with tractors, implement, planters, harvesters, threshers and are in demand-driven areas providing mechanisation services to the smallholder farmers for a fee. Another example is Propcom Mai-Karfi's TOHFAN intervention program which saw TOHFAN's tractors go from 27 in 2014 to over 400 in 2017. The impact of the intervention was such that 68,000 farmers used mechanisation services of which around 30% were women (Propcom Mai-Karfi, 2017).
2. Capacity building e.g., Propcom Mai-Karfi engaged the services of New Nigeria Foundation (NNF) to strengthen the capacity of three newly established zonal agricultural mechanisation networks in Kano, Ibadan and Enugu (Propcom Mai-Karfi, 2010)

It is critical that a sustainable mechanisation strategy engages all the stakeholders in the supply chain and offers a range of suitable options from which the users of the services can select. Because top-down solutions are rarely successful (Sims, Hilmi, and Kienzle, 2016).

### 3.8 Agricultural mechanisation financing in Nigeria

A 75hp tractor costs between USD 25,000 to 40,000 (World Bank, 2014a; Propcom Mai-karfi, 2019) or NGN 10m to 16m. It will take an individual farmer several years of financial savings to purchase even a smaller tractor in Nigeria, as credit is not easily accessible from financial institutions in the country. Providing financial support for increased uptake of agricultural machinery remains a challenge for the government. Commercial banks are often reluctant to provide loans to farmers, including to medium-to-large scale farmers among whom tractor owners. This is because of the high transactions' costs associated with information asymmetry in assessing the likelihood of default and repayment monitoring. While government guaranteed loans may partly mitigate the effects of risks associated with lending through NIRSAL, it may sometimes aggravate other problems, e.g., moral hazard by the banks. Without addressing these problems, providing financial support for smaller tractors through the banks may remain difficult (Takeshima, 2016). However, modern technology like the tracking devices made by Hello Tractor can overcome many of the concerns that banks have with financing movable assets.

Further, financing a larger number of smaller tractors may raise the transactions costs relative to the loan amount, discouraging bank lending. The potential of smaller tractors may hinge on the fact that a substantial share of tractors in the private sector in Nigeria has been purchased by farmers' saving without bank loans. Since smaller tractors are cheaper than larger tractors, their increased availability in the Nigerian market may boost tractor investments by medium-scale farm size and middle-income farm households. This may raise tractor density in Nigeria, compared to the current situation in which only a few large, high-income farm households' own tractors (Takeshima et al. 2015; Takeshima, 2016).

### 3.9 Position of women and young people in the market

In Nigeria, many smallholder farmers and food producers are women, though as in most of Sub-Saharan Africa women are accorded lower status than men, which has a significant impact on access to resources and assignment of roles and responsibilities (BMGF 2008).

Beyond status, other barriers affect the position of women in agriculture in Sub-Saharan Africa. Examples of these barriers are limited education (formal/informal) which affect their skill levels and their ability to adopt technology and mechanisation and religious beliefs which restrict their participation in training activities.

Julius (2014), describes how it proved difficult to interact with women during an agricultural mechanisation study in Abuja, North Central Zone, Nigeria. This was due to religious beliefs. Even though women's involvement in Nigeria's agricultural production has been on the rise since 1995, less than 15% of the participants in the study were women. What this means is that the needs of those women farmers could not be captured at depth which further reduced the chances of creating the kind of mechanisation that was easy for them to adopt.

An example of the implications of not capturing the needs of women is how agricultural machines and equipment are mostly made by male mechanics without considering women's body size and

physical strength. Adjustment is often needed to make the tools suitable for women farmers but that is often undervalued in the process of development and introduction. Factoring in the needs of women could increase their adoption rate and thereby bring greater impacts (CGIAR, 2018).

Gender influences the kind of technology available for use by women farmers. In some cultures, women do not traditionally use draught oxen, and this can severely curtail their access to timely farm power. Even if they did, the strength required to take on such a task could be discouraging.

In addition, social norms may regard mechanised tasks as inappropriate for women (Eerdewijk and Danielsen, 2015). For example, depending on the community, the gender identity of extension agents may contribute to the decision of a woman to attend a training or not (Njuguna, Liani, Beyene, and Ojiewo, 2016). Tolu Owolabi, Babban Gona's Director of Human Resources, described how a simple idea of recruiting more female extension agents to serve as role models and attract women farmers resulted in a dramatic increase in women's engagement (Winrock International, 2017).

Youth involvement in Nigerian agriculture is limited. In part, this is due to the perception that agriculture is a hard and backward way of life, rather than a business. To another part, youths may have limited access to land and start-up capital, making it difficult for them to step into agriculture.

This knowledge/skill gap of the women and youth reinforces the need to push for mechanisation education in Nigeria, specifically where the north-eastern states have female primary net attendance rates of 47.7% (UNICEF, 2019). This can be achieved by zooming in on gender-transformative skills development opportunities for women in agriculture, especially young women (RURAL21, 2020). Similarly, the mainstreaming of formal vocational training is needed to turn young people and farmers in the food system into skilled entrepreneurs who can use and maintain farm machinery, run their farms or businesses as economical, productive, and sustainable enterprises (Malabo Montpellier Panel, 2018).

### 3.10 SWOT analysis

Figure 8 Shows strengths, weaknesses, opportunities and threats for the Nigerian agricultural mechanisation sector.

## S

- Large market: 24 million farming households of which 3/4 do not currently use mechanisation
- Favourable agro ecological zones
- International market for mechanisation services which is now supported by the Africa Free Trade Agreement

## W

- High fragmentation of land holdings and small farm sizes, making tractor ownership uneconomic for most individual farmers
- Mismatch between size of tractors in current fleet (typically 75hp) and average plot size (<2ha)
- Low capacity utilisation of machinery due to spatial fragmentation of plots, single season farming and limited range of mobility of tractors
- History of government intervention in the tractor market, distorting the market and crowding out private sector players
- Inavailability of suitable and affordable credits for tractor finance
- Spare parts (quality/access), lead time, ploughing periods, demand for other implements...
- Lack of trained tractor operators leading to frequent breakdowns of equipment
- Lack of trained mechanics to service and repair equipment

## O

- Growing demand for mechanisation services among medium size smallholder farmers
- Increasing private sector investment in commercial agriculture and access to new markets for service provision due to newly signed Africa Free Trade Agreement
- Business opportunity in tillage services with very few market players with an average of 100 tractors each
- Intervention funds in place with financial institutions at sub-market interest rates: Commercial Banks at 9% p.a. over 36-60 months ... rephrase to emphasize on the increased role of atypical financing platforms beyond banks such as crowd funding

## T

- Tariffs on importation of agricultural equipment and spare parts limiting affordability and returns to investment in mechanisation
- Unstable foreign exchange rates that affect cost of tractor importation, purchase and interest rates.
- Expanding urbanization and lack of interest in engaging in ag. Activities... not clear, expatiate a bit more
- Inadequate tech. manpower and spare parts
- Distortion by state actors providing the service below market value

Figure 8. SWOT Analysis of Nigerian Mechanisation. Sources: Propcom Mai-Karfi (2019), Agramondis (2020).

## 4 Supply and demand of agricultural mechanisation in Nigeria

### 4.1 Current tractor fleet

FAO Stat used to collect tractor fleet data for various countries, but the latest figure for Nigeria is from 2007: Then, FAO reported 24,800 tractors, based on data from the Nigerian government. The World Bank (2014a) reports 45,000 tractors in Nigeria in 2012, though this number is based on a conceptual error and should be 19,000 tractors<sup>4</sup>. However, as discussed above, the numbers of tractors in working condition have steadily declined over the past decade (compare Figure 7).

The 2020 Agricultural Performance Survey (NAERLS & FMARD, 2020) reports a total of 2,847 tractors in Nigeria, of which 642 are government-owned 2,205 privately owned. In addition, States reported they procured 422 tractors in 2020 and distributed 367 of them, bringing the total number up to 3,269. However, the authors of the report note that the numbers of state-owned tractors are likely under-reported<sup>5</sup>. Similarly, the number of privately owned tractors reported by the Agricultural Performance Survey is lower than estimates from other sources.

Propcom Mai-karfi (Abaagu 2020, pers. comm) estimates that there are currently between 5,000 and 7,000 working tractors in the country. Mr Biodun Olugbami, National Secretary of the Agricultural Equipment Hiring Operators Association, estimated a range of 7,000 to 10,000 tractors in an interview with The Guardian in March 2020 (The Guardian, 2020).

The tractors in the networks of the organisation we interviewed for this study add up to a similar number: TOHFAN, TOOAN, NECAS, NAMEL, ACT-Agribusiness and Hello Tractor collectively own 900 tractors plus have a combined 7,570 tractors registered on their hiring platforms. The latter figure would double-count tractors that are registered on several platforms. However, assuming that tractors are only registered on a single platform, the organisations we interviewed for this study alone account for nearly 8,500 privately owned tractors in working condition. Tractors of other private and public owners would come on top of this number.

The above estimates range from 3,200 to 10,000 working tractors in Nigeria, with a mean estimate of 7,000. This range is higher than many other recent estimates. However, considering that in 2018

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<sup>4</sup> The report states that Nigeria's arable land was 79m ha. However, this figure is actually Nigeria's total cropland, including tree crops. Arable land is only 34m ha (see FAO Stat). The authors then multiply a given tractor density of 5.7 tractors per 100 km<sup>2</sup> with the crop land figure of 79m ha, arriving 45,030. However, multiplied with the correct arable land size of 34m ha, the figure would only be 19,380.

<sup>5</sup> The authors of the 2020 NAERLS & FMARD report note that the government figures "depict a gross under reporting of the tractor population in the country". We find this confirmed in Delta State, for instance, which reported 2 state-owned tractors for 2019. However, for the same year, a paper by Nkakini & Etenero (2019) reports research conducted on 60 state-owned tractors in Delta State, though only 14 of them were in working condition. So, for Delta State, the actual number of working tractors was 7 time higher than reported, though this ratio will not be representative for all states.

and 2019 alone, over 30,000 tractors have been imported into Nigeria (see 4.7), this estimate is still likely below the actual number of working tractors in the country.

Given the uncertainty around tractor numbers, their engine power, age and state of repair, a national stock-take of tractors would be useful. According to Engr. Akeem Lawal, mechanisation expert at Ahmadu Bello University, Zaria, plans for a national tractor census exist but are lacking funding. The fact that tractor hire services have now registered thousands of tractors across the nation offers the opportunity for a simplified study that combines elements of a classic census and desk-based elements.

## 4.2 The current stock of mechanisation assets other than tractors

NEARLS & FMARD (2020) report the number of draught animals (bulls, donkeys and camel) in 11 Northern States as 627,500 (2019 and 2020 average). We assume that this number is under-reporting actual numbers, as with tractors, see above, and considering that cows may be used as 'casual' draught animals when the need arises. However, with roughly 13.5m agricultural household in the region, the NEARLS & FMARD number means that less than 5% of households own draught animals.

We did not find data on the stocks of other mechanisation tools and implements than tractors. According to the National Bureau of Statistics (2019) 90% or more of agricultural households in Nigeria report owning hoes and cutlasses, 14% owning sprayers and c.5% owning ploughs or ridgers (the latter percentage being consistent with the percentage of households owning draught animals). This corresponds to stocks of at least 24m hoes and cutlasses, 4m sprayers and just over 1m ploughs and ridgers.

NEARLS & FMARD (2020) report the numbers of new implements and knapsack sprayers procured and distributed by the States in 2020 (202,560 and 5,285, respectively).

## 4.3 The current supply of tractor hire services

We were unable to determine the total number of farmers currently benefitting from tractor hire services. From the information given by our Key Informants, one hire-tractor typically serves 25 to 60 farmers per year (some of which book services twice). Using this figure, a fleet of 7,000 hire tractors could serve between 175,000 and 420,000 farmers per year.

In 2020, 19% of the 725 farmers surveyed for the Wet Season Agricultural Performance Survey (NAERLS & FMARD, 2020) stated they had hired tractor services, 14% from private providers, 3% from Cooperative Associations and 2% from government services.

## 4.4 Demand for tractors

Figures cited for the total number of tractors needed in Nigeria go as high as 1.5m. In our Key Informant Interview, Hello Tractor estimated a need for an additional 750,000 tractors. The World Bank (2014a) suggest a need for 1.5 hp per hectare, referring to FAO recommendations, which



would amount to 680,000 75-hp-tractors or 510,000 100-hp-tractors. In contrast, in our Key Informant interview, Tata stated a need for 100,000 75-hp-tractors or 70,000 100-hp-tractors. The Guardian (2020) cites Mr Biodun Olugbami, National Secretary of the Agricultural Equipment Hiring Operators Association saying that “for the country to get agriculture moderately mechanised, no fewer than 70,000 functional tractors are required”.

The figures given by Tata and Mr Olugbami are consistent with the actual practice of tractor use in Nigeria: TOHFAN (2020) state that a typical tractor can plough 3ha per working day<sup>6</sup>. Assuming that a tractor works 100 days per year on soil cultivation, a single tractor can plough 300 ha. Engr. Akeem Lawal, mechanisation expert at the Ahmadu Bello University, Zaria, and co-author of the NAERLS/FMARD Wet Season Agricultural Performance Survey (NEARLS & FMARD, 2020) estimates that a commercial tractor can plough 4 to 5 ha per day, though can only be deployed for cultivation for a season of 60 days if moving with the rains. However, these assumptions lead to a similar annual total of 240 to 300 ha per tractor per year.

Nigeria has 34m ha of arable land. If 80% of this area were to be cultivated with 75-hp-tractors, each achieving 270 ha per year, then c. 100,000 tractors would be required for full mechanisation. This is a ‘back of the envelope calculation’ and reality would be more complex<sup>7</sup>. However, in the absence of a detailed model, we may assume that 100,000 tractors would achieve a c. 80% tractorisation of Nigerian agriculture.

This level of tractorisation cannot be achieved overnight. Table 6 offers different scenarios for achieving tractorisation of Nigerian agriculture over several years. Depending on the tractorisation target, the time to achieve it and the average lifespan of a tractor, Nigeria needs an additional 7,500 to 35,500 tractors per year, with a median estimate of 15,000. Once that target is achieved, the annual demand of new tractors would drop to the annual replacement rate (which depends on the size of the tractor fleet and the life span of tractors) plus any growth of the sector.

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<sup>6</sup> A typical 75-ha-tractor that can plough 0.5ha per hour. 3ha per day would thus equals an average of 6 working hours per day, leaving room for transportation, preparation and tractor downtime due to service and repairs.

<sup>7</sup> First, not all crops need ploughing. Harrowing, as an alternative cultivation technique is about twice as fast than ploughing, so will reduce the number of tractors needed. Counteracting that, not all tractors will cultivate 270 ha per year, as this often requires a tractor to move across the country with the rains. If the cultivated area per tractor is less than 270 ha per year, more tractor will be needed. Then, not all of Nigeria’s arable land will need cultivation by tractor every year. Some land is idle, some plots may not be accessible by tractor or may be more economic to cultivate by hand, animal traction or tiller. This will reduce the number of tractors needed. Lastly, tractors will be required for other work than ploughing during the planting season, i.e. there is need for extra tractor capacity for work like transport, spraying etc. Without being able to quantify these effects, we here make the simplified assumption that they cancel each other out.

Table 6: Number of additional tractors needed in Nigeria per year to build up to different target numbers of tractors and depending on the number of years to achieve the target and the average lifespan of tractors. The 500,000-tractor scenario is not likely and added for illustration only. Source: own calculation.

Years to achieve target		National tractor number target			
	<i>Avg tractor lifespan</i>	<i>75,000</i>	<i>100,000</i>	<i>125,000</i>	<i>500,000</i>
5	6	21,250	28,333	35,417	141,667
	10	18,750	25,000	31,250	125,000
	15	17,500	23,333	29,167	116,667
10	6	13,750	18,333	22,917	91,667
	10	11,250	15,000	18,750	75,000
	15	10,000	13,333	16,667	66,667
15	6	11,250	15,000	18,750	75,000
	10	8,750	11,667	14,583	58,333
	15	7,500	10,000	12,500	50,000

## 4.5 Demand for mechanisation assets other than tractors

As mentioned in section 4.2, nearly all agricultural households owning cutlasses and hoes. Draught-animals and animal-drawn implements are potentially lacking, though: In the North East and North West, c. 1 in 10 agricultural households report owning ploughs or ridgers. Just under half of all agricultural households in these zones use animal traction (National Bureau of Statistics, 2020). We don't know the reasons why the remaining half do not use animal traction. Reasons may include the limited range of motion of animal-drawn implements (i.e. farmers not in range of the nearest set of animals cannot use them), the cost of keeping draught animals and the availability of implements.

4-wheel tractors do not directly replace draught animals, because the economic optimum of their use is at larger farm sizes than that for draught animals. However, 2-wheel tractor can substitute animal traction directly. As 2-wheel tractors become increasingly established and available, both owned and for-hire, the demand for animal traction may quickly decline.

## 4.6 Demand for tractor hiring services

We did not find systematic market studies on the demand for tractor hiring services in Nigeria. However, all tractor hire providers we interviewed reported that they cannot meet demand during the planting season. *TOFAN* stated that they could only service 11,000 out of 78,000 (14%) of the requests this year, *NECAS* 70% of the requests during peak times. *Hello Tractor* estimated that they only serve 10 to 20% of their current potential market. The other 3 providers did not give numbers but uniformly reported that they could not meet demand during the season and that tractors were hardly idle even during the off-season. *NAERLS* and *FMARD* (2020) report that only 19% of survey respondents across the country had access to tractor hire services in 2020.

These figures suggest that as little as 20% or less of farmers requesting tractor hire services can be served. This means that the immediate unmet demand for tractor hire services could be five times higher than the current supply. Above we estimated that currently, 150,000 to 360,000 farmers benefit from tractor hire. Multiplied by five this would be a market between 1.75 million and 1.80 million farmers. The latent demand may even be higher: As discussed earlier, tractor services are particularly attractive for medium-scale farmers with between 5 and 100 ha. We estimate that there are currently 4 million farmers in Nigeria that fall into this category<sup>8</sup>.

## 4.7 Supply of tractors

**Tractor imports.** There is currently no tractor manufacturing in Nigeria. All tractors are imported. Between 2015 and 2019, a total of 52,750 tractors have been reported as exported to Nigeria by its trading partners (we used ‘mirror’ statistics, i.e. exports to Nigeria reported by its trading partners which may be assumed to be more accurate). Imports rose markedly in 2018 and 2019 (see Figure 9), driven by high exports from China (7,075 and 8,128 tractors, respectively). Over the 5-year period, main tractor exporting nations to Nigeria were China, the EU and USA, see Table 7.

The total value of tractor imports to Nigeria was USD 917m over the 5-year period, over 60% of which went to China, see Table 7.

The import figures include all sizes of agricultural tractors, including 2-wheel tractors, as none of the reporting countries differentiates by tractor type. However, the average value per tractor by country indicates the typical tractor size imported from there. Interestingly, smaller tractors (average cost <USD 10,000) were predominantly imported from Italy, Spain, the UK and Pakistan. Larger average costs (>USD 30,000) from Brazil, France, Finland South African and Thailand.

**Government procurement of tractors with subsidized distribution.** As mentioned, Nigerian governments have long intervened in the domestic tractor market. In 2012, the Federal government stopped the subsidized distribution of tractors. However, State governments continue the practice and in January 2020, the Federal Minister of Agriculture and Rural Development re-entered the scene by announcing the plan to buy 10,000 donor funded tractors plus implements worth USD1.1bn. This means that both Federal and State governments’ role in the tractor market remains fickle and continued intervention in the market seems likely. It remains to be seen if the recent announcement by the Federal government will have a negative effect on private sector imports and sales of tractors in Nigeria

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<sup>8</sup> Estimate using percentage farm size distribution from 2010 FAO farmer census data (Lowder et al., 2019), applied to our estimate of 2018/19 numbers of agricultural households in Nigeria (Table 2).

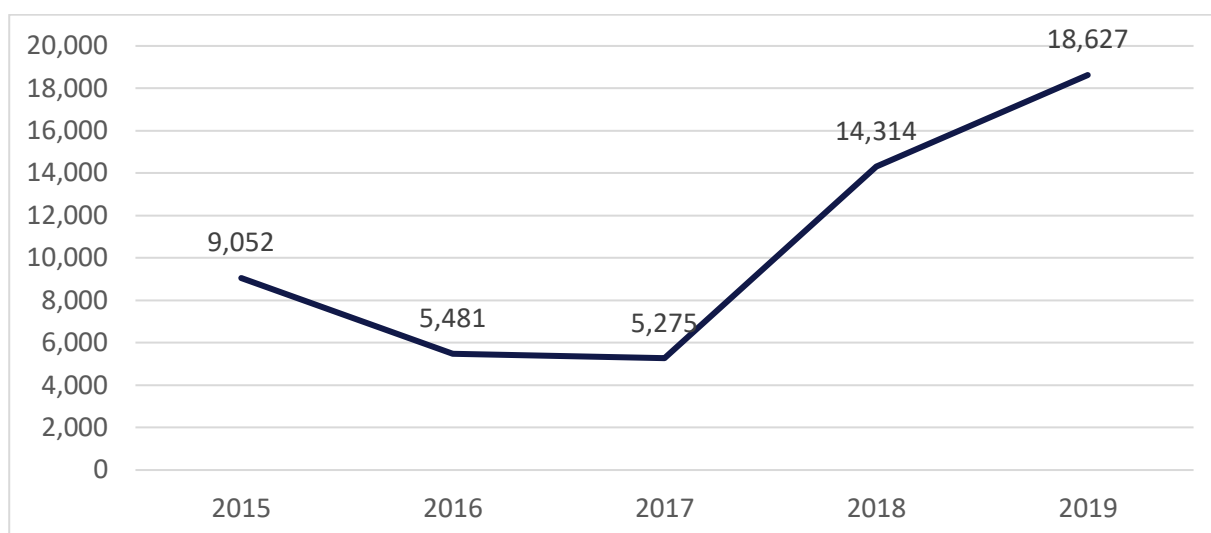


Figure 9: Tractor exports to Nigeria. Includes all types of agricultural tractors (HS Commodity Codes 8701 and 8701... as reported). Source: UN Comtrade (2020).

**Tariffs and taxes on imported agricultural machinery.** Import tariffs have been generally imposed on tractors and spare parts in Nigeria. Import duties (customs duties) have accounted for the bulk of import tariffs on agricultural tractors. The 2020 draft Finance Bill proposes the reduction of duties on vehicles from 35% to 10%, including on tractors.

Agricultural equipment, including tractors and spare parts, have long been exempt from value-added tax (VAT). Since 2016, a VAT of 5% was imposed on imported fully assembled tractors, while partly assembled and knocked down imported tractors remained 0% VAT rated (Takeshima & Lawal, 2018).

However, the information of distributors of second-hand tractors in Nigeria is limited. Currently, tractors in Nigeria are sold by both the large importers, and small and medium retailers. Several importers in Nigeria focus on institutional clients, such as state governments, for their tractor distribution programs, sugarcane estates and large farming corporations. They import both

Table 7: Number and values of tractors exported to Nigeria between 2015 and 2019 by trading partner. Includes all types of agricultural tractors (HS Commodity Codes 8701 and 8701... as reported). Source: UN Comtrade (2020).

Exporter	Number of tractors		Trade value (million USD)	
China	20,712	39%	562	61%
EU*	13,511	26%	111	12%
USA	11,294	21%	131	14%
India	4,553	9%	66	7%
Pakistan	2,207	4%	20	2%
Others*	472	1%	27	3%
<b>Sum</b>	<b>52,749</b>	<b>100%</b>	<b>917</b>	<b>100%</b>

\*EU: Mainly UK, Belgium, Italy, Germany and Spain. Others: Mainly Brazil, Turkey, South Africa Thailand and UAE.

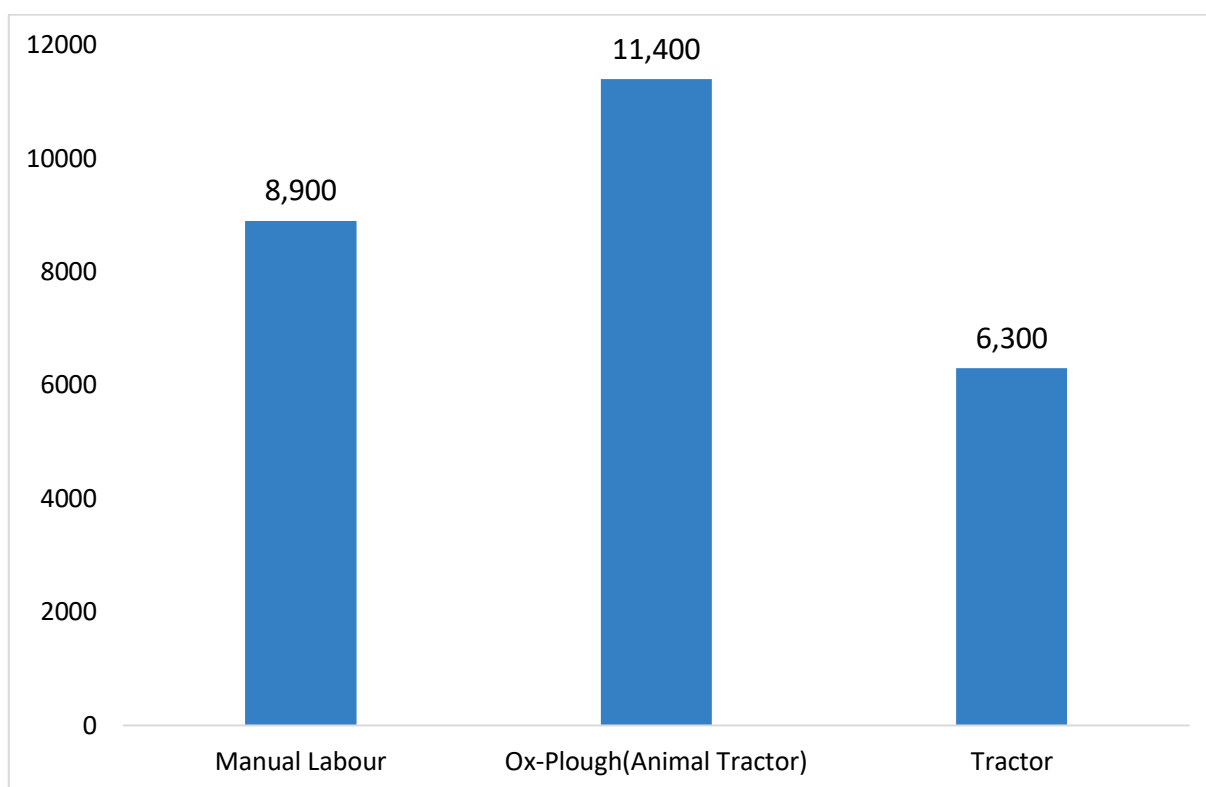
assembled and knocked down machinery, the latter being then assembled by distributors. In addition, several tractor retailers operate in Nigeria, ranging from medium-scale retailers selling about 100 tractors per year to small-scale retailers selling 10–30 tractors per year (new, refurbished, or combined). Small-scale retailers often focus on repairs and maintenance, with sales often being supplementary. These small retailers transact mostly with individual farmers and they are likely to be the major sources of second-hand tractors for individual buyers.

**Public-sector tractor hiring units:** The Nigerian public-sector tractor hiring units (THUs) expanded after the 1970s. However, they were unable to meet much of the demand for tractor services during the peak season in Nigeria, as a result, many state governments started using the private sector to provide the services by subsidizing tractors. This service has often turned out economically viable, and private tractor owner-operators now serve greater areas. Another contributing factor to the increasing areas serviced by private tractor owners is the establishment of the Agricultural Equipment Hiring Enterprises (AEHE) by the Nigerian government (Takeshima et al. 2014). In our stakeholder interview, we found that AEHE delivers mechanisation without having the farmer own the equipment. They do this through a tractor-hiring system operated by NAMEL and through a lease financing program. They also set up service providers who take loans and puts tractors to use. The lease package is similar to what operates in Oil & Gas, housing, etc where service providers can get a product and pay over a period of time. The program has been able to fund the acquisition of over 2000 tractors and is looking forward to getting up to 4000.

**Private-sector tractor hiring services: farmer-to-farmer service provisions:** By the mid-1980s, private-sector THUs had been growing while various types of tractor ownership and service provision have been promoted, including cooperative, joint ownership, or enterprise ownership and the most common type is the individual ownership of tractors by farmers, who provide farmer-to-farmer THUs. There are two types of tractor owners in Nigeria: (1) government-sourced (GS) tractor owners who obtained tractors from the government; and (2) market-sourced (MS) tractor owners who obtained tractors from the market (Takeshima & Lawal, 2018). Typically, MS owners have obtained second-hand tractors which were mainly Steyr, Fiat, and Ford brands, while GS owners have obtained new tractors (New Holland, Massey Ferguson). Massey Ferguson and Mahindra are widely owned by both MS and GS owners. We did not find information about the relative sizes of the two segments. This is information that could be gathered through a national tractor stock-take, as suggested above. For MS owners, 80% of tractor acquisition costs were financed by personal savings and informal loans. For GS owners, about 34% of the costs were financed by government loans, although 40% of the costs were still financed by private savings and informal loans (Takeshima & Lawal, 2018).

## 4.8 Cost of mechanisation

The Wet Season Agricultural Performance Survey (NEARLS & FMARD, 2020) records the average cost of different cultivation operations by State. In 2020, the cost of ploughing varied from NGN 7,000 per ha in Bayelsa to NGN 40,000 per ha in Enugu, with a median cost of NGN25,000 per ha. Compared to 2019, prices have increased from less than 10% in the 3 Southern zones to 15%



*Figure 10: Relative cost (NGN) of land preparation with different sources of farm power in 2014. Note that today's costs are nearly twice as high. Source: World Bank (2014).*

in North Central 28% and 41% in the North East and North West, respectively. The report fails to seek explanations of the sharp increase in costs in the North, though.

According to 2014 World Bank data (World Bank, 2014a), cultivation by tractor has the lower per-hectare cost, animal traction the highest (Figure 10). While the absolute costs have changed since then, we may assume that the relative cost has remained similar.

Table 8 shows the cost of hiring tractors in 2014 and 2020 across the geo-political zones. The cost of tractorised cultivation nearly doubled over the period. Note that there are price differences between different hire services. For instance, TOHFAN charges NGN 12,500 per ha for harrowing, NECAS NGN 15,000 per ha.

## 4.9 Tractor financing

In a 2014 survey, Takeshima & Lawal (2018) found that people buying tractors from the private market raised 80% of acquisition costs through personal savings and informal loans. Bank loans did not play a role in tractor finance. In the case of tractors sold by governments, 34% of the costs were financed by government loans, but a large part was still financed through private savings and informal loans.

All mechanisation service providers and manufacturers we interviewed mentioned that debt finance was problematic because of

Table 8: Cost of hiring tractors in the different agricultural zones in Nigeria. Source: The World Bank (2014) and own research (2020).

Zone	Ploughing Naira (USD)/ha		Harrowing Naira (USD)/ha		Ridging Naira (USD)/ha	
	2014	2020	2014	2020	2014	2020
North Central	7,125 (44.53)	20,000 (52.47)	6,750 (42.19)	12,500 (32.79)	7,600 (47.50)	12,500 (32.79)
North East	15,000 (93.75)	20,000 (52.47)	15,000 (93.75)	15,000 (93.75)	15,000 (93.75)	15,000 (93.75)
North West	6,840 (42.75)	20,000 (52.47)	4,725 (29.53)	12,500 (32.79)	3,450 (21.56)	12,500 (32.79)
South East	11,900 (74.38)	20,000 (52.47)	11,500 (71.88)	12,500 (32.79)	10,833 (67.71)	12,500 (32.79)
South West	6,813 (42.58)	20,000 (52.47)	4,250 (26.56)	12,500 (32.79)	4,250 (26.56)	12,500 (32.79)
<b>National Average</b>	<b>9,535 (59.59)</b>	<b>20,000 (52.47)</b>	<b>8,445 (52.78)</b>	<b>13,000 (34.10)</b>	<b>8,226.67 (51.42)</b>	<b>13,000 (34.10)</b>

- High-interest rates of commercial loans
- High down payments and the requirement for personal collateral
- In the case of Development Finance Institutions, cumbersome and lengthy process, despite better rates.

Nonetheless, all stakeholders we interviewed had managed to raise loan capital, some from commercial banks, some from Bank of Industry and Bank of Agriculture. This could, by reverse logic, mean that the ability to access to debt finance may be a make-or-break criterion for entering the tractor hire market; and that, if improved, more companies would enter the market and offer mechanization services to farmers.

A simple financial model (Table 9) shows that, despite high-interest rates, debt finance is favourable, because of the high internal rate of return (leverage effect). It also shows that investment in small 2-wheel tractors may be attractive, though the model assumptions for costs and revenues are less certain than for the 4-wheel tractors.

From our own consulting experience with agribusinesses, we know that banks do generally not like financing movable assets. If they do, then only with high collateral, such as a mortgage on a private residence. This reluctance is explicable by the fear that movable assets cannot be secured if the borrower defaults.

However, tractor finance should be attractive for commercial banks in Nigeria:

1. Commercial banks are mandated by the CBN to set aside 5% of their loan portfolio for agriculture, yet most banks are struggling to meet this quota because of the scarcity of investable project and/or the small ticket size of many investments.
2. Financing tractors, or entire tractor fleets, for hiring out has a straightforward business case with an attractive debt-coverage ratio (see below), offers tangible assets as collateral and larger ticket sizes.

3. Technology solutions (such as the temper-proof tracking devices developed and manufactured in Nigeria by Hello Tractor) make obsolete banks' concerns over financing movable assets and are in fact already used by some financiers and insurances.

Government financial instruments like first loss guarantees may further help easy commercial bank's concerns.

Given the above, improving the availability of bank loans for tractor finance may be a matter of raising awareness and brining banks, tractor owners, technology providers, NIRSAL and other stakeholders to the table to promote the development of finance products that are tailored towards financing tractors and other movable agricultural assets.



Table 9: Simple financial model (income statement only) for three different tractor purchase scenarios: (a) 75 hp 4-wheel tractor with implements, 70% debt financed and 30% equity financed; (b) the same tractor, but 100% equity financed; (c) a 2-wheel tractor with implements, 70% debt financed and 30% equity financed. Costs are adapted from Propcom Mai-karfi (pers. comm., 2020). Note that (i) cost and revenue assumptions for the 2-wheel tractor need to be confirmed by market players; and (ii) costs in all scenarios do not yet include insurance and company overheads, such as marketing, sales, head office and IT-platform development.

Assumption	(a) 75 hp 4w 70% loan financed	(b) 75 hp 4w self-financed	(c) 2-wheel tractor 70% loan financed			
Purchase price (NGN)	12,500,000	12,500,000	750,000			
Loan (%)	<b>70%</b>	<b>0%</b>	<b>70%</b>			
Equity investment (NGN)	<b>3,750,000</b>	<b>12,500,000</b>	<b>225,000</b>			
Interest rate (% pa)	25%	25%	25%			
Repayment period (yrs)	7	7	<b>3</b>			
Revenue per operating day (NGN)	75,000	75,000	30,000			
Days per year at 100% utilisation	60	60	<b>30</b>			
Days per year at 70% utilisation	190	190	<b>150</b>			
Days per year idle	115	115	<b>185</b>			
Booking agent commission (% on revenue)	7.5%	7.5%	7.5%			
Operator cost per operating day (NGN)	7,000	7,000	7,000			
Fuel cost per day (NGN)	14,000	14,000	7,000			
Service cost (NGN per month)	52,000	52,000	30,000			
Repairs per operating day (NGN)	6,500	6,500	3,000			
Repayment and interest (NGN per month)	221,477	0	20,874			
<b>Income statement (NGN / year)</b>						
	<i>Costs</i>		<i>Revenues</i>		<i>Costs</i>	
Revenue	14,475,000		14,475,000		4,050,000	
Booking agent commission	1,085,625		1,085,625		303,750	
Operator costs	1,750,000		1,750,000		1,260,000	
Fuel costs	2,702,000		2,702,000		945,000	
Service costs	624,000		624,000		360,000	
Repairs	1,625,000		1,625,000		540,000	
Depreciation	1,785,714		1,785,714		250,000	
Repayment and interest	2,657,722		0		250,487	
<b>Total</b>	<b>12,230,061</b>	<b>14,475,000</b>	<b>9,572,339</b>	<b>14,475,000</b>	<b>3,909,237</b>	<b>4,050,000</b>
<b>Earnings w/o insurance &amp; overheads, before tax</b>	<b>2,244,939</b>		<b>4,902,661</b>		<b>140,763</b>	
Annualised rate of return (ARR) on project (%)	21%		21%		37%	
Annualised rate of return (ARR) on equity (%)	27%		21%		42%	
Internal rate of return (IRR) on equity (%)	149%		61%		167%	

## 5 Mapping the future of agricultural mechanisation in Nigeria

Far-reaching mechanisation (80% tractorisation) of Nigeria's agricultural sector should be achievable within the next 10 years. Tractor imports in 2018 and 2019 have already put the country on track for that goal. Drawing on the material compiled in this report, we identified the following priorities for shaping the path to a mechanised agricultural sector:

- 1. Creating a predictable and non-interventionist policy environment.** Past policies on mechanisation in Nigeria appear volatile, un-coordinated and focused on direct market intervention, i.e. the large-scale procurement and subsidised re-sale of tractors and equipment. Federal and State governments could adopt key elements of policies of countries that are successfully mechanising their agricultural sectors, such as Kenya, Zambia and Thailand. All of them create policy environments that are
  - Long-term, predictable and follow a logical pathway of mechanisation development
  - Focus on developing and coordinating the institutional capacity for testing and adapting agricultural equipment to local needs, for research and development in agricultural machinery and for building human resources, i.e. training agricultural engineers
  - Abstain from intervening in the market directly or in other ways distorting the market in a way that damages private sector players
- 2. A better understanding of farmers' needs.** We found a wealth of information on the Nigerian agricultural mechanisation sector. One perspective is largely absent, though: That of farmers. This is surprising, as they are the ultimate customers requesting, and paying for, mechanisation and mechanisation services. We believe that an intimate understanding of farmers' needs, worries, aspirations and economic realities is essential for understanding how to best serve them; and thereby for making the right investment decisions. Much better knowledge is required of customer segmentation and customers' location, mechanisation needs, decision processes, household cash flows, financial constraints etc. This knowledge will be directly relevant to prospective investors. An intelligent market study, using participatory techniques, could provide such information.
- 3. Focus on 2-wheel tractors.** Animal traction is still the most important source of traction power for soil cultivation in Nigeria. While much attention has been paid to introducing and promoting 4-wheel tractors, the more suitable substitute for animal traction may be 2-wheel tractors. They also offer a route to mechanisation to farmers in the South of Nigeria who cannot use animal traction because of Trypanosomiasis. 2-wheel tractors are well-established in many countries where, like in Nigeria, agriculture is dominated by smallholder farmers, such as China, India, Vietnam and Thailand and Italy. In Nigeria, however, 2-wheel tractors are still new. Farm Help Centre Nigeria Ltd., who operate a fleet of 2-wheel hire tractors, told us that marking was one of their major costs because people still were to grow accustomed to 2-wheel tractors.

2-wheel tractors have advantages over 4-wheel tractors:

- Low costs: A 2-wheel tractor costs 10% or less of the purchase price of a 75-hp 4-wheel tractor

- Suitability for the small-scale nature of Nigerian agriculture: Most farmers have little land and small plots where 4-wheel tractors are over-sized, but 2-wheel tractors can still operate
- Versatility: 2-wheel tractor can be equipped for cultivating, mowing/reaping/cutting, spraying, transporting and stationary power provision for threshing, milling or electricity generation. This increases the chances to maximise asset utilisation
- Easy mechanical adaptation: 2-wheel tractors can easily be adapted for special purposes, e.g. cultivation in flooded paddy rice fields, as common in South East Asia
- Technical simplicity: 2-wheel tractors are often robust and easy to operate, maintain and repair. This maximises the chances of keeping them working. Mechanics who can repair a motorcycle can also repair a 2-wheel tractor.

Fabrication, or at least assembly, of 2-wheel tractors in Nigeria seems possible. With an estimated 2 to 3 million farmers currently owning animal-drawn cultivation tools, there may be a ready market of an estimated NGN 75bn per year<sup>9</sup>.

A focus on promoting smaller-scale tractors could include millions of farmers in the mechanisation market who were previously excluded. However, this should complement, rather than replace, efforts to optimise the use of larger tractors.

- 4. Redefining the role of booking agents.** Booking agents are currently adding value by aggregating demand. However, this comes at a cost – usually 10% of the tractor hire fee—which inflates tractor hire prices and makes tractor services less affordable for poorer farmers. As smartphones become more affordable and more widely used among farmer, the usefulness of booking agents decreases, as farmers can now directly interact with booking platforms and other users to aggregate demand and order services. In this scenario, booking agents become obsolete, turning from value chain actors who add value to mere middlemen who only add cost.

However, booking agents can redefine their role from mere aggregators to mechanisation experts who support their farmer clients with technical advice on soil cultivation; timing of cultivation; choice of implements and machine size; optimising the cost of tractor services etc. Equally, they could provide valuable information to tractor service providers and help them make more money. The case of the European and US grain merchants illustrates that such a transformation is feasible and fruitful: Over the past 30 years, grain merchants have re-invented themselves, tuning them from middlemen, who exploit their one-sided access to market information, to expert advisors who use their knowledge to help their business partners up and down the value chain make better business decisions and more money.

Technology may help booking agents define and carve out this new role.

- 5. Technology integration.** Many tractors are still used well below their technical capacity. This inflates the costs to the tractor owner and ultimately to the farmers, to who the high fixed costs

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<sup>9</sup> If 5% of the 2 million farmers using animal traction changed to 2-wheel tractors every year, there would be a demand for 100,000 2-wheel tractors per year. At NGN 750,000 (including a tiller implement) this equals NGN 75bn of sales per year.

are passed on. Under-utilisation also means that fewer farmers benefit from tractor services than potentially could. We believe that the main reason for the under-utilisation of Nigerian tractors is logistics: They are in the wrong place at the wrong time too often. Technology can overcome this. Two solutions seem promising, one of which already exists in the market:

1. *Hello Tractor's* tracking devices, developed and built in Nigeria, do not only trace tractors geographically, letting owners know where they are; they also collect data on engine runtime, travel routes, fuel use and servicing needs, which can help optimise routes, work plans, servicing intervals, fuelling etc. and thereby reduce downtime and idle time.
2. A data collection, aggregation and sharing platform that cuts across individual hire services, to better map demand and supply, optimise routes and collect year-on-year data that can be used after a few years to train machine learning algorithms that further help optimise tractor deployment. Travel agents' airline booking software may serve as an example, as well as, Expedia, which bundle information from various airlines and travel platforms to optimise capacity utilization of hotels and aeroplanes on one hand; and give travellers access to a wider market and better prices. In the case of a tractor hire platform, 'internet of things' principles might also apply, where tractors, implements, smartphones, whether stations etc., could interact via one platform. Further services and sectors could be integrated, such as advisory, input ordering and mobile payments. Or road logistics, which has similar structures and challenges. Creating such a platform will however require the willingness of tractor services to collaborate and share data. Propcom Mai-karfi could both provide thought leadership and play a convening role.

**6. Supporting new entrants in the market with technical advice.** The simple financial model above (Table 9) suggests that tractor hire services can be an attractive business with competitive returns to investors. Industry stakeholder we spoke to in Key Informant Interview indirectly confirm this through their desire to further expand in the market. In addition, the market is undersaturation, making it easy for new businesses to enter. This creates ideal conditions for start-ups as well as new entrants from adjacent sectors, such as vehicle sales, large farming companies or transport companies. These potential new players will need specialist advice, e.g. with

- Market intelligence
- Business planning
- Selection of the right kind, size and number of machines
- Understanding regulations and licensing
- Understanding machine vendor contracts and ensuring they include key clauses, e.g. provision of critical spares
- Awareness of financing option, government support and donor programmes

Propcom Mai-karfi could use its sector experience and networks to create the necessary tools, checklists, online resources and advisory products to help prospective entrants in the mechanisation market succeed. Good information products can help avoid known mistakes, increase chances of survival and speed up growth, which in turn would lead to quicker growth

of the mechanisation sector. Obvious partnership opportunities to be explored are with tech incubators and accelerators as well as early-stage and angel investors.

In addition to technical advice, new entrants as well as existing players, need finance.

**7. Facilitating credit finance.** Mechanisation, especially equipment hire, is capital intensive. We have shown above that credit finance is economically preferable to equity finance, which is also reflected in the financing strategies used by the Key Informants we spoke to. However, we also found that in practice, banks in Nigeria are generally reluctant to providing loans for movable agricultural assets; and when they do, the process can be complicated, protracted and result in terms and conditions that are often not entirely in synch with the needs of a new business operating in the agricultural sector. At the same time, the ingredients are present for a market that can bring banks and agricultural mechanisation investors together:

- An attractive overall business case, as outlined above, likely to give banks robust debt coverage ratios
- Existing technology to de-risk investment in movable assets, such as Hello Tractor's tracking devices, which are already used to secure movable assets for investors
- Existing government guarantee schemes and NIRSAL, which de-risk loans through financial instruments
- The obligation put on commercial banks by the CBN to set aside 5% of their loan portfolio for agriculture, on which most banks are currently failing to deliver and should therefore have an interest in finding attractive investment projects
- Large ticket sizes in the tens or hundreds of million Naira, making deals attractive for banks
- The persistently articulated political will to promote the mechanisation of Nigerian agriculture, as most recently reflected in the Federal government's Green Imperative Programme (The Guardian, 2020).

To bring these ingredients together and to bear, a coordinated approach will be required, bringing together financial sector players, like the CBN, NIRSAL, Bank of Industry, Bank of Agriculture, Federal government; and interested commercial banks and representatives of the mechanisation sector. Given the size of the trade-in tractors – imports alone of close to USD 1bn or NGN 380bn since 2015, see Table 7 – it seems justified to call for a coordinated route to credit for businesses in the mechanisation sector. Propcom Mai-karfi could play advocacy and facilitating role in making this overall conclusions and recommendations.

**8. An inclusive mechanisation strategy.** Tractors and draught animals are a male-dominated business in most places and cultural norms sometimes exclude (or at least discourage) women from interacting with these technologies. At the same time, women bear the brunt of agricultural labour and would benefit the most from the time saving brought about by mechanisation. This benefit will usually be passed on to the family, in the form of more time for childcare, education or attention to other income-generating activities.

Mechanisation also creates new income opportunities directly, be it as tractor operator, mechanic or booking agent. There are examples of how mechanisation programmes can ensure that women are included in the new technologies in the same way as men. Compounding

existing gender divides can be an unintended consequence of mechanisation if not explicitly managed.

Similarly, youths in rural communities are often disadvantaged in their access to land and other productive assets. Mechanisation offers opportunities for income and social status, but can, if not implemented in an inclusive way, compound the disadvantages.

## 5.1 Summary of key insights

1. Human labour and animal traction are the prevalent sources of power in Nigerian agriculture: Nearly three-quarters of farmers rely on manual labour and just under one quarter use draught animals. Tractor use is marginal, with c. 4% of farming households using tractors.
2. The use of animal traction for soil cultivation is widespread in the Northern geopolitical zones but absent in the Southern ones (because of animal trypanosomiasis) and varies between crops: Fine grains and legumes are cultivated by animal traction more often than rice, maize and tubers.
3. The adoption rate of mechanisation increases with farm size: Farms of 3 ha and more are using animal traction more often than smaller ones. From 5 or 6 ha, tractors hire becomes attractive and farm sizes above 50 ha justify owning a small tractor.
4. Medium-scale farmers (5 ha to 100 ha) both rely strongly on the availability of tractor hire services and drive availability for smaller neighbouring farmers.
5. Tractor utilisation in Nigeria is low. Utilisation rates of privately owned commercially hired-out tractors are typically higher than those of other owners (which shows that utilisation can be optimised), but still lower than technically possible. Increasing utilisation of Nigeria's existing tractor fleet would be the single most effective measure for increasing the availability of tractorisation in the short term: Increasing the average annual use by 100 days could make tractors available to twice as much land as today.
6. Prolonging the useful lifespan of tractors is another lever that could increase tractor availability, though less effective than increased utilisation.
7. There are an estimated 3,000 to 10,000 working tractors in Nigeria, with the best estimate of 7,000 and higher, though imports of over 30,000 tractors in 2018 and 2019 alone should have increased the number of working tractors further.
8. Nigeria's demand for additional tractors has sometimes been overstated. Realistically, a fleet of around 100,000 75-hp tractors could achieve c. 80% tractorisation. To build this fleet over a 10-year period, c. 15,000 tractors will need to be added every year. Tractor imports in the recent past are in line with this number.
9. Nigeria's tractor service market is supply-constrained: Current supply seems to only satisfy 20% or less of the articulated demand. In addition, there is a latent demand that could surpass the current demand by 3 or 4 times.

10. As there is no domestic tractor industry, Nigeria imports all its tractors. Between 2015 and 2019, Nigeria has imported c. 52,000 tractors, with an increase in imports in 2018 and 2019. The country spent nearly USD 1bn on these imports. The main origins of the imports are China, the EU and the US.
11. Buying tractors to hire them out offers attractive returns to equity investors. This is true despite high-interest rates on bank loans. Companies in the sector unanimously report difficulties accessing credit finance to purchase tractors.

## 5.2 Recommendations

We recommend the following to Propcom Mai karfi and other mechanisation stakeholders

1. Better understanding farmers' needs: Farmers are the ultimate customers of mechanisation, yet their needs, aspirations and drivers are largely missing from the discourse on mechanisation. We recommend conducting a needs assessment to understand customer segmentation and customers' location, mechanisation needs, decision processes, household cash flows, financial constraints etc.
2. Focus on 2-wheel tractors: 2-wheel tractors have not featured highly in past mechanisation efforts yet seem the most appropriate technology for a large segment of Nigeria's farmers (those with less than 3 to 5 ha). They offer practical advantages and an attractive business case for investors in mechanisation services. We recommend confirming the business case and if favourable, add a strategic focus on 2-wheel tractors, which could include domestic production or assembly.
3. Redefining the role of booking agents: Booking agents are likely to become obsolete as technology advances, increasingly allowing farmers to connect with each other and with tractor service providers directly. However, there can be a role for booking agents in providing technical expertise as well as aggregation services. We recommend supporting booking agents in redefining their role and making the transition to a sustainable future, as brokers of technical knowledge and expertise around mechanisation.
4. Technology integration: With an atomised demand side in the tractor hire market, digital technology will be a critical enabler for maximising tractor capacity utilisation and reducing downtime, travel and idle time. We recommend studying the potential benefits of technology on tractor hiring services, in particular tracking and GPS technology; and the possibility of creating a meta-booking platform that cuts across providers and integrates data from all platforms to maximise the use of the entire Nigerian tractor fleet.
5. Supporting new entrants in the market with technical advice: The tractor hire market offers opportunities for start-ups and other new entrants. Helping these businesses navigate some of the technical challenges and avoid known mistakes will increase their chances of success in the market and thereby speed up the mechanisation of Nigerian agriculture. We recommend putting together a package of technical information, tools and advisory tailored to the needs and challenges of new entrants in the mechanisation sector.

6. Facilitating credit finance: Credits for movable assets are difficult to get in Nigeria. However, considering (a) the finance volume that will be required to achieve mechanisation of Nigeria's agriculture and (b) that many of the components are already there that can facilitate de-risked credit provision to tractor buyers, we recommend that Propcom Mai-karfi convenes a coalition of banks and government guarantors that creates a standardised path to credit provision for tractor buyers.
7. An inclusive mechanisation strategy: Mechanisation has the potential to include or leave behind currently disadvantaged groups, such as women and youths. To maximise the positive impact of mechanisation, we recommend designing interventions in a way that is inclusive of disadvantaged groups for their own benefit and that of the wider economy.
8. Advocating effective policies for mechanisation: Federal and State governments have a history of policies that may be well-intentioned but are in practice detrimental to the development of a strong and thriving mechanisation sector in Nigeria. Governments should focus on creating conducive boundary conditions for private sector, especially building and coordinating institutional capacities for testing, research and development of agricultural equipment and training agricultural engineers; and stop the practice of intervening in the market by buying and selling tractors at a subsidised price.



## 6 Sources of information

### 6.1 Key Informant Interviews (KIIs)

Organisation	Type	Role title of interviewee
ACT Agribusiness	Commercial Hire/Services/Tech	CEO
Ahmadu Bello University, Zaria	Academic	
Cassava Growers Association of Nigeria	Farmer Association / Agribusiness	Agricultural Extension Specialist, National Agricultural Extension And Research Services
Farm Help Centre Limited	Two-wheel tractor hiring company	
Habgito	Power tiller seller	
Hello Tractor	Commercial Hire/Services/Tech	Chief Data Scientist
Machines and Equipment Corporation (MECA)	Commercial Hire/Services/Tech	General Manager
Nigeria Agricultural Mechanisation and Equipment Leasing Company (NAMEL)	Commercial Hire/Services/Tech	CEO
National Center for Agricultural Mechanization (NCAM)	Mechanisation Association	Director Engineering
Nigerian Incentive-based Risk Sharing System for Agricultural Lending (NIRSAL)	Financial	Assistant General Manager Agricultural Value Chain Finance and Investment Services
Nigerian Investment Promotion Commission (NIPC)	Investment promotion	Acting Director, States Coordination Department
North East Commodity Association (NECAS)	Mechanisation Association	Technical Advisor to the CEO
Small Scale Women Farmers Organizations in Nigeria SWFON)	Farmer Association	
Sterling Bank	Financial	Group Head, Agric and Solid Minerals
Tata International	Manufacturer	
Tractor Owners and Hiring Facility of Nigeria (TOHFAN)	Mechanisation Association	CEO

## 6.1 Literature used

- Agramondis (2021): 2021 Nigerian Agribusiness Leaders Survey. Forthcoming on <https://aqramondis.com>
- Binswanger, H., & McIntire, J. (1987). Behavioral and material determinants of production relations in land-abundant tropical agriculture. *Journal of Economical Development and Cultural Change*. <https://doi.org/10.1086/451637>.
- FAO & AUC. 2018. *Sustainable Agricultural Mechanisation: A Framework for Africa*. Addis Ababa. 127pp. Licence: CC BY-NC-SA 3.0 IGO.
- FAO & UNIDO. 2008. *Agricultural mechanisation in Africa: Time for action. Planning investment for enhanced agricultural productivity Report of an Expert Group Meeting January 2008, Vienna, Austria*. Rome. Food and Agriculture Organization of the United Nations.
- FAO & UNIDO. 2009. *Investment in agricultural mechanisation in Africa. Executive summary: Conclusions and recommendations of a Round Table Meeting of Experts*. <http://www.fao.org/3/i1436e/i1436e.pdf>.
- FAO and UNIDO. 2011. *Investment in Agricultural Mechanisation in Africa. Workshop organized and hosted by FAO and UNIDO, Centre for Agricultural Mechanisation and Rural Technologies (CAMARTEC), 3–5 June 2009. Arusha, Tanzania*.
- FAO. 2005. *Contribution of farm power to smallholder livelihoods in sub-Saharan Africa. The Agricultural and Food Engineering Technical Reports*. Rome. Food and Agriculture Organization of the United Nations. <http://www.fao.org/3/a0229e/a0229e0h.htm>.
- FAO. 2006. *Farm Power and Mechanisation for Small Farms in Sub-Saharan Africa. The Agricultural and Food Engineering Technical Reports*. Rome. Food and Agriculture Organization of the United Nations.
- FAO. 2009. *Farm equipment supply chains: Guidelines for policy-makers and service providers: experiences from Kenya, Pakistan and Brazil. The Agricultural and Food Engineering Technical Reports*. Rome. Food and Agriculture Organization of the United Nations.
- FAO. 2012. *FAO Statistical Yearbook 2012 Africa Food and Agriculture. Food and Agriculture Organization of the United Nations Regional Office for Africa Accra*. <http://www.fao.org/3/i3137e/i3137e.pdf>.
- FAO. 2013. *Agricultural Mechanisation in Sub-Saharan Africa Guidelines for preparing a strategy*. Rome. Plant Production and Protection Division Food and Agriculture Organization of the United Nations.
- Financial Nigeria. 2017. *Banks to remit 5% of profit for Agric/SME investment scheme – CBN*. <http://www.financialnigeria.com/banks-to-remit-5-of-profit-for-agric-sme-investment-scheme-cbn-news-1235.html>.
- Grand View Research. 2020. *Agricultural Tractor Market Size, Share & Trends Analysis Report By Engine Power (Less than 40 Hp, 41 To 100 Hp, More Than 100 Hp), By Region (North America, Europe, APAC, LATAM, MEA), And Segment Forecasts, 2020 – 2027*.

- IFPRI. 2010. *Agricultural Mechanisation and the Smallholder Farmers in Nigeria*. NIGERIA STRATEGY SUPPORT PROGRAM: Policy Note No. 22.
- IFPRI. 2014. *Tractor Owner-Operators in Nigeria: Insights from a Small Survey in Kaduna and Nasarawa States*. IFPRI Discussion Paper 01355 June 2014.  
<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.446.6140&rep=rep1&type=pdf>.
- IFPRI. 2019. *Mechanisation in Nigeria: What needs to be done to stimulate demand and support market growth?* <https://www.ifpri.org/publication/mechanisation-nigeria-what-needs-be-done-stimulate-demand-and-support-market-growth>.
- Jayne TS, Muyanga M, Wineman A, et al. 2019. *Are medium-scale farms driving agricultural transformation in sub-Saharan Africa?* *Agricultural Economics*. 2019;1–21. <https://doi.org/10.1111/agec.12535> <https://www.land-links.org/wp-content/uploads/2019/11/Are-medium-scale-farms-driving-agricultural-transformation-in-sub-Saharan-Africa.pdf>.
- Kirui, O.K. & Braun, J.V., 2018. *Mechanisation in African Agriculture: A Continental Overview on Patterns and Dynamics*. Working Paper 169. Germany. Center for Development Research (ZEF), University of Bonn.
- Kirui, O.K. 2019. *The Agricultural mechanisation in Africa: micro-level analysis of state drivers and effects*. Discussion Papers on Development Policy No. 272, Center for Development Research, University of Bonn, April 2019, pp. 56.
- Kydd, J., & Dorward, A. (2004). *Implications of market and coordination failures for rural development in least developed countries*. *Journal of International Development*.  
<https://doi.org/10.1002/jid.1157>.
- Lowder, S.K., Sánchez, M.V. & Bertini, R. 2019. *Farms, family farms, farmland distribution and farm labour: What do we know today?* FAO Agricultural Development Economics Working Paper 19-08. Rome, FAO.
- Malabo Montpellier Panel. 2018. *Mechanised: Transforming Africa's Agriculture Value Chains*. Dakar. June 2018.  
<http://ebrary.ifpri.org/utills/getfile/collection/p15738coll2/id/132766/filename/132977.pdf>.
- Mordor Intelligence. 2019. *Tractors Market – Growth, Trends and Forecast (2020 – 2025)*.  
<https://www.mordorintelligence.com/industry-reports/tractors-market>.
- NAERLS & FMARD (2020): *Wet Season Agricultural Performance in Nigeria*. NAERLS Press, Zaria..
- Nairametrics (2020): *FG offers \$1.1billion Agric mechanisation scheme*. Published on January 26, 2020 by Chidinma Nwagbara, <https://nairametrics.com/2020/01/26/fg-offers-1-1billion-agric-mechanisation-scheme/>.
- National Bureau of Statistics (2020). *2019 Poverty and Inequality in Nigeria: Executive Summary*.  
<https://nairametrics.com/wp-content/uploads/2020/05/2019-POVERTY-AND-INEQUALITY-IN-NIGERIA.pdf>.
- National Bureau of Statistics (2019): *LSMS Integrated Surveys on Agriculture Nigeria General Household Survey-Panel Wave 42018/2019*. A Survey Report by the Nigerian National Bureau of

*Statistics in Collaboration with the World Bank.*

file:///C:/Users/User/AppData/Local/Temp/GHS\_Panel\_Wave4\_Survey\_Report.pdf.

NAERLS AND FMARD. 2020. Wet Season Agricultural Performance in Nigeria. National Report. NAERLS Press, Zaria. <https://fscluster.org/nigeria/document/2020-wet-season-agricultural-performance>.

NIPC (2020): FEC Approves \$1.2bn Loan for Agric Mechanisation. Nigerian Investment Promotion Commission, May 18, 2020, <https://nipc.gov.ng/2020/05/18/fec-approves-1-2bn-loan-for-agric-mechanisation/>.

Nkakini, S. O. and Etenero, F. O (2019) *Agricultural tractor and machinery performance and serviceability in Delta State, Nigeria. Journal of Engineering and Technology Research Vol. 11(5), pp. 47-57, October 2019, DOI: 10.5897/JETR2019.0662.*

Nkanya, J.A.M. 2016. *Agricultural Mechanisation in Kenya A presentation during Consultative Meeting on Mechanisation Strategy* <http://africamechanise.act-africa.org/wp-content/uploads/2016/12/Agricultural-Mechanisation-in-Kenya-Eng.-Nkanya.pdf>.

NPC & BBS. 2016. *National Population Commission and National Bureau of Statistics Estimates.* <https://nigerianstat.gov.ng/elibrary>.

Pingali. 2007. *Agricultural Mechanisation: Adoption Patterns and Impact.* [https://www.researchgate.net/publication/292809779\\_Agricultural\\_mechanisation\\_adoption\\_patterns\\_and\\_impact](https://www.researchgate.net/publication/292809779_Agricultural_mechanisation_adoption_patterns_and_impact).

Propcom Mai-Karfi. 2007. *Value Chain Study of Small-Scale Agricultural Mechanisation. Monograph Series # 9. February 15, 2007.*

Propcom Mai-Karfi. 2017. *A summary of Propcom Mai-karfi's activities and key results from 2017.* <http://www.propcommaikarfi.org/wp-content/uploads/2018/07/2017-summary-doc-Copy-2.pdf>.

Propcom Mai-Karfi, 2010 Report of Assessment of Agricultural Mechanisation Zonal Networks in Nigeria. <http://www.propcommaikarfi.org/wp-content/uploads/2020/04/45-Assessment-of-Agricultural-Mechanisation-Zonal-Networks-in-Nigeria-1.pdf>.

Propcom Mai-Karfi. 2019. *Investment Promotion MSP Business Case. 26 November 2019.*

ReportLinker. 2020. *Tractors Market - Growth, Trends, and Forecast (2020 - 2025).* <https://www.globenewswire.com/news-release/2020/04/09/2014445/0/en/Tractors-Market-Growth-Trends-and-Forecast-2020-2025.html>.

Sacerdoti, E. 2005. *Access to Bank credit in sub-Saharan Africa - key issues and reform strategies. IMF Working Paper 05/166.* <https://doi.org/10.5089/9781451861853.001>.

Soni, P. 2016. *Agricultural mechanisation in Thailand: Current status and future outlook. AMA, Agricultural Mechanisation in Asia, Africa and Latin America. 47. 58-66.*

Soyoye, I. 2019. *History of Farm Mechanisation in Nigeria.* <https://infoguidenigeria.com/history-farm-mechanisation-nigeria/>.

- Takeshima, H. & Lawal, A. 2018. *Overview of the Evolution of Agricultural Mechanisation in Nigeria*. IFPRI Discussion Paper 01750. Washington, DC: International Food Policy Research Institute.  
<http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/132790/filename/133002.pdf>.
- Takeshima, H. 2016. *Market Imperfections for Tractor Service Provision in Nigeria: International Perspectives and Empirical Evidence*. Working Paper 32, Nigeria Strategy Support Program.
- Takeshima, H., E. Edeh, A. Lawal, and M. Isiaka. 2015. "Characteristics of private-sector tractor service provisions: Insights from Nigeria." *Developing Economies* 53 (3): 188–217.
- Takeshima, H., H. Edeh, A. Lawal, and M. Isiaka. 2014. *Tractor Owner Operators in Nigeria: Insights from a Small Survey in Kaduna and Nasarawa States*. IFPRI Discussion Paper 01355. Washington, DC: International Food Policy Research Institute.
- The Guardian*, 2020: 'Nigeria needs extra 63,000 tractors'. By Femi Ibiroga, Head, Agro-Economy 23 March 2020, 4:52 am. <https://guardian.ng/features/agro-care/nigeria-needs-extra-63000-tractors/>
- Thepent, V. 2014. *Country Report on Sustainable Agricultural Mechanisation in Thailand*. Presentation at the Regional Forum of the UN-CSAM on Sustainable Agricultural Mechanisation in Asia and the Pacific 26-27 October 2013, Qingdao, China.
- TOHFAN (2020): FAQ on website of the Tractor Owners and Hiring Facilities Association of Nigeria, accessed 25 Nov 2020: <http://tohfan.com/faqs/>.
- UN Comtrade (2020): UN Comtrade Database, accessed on 30 Nov 2020.  
<https://comtrade.un.org/data/>.
- USAID. (2013). *Country profile Ghana: Property rights and resource governance*. DC: Washington.
- Wawire, W.N., Bett, C., Ruttoh, C.R., et al. (2016): *The Status of Agricultural Mechanisation in Kenya*. Korea-Africa Food and Agriculture Initiative (KAFACI), Rural Development Administration of the Republic of Korea (RDA) and Kenya Agricultural and Livestock Research Organization KALRO. [https://www.kalro.org/sites/default/files/kafaci\\_report.pdf](https://www.kalro.org/sites/default/files/kafaci_report.pdf).
- Wiggins & Keats. 2013. *Leaping & Learning: linking smallholders to markets in Africa*. London. Agriculture for Impact, Imperial College London. <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8401.pdf>.
- World Bank. 2014. *Agribusiness Indicators: Synthesis Report*. Agriculture Global Practice Discussion Paper 01. Washington. DC.
- World Bank 2014a: *Agribusiness Indicators: Nigeria*. International Bank for Reconstruction and Development / World Bank. Washington. DC.